2023 NIA Clinical Guidelines For Medical Necessity

ADVANCED IMAGING & CARDIAC GUIDELINES – HMSA

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version 6

Guidelines for Clinical Review Determination

Preamble

NIA is committed to the philosophy of supporting safe and effective treatment for patients. The medical necessity criteria that follow are guidelines for the provision of diagnostic imaging. These criteria are designed to guide both providers and reviewers to the most appropriate diagnostic tests based on a patient's unique circumstances. In all cases, clinical judgment consistent with the standards of good medical practice will be used when applying the guidelines. Determinations are made based on both the guideline and clinical information provided at the time of the request. It is expected that medical necessity decisions may change as new evidence-based information is provided or based on unique aspects of the patient's condition. The treating clinician has final authority and responsibility for treatment decisions regarding the care of the patient.

Guideline Development Process

These medical necessity criteria were developed by NIA for the purpose of making clinical review determinations for requests for therapies and diagnostic procedures. The developers of the criteria sets included representatives from the disciplines of radiology, internal medicine, nursing, cardiology, and other specialty groups. NIA's guidelines are reviewed yearly and modified when necessary following a literature search of pertinent and established clinical guidelines and accepted diagnostic imaging practices.

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Clinical guidelines **CARDIAC RESYNCHRONIZATION THERAPY (CRT)**	**Original Date: February 2013**
CPT Codes: 33221, 33224, 33225, 33231	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_320	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR CARDIAC RESYNCHRONIZATION THERAPY (CRT)[1-8]

Indications for CRT for patients are based upon LV ejection fraction (LVEF), QRS duration, New York Heart Association (NYHA) functional class (presence or absence of symptoms), and need for ventricular pacing regardless of etiology (ischemic or non-ischemic cardiomyopathy). The beneficial effects of CRT have been extensively proven in patients with NYHA class II, III, and IV; there is limited evidence of CRT benefit in patients with NYHA functional class I.

Hence, for the most part, CRT is recommended in only defined subsets of the HF patient population, the majority being symptomatic (NYHA class II-IV) HF patients in SR with a reduced LVEF and a QRS duration ≥130 ms. Other special situations, such as patients with atrial fibrillation or who require an upgrade from a conventional pacing or ICD system, will be addressed below as well.

Patients with cardiomyopathy on GDMT for 3 months or on GDMT and 40 days after MI; or with implantation of pacing or defibrillation device for special indications

CRT-D Indications By NYHA Heart Failure Class (see full definitions further below in document)

- Class I: No limitation of functional activity:
  - LVEF ≤ 30%, QRS ≥ 150ms, LBBB, Sinus Rhythm

- Class II: Slight limitation of activity:
  - LVEF ≤ 35%, QRS ≥ 120ms, LBBB, Sinus Rhythm
  - LVEF ≤ 35%, QRS ≥ 150ms, non-LBBB, Sinus Rhythm

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- Class III and Ambulatory Class IV: Severe limitation of activity but not refractory to therapy
  - LVEF ≤ 35%, QRS ≥ 120ms, LBBB or non-LBBB, Sinus Rhythm

Special Situations

- Independent/Regardless of NYHA Heart Failure Class
  - Patients with HFrEF <40% who have an indication for ventricular pacing and high degree AV block or are expected to be paced more than 40% of the time; this includes patients with Atrial fibrillation

- Atrial fibrillation and LVEF ≤ 35% if:
  - Patient requires ventricular pacing or otherwise meets CRT criteria; AND
  - AV nodal ablation or pharmacologic rate control will allow nearly 100% ventricular pacing with CRT

- LVEF ≤ 35% and undergoing new or replacement device with anticipated requirement for significant (> 40%) ventricular pacing

- In patients with nonobstructive HCM who have NYHA class II to IV heart failure with LBBB, LVEF < 50%, CRT therapy for symptom reduction is reasonable

NOT Indicated for Cardiac Resynchronization Therapy (CRT)

- NYHA class I and non-LBBB pattern with QRS duration < 150 ms,[3] except as in Special Situations section above

- Comorbidities and/or frailty expected to limit survival with good functional capacity to <1 year

- Active bloodstream infection

- Reversible causes are present, such as toxic-, metabolic- or tachycardic-mediated cardiomyopathy. Would require reassessment once the situation is corrected

Indications for CRT in Adult Congenital Heart Disease[9-11]

Systemic LV

- Systemic LV EF ≤ 35%, sinus rhythm, wide QRS complex ≥ 130 ms NYHA function Class II— IV

Any Systemic V

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- Systemic ventricle any EF (not restricted to ≤ 35%), intrinsic narrow QRS complex, NYHA function Class I—IV and are undergoing new device placement or replacement with anticipated requirement for significant (>40%) ventricular pacing.

Any CHD

- CRT may be considered for patients with a severe subpulmonary RV dysfunction and dilatation despite interventions to decrease RV volume overload, NYHA function Class II—ambulatory IV and wide QRS complex ≥ 150 ms due to a complete RBBB

- NYHA function Class IV and severe ventricular dysfunction who would otherwise be candidates for heart transplantation or mechanical circulatory support

NOT Indicated for CRT in Adult Congenital Heart Disease

- Patients whose co-morbidities and/or frailty limit survival with good functional capacity to less than 1 year

INDICATIONS FOR CRT AS THE APPROPRIATE PACING MODALITY IN SPECIAL SITUATIONS WITH < 3 MONTHS OF GDMT[6, 12, 13]

Criteria are met for a non-elective implantable cardioverter defibrillator (ICD) or pacemaker and based upon the low likelihood of improvement in symptoms and adequate recovery of LVEF, despite less than 3 months GDMT for heart failure or < 40 days post myocardial infarction or 3 months post revascularization, criteria for CRT are otherwise met. This avoids a second implantation procedure within less than 3 months.

BACKGROUND[1, 3-6]

CRT, which paces the left and right ventricle in rapid sequence, also known as biventricular pacing, improves coordination of ventricular contraction in the presence of a wide QRS complex in systolic heart failure.

CRT improves cardiac function and quality of life, and it decreases cardiac events and mortality among appropriately chosen patients. In the proper patient population, improved survival in patients with CRT can be greater than that provided by ICD insertion alone.

Guiding principles in the consideration of CRT:

- NYHA class is an important qualifying factor, with candidacy based on functional class, EF, and QRS duration.

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- Bundle branch block or intraventricular conduction delay should be persistent, not rate-related.[6]

- GDMT should have been in place continuously for at least 3 months[3-5] and recovery of LVEF from myocardial infarction (40 days) if no intervening revascularization or > 3 months if revascularization was performed. Reversible causes (e.g., ischemia) should be excluded.

- The patient should have expected survival with reasonably good functional status for more than 1 year.[3, 5, 10]

OVERVIEW

NYHA Class Definitions[6, 14]

- Class I: No limitation of functional activity. Ordinary physical activity does not cause symptoms of HF

- Class II: Slight limitation of activity. Comfortable at rest but ordinary physical activity results in symptoms of HF

- Class III: Marked limitation of activity. Comfortable at rest but less than ordinary activity causes symptoms of HF

- Class IV: Unable to carry on any physical activity without symptoms of HF, or symptoms of HF at rest

Heart Block Definitions[3]

- First Degree: All atrial beats are conducted to the ventricles, but with a delay of > 200 ms.

- Second Degree: Intermittent failure of conduction of single beats from atrium to ventricles.

    - Type I: Conducted beats have variable conduction times from atrium to ventricles.
    - Type II: Conducted beats have uniform conduction times from atrium to ventricles.
    - Advanced: Two or more consecutive non-conducted beats (premature atrial beats might not normally be conducted).

- Third Degree: No atrial beats are conducted from atrium to ventricle.

Guideline-Directed (or Optimal) Medical Therapy in Heart Failure[4, 15]

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- Angiotensin converting enzyme inhibitor (ACE-I), angiotensin receptor blocker (ARB), or combined angiotensin receptor inhibitor and neprilysin inhibitor (ARNI)

- Beta blocker

Other options/considerations for GDMT

- Addition of loop diuretic for all NYHA class II – IV patients

- Addition of hydralazine and nitrate for persistently symptomatic African Americans, NYHA class III-IV

- Addition of an aldosterone antagonist, provided eGFR is ≥ 30 ml/min/1.73m2 and K+ < 5.0, NYHA class II-IV

- Not required for consideration of CRT: Ivabradine for NYHA class II – III, when a beta blocker has failed to reduce a sinus rate to < 70 bpm.

Abbreviations

ACE-I	Angiotensin converting enzyme inhibitor
ARB	Angiotensin receptor blocker
ARNI	Combined angiotensin receptor inhibitor and neprilysin inhibitor
AV	Atrioventricular
CAD	Coronary artery disease, same as ischemic heart disease
CHD	Congenital heart disease
CHF	Congestive heart failure
CRT	Cardiac resynchronization therapy (also known as biventricular pacing)
CRT-D	Cardiac resynchronization therapy defibrillator
ECG	Electrocardiogram
EF	Ejection Fraction
eGFR	Estimated glomerular filtration rate
EPS	Electrophysiologic Study
GDMT	Guideline-Directed Medical Therapy
HCM	Hypertrophic Cardiomyopathy
HF	Heart failure
HFrEF	Heart failure with reduced ejection fraction
HV	His-ventricular
ICD	Implantable cardioverter-defibrillator
LBBB	Left bundle branch block
LV	Left ventricular/left ventricle
LVEF	Left ventricular ejection fraction
MI	Myocardial infarction
ms	Milliseconds
NYHA	New York Heart Association

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RBBB	Right bundle branch block
RV	Right ventricle
SND	Sinus node dysfunction
SR	Sinus rhythm
STEMI	ST-Elevation Myocardial Infarction
VT	Ventricular tachycardia

POLICY HISTORY

Date	Summary
February 2022	• Added blood stream infection and reversibility as contraindication • Reworded NYHA • Removed single ventricle and RV
March 2021	• Added indication and reference for hypertrophic cardiomyopathy with reference • Added indication for patient with expected ventricular pacing > 40% of the time • Updated /Reorganized Section: Patients with cardiomyopathy on GDMT for 3 months or on GDMT and 40 days after MI; or with implantation of pacing or defibrillation device for special indications • Updated /Reorganized Section: Indications for CRT in Adult Congenital Heart Disease • Updated Abbreviations Section
	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Removed comment that single site pacing from the systemic ventricular apex or mid-lateral wall may be considered as an alternative from the indication systemic ventricular EF ≤ 35%, intrinsic narrow QRS complex, NYHA class I to ambulatory class IV and undergoing new or replacement device implantation with anticipated requirement for significant (>40%) ventricular pacing. • Removed the following from the Guideline Directed Medical Therapy section: Ivabradine listed as a class IIa recommendation, while others are class I recommendations. CRT trials antedated routine use of ivabradine.

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August 2019	• Changed ms from 130 to 150 in indication: 'left ventricular ejection fraction (LVEF) ≤ 35%, sinus rhythm, left bundle branch block (LBBB) with a QRS ≥ 150 ms, and NYHA class II, III or ambulatory class IV symptoms on GDMT' • Added indication for LVEF ≤ 35%, sinus rhythm, LBBB with a QRS duration 120 to 149 ms, and NYHA class II, III, or ambulatory class IV symptoms on GDMT • Changed ms from 130 to 150 in indication: 'LVEF ≤ 35%, sinus rhythm, a non-LBBB pattern with a QRS duration ≥ 150 ms, and NYHA III or ambulatory class IV symptoms on GDMT' • Revised indication to state that LVEF ≤ 35% and are undergoing new or replacement device placement with anticipated requirement for significant (> 40%) ventricular pacing • Removed indication for LVEF ≤ 30%, ischemic etiology of HF, sinus rhythm, LBBB with a QRS duration ≥ 150 ms, and NYHA class I on GDMT • Removed indication for LVEF ≤ 35%, sinus rhythm, a non LBBB pattern with a QRS duration ≥ 150 ms, and NYHA class II on GDMT • Adult congenital heart disease, added indication for systemic LVEF ≤ 35%, sinus rhythm, complete LBBB with a QRS complex 120 - 149 ms (spontaneous or paced), and NYHA class II to ambulatory IV • Adult congenital heart disease, removed the following indications: o Cardiac surgery with a QRS duration > 150 ms o Systemic RV with significant tricuspid valve regurgitation o Severe subpulmonic RV dysfunction o Severe ventricular dysfunction and NYHA class IV in attempt to delay transplant or mechanical support • The following statement has been revised to add 'or 3 months post-revascularization.' Criteria are met for a non-elective implantable cardioverter defibrillator (ICD) or a non-elective pacemaker, either initial or replacement, and based upon the low likelihood of improvement in symptoms and adequate recovery of LVEF, despite less than 3 months GDMT for heart failure or < 40 days post myocardial infarction or 3 months post revascularization, criteria for CRT are otherwise met. The following statement has been added: 'This avoids a second implantation procedure within less than 3 months.'

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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Clinical guideline **IMPLANTABLE CARDIOVERTER DEFIBRILLATOR (ICD)**	**Original Date: February 2013**
CPT Codes: 33230, 33240, 33249	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_321	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

All indications are predicated on a meaningful life expectancy of greater than one year if the ICD is implanted.

INDICATIONS FOR ICD INSERTION[1-7]

ISCHEMIC HEART DISEASE (CAD)[1, 5, 6]

Primary Prevention of SCD (prophylactic ICD implantation)

- LVEF ≤ 35% due to ischemic heart disease and NYHA class II or III, despite guideline-directed medical therapy (GDMT), and at least 40 days post-myocardial infarction (MI) and 90 days post-revascularization
- LVEF ≤ 30% due to ischemic heart disease, NYHA class I, GDMT, and at least 40 days post-MI and 90 days post-revascularization
- LVEF ≤ 40% with prior MI, NSVT, and inducible sustained ventricular tachycardia (VT) or ventricular fibrillation (VF) at electrophysiological testing

Secondary Prevention of SCD

- Patients with documented ventricular fibrillation (VF), hemodynamically unstable ventricular tachycardia (VT), or sustained VT, after exclusion of reversible causes
- Syncope of undetermined origin, with inducible VF or sustained VT at electrophysiological study (EPS)

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- Syncope of undetermined origin, with EF ≤ 35%

NONISCHEMIC CARDIOMYOPATHY (NICM)[1]

Primary Prevention of SCD (prophylactic ICD implantation)

- Lamin A/C gene mutation, with ≥ 2 risk factors from the following: NSVT, LVEF < 45%, male sex, nonmissense mutation
- LVEF ≤ 35% and NYHA functional Class II or III, despite at least 3 months of GDMT: Recommended
- LVEF ≤ 35% and NYHA functional Class I despite at least 3 months of GDMT: May be considered

Secondary Prevention of SCD

- Patients with documented VF, hemodynamically unstable VT, or sustained VT, after exclusion of reversible causes
- LVEF ≤ 50% with unexplained syncope presumed to be due to VA and who do not meet indications for primary prevention ICD implantation

ADVANCED HEART FAILURE & TRANSPLANTATION[1, 6]

- In non-hospitalized patients with NYHA class IV who are candidates for cardiac transplantation or left ventricular assist device (LVAD)[1, 5, 6]
- In a patient with an LVAD, sustained ventricular arrhythmias[1]
- In NYHA ambulatory class IV, with appropriate indications for CRT (see Background Information section for definition of ambulatory NYHA class IV)

MYOCARDIAL DISEASES

Hypertrophic cardiomyopathy (HCM)

- Previously documented cardiac arrest or sustained ventricular tachycardia
- Adult patients with HCM with at least 1 risk factor for SCD as follows:
    - Sudden death attributable to HCM in at least 1 first-degree relative who is ≤ 50 years of age
    - LVH ≥30 mm
    - At least 1 recent episode of syncope suspected by history to be arrhythmic (unlikely neurocardiogenic (vasovagal) and especially occurring within 6 months of evaluation (events beyond 5 years do not appear to have relevance))
    - LV apical aneurysm
    - LV systolic dysfunction (EF < 50%)
- Pediatric patients with HCM with at least 1 risk factor for SCD as follows:
    - Including unexplained syncope
    - LVH ≥ 30 mm
    - Nonsustained ventricular tachycardia
    - Family history of HCM-related SCD

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NOTE: **ICD placement for the sole purpose of participation in competitive athletics should not be performed**

- **Cardiac Sarcoidosis** with one of the following[1, 3, 6]:
  - Cardiac arrest or documented sustained VT
  - LVEF ≤ 35%
  - LVEF > 35% with inducible sustained ventricular arrhythmia at EPS
  - Syncope and/or scar on CMR or positron emission tomography (PET)
  - Requires a permanent pacemaker

- **Neuromuscular Disorders (including but not limited to Duchenne, Becker, Limb-girdle type 1B, Limb-girdle type 2C-2F, Limb-girdle type 2I, Myotonic type 1, Myotonic type 2, Emery-Dreifuss, Facioscapulohumeral)** with one of the following[1]:
  - Primary and secondary prevention, with same indications as for NICM[6]
  - Emery-Dreifuss or limb-girdle type I-B muscular dystrophy with progressive cardiac involvement

- **Arrhythmogenic right ventricular cardiomyopathy** and **at least 1** of the following risk factors for SCD[1-3, 8, 9]:
  - Resuscitated sudden cardiac arrest
  - Sustained VT
  - Right or left ventricular systolic dysfunction with an ejection fraction ≤ 35%
  - Syncope with documented or presumed ventricular arrhythmia

CHANNELOPATHIES

- **Congenital long QT syndrome** with **one** of the following[1, 2, 6, 10, 11]
  - Sudden cardiac arrest
  - Sustained VT or recurrent syncope when beta blocker is ineffective or not tolerated
  - QTc > 500 ms on a beta blocker[1]
  - Strong family history of SCD
  - High risk genotype

- **Brugada syndrome and spontaneous type 1 Brugada electrocardiographic pattern** with **one** of the following[1, 2, 6, 12]:
  - Cardiac arrest
  - Documented sustained ventricular arrhythmia
  - Syncope presumed to be due to ventricular arrhythmia

- **Catecholaminergic polymorphic VT** with **one** of the following[1, 2, 5, 13]:
  - Sudden cardiac arrest
  - Syncope or sustained VT
  - Inducible VT or VF

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- **Early Repolarization ("J-wave Syndrome") or Short QT Syndrome** with **one** of the following[1, 6]:
    - Cardiac arrest
    - Sustained ventricular arrhythmia

- **Idiopathic Polymorphic VT/VF** with **one** of the following[1]:
    - Cardiac arrest due to polymorphic VT or VF

ADULT & PEDIATRIC CONGENITAL HEART DISEASE (CHD)[1, 3, 6, 14-16]

- Cardiac arrest due to VF or VT, or unstable VT, after exclusion of a reversible etiology
- Systemic LVEF ≤ 35%, biventricular physiology, and NYHA class II or III on GDMT
- Tetralogy of Fallot with one of the following[1, 3]:
    - Spontaneous sustained VT
    - Inducible VF or sustained VT
    - ≥ 1 risk from the following list:
        - Prior palliative systemic to pulmonary shunts
        - Unexplained syncope
        - Frequent PVCs (Premature Ventricular Contractions)
        - Atrial tachycardia
        - Left ventricular dysfunction or diastolic dysfunction
        - NSVT
        - QRS duration ≥ 180 ms
        - Dilated right ventricle
        - Residual pulmonary regurgitation or stenosis
        - RV Hypertension
- Single or systemic right ventricular ejection fraction (RVEF) < 35%, in the presence of an additional risk factor such as:
    - NSVT
    - Unexplained syncope
    - NYHA class II or III, despite GDMT[1, 6]
    - QRS duration ≥ 140 ms
    - Severe systemic AV valve regurgitation
- Syncope of unknown origin in the presence of either at least moderate ventricular dysfunction or marked hypertrophy or inducible sustained VT or VF[1, 3]
- Syncope and moderate or severe complexity CHD, with high clinical suspicion of ventricular arrhythmias
- Non-hospitalized patients with CHD awaiting heart transplantation
- Left ventricular non-compaction that meets same indications as NICM, including a familial history of SCD[5, 17]

EXEMPTIONS

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Indications for ICD with an Appropriate Pacing Modality in Special Situations[5, 18] *

- ICD criteria met, and elevated troponin is deemed not due to a myocardial infarction[1]
- ICD criteria met, except for myocardial infarction within 40 days or revascularization within 3 months, but a non-elective permanent pacemaker (new or replacement) is required, and recovery of left ventricular function to LVEF > 35% is uncertain or not expected[5] **
- ICD criteria met, except NICM or ischemic cardiomyopathy has not had 3 months' time for LVEF to improve on medical therapy, a non-elective permanent pacemaker is required, and recovery of LVEF is uncertain or not expected**
- Patient met primary prevention criteria for an ICD prior to coronary revascularization, and it is unlikely that LVEF will recover to > 35% despite a 90-day wait[18]

*** With these ICD indications, CRT would sometimes be the appropriate pacing modality. CRT is likely to be the appropriate modality** with anticipated requirement for significant (> 40%) ventricular pacing

**** These indications avoid a second implantation procedure within less than 3 months**

BACKGROUND[1-7]

The implantable cardioverter defibrillator (ICD) has become valuable in the management of patients with ventricular arrhythmias (VA) capable of causing syncope, cardiac arrest, and sudden cardiac death (SCD).

Patient eligibility for an ICD presumes all the following:

- Anticipated reasonable quality of life for ≥ 1-year post implantation[12]
- Patient's ability to live with a shock-delivering device that requires management
- Absence of a completely reversible cause that led to VA for which an ICD is being considered
- Completion of ≥ 3 months of guideline-directed medical therapy (GDMT) for heart failure (HF), unless an intervening indication for pacemaker implantation arises (see Overview Information section for definition of GDMT)
- ICD indications are present in most scenarios in which cardiac resynchronization therapy (CRT) is appropriate
- Sustained VT is defined as having duration > 30 seconds or requiring termination due to hemodynamic compromise in < 30 seconds

Guidelines for the pediatric population are extrapolated from the adult population due to a lack of relevant trials.[6, 14]

OVERVIEW

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General[1-7]

Implantable cardioverter defibrillators (ICDs) are indicated for the treatment of life-threatening ventricular tachycardia and ventricular fibrillation. An ICD system includes a pulse generator and one or more leads. ICDs are indicated both for patients who have survived life threatening rhythm disturbances (secondary prevention) and for those who are at risk for them (primary prevention).

- An ICD continually monitors heart rhythm. If a rapid rhythm is detected, the device delivers electrical therapy directly to the heart muscle to terminate the rapid rhythm and restore a normal heart rhythm. There are two types of therapy that can be delivered:
    - Rapid pacing OR
    - High-voltage shocks are necessary for ventricular fibrillation and when rapid pacing has failed to correct the abnormal rhythm
- In addition, all ICDs have pacing capability, and deliver pacing therapy for slow heart rhythms (bradycardia)
- The parameters defining limits for pacing therapy and for tachycardia therapy are programmable using noninvasive radio signals on all available ICDs

NYHA Class Definitions[5, 19, 20]

- **Class I:** No limitation of functional activity or only at levels of exertion that would limit normal individuals
- **Class II:** Slight limitation of activity. Fatigue, palpitation, or dyspnea with moderate exercise
- **Class III:** Marked limitation of activity. Fatigue, palpitation, or dyspnea with minimal activity
- **Class IV:** Severe limitation of activity. Symptoms even at rest, worse with activity
- **Ambulatory Class IV:** Class IV heart failure with 1) no active acute coronary syndrome; 2) no inotropes; and 3) on GDMT

Guideline-Directed (or Optimal) Medical Therapy for Heart Failure[4, 21]

- Angiotensin converting enzyme (ACE-I), angiotensin receptor blockers (ARB), or combined angiotensin receptor inhibitor and neprilysin inhibitor (ARNI)
- Beta blockers
- Addition of loop diuretic for all NYHA class II – IV patients
- Addition of hydralazine and nitrate for persistently symptomatic African Americans
- Addition of an aldosterone antagonist, provided eGFR is > 30 ml/mi
- Normal serum sodium and potassium
- Not required for consideration of ICD: Ivabradine for NYHA class II – III, when a beta blocker has failed to reduce a sinus rate to < 70 bpm. Ivabradine listed as a class IIa recommendation, while others are class I recommendations. CRT trials antedated routine use of Ivabradine.

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Abbreviations

ACE-I	Angiotensin converting enzyme inhibitor
ARNI	Combined angiotensin receptor inhibitor and neprilysin inhibitor
ARVD/C	Arrhythmogenic right ventricular dysplasia/cardiomyopathy
AV	Atrioventricular
CAD	Coronary artery disease, same as ischemic heart disease
CHD	Congenital heart disease
CHF	Congestive heart failure
CRT	Cardiac resynchronization therapy
CRT-D	Cardiac resynchronization therapy ICD system
DCM	Dilated cardiomyopathy
ECG	Electrocardiogram
EF	Ejection fraction
EPS	Electrophysiologic Study
GDMT	Guideline-Directed Medical Therapy
HCM	Hypertrophic cardiomyopathy
HF	Heart failure
HV	His-ventricle
ICD	Implantable cardioverter-defibrillator
LBBB	Left bundle-branch block
LV	Left ventricular/left ventricle
LVAD	Left ventricular assist device, mechanical heart
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
MI	Myocardial infarction
ms	Milliseconds
NICM	Nonischemic cardiomyopathy
NSVT	Nonsustained ventricular tachycardia
NYHA	New York Heart Association
PET	Positron emission tomography
PVC	Premature Ventricular Contraction
RV	Right ventricular/right ventricle
RVEF	Right ventricular ejection fraction
SCD	Sudden Cardiac Death
STEMI	ST-elevation myocardial infarction
SND	Sinus node dysfunction
VT	Ventricular tachycardia
VF	Ventricular fibrillation

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POLICY HISTORY

Date	Summary
February 2022	• Removed statement about hypertrophic cardiomyopathy being reasonable with family history of SCD
March 2021	• Added section to clarify indications for unexplained syncope • Revised and added reference for hypertrophic cardiomyopathy to include: o Indication for EF < 50% • Added statement on consideration for ICD in children • Statement on placement of ICD in competitive athletics • Addition: All indications are predicated on an expected life expectancy of greater than one year if the ICD is implanted. • Reorganization: Ischemic Heart Disease (CAD) sections • Addition : indications under ischemic heart disease for NSVT due to prior MI, LVEF ≤ 40%, and inducible VT or VF at EPS • Revision: HCM section as per new HOCM guidelines J Am Coll Cardiol. 2020 Dec, 76 (25) 3022–3055 • Addition: Neuromuscular Disorders section, various included types, expanded criteria • Deletion: Channelopathies section, deleted types from High-Risk Genotype • Addition: Brugada syndrome, broadened definition to "Syncope presumed to be due to ventricular arrhythmia" • Addition: added "J-wave Syndrome" to Early Repolarization section • Changes to Adult & Pediatric Congenital Heart Disease (CHD) section: • Addition: added "Cardiac arrest due to VF or VT, or unstable VT, after exclusion of a reversible etiology" to Adult & Pediatric Congenital Heart Disease (CHD) section • Revision: Tetralogy of Fallot, changed to "Residual pulmonary regurgitation or stenosis" • Addition: Tetralogy of Fallot, added RV Hypertension • Revision: "Syncope of unknown origin in the presence of either at least moderate ventricular dysfunction or marked hypertrophy or inducible sustained VT or VF" • Revision: "Syncope and moderate or severe complexity CHD, with high clinical suspicion of ventricular arrhythmias"
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review

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	• Removed the statement regarding waiting period from the Overview section • Updated and added new references
August 2019	• Removed indications under ischemic heart disease for NSVT due to prior MI, LVEF ≤ 40%, and inducible VT or VF at EPS • Removed indications under ischemic heart disease for VT or VF < 48 hours post MI or elective coronary revascularization • Under NICM, removed indication for peripartum cardiomyopathy with LVEF ≤ 35% that persists > 3 months • Under advanced heart failure and transplantation, removed indication for severe allograft vasculopathy • Revision to cardiac sarcoidosis indication to add cardiac arrest • Under hypertrophic cardiomyopathy revised indications for documented NSVT to include an additional SCD risk modifier (age < 30 yr, delayed hyperenhancement on cardiac MRI, LVOT obstruction, or syncope > 5 yr ago) or high risk feature (LV aneurysm or LVEF < 50%) • Removed indications for giant cell myocarditis and chronic Chagas cardiomyopathy • Removed indication for hypertensive heart disease with LVH and LVEF ≤ 35% • Under Tetrology of Fallot added the following indications : o Prior palliative systemic to pulmonary shunts o Unexplained syncope o Frequent PVCs o Atrial tachycardia o Left ventricular diastolic dysfunction o Dilated right ventricle

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Reviewed / Approved by NIA Clinical Guideline Committee

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National Imaging Associates, Inc.*	
Clinical guidelines **PACEMAKER**	**Original Date: February 2013**
CPT Codes: **33206, 33207, 33208, 33212, 33213, 33214, 33227, 33228**	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_322	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results, and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR PACEMAKERS – ADULT (Excludes conditions that are expected to resolve)[1, 2]

Sinus Node Dysfunction (SND)

- Documented symptomatic sinus bradycardia, including frequent sinus pauses
- Symptomatic chronotropic incompetence (broadly defined as an inability to increase heart rate commensurate with activity or demand), documented by stress test or cardiac monitoring data (Holter/MCOT/Electrocardiography (ECG)) recording data
- Symptomatic sinus bradycardia that results from required guideline-directed medical therapy (GDMT) for which there is no alternative treatment
- Heart rate less than 40 while awake, even without definite association with significant symptoms consistent with bradycardia
- Tachycardia-bradycardia syndrome and symptoms attributable to bradycardia[2]
- Syncope of unexplained origin with clinically significant SND, either documented or provoked in electrophysiologic study (EPS)

Acquired Atrioventricular (AV) Block

First-Degree AV Block

- Marked first-degree Mobitz Type 1 AV block with symptoms clearly attributable to the AV block

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- First-degree AV block with "pacemaker syndrome" symptoms (chronic fatigue, dyspnea on exertion, symptomatic hypotension) or hemodynamic compromise

Second-Degree AV Block (Mobitz Types I and II)

- Marked second-degree Mobitz Type 1 AV block with symptoms clearly attributable to the AV block
- Second-degree AV block with "pacemaker syndrome" symptoms (chronic fatigue, dyspnea on exertion, symptomatic hypotension) or hemodynamic compromise
- Second-degree Mobitz Type II AV block regardless of symptoms
- Advanced second-degree AV block
- Second-degree AV block associated with a wide QRS, or EPS-documented intra- or infra-His conduction
- Symptomatic bradycardia associated with second-degree AV block, either Mobitz I or II

Third-Degree/Complete AV Block

- Third-degree (complete) AV block, intermittent or persistent, regardless of symptoms
- High-grade AV block, regardless of symptoms

AF/Other

- Atrial fibrillation while awake, with pauses ≥ 5 seconds, or symptomatic bradycardia
- In sinus rhythm (with AV block) while awake, pauses ≥ 3 seconds or heart rates less than 40 beats per minute or an escape rhythm below the AV node
- Following catheter ablation of the AV junction
- Symptomatic AV block that results from required medical therapy for which there is no alternative treatment
- Exercise-induced second- or third-degree AV block without myocardial ischemia

Neuromuscular Disorders

- Marked first-degree or higher AV block, or an H-V interval ≥ 70 ms, associated with neuromuscular diseases, such as myotonic muscular dystrophy, Erb dystrophy, Kearns-Sayre syndrome, and peroneal muscular atrophy, regardless of symptoms

Chronic Fascicular (Including any of RBBB, LBBB, LAHB, LPHB) Block

- Alternating bundle-branch block
- Syncope of unexplained origin when other likely causes have been excluded, specifically ventricular tachycardia[3]
- Syncope and bundle branch block with an HV interval ≥ 70 ms, or evidence of infranodal block at EPS[2]
- Incidental findings at EPS study of an H-V interval ≥ 100 milliseconds, or non-physiological, pacing-induced infra-His block in asymptomatic patients

Hypersensitive Carotid Sinus Syndrome and Neurocardiogenic Syncope

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- Recurrent syncope due to spontaneously occurring carotid sinus stimulation AND carotid sinus pressure induced ventricular asystole ≥ 3 seconds, or AV block, or ≥ 50 mmHg drop in systolic BP[1, 3]
- Syncope without clear, provocative events and with a hypersensitive cardioinhibitory response (asystole) ≥ 3 seconds
- Recurrent syncope and asystole ≥ 3 seconds with syncope or ≥ 6 seconds without symptoms or with presyncope, documented by ECG recording data[4, 5]

Pacing to Terminate or Prevent Tachycardia

- Symptomatic recurrent supraventricular tachycardia documented to be terminated by pacing in the setting of failed catheter ablation and/or drug treatment
- Prevention of pause-dependent ventricular tachycardia (VT)

INDICATIONS FOR PEDIATRIC AND ADULT CONGENITAL HEART DISEASE PACING[1, 4, 6]

Children, Adolescents (< 19 years), and ADULT Patients with Congenital Heart Disease (CHD)

Sinus Node Dysfunction (SND)

- SND with symptomatic age- and activity-inappropriate bradycardia
- Sinus bradycardia with complex CHD AND a resting heart rate < 40 bpm **OR** pauses in ventricular rate > 3 seconds
- CHD and impaired hemodynamics due to sinus bradycardia or loss of AV synchrony
- Asymptomatic sinus bradycardia following repair of CHD with an awake resting heart rate < 40 bpm or pauses in ventricular rate > 3 seconds
- CHD and SND or junctional bradycardia, for the prevention of recurrent episodes of intra-atrial reentrant tachycardia[4, 6, 7]

AV Block

- Second- or third-degree AV block with symptomatic bradycardia, ventricular dysfunction, or low cardiac output
- Congenital third-degree AV block with a wide QRS escape rhythm, complex ventricular ectopy, or ventricular dysfunction
- Congenital third-degree AV block in the infant with a ventricular rate < 55 bpm or with congenital heart disease and a ventricular rate < 70 bpm
- Congenital third-degree AV block after 1 year of age with an average heart rate < 50 bpm, abrupt pauses in ventricular rate that are 2 or 3 times the basic cycle length, or associated with symptoms due to chronotropic incompetence
- Adults with congenital complete AV block with symptomatic bradycardia, wide QRS escape rhythm, mean daytime heart rate < 50 bpm, complex ventricular ectopy, or ventricular dysfunction[2]
- Adults with congenital complete AV block, regardless of symptoms[2]

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- Unexplained syncope after prior congenital heart surgery complicated by transient complete heart block, with residual fascicular block after excluding other causes of syncope
- Congenital third-degree AV block in asymptomatic children or adolescents with an acceptable rate, a narrow QRS, and normal ventricular function

Scenarios in which Pacemakers are Not Indicated

- SND in patients that are asymptomatic or symptoms occur without documented bradycardia
- Asymptomatic first-degree AV block or Mobitz I second-degree AV block with a narrow QRS
- Asymptomatic fascicular block (Including any of RBBB, LBBB, LAHB, LPHB)
- Asymptomatic bifascular block (RBBB/LAHB or RBBB/LPHB) with or without first-degree AVB where a higher degree of heart block has not been demonstrated
- Hypersensitive cardioinhibitory response to carotid sinus stimulation without symptoms or with vague symptoms
- Asymptomatic bifascicular block (RBBB/LAHB or RBBB/LPHB) with or without first-degree AVB after surgery for CHD without prior transient complete AV block

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BACKGROUND[1]

Pacemaker implantation generally serves to address bradycardia, with the intention of ameliorating related symptoms, preventing complications of syncope, and/or reducing mortality risk.

This guideline is not intended to cover the type of bradycardia pacing device. CRT (cardiac resynchronization therapy or biventricular pacing) and ICD (implantable cardioverter defibrillator) implantation are covered in separate guidelines.

OVERVIEW

General

A pacemaker system is composed of a pulse generator and one or more leads. The pulse generator is implanted under the skin, usually below one of the collarbones (clavicles). It contains a battery, a microprocessor that governs timing and function, and a radio antenna to allow for noninvasive interrogation and reprogramming. The leads are insulated cables that conduct electricity from the pulse generator to the heart. Leads are most commonly inserted into a vein and then advanced under fluoroscopy (x-ray guidance) to within one or more heart chambers. The leads are fastened within the chambers to the heart muscle using either hooks or retractable/extendable screws, which are built into their tips. Timed electrical impulses are

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delivered from the pulse generator via the leads to the heart, where stimulation results in heart muscle contraction.

Additionally, the Micra transcatheter pacing system is a leadless pacemaker system for indicated patients. Leadless pacemakers are sometimes used as an alternative to transvenous pacemakers when no upper extremity venous access exists or when risk of device pocket infection is particularly high, such as previous infection and patients on hemodialysis.[8] The prevalence of leadless device infections is low as the principal source of infection.

Heart Block Definitions[1]

- First-Degree: All sinus or atrial beats are conducted to the ventricles, but with a delay (PR interval of > 200 ms)
- Second-Degree: Intermittent failure of conduction of single beats from atrium to ventricles
    - (Mobitz) Type I: Conducted beats have variable conduction times from atrium to ventricles
    - (Mobitz) Type II: Conducted beats have uniform conduction times from atrium to ventricles
    - Advanced or high degree: Two or more consecutive non-conducted sinus or (non-premature) atrial beats with some conducted beats
- Third-Degree: No atrial beats are conducted from atrium to ventricle

Abbreviations

AV	Atrioventricular
CHF	Congestive heart failure
CRT	Cardiac resynchronization therapy (same as biventricular pacing)
ECG	Electrocardiogram
EPS	Electrophysiologic Study
GDMT	Guideline-Directed Medical Therapy
HV	His-ventricular
ICD	Implantable cardioverter-defibrillator
LAHB	Left Anterior Hemiblock
LBBB	Left bundle-branch block
LPHB	Left Posterior Hemiblock
LV	Left ventricular/left ventricle
LVEF	Left ventricular ejection fraction
MI	Myocardial infarction
ms	Milliseconds
RBBB	Right Bundle Branch Block

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s	Seconds
STEMI	ST-elevation Myocardial Infarction
SND	Sinus node dysfunction
VT	Ventricular tachycardia

POLICY HISTORY

Date	Summary
February 2022	• Added section on leadless pacemakers
March 2021	• In Sinus Node Dysfunction section: added Holter/MCOT as acceptable monitoring techniques • In Acquired Atrioventricular (AV) Block section: re-organized section • In Chronic Bifascicular Block section: Changed to 'Bifascicular' to 'Fascicular' and added RBBB, LBBB, LAHB, LPHB • In Pacing to Terminate or Prevent Tachycardia section: changed 'Sustained' to 'Prevention of' • Added 'Adult' to INDICATIONS FOR PEDIATRIC AND CONGENITAL HEART DISEASE PACING • In Scenarios in which Pacemakers are Not Indicated section: ○ defined and added criteria RBBB/LBBB/LAHB/LPHB/1st degree AVB • Added Asymptomatic bifascular block (RBBB/LAHB or RBBB/LPHB) with or without 1st degree AVB where a higher degree of heart block has not been demonstrated
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added information regarding a leadless pacemaker system for indicated patients to the Overview section
July 2019	• Added broad definition of chronotropic incompetence • For sinus node dysfunction added indication for tachycardia-bradycardia syndrome "and symptoms attributable to bradycardia" • Indications after the acute phase of myocardial infarction were removed • For hypersensitive carotid sinus syndrome and neurocardiogenic syncope:

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	○ Added indication for recurrent syncope and asystole ≥ 3 seconds with syncope or ≥ 6 seconds without symptoms or with presyncope, documented by implantable loop recorder ○ Removed indication for neurocardiogenic syncope associated with bradycardia occurring spontaneously or at the time of tilt table testing • For hypertrophic cardiomyopathy, removed symptomatic hypertrophic cardiomyopathy and hemodynamically significant resting (peak > 30 mmHg) or provoked (peak > 50 mmHg) LV outflow tract gradient, refractory to medical therapy, and suboptimal candidates for septal reduction therapy (including high risk for developing heart block post procedure) • For pediatric and congenital heart disease pacing, AV block, the following indications were added: ○ Adults with congenital complete AV block with symptomatic bradycardia, wide QRS escape rhythm, mean daytime heart rate < 50 bpm, complex ventricular ectopy, or ventricular dysfunction ○ Adults with congenital complete AV block, regardless of symptoms • For pediatric and congenital heart disease pacing, AV block, removed postoperative advanced second- or third-degree AV block that is expected to be permanent or that persists ≥ 7 days after cardiac surgery; and transient postoperative third degree AV block that reverts to sinus rhythm with residual bifascicular block • For pediatric and congenital heart disease pacing, scenarios in which pacemakers are not indicated, the following were added: ○ Asymptomatic first-degree AV block or Mobitz I second-degree AV block with a narrow QRS ○ Asymptomatic fascicular block (left anterior or posterior fascicular block) ○ Hypersensitive cardioinhibitory response to carotid sinus stimulation without symptoms or with vague symptoms

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Reviewed / Approved by NIA Clinical Guideline Committee

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National Imaging Associates, Inc.*	
Clinical guidelines **TEMPOROMANDIBULAR JOINT (TMJ) MRI**	**Original Date: May 23, 2003**
CPT Code: 70336	**Last Revised Date: May 2022**
Guideline Number: NIA_CG_007	**Implementation Date: January 2023**

INDICATIONS FOR TEMPOROMANDIBULAR JOINT (TMJ) MRI

For evaluation of temporomandibular joint dysfunction (TMD) with suspected internal joint derangement with[1-3]:

- Persistent symptoms of facial or jaw pain, restricted range of motion, pain and/or noise with TMJ function (i.e., chewing) **AND**
- Conservative therapy with a trial of anti-inflammatory AND behavioral modification* has been unsuccessful for at least four (4) weeks

* Behavioral modification includes patient education, self-care, cognitive behavior therapy, physical therapy, and occlusal devices. Muscle relaxants can be used for spasm.
Note: X-ray should be the initial study if there is recent trauma, dislocation, malocclusion, or dental infection

For evaluation of juvenile idiopathic arthritis (JIA)[3, 4]

Abnormal initial x-ray or ultrasound needing additional imaging[1]

Pre-operative evaluation in candidates for orthognathic surgery

Post-operative evaluation[5]

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Temporomandibular joint (TMJ) dysfunction causes pain and dysfunction in the jaw joint and muscles controlling jaw movement. Symptoms may include jaw pain, masticator muscle stiffness, limited movement or locking of the jaw, clicking or popping in jaw joint when opening

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or closing the mouth, and a change in how the upper and lower teeth fit together. The cause of the condition is not always clear but may include acute or chronic trauma to the jaw or temporomandibular joint, e.g., grinding of teeth, clenching of jaw, or impact in an accident. Osteoarthritis or rheumatoid arthritis may also contribute to the condition.

Etiologies of TMJ dysfunction (TMD) include intra-articular (intracapsular) and extra-articular (extracapsular pathology). Intra-articular (intracapsular pathology), such as disc displacement and coexisting osteoarthritis or degenerative joint disease, is considered the most common cause of serious TMJ pain and dysfunction and the most likely to be treated surgically. Extra-articular (extracapsular pathology) includes musculoskeletal (bone, masticatory muscles and tendons) and central nervous system/peripheral nervous system.[6]

Imaging can assist in the diagnosis of TMD when history and physical examination findings are equivocal. The initial study should be plain radiography (transcranial and transmaxillary views) or panoramic radiography when there is recent trauma, dislocation, malocclusion, or dental infection.[2] Ultrasound is an inexpensive and easily performed imaging modality that can also be used to evaluate the TMJ.[7] CT is useful to evaluate the bony structures of the TMJ when there is suspicion of bony involvement (i.e., fractures, erosions, infection, invasion by tumor, as well as congenital anomalies).[1] Magnetic resonance imaging (MRI) has the highest sensitivity, specificity, and accuracy in the evaluation of temporomandibular joint dysfunction and provides tissue contrast for visualizing the soft tissue and periarticular structures of the TMJ.

Conservative care for TMD includes patient education, self-care, behavioral modification, cognitive behavioral therapy/biofeedback, medication, physical therapy, and occlusive devices. Medications include NSAIDS and muscle relaxants and in chronic cases, benzodiazepines, or antidepressants. There is lack of high-quality evidence and uncertainty about the effectiveness of manual therapy and therapeutic physical therapy in treating TMJ dysfunction.[8] The use of occlusive splints is thought to alleviate some of the degenerative forces on the TMJ which may be helpful in patients with bruxism or nocturnal teeth clenching. Preferred devices are unclear from the literature and dental consultation is required.[2] In systematic reviews, there has been short-term benefit observed from splinting but no clear role in the overall long-term treatment of TMD patients.[9, 10]

POLICY HISTORY

Date	**Summary**
May 2022	Updated background and references
June 2021	Deleted: Initial x-rays have been performed Added**: Note**: X-ray should be the initial study if there is recent trauma, dislocation, malocclusion, or dental infection * Behavioral modification includes patient education, self-care, cognitive behavior therapy, physical therapy, and occlusal devices. Muscle relaxants can be used for spasm.

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May 2020	Added: • For evaluation of temporomandibular joint dysfunction (TMD) with suspected internal joint derangement with ALL of the following o Persistent symptoms of facial or jaw pain, restricted range of motion, pain and/or noise with TMJ function (i.e., chewing) o Conservative therapy with a trial of anti-inflammatory AND behavioral modification has been unsuccessful for at least four (4) weeks o Initial X-rays have been performed • For evaluation of Juvenile idiopathic arthritis (JIA) • Abnormal initial x-ray or ultrasound needing additional imaging Deleted: • Locked or Frozen Jaw o For evaluation of dysfunctional temporomandibular joint after unsuccessful conservative therapy for at least four (4) weeks with bite block or splint and anti-inflammatory medicine
May 2019	Updated background information and references

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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MAGELLAN HAWAI'I

Specific policy administered by National Imaging Associates, Inc. (NIA)

Clinical guidelines BRAIN CT	
CPT Codes: 70450, 70460, 70470	**Original Date:** February 2023
Guideline Number: **HMSA NIA_CG_002**	**Last Revised Date** (by **Magellan Hawai'i**) February 2023
	Last Reviewed Date (by NIA): February 2023
	Implementation Date: April 2023

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- INDICATIONS FOR BRAIN CT

INDICATIONS FOR COMPUTED TOMOGRAPHY CEREBRAL PERFUSION ANALYSIS (CTP)

CTP (using automated post-processing software algorithmic analysis) in patients with acute ischemic stroke (AIS) caused by a unilateral large vessel occlusion (LVO) evaluated at stroke centers; CTP can be used to aid in selection for endovascular therapy (EVT)*, if one of the following other conditions is fulfilled:

- Treatment (femoral puncture) can be started within **6-24 hours** of the time last known to be at neurologic baseline and who meet the pre-CTP inclusion/exclusion criteria† as defined by the DAWN trial[1]; or
- Treatment (femoral puncture) can be started within **6-16 hours** of the time last known to be at neurologic baseline and who meet the pre-CTP inclusion/exclusion criteria† as defined by the DEFUSE 3 trial[2]

* EVT is a treatment for patients with acute ischemic strokes that removes the clot or thrombus from the brain, which ultimately caused the stroke. EVT involves thrombectomy, the mechanical

disintegration of vessel-occluding thrombi or blood clots, with or without intra-arterial administration of thrombolytic medications.[3]
† Excluding criteria purely related to study mechanics (e.g., able to return for protocol required follow-up visits, etc.).

BRAIN CT

REDUCING RADIATION EXPOSURE
Brain CT/CTA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain CT/Brain CTA combination studies section. If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the **combination section** as noted in the guidelines)

Important Note: Brain MRI is preferred to Brain CT in most circumstances where the patient can tolerate MRI and sufficient time is available to schedule the MRI examination. Assessment of subarachnoid hemorrhage, acute trauma, or bone abnormalities of the calvarium (fracture, etc.) may be better imaged with CT. CT is also appropriate in an urgent situation where MRI is not readily available (stroke, increased ICP, CNS infection).

‡‡ — *Designates CT is indicated only when MRI is contraindicated or cannot be performed*

INDICATIONS FOR BRAIN CT

For evaluation of headache[4-8]

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity or duration) **‡‡**
- Cluster headaches or other trigeminal-autonomic cephalgia's, i.e., paroxysmal hemicrania, hemicrania continua, short-lasting unilateral neuralgiform headache attacks (SUNCT/SUNA) imaging is indicated once to eliminate secondary causes[9] **‡‡**
- Acute headache, sudden onset:
    - With a personal or family history (brother, sister, parent, or child) of brain aneurysm or AVM (arteriovenous malformation)
    - < 48 hours of "worst headache in my life" or "thunderclap" headache
        - Note: The duration of a thunderclap type headache lasts more than 5 minutes. Sudden onset new headache reaching maximum intensity within 2-3 minutes.
    - Prior history of stroke or intracranial bleed
    - Known coagulopathy or on anticoagulation
- New onset of headache with any of the following[4, 10, 11]:
    - Acute, new, or fluctuating neurologic deficits, such as sensory deficits, limb weakness, abnormal reflexes, speech difficulties, visual loss, lack of coordination, or mental status

changes or with signs of increased intracranial pressure (papilledema). See **background** ‡‡
    - History of cancer or significantly immunocompromised ‡‡
    - Fever
    - Subacute head trauma
    - Age ≥ 50 ‡‡
    - New severe unilateral headache with radiation to or from the neck, associated with suspicion of carotid or vertebral artery dissection ‡‡
    - Related to activity or event (sexual activity, exertion, position) and (new or progressively worsening ‡‡
    - Persistent or worsening during a course of physician-directed treatment[4, 12, 13] ‡‡

Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see **background**)

- Special considerations in the pediatric population with persistent headache[14]:
    - Occipital location ‡‡
    - Age < 6 years ‡‡
    - Symptoms indicative of increased intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting ‡‡
    - Documented absence of family history of headache ‡‡
    - Severe headache in a child with an underlying disease that predisposes to intracranial pathology (e.g., immune deficiency, sickle cell disease, neurofibromatosis, history of neoplasm, coagulopathy, hypertension, congenital heart disease)

For evaluation of neurologic symptoms or deficits[15]

- Acute, new, or fluctuating neurologic symptoms or deficits, such as sensory deficits, limb weakness, abnormal reflexes, speech difficulties, visual loss, lack of coordination, or mental status changes (see **background**)

For evaluation of known or suspected stroke or vascular disease[16-18]

- Known or suspected stroke with any acute, new, or fluctuating symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes (see **background**)
- Suspected stroke with first-degree family history of aneurysm (brother, sister, parent, or child) or known coagulopathy or on anticoagulation
- Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes) ‡‡
- Suspected acute subarachnoid hemorrhage (SAH)
- Follow-up for known hemorrhage, hematoma, or vascular abnormalities
- Suspected central venous thrombosis - see **background**[17, 19] ‡‡
- Evaluation of neurological signs or symptoms in sickle cell disease[20-22] ‡‡
- High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity >200 ‡‡[22]

For evaluation of known or suspected trauma[23-27]

- Known or suspected trauma or injury to the head with documentation of one or more of the following acute, new, or fluctuating:
    - Focal neurologic findings
    - Motor changes
    - Mental status changes
    - Amnesia
    - Vomiting
    - Seizures
    - Headache
    - Signs of increased intracranial pressure
- Known coagulopathy or on anticoagulation
- Known or suspected skull fracture by physical exam and/or prior imaging
- Repeat scan 24 hours post head trauma for anticoagulated patients with suspected diagnosis of delayed subdural hematoma
- Post concussive syndrome if persistent or disabling symptoms and imaging has not been performed
- Subacute or chronic traumatic brain injury with new cognitive and/or neurologic deficit ‡‡

For evaluation of suspected brain tumor, mass, or metastasis[28-30]

- Suspected brain tumor with any acute, new, or fluctuating neurologic symptoms or deficits such as sensory deficits, abnormal reflexes, limb weakness, speech difficulties, visual loss, lack of coordination or mental status changes ‡‡ (see **background**)
- Suspected brain metastasis or intracranial involvement in patients with a history of cancer based on symptoms or examination findings (may include new or changing lymph nodes) ‡‡
- Histiocytic Neoplasms for screening and/or with neurological signs or symptoms[31, 32]
    - Erdheim-Chester Disease
    - Langerhans Cell Histiocytosis
    - Rosai-Dorfman Disease
- Suspected Pituitary Tumors (Brain MRI is the study of choice if indicated) or Sella CT if MRI is contraindicated or cannot be performed
- Screening for known non-CNS Cancer and for screening of hereditary cancers syndromes (Brain MRI is the study of choice if indicated)

For evaluation of known brain tumor, mass, or metastasis

- Follow-up of known CNS cancer (either primary malignant brain tumor or secondary brain metastasis) as per NCCN[30] ‡‡
- Suspected recurrence with prior history of CNS cancer (either primary or secondary) based on neurological symptoms or examination findings ‡‡
- Follow-up of known low grade tumor (WHO I-II) (i.e., meningioma, glioma, astrocytoma, oligodendroglioma) ‡‡
    - For surveillance as per NCCN[30]
    - If symptomatic, new/changing signs or symptoms or complicating factors
- Known pituitary tumors (Brain MRI is the study of choice if indicated) or Sella CT if MRI is contraindicated or cannot be performed

- Tumor monitoring in neurocutaneous syndromes as per tumor type ‡‡
- Bone tumor or abnormality of the skull[33]
- Histiocytic Neoplasms to assess treatment response and surveillance of known brain/skull lesions[31, 32]
    - Erdheim-Chester Disease
    - Langerhans Cell Histiocytosis
    - Rosai-Dorfman Disease [34]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases[30] ‡‡

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine, or Lumbar Spine

For evaluation of known or suspected seizure disorder[35-38]

- New onset of seizures or newly identified change in seizure activity/pattern ‡‡ (Brain MRI is the study of choice if indicated)

For evaluation of known or suspected inflammatory disease or infection (e.g., meningitis or abscess)[39, 40] ‡‡

- Suspected intracranial abscess or brain infection with acute altered mental status OR positive lab findings (such as elevated WBCs) OR follow-up assessment during or after treatment completed ‡‡
- Meningitis with positive signs and symptoms (such as fever, headache, mental status changes, stiff neck) OR positive lab findings (such as elevated white blood cells or abnormal lumbar puncture fluid exam) ‡‡
- Suspected encephalitis with headache and altered mental status OR follow-up as clinically warranted ‡‡
- Endocarditis with suspected septic emboli ‡‡
- Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with abnormal inflammatory markers or autoimmune antibodies ‡‡
- Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up ‡‡ [41, 42]
- Immunocompromised patient (e.g., transplant recipients, HIV with CD4 < 200, primary immunodeficiency syndromes, hematologic malignancies) with focal neurologic-symptoms, headaches, behavioral, cognitive, or personality changes ‡‡ [43]

For evaluation of clinical assessment documenting cognitive impairment of unclear cause[44-47]

- Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments */formal neuropsychological testing showing at least mild cognitive impairment AND a completed basic metabolic workup (such as thyroid function testing, liver function testing, complete blood count, electrolytes, and B12) ‡‡

* Other examples include Mini-Cog, Memory Impairment Screen, Saint Louis University Mental Status Examination (SLUMS), Brief Alzheimer's Screen (BAS), Blessed Dementia Scale (BDS), Clinical Dementia

Rating (CDR)[48, 49]

For evaluation of movement disorders[50]

- Acute onset of a movement disorder with concern for stroke or hemorrhage ‡‡
- For evaluation of Parkinson's disease with atypical feature or other movement disorder (i.e., suspected Huntington disease, chorea, parkinsonian syndromes, hemiballismus, atypical dystonia) to exclude an underlying structural lesion ‡‡

Note: CT has limited utility in the chronic phases of disease. Brain MRI is the study of choice if indicated. Imaging is not indicated in essential tremor, Tourette' syndrome or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer's dystonia).[51-53]

For evaluation of cranial nerve and visual abnormalities (Brain MRI is the study of choice if indicated)

- Anosmia (loss of smell) or dysosmia (documented by objective testing) that is persistent and of unknown origin[54, 55] ‡‡
- Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit, etc.)[56] ‡‡
  Note: See **background**
- Binocular diplopia with concern for intracranial pathology[57] after comprehensive eye evaluation ‡‡
- Childhood strabismus with development delay or abnormal fundoscopic exam to rule out intracranial abnormalities[58, 59] ‡‡
- Horner's syndrome with symptoms localizing the lesion to the central nervous system[60] ‡‡
- Evaluation of cranial nerve palsy/neuropathy/neuralgia when thought to be due to tumor, stroke, or bony abnormalities of the skull base or when MRI is contraindicated or cannot be performed[54]
- Bulbar or pseudobulbar symptoms ‡‡

For evaluation OF KNOWN OR SUSPECTED CONGENITAL ABNORMALITY (SUCH AS CRANIOSYNOSTOSIS, NEURAL TUBE DEFECTS)[61-63]

- Known or suspected congenital abnormality with any acute, new, or fluctuating neurologic, motor, or mental status changes
- For initial evaluation of a suspected Arnold Chiari malformation ‡‡
- Follow-up imaging of a known type II or type III Arnold Chiari malformation ‡‡. For Arnold Chiari type I, follow-up imaging only if new or changing signs/symptoms[64, 65]
- Evaluation of macrocephaly in an infant/child <18 with previously abnormal US, abnormal neurodevelopmental examination,[66] signs of increased ICP or closed anterior fontanelle ‡‡
- Microcephaly in an infant/child < 18 ‡‡
- Craniosynostosis and other head deformities
- Evaluation of the corticomedullary junction in Achondroplasia[67, 68] ‡‡
- Cerebral palsy if etiology has not been established in the neonatal period, there is change in the expected clinical or developmental profile or concern for progressive neurological disorder[69, 70]
- Prior treatment or planned treatment for congenital abnormality

Note: For evaluation of known or suspected hydrocephalus please see section on CSF abnormalities.

Cerebral Spinal Fluid (CSF) Abnormalities

- Evaluation of suspected hydrocephalus with any acute, new, or fluctuating neurologic, motor, or mental status changes
- Known hydrocephalus†
- Known or suspected normal pressure hydrocephalus (NPH)[71]
    - With symptoms of gait difficulty, cognitive disturbance, and urinary incontinence
- Follow-up shunt evaluation[72-74]
    - Post operativity if indicated based on underlying disease and pre-operative radiographic findings and/or
    - 6-12 months after placement and/or
    - With neurologic symptoms that suggest shunt malfunction
- Evaluation of known or suspected cerebrospinal fluid (CSF) leakage[75]
- Cisternography for intermittent and complex CSF rhinorrhea/otorrhea. CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)[76, 77]
- Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance[78] ‡‡

†Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection, etc.[79]

Pre-operative/procedural evaluation for brain/skull surgery

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other Indications[22, 80-82]

- Vertigo associated with any of the following: ‡‡
    - Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness or a change in sensation)[83, 84]
    - Progressive unilateral hearing loss
    - Risk factors for cerebrovascular disease with concern for stroke
    - After full neurologic examination and vestibular testing with concern for central vertigo (i.e., skew deviation, vertical nystagmus, head thrust test, videonystagmography (VNG)/ electronystagmography (ENG))
- Diagnosis of central sleep apnea on polysomnogram ‡‡
    - Children > 1 year[85]
    - Adults in the absence of heart failure, chronic opioid use, high altitude, or treatment emergent central sleep apnea AND concern for a central neurological cause (Chiari malformation, tumor, infectious/inflammatory disease) OR with an abnormal neurological exam[86]
- Syncope with clinical concern for seizure or associated neurological signs or symptoms[87-90] ‡‡

- Cyclical vomiting syndrome or abdominal migraine with any localizing neurological symptoms[91-93] ‡‡
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph)[94-96] ‡‡
- Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause[97] ‡‡
- Global developmental delay or developmental delay with abnormal neurological examination in a child < 18 years[98, 99] ‡‡
- Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam[100] ‡‡

Note: Imaging is not indicated in low-risk patients

- Prior to lumbar puncture in patients with suspected increased intracranial pressure or at risk for herniation

Indications for Combination Studies[16, 17]

Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the neuroaxis), patient history, and other available information, including prior imaging.

Exception: Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[101]

- **Brain CT/Neck CTA**
  - Recent ischemic stroke or transient ischemic attack
  - Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

- **Brain CT/Brain CTA**
  - Recent ischemic stroke or transient ischemic attack
  - Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
  - Headache associated with exercise or sexual activity[9] ‡‡
  - Suspected venous thrombosis (dural sinus thrombosis) – Brain CTV (see **background**) ‡‡
  - Neurological signs or symptoms in sickle cell patients ‡‡
  - High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200 ‡‡ [22]

- **Brain CT/Brain CTA/Neck CTA**
  - Recent stroke or transient ischemic attack (TIA)
  - Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

*Note: MRA and CTA are generally comparable noninvasive imaging alternatives each with their own advantages and disadvantages.

- Brain MRI can alternatively be combined with Brain CTA/Neck CTA.

- **Brain CT/Orbit CT**
  - Optic neuropathy or unilateral optic disk swelling of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion, or optic nerve infiltrative disorders[102] ‡‡
  - Bilateral optic disk swelling (papilledema) with visual loss[103] ‡‡

- **Brain CT/Cervical CT/Thoracic CT/Lumbar CT (any combination) ‡‡**
  - For initial evaluation of a suspected Arnold Chiari malformation
  - Follow-up imaging of a known type II or type III Arnold Chiari malformation. For Arnold Chiari type I, follow-up imaging only if new or changing signs/symptoms[64, 65]
  - Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (CT spine imaging in this scenario is usually CT myelogram) see **background**
    - Suspected leptomeningeal carcinomatosis (see **background**)[104]
    - Tumor evaluation and monitoring in neurocutaneous syndromes

CSF leak highly suspected and supported by patient history and/or physical exam findings (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula - CT spine imaging in this scenario is usually CT myelogram)[105]

BACKGROUND

Non-contrast CT (NCCT) is the mainstay for initial AIS imaging due to widespread availability, rapid scan times, and detection of intracranial hemorrhage (which leads to very different management from infarction). Multimodal CT includes NCCT, CT angiography (CTA) (to assess site of vascular occlusion), and CT Perfusion Imaging (CTP). CTP consists of a temporal sequence of head CT scans obtained during the wash-in and wash-out of an IV bolus of iodinated contrast agent. Post-acquisition data analysis by dedicated software allows creation of multiple hemodynamic parametric maps (based on contrast time-density curves) for clinical interpretation. Hemodynamic parameters include time to maximum contrast intensity (Tmax), mean transit time (MTT), cerebral blood flow (CBF) and cerebral blood volume (CBV), mathematically related by the equation CBF = CBV/MTT[106]. These maps are able to estimate brain regions with high probability of irreversible infarction (ischemic core) versus areas of potentially reversible ischemia (penumbra). Both core and penumbra are estimates of probabilistic tissue fate. While CTP has been studied in acute ischemic stroke for decades[107], only recently was it found likely to influence treatment decision[108]. Subsequently, two level I randomized controlled trials (RCTs) (DAWN and DEFUSE 3) found CTP helped determine eligibility for EVT in the late time period (6-24 hr.) of an acute (< 24 hr.) ischemic stroke (AIS)[1, 2], a paradigm shift away from confinement to the early window (< 6 hr.).

The DAWN trial (Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention with Trevo) studied whether patients with a clinical deficit that is disproportionately severe relative to the infarct volume may benefit from late EVT[1]. See table for key inclusion criteria. Patients were randomly assigned to EVT plus standard medical management (MM) (N=107, mean age 69.4 yr.) or to MM alone (N=99, mean age 70.7 yr.). Median National Institutes of Health Stroke Scale (NIHSS) score was 17 (moderate to severe stroke) for both groups. The trial was stopped for efficacy at the first interim analysis. At 90 days, the rate of functional independence, as defined by a score of 0-2 on the modified Rankin scale (mRS) of 0-6, was greater for EVT than MM (49% versus 13%; adjusted difference, 33%; 95% CI, 21–44; posterior probability of superiority >0.999). The rate of symptomatic intracranial hemorrhage did not differ significantly between the two groups (6% in the EVT group and 3% in the MM group, P=0.50), nor did 90-day mortality (19% and 18%, respectively; P=1.00).

Key Inclusion Criteria for DAWN and DIFUSE 3

PARAMETER	DAWN	DEFUSE 3
Pre-stroke baseline mRS (0-6)	mRS ≤ 1 (no significant disability)	mRS ≤ 2 (slight disability)
Last known well to treatment time	6-24 h	6-16 h
Minimum NIHSS score (0-42)	10 (moderate stroke)	6 (moderate stroke)
LVO by MR or CT angiography	ICA (intracranial) and/or M1 segment of MCA	ICA (cervical or intracranial) and/or M1 segment of MCA
Clinical-core mismatch (core volume based on a relative CBF threshold of < 30% of normally perfused tissue)	≤ 20 mL if age ≥ 80 ≤ 30 mL if age < 80 and NIHSS 10–20 ≤50 mL if age <80 and NIHSS > 20	≤ 70 mL and NIHSS ≥ 6
Penumbra-core volume mismatch	not required	penumbra volume ≥ 15 mL (Tmax > 6 s volume minus core volume) and a penumbra to core ratio of ≥ 1.8

mRS, modified Rankin score; NIHSS, National Institutes of Health Stroke Scale; LVO, large anterior vessel occlusion; ICA, internal carotid artery; M1/MCA, first segment of the middle cerebral artery; CBF, cerebral blood flow; Tmax, time from contrast injection to maximum intensity.

The DEFUSE 3 trial (Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution) was a multicenter, randomized, open-label trial that used perfusion-core mismatch and maximum core size as imaging criteria to select patients for late EVT[2]. See table for key inclusion criteria. Patients were randomly assigned to EVT plus standard MM or standard MM alone. The trial was conducted at 38 U.S.

centers and terminated early for efficacy after 182 patients had undergone randomization (EVT N=92, median age 70; MM N=90, median age 71). Median NIHSS score was 16 (moderate to severe stroke) for both groups. The EVT group showed a benefit in functional outcome at 90 days (mRS score 0–2, 44.6% versus 16.7%; RR, 2.67; 95% CI, 1.60–4.48; P<0.0001). The 90-day mortality rate trended in favor of EVT (14% vs. 26% (P=0.05)), and there was no significant difference between groups in the rate of symptomatic intracranial hemorrhage (7% and 4%) or of serious adverse events (43% and 53%). In a subgroup analysis, both the favorable outcome rate and treatment effect did not decline in transfer patients compared to direct admission patients[109].

The DAWN and DEFUSE 3 trials differed in their approach in identifying salvageable brain (table). The DAWN trial selected patients based on a clinical-core mismatch, whereas the DEFUSE 3 trial focused on a penumbra-core mismatch. Both target the same conceptual goal, identifying patients with enough salvageable, at risk, tissue to warrant EVT risks. In both cases, brain tissue was designated as having irreversible injury if CBF was less than 30% of that seen in contralateral perfused tissue by CTP (or less commonly, magnetic resonance MR (MR) perfusion-weighted imaging (MR-PWI)) as detected by RAPID automated perfusion post-processing software. Both trials demonstrated a large clinical benefit, with numbers needed to treat (NNT) of 3-4 to prevent functional dependence. There were differences in protocol as well. DAWN excluded patients with an infarct involving more than one third of the territory of the MCA at baseline. DEFUSE-3 enrolled patients with lower NIHSS score (less clinical severity), larger core infarct, and slightly higher baseline mRS disability score. One third of DAWN-eligible patients are DEFUSE-3 ineligible. Epidemiologic data suggest that about one-third of AIS patients present between 6-24 hours, and only 9.2% of these (or 2.7% overall) meet DAWN or DIFFUSE 3 inclusion criteria[110,111]. Of all patients with acute ischemic stroke presenting to a single comprehensive stroke center, 1.7% of patients qualified for DAWN clinical trial enrollment with an additional 0.6-1% qualifying for the DEFUSE-3 trial[110].

Both studies employed CTP or MR-PWI to select patients for EVT, with CTP predominating. DEFUSE 3 subgroup analysis showed no statistical difference in treatment effect between “patients selected on the basis of diffusion/perfusion MRI and those selected on the basis of CT perfusion imaging,” though the authors admit statistical power was limited by the lower number of patients enrolled as a result of early termination. DAWN subgroup analysis did not include comparison by qualifying image method. One criticism of both studies was the large number of “wake-up strokes” (~50%) vs. 14-28% in the general population, perhaps contributing to overestimation of stroke age, and therefore, better outcomes[112, 113]. The authors note that a higher proportion of unwitnessed strokes are expected in trials enrolling patients late after onset, as witnessed strokes are typically treated early, and that the benefit persisted even after stratification into witnessed and unwitnessed stroke groups[114, 115]. They also explain that outcomes were “paradoxically” superior to early window (< 6 hr.) treatment trials, probably due to selection for a large volume of penumbral (i.e., salvageable) tissue.

A subsequent prospective review[116] and retrospective registry[117] analysis also support the value of CTP in late period EVT eligibility assessment, while also emphasizing the need to correlate perfusion abnormalities with other imaging (NCCT, CTA) and clinical information; they may be more sensitive than CTP for detecting irreversibly damaged tissue as time progresses. For example, CTP may show increased CBF over time due to collaterals to tissue already irreversibly injured[118]. Also stressed is the need for more standardization of CTP vendor software and post-processing techniques to decrease

variation in calculated core and mismatch[106, 118]. However, even with fully automated software, a significant clinician interpretation learning curve remains[119].

Non-AIS indications

One non-ischemic stroke CTP potential use is in determining delayed cerebral ischemia (DCI), occurring in approximately 30% of patients within two weeks after aneurysmal subarachnoid hemorrhage (SAH)[120]. The most common etiology of DCI is thought to be vasospasm produced by spasmogenic substances generated during lysis of subarachnoid blood. Monitoring for DCI can be done with CTA to confirm vasospasm in patients with elevated velocities on transcranial Doppler (TCD) ultrasound[120]. However, brain perfusion asymmetry on CTP has been studied for this purpose as well. A 2014 systematic review and meta-analysis[121], included four small observational studies of 188 patients[122-125]. The weighted averages and ranges of the pooled sensitivity and specificity of CTP in the determination of DCI were 0.84 (0.7-0.95) and 0.77 (0.66-0.82), respectively. The pooled odds ratio was 23.14 (95% CI, 5.87-91.19). The authors conclude that "perfusion deficits on CTP may be helpful in identifying patients with delayed DCI before development of infarction and neurologic deficits." However, they also cite many definitional and methodology limitations of the underlying studies (nonuniform DCI definition as an outcome measure, CTP protocol and postprocessing software differences, lack of consistency of what constitutes an abnormal CTP test result, optimal time to perform CTP, and nonstandard hemodynamic parameter thresholds). In addition, accurate quantification is dependent on an intact blood-brain barrier, which may not be functioning in DCI.

Small cohort studies have explored the potential role of CTP for patients with traumatic brain injury (TBI). A small study of 48 patients reported NCCT had sensitivity of 39.6% compared to improved sensitivity of CTP of 87.5% for cerebral contusions diagnosed on delayed follow-up imaging[126]. Additional studies suggest reductions in blood flow and volumes determined by CTP are associated with worse outcome[127]. A subset analysis of 30 patients from an observational study reported the information obtained from CTP is useful in decision making[128].

CTP has been proposed as a possible modality for non-invasive assessment of brain tumors. Several small (< 20 patient), retrospective reports showed promising early results in diagnosing malignant verses normal tissue, evaluating for metastatic disease, and differentiating tissue type in brain tumors[129, 130]. A small prospective trial of 49 consecutive patients with brain tumors or tumor-like lesions were evaluated with CT and CTP. The results suggest CTP can aid in distinguishing glioma and lymphomas based on quantitative measurements of CBV and permeability[131]. The reports indicate need for further investigation of cut-off values, accuracy and patient selection criteria, to determine if clinically useful.

Analysis of Evidence (Rationale for Determination)

The 2019 update to the 2018 American Heart Association (AHA)/American Stroke Association (ASA) guidelines for the early management of patients with AIS state: "When selecting patients with AIS within 6 to 24 hours of last known normal who have LVO in the anterior circulation, obtaining CTP, DW-MRI, with or without MRI perfusion, is recommended to aid in patient selection for mechanical thrombectomy, but only when patients meet other eligibility criteria from one of the RCTs that showed benefit from mechanical thrombectomy in this extended time window" (Class of recommendation I-strong; level (quality) of evidence A)[132]. Since only the DAWN and DEFUSE 3 RCTs show a benefit of late period EVT, they further warn: "DAWN or DEFUSE 3 eligibility should be strictly adhered to in clinical

practice." These guidelines do not recommend CTP to determine eligibility for either thrombolytic therapy or EVT in the early (<6 hour) period (Class of recommendation I-strong; level (quality) of evidence B-Nonrandomized), or for any other indication (e.g., prediction of hemorrhagic transformation (HT) in acute ischemic injury). Other guidelines have similar recommendations[133-135] National Institute for Health and Care Excellence (NICE) recommends: "Add CT perfusion imaging (or MR equivalent) if thrombectomy might be indicated beyond 6 hours of symptom onset"[136]. This recommendation uniquely also includes posterior circulation stroke. However, there is minimal evidence regarding the appropriate threshold and utility of CTP in the posterior circulation, and MRI is a better alternative[106].

The 2017 American College of Radiology (ACR)-American Society of Neuroradiology (ASNR)-Society of Pediatric Radiology (SPR) guidelines lists primary and secondary indications for CTP in neuroradiology, including evaluation of AIS, neoplasia, trauma, cerebral hemorrhage, and vasospasm following subarachnoid hemorrhage[137]. The 2012 AHA/ASA guidelines for the management of aneurysmal SAH state that "perfusion imaging with CT or magnetic resonance can be useful to identify regions of potential brain ischemia" (Class IIa; Level of Evidence B)[138]. However, current UpToDate guidance concludes that CTP "clinical utility…..remains to be established" and that "the use of this technique as a monitoring tool may be limited by risks of recurrent dye loads and radiation exposure"[120], as well as by lack of standardized methodology[121]. The 2015 AHA/ASA guidelines for the management of spontaneous intracerebral hemorrhage has no mention of CTP[139], nor does UpToDate[140]. Regarding trauma and oncologic indications, there appears to be insufficient evidence to support routine use of CTP.

In summary, we consider the concordant level I evidence of a large clinical benefit after CTP imaging (using automated post-processing software algorithmic analysis) in AIS secondary to LVO, to assist in late EVT eligibility determination per AHA/ASA guidelines, medically reasonable and necessary. Other stroke or non-stroke indications lack level I evidence and are not considered medically reasonable and necessary at this time.

Computed tomography (CT) is an imaging technique used to view the structures of the brain and is useful in evaluating pathologies in the brain. It provides more detailed information on head trauma, brain tumors, stroke, and other pathologies in the brain than regular radiographs.

CT scan for Headache – Generally, magnetic resonance imaging is the preferred imaging technique for evaluating the brain parenchyma, and CT is preferable for evaluating subarachnoid hemorrhage. CT is faster and more readily available than MRI and is often used in urgent clinical situations. Neurologic imaging is warranted in individuals with headache disorders along with abnormal neurologic examination results or predisposing factors for brain pathology.

Headache timeframes and other characteristics – Generally, acute headaches are present from hours to days, subacute from days to weeks, and chronic headaches for more than 3 months. Acute severe headaches are more likely to be pathological (e.g., SAH, cerebral venous thrombosis) than non-acute (e.g., migraine, tension-type). Headaches can also be categorized as new onset or chronic/recurrent. Non-acute, new onset headaches do not require imaging unless there is a red flag as delineated above. Incidental findings lead to additional medical procedures and expense that do not improve individual well-being. Primary headache syndromes, such as migraine and tension headaches, are often episodic

with persistent or progressive headache not responding to treatment, requiring further investigation (e.g., new daily persistent headache). Imaging is indicated in chronic headaches if there is a change in the headache frequency (number of headaches episodes/month), duration of each episode, severity of the headaches or new characteristics, such as changing aura or associated symptoms.[4, 9, 141-143]

Migraine with Aura[9, 10, 144] – The headache phase of a migraine is preceded and/or accompanied by transient neurological symptoms, referred to as aura, in at least a third of migraine attacks. The most common aura consists of positive and/or negative visual phenomena, present in up to 99% of the individuals. Somatosensory is the secondary most common type of aura (mostly paresthesia in an upper limb and/or hemiface). Language/speech (mainly paraphasia and anomic aphasia) can also be affected. These neurological symptoms typically evolve over a period of minutes and may last up to 20 minutes or more. The gradual evolution of symptoms is thought to reflect spreading of a neurological event across the visual and somatosensory cortices. Characteristically, the aura usually precedes and terminates prior to headache, usually within 60 minutes. In others, it may persist or begin during the headache phase. ICHD-3 definition of the aura of migraine with typical aura consists of visual and/or sensory and/or speech/language symptoms, but no motor, brainstem, or retinal symptoms and is characterized by gradual development, duration of each symptom no longer than one hour, a mix of positive and negative features and complete reversibility. Atypical or complex aura includes motor, brainstem, monocular visual disturbances, or ocular cranial nerve involvement (hemiplegic migraine, basilar migraine/brainstem aura, retinal migraine, ophthalmoplegic migraine) and secondary causes need to be excluded. Additional features of an aura that raise concern for an underlying vascular etiology include late age of onset, short duration, evolution of the focal symptoms, negative rather than positive visual phenomenon, and history of vascular risk factors.

Neurological Deficits – Examples of abnormal reflexes related to upper motor neuron lesion/central pathology include hyperreflexia, clonus, Hoffman sign and Babinski, snout, palmar grasp, and rooting reflexes.

Visual loss has many possible etiologies, and MRI or CT is only indicated in suspected neurological causes of visual loss based on history and exam. Visual field defects, such as bitemporal hemianopsia, homonymous hemianopsia, or quadranopsia, require imaging as well as does suspected optic nerve pathology. Subjective symptoms such as blurred vision or double vision with no clear correlate on neurological examination requires a comprehensive eye evaluation to exclude more common causes, such as cataracts, refractive errors, retinopathy, glaucoma, or macular degeneration. Transient visual loss with history consistent with TIA but normal exam at time of examination also should be imaged. Positive visual phenomena, such as photopsias or scintillations that march across the visual field, suggest migraine whereas negative phenomenon, such as shaded or blurred, is more characteristic of ischemia.

Imaging for Stroke – Individuals presenting with symptoms of acute stroke should receive prompt imaging to determine whether they are candidates for treatment with tissue plasminogen activator. Non-contrast CT can evaluate for hemorrhage that would exclude the individual from reperfusion therapy. Functional imaging can be used to select individuals for thrombolytic therapy by measuring the mismatch between “infarct core” and “ischemic penumbra” and may define ischemic areas of the brain with the potential to respond positively to reperfusion therapy. Contrast-enhanced CT

angiography (CTA) may follow the non-contrast CT imaging to identify areas of large vessel stenosis or occlusion which may be a target for therapy.

Recent stroke or transient ischemic attack – A stroke or central nervous system infarction is defined as "brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. … Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms."[145] If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes.[146] TIAs in contrast, "are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging."[147] On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention.[148] Therefore, when revascularization therapy is not indicated or available in individuals with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology and to assess immediate complications and risk of future stroke. The majority of stoke evaluations take place in the inpatient setting. Admitting TIA individuals is reasonable if they present within 72 hours and have an ABCD (2) score ≥3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis.[147] Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors, such as carotid stenosis atrial fibrillation, as the cause of ischemic symptoms.[146] Diagnostic recommendations include neuroimaging evaluation as soon as possible, preferably with MRI, including DWI; noninvasive imaging of the extracranial vessels should be performed; and noninvasive imaging of intracranial vessels is reasonable.[149]

Individuals with a history of stroke and recent workup with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Individuals with remote or silent strokes discovered on imaging should be evaluated for high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.

Imaging of Cavernomas – MRI is the study of choice for detecting cavernous malformations (CCM). Follow-up imaging of known CCM should be done only to guide treatment decisions or to investigate new symptoms. First-degree relatives of individuals with more than one family member with a CCM should have a screening MRI as well as genetic counseling.[150-152]

Non-aneurysmal vascular malformations – Non-aneurysmal vascular malformations can be divided in low flow vascular malformations and high flow vascular malformations. Low flow vascular malformations include dural venous anomalies (DVA), cavernomas, and capillary telangiectasias. High flow vascular malformations include AVM and dural arteriovenous fistulas (dAVF). For low flow malformations, MRI is the study of choice. Limited medical literature is available to support vascular imagining (CTA or MRA). CTA plays a limited role in the assessment of cavernoma but may be used to

demonstrate a DVA. MRA is not usually helpful in the assessment of cavernoma, capillary telangiectasia, and DVA. Vascular imaging is indicated in high flow vascular malformations.[153-155]

CT and Central Venous Thrombosis – A CTV or MRV is indicated for the definite evaluation of a central venous thrombosis/dural sinus thrombosis. The most frequent presentations are isolated headache, intracranial hypertension syndrome (headache, nausea/vomiting, transient visual obscurations, pulsatile tinnitus, CN VI palsy, papilledema),[156] seizures, focal neurological deficits, and encephalopathy. Risk factors are hypercoagulable states inducing genetic prothrombotic conditions, antiphospholipid syndrome and other acquired prothrombotic diseases (such as cancer), oral contraceptives, pregnancy, puerperium (6 weeks postpartum), infections, and trauma. Since venous thrombosis can cause SAH, infarctions, and hemorrhage, parenchymal imaging with MRI/CT is also appropriate.[19, 157, 158]

CT scan for Head Trauma – Most types of head injury are minor injuries; clinical signs and symptoms help predict the need for brain CT following injury. CT has advantages in evaluating head injury due to its sensitivity for demonstrating mass effect, ventricular size and configuration, bone injuries, and acute hemorrhage. An individual who presents with certain clinical risk factors may be more likely to benefit from CT imaging. Some of the clinical risk factors that may be used as a guide to predict the probability of abnormal CT following minor head injury are vomiting, skull fracture, and age greater than 60 years. Individuals with a Glasgow Coma Scale of 15 or less who also have been vomiting or have a suspected skull fracture are likely to show abnormal results on CT scan. CT is also useful in detecting delayed hematoma, hypoxic-ischemic lesions, or cerebral edema in the first 72 hours after head injury.

CT and tumors – MRI is the ideal modality to follow-up meningioma, pituitary tumors, low grade tumors, neurocutaneous syndromes, and staging/surveillance for non-CNS cancers. CT should only be used when MRI is contraindicated or is unable to be obtained. Surveillance timelines should follow NCCN guidelines. Imaging is also warranted if the individual is symptomatic or there are new/changing signs or symptoms or complicating factors.

MMSE – The Mini Mental State Examination (MMSE) is a tool that can systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The MMSE has been the most commonly used measure of cognitive function in dementia research, but researchers have recognized that it is relatively insensitive and variable in mildly impaired individuals. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is, therefore, practical to use repeatedly and routinely.

MoCA – The Montreal Cognitive Assessment (MoCA) was designed as a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. MoCA differs from the MMSE mainly by including tests of executive function and abstraction, and by putting less weight on orientation to time and place. Ten of the MMSE's 30 points are scored solely on the time-place orientation test, whereas the MoCA assigns it a maximum of six points. The MoCA also puts more weight on recall and attention-calculation performance, while de-

emphasizing language skill. Time to administer the MoCA is approximately 10 minutes. The total possible score is 30 points; a score of 26 or above is considered normal.

CT for evaluation of the cranial nerves – Magnetic resonance imaging (MRI) is considered the gold standard in the study and evaluation of the cranial nerves. Computed tomography (CT) allows, usually, an indirect view of the nerve and is useful to demonstrate the intraosseous segments of cranial nerves, the foramina through which they exit skull base, and their pathologic changes. In optic neuritis, CT has limited utility. Contrast-enhanced CT scanning of the orbits may help exclude other orbital pathology. CT scanning of the brain, regardless of whether intravenous contrast material is administered or not, does not yield prognostic and treatment-altering information. In Bell's Palsy temporal bone CT is useful in the evaluation of the caliber and the course of the IAC and bony facial nerve canal in the temporal bone. When using CT to evaluate the facial nerve, pathology often can only be inferred by visualization of erosion or destruction of the adjacent bony facial nerve canal. In contrast, MRI visualizes soft tissues well and so is better suited for evaluating soft tissue facial nerve abnormalities.

Anosmia – Nonstructural causes of anosmia include post-viral symptoms, medications (Amitriptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Trifluoperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause. Anosmia and dysgeusia have been reported as common early symptoms in individuals with COVID-19, occurring in greater than 80 percent of individuals. For isolated anosmia, imaging is typically not needed once the diagnosis of COVID has been made, given the high association. As such, COVID testing should be done prior to imaging.[159-161]

Evaluation of olfactory function is essential to determine the degree of chemosensory loss and confirm the individual's complaint. It also allows monitoring of olfactory function over time, detecting malingerers, and establishing compensation for disability. The two general types of olfactory testing are psychophysical and electrophysiologic testing. Psychophysical tests are used for clinical evaluation of olfactory loss; whereas electrophysiologic tests, such as electro-olfactogram (EOG) or odor event–related potentials (OERPs), are used for research purposes only.

Olfactory threshold tests rely on measuring detection thresholds of a specific odorant, such as phenyl ethyl alcohol (PEA) or butyl alcohol. Odor identification tests are quantitative tests in which individuals are asked to identify the odorants at the suprathreshold level. Examples include *The Connecticut odor identification, The University of Pennsylvania Identification Test (UPSIT) and the Cross-Cultural Smell Identification Test (CC-SIT)*. In Europe, a commonly used test is a threshold- and odorant-identification forced-choice test that uses odorant-impregnated felt-tipped pens (Sniffin' Sticks). A simple olfactory screening test using a 70% isopropyl alcohol pad as a stimulant has also been well described in the literature.[162]

CT scan for congenital abnormalities – While MRI is preferred to CT for evaluation of most congenital CNS abnormalities, in some clinical situations CT is preferred (craniosynostosis) or equivalent to MRI. CT is appropriate in the follow-up of hydrocephalus or VP shunt function where the etiology of hydrocephalus has been previously determined or in individuals for which MRI evaluation would require general anesthesia.

CT for Macrocephaly – Consider ultrasound in infants with macrocephaly and a normal neurological examination, no evidence of increased ICP, and an open anterior fontanelle. If head US is normal, the infant should be monitored closely.[163] The anterior fontanelle generally closes between 10 and 24 months of age, with 3% closing between 5-9 months and 11% after 24 months.[164]

CT and Normal Pressure Hydrocephalus (NPH) – Although diagnosis can be made based on CT findings alone, MRI is more accurate for disclosing associated pathologies (such as cerebrovascular disease), excluding other potential etiologies, and for detecting NPH typical signs of prognostic value. A CT scan can exclude NPH and is appropriate for screening purposes and in individuals who cannot undergo MRI.

CT and Vertigo – The most common causes of vertigo seen are benign paroxysmal positional vertigo (BPPV), vestibular neuronitis (VN) and Ménière's disease. These peripheral causes of vertigo are benign, and treatment involves reassurance and management of symptoms. Central causes of vertigo, such as cerebrovascular accidents (CVAs), tumors and multiple sclerosis (MS), need to be considered if the individual presents with associated neurological symptoms, such as weakness, diplopia, sensory changes, ataxia or confusion. Magnetic resonance imaging is appropriate in the evaluation of individuals with vertigo who have neurologic signs and symptoms, progressive unilateral hearing loss or risk factors for cerebrovascular disease. MRI is more appropriate than CT for diagnosing vertigo due to its superiority in visualizing the posterior portion of the brain, where most central nervous system disease that causes vertigo is found. A full neurologic and otologic evaluation including provocative maneuvers, vestibular function testing and audiogram can help evaluate vertigo of unclear etiology and differentiate between central and peripheral vertigo.

CT and developmental delay – Significant developmental delay is defined as significant delay (more than two standard deviations below the mean) in one or more developmental domains: gross/fine motor, speech/language, cognition, social/personal, and activities of daily living. Isolated delay in social/language development is characteristic of autism spectrum disorders or hearing loss. Isolated delay in motor development is characteristic of cerebral palsy (a static encephalopathy) or myopathy. Global developmental delay (GDD) is a subset of developmental delay defined as significant delay (by at least 2 SD's) in two or more developmental categories. Note that the term "GDD" is usually reserved for children < 5 years old, whereas in older children > 5 years, disability is quantifiable with IQ testing.

CT scan and Meningitis – In suspected bacterial meningitis, CT with contrast may be performed before lumbar puncture (LP) to show preliminary meningeal enhancement. It is important to evaluate for a mass lesion or cause of elevated ICP that would contraindicate an LP. CT may be used to define the pathology of the base of the skull and that may require therapeutic intervention and surgical consultation. Some causes of an intracranial infection include fractures of the paranasal sinus and inner ear infection.

Leptomeningeal Carcinomatosis[165-168] – Leptomeningeal metastasis is an uncommon and typically late complication of cancer with poor prognosis and limited treatment options. Diagnosis is often challenging with nonspecific presenting symptoms ranging from headache and confusion to focal neurologic deficits such as cranial nerve palsies. Standard diagnostic evaluation involves a neurologic examination, MRI of the brain and spine with gadolinium, and cytologic evaluation of the cerebral spinal fluid (CSF). Hematologic malignancies (leukemia and lymphoma), primary brain tumors as well as

solid malignancies can spread to the leptomeninges. The most common solid tumors giving rise to LM are breast cancer (12 - 35 %), small and non-small cell lung cancer (10-26 %), melanoma (5 -25 %), gastrointestinal malignancies (4-14 %), and cancers of unknown primary (1-7 %).

Drop Metastases – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.[169]

POLICY HISTORY

Date	Summary
February 2023	New Guideline for Indications for Computed Tomography Cerebral Perfusion Analysis (CTP)
April 2023	Added NIA_CG_002 for BRAIN CT

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National Imaging Associates, Inc.*	
Clinical guidelines **TEMPORAL BONE, MASTOID, ORBITS, SELLA, INTERNAL AUDITORY CANAL CT**	**Original Date: September 1997**
CPT Codes: 70480, 70481, 70482	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_006 - 1	**Implementation Date: January 2023**

INDICATIONS FOR ORBIT CT

Note: CT is preferred for visualizing bony detail and calcifications. MRI is superior for the evaluation of the visual pathways, globe, and soft tissues[1, 2]

- Abnormal external or direct eye exam[1]:
  - Exophthalmos (proptosis) or enophthalmos
  - Ophthalmoplegia with concern for orbital pathology[3]
  - Unilateral optic disk swelling if MRI is contraindicated or cannot be performed[4-6]
  - Documented visual defect if MRI is contraindicated or cannot be performed[7-10]
    - Unilateral or with abnormal optic disc(s) (i.e., optic disc blurring, edema, or pallor); AND
    - Not explained by an underlying diagnosis, glaucoma, or macular degeneration
- Optic Neuritis if MRI is contraindicated or cannot be performed
  - If atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery or recurrence)[11-14]
  - If needed to confirm optic neuritis and rule out compressive lesions
- Orbital trauma
  - Physical findings of direct eye injury
  - Suspected orbital trauma with indeterminate x-ray
  - For further evaluation of a fracture seen on x-ray for treatment or surgical planning
- Orbital or ocular mass/tumor, suspected, or known[1, 7]
- Clinical suspicion of orbital infection[15, 16]
- Clinical suspicion of osteomyelitis[17, 18]
  - Direct visualization of bony deformity OR
  - Abnormal x-rays

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- Clinical suspicion of Orbital Inflammatory Disease (e.g., eye pain and restricted eye movement with suspected orbital pseudotumor) if MRI is contraindicated or cannot be performed[19]
- Congenital orbital anomalies[20]
- Complex strabismus (with ophthalmoplegia or ophthalmoparesis) to aid in diagnosis, treatment and/or surgical planning[21-23]

Combination Studies with Orbit CT

- Brain CT/Orbit CT if MRI is contraindicated or cannot be performed
    - Optic neuropathy or unilateral optic disk swelling of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion, or optic nerve infiltrative disorders[24]
    - Bilateral optic disk swelling (papilledema) with vision loss[5]
    - Approved indications as noted above and being performed in high-risk populations and will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[25]

INDICATIONS FOR SELLA CT[26]

When MRI is contraindicated or cannot be performed[27, 28]

- For further evaluation of known sellar and parasellar masses
- Suspected pituitary gland disorder[29] based on any of the following:
    - Documented visual field defect suggesting compression of the optic chiasm; **OR**
    - Laboratory findings suggesting pituitary dysfunction[30]; **OR**
    - Pituitary apoplexy with sudden onset of neurological and hormonal symptoms; **OR**
    - Other imaging suggesting sella (pituitary) mass

INDICATIONS FOR TEMPORAL/MASTOID/INTERNAL AUDITORY CANAL CT

Hearing loss (documented on audiogram)[31, 32]

- Asymmetric sensorineural when MRI is contraindicated[33, 34]
- Conductive or mixed[35]
- Congenital[35]
- Cochlear implant evaluation[36]

Tinnitus[37-39]

- Pulsatile tinnitus with concern for osseous pathology of the temporal bone
- Unilateral non-pulsatile tinnitus and MRI is contraindicated or cannot be performed

Ear Infection

- Clinical suspicion of acute mastoiditis as a complication of acute otitis media[40-43]
    - Systemic illness or toxic appearance

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    - Signs of extracranial complications (e.g., postauricular swelling/erythema, auricular protrusion, retro-orbital pain, hearing loss, tinnitus, vertigo, nystagmus)
    - Not responding to treatment

  Note: MRI is also indicated if there are signs of intracranial complications (e.g., meningeal signs, cranial nerve deficits, focal neurological findings, altered mental status). This is most common in the pediatric population
- Chronic Otitis Media (with or without cholesteatoma on exam)[42, 44]
    - Failed treatment for acute otitis media

Cholesteatoma[45, 46]

CSF Otorrhea[47, 48]

- When looking to characterize a bony defect (for intermittent leaks and complex cases consider CT/MR/Nuclear Cisternography). CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay.)

Temporal Bone Fracture[49-51]

- Suspected based on mechanism of injury OR
- Indeterminate findings on initial imaging OR
- For further evaluation of a known fracture for treatment or surgical planning

Vascular Indications[52, 53]

- Suspected or known with need for further evaluation
    - Dehiscence of the jugular bulb or carotid canal OR
    - Other vascular anomalies of the temporal bone (i.e., aberrant internal carotid artery, high jugular bulb, persistent stapedial artery, aberrant petrosal sinus)

Peripheral vertigo[32, 54, 55]

- Based on clinical exam (Head-Impulse with saccade, Spontaneous unidirectional horizontal nystagmus, Dix-Hallpike maneuver); **AND**
    - Persistent symptoms after a trial of medication and four weeks of vestibular therapy (e.g., Epley's maneuvers)

Bell's Palsy/hemifacial spasm if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course)

- If atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset[56]

OTHER INDICATIONS FOR TEMPORAL BONE, MASTOID, ORBIT, SELLA, INTERNAL AUDITORY CANAL CT

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

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Post- operative/procedural evaluation

- When imaging, physical, or laboratory findings indicate surgical or procedural complications
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Computed tomography's use of thin sections with multi-planar reconstruction (e.g., axial, coronal, and sagittal planes), along with its three-dimensional rendering, permits thorough diagnosis and management of ocular and orbital disorders. Brain CT is often ordered along with CT of the orbit for head injury with orbital trauma. MRI Orbits is preferred over CT Orbits except in the case of orbital trauma, infection, or bone abnormalities

Temporal bone, mastoid, and internal auditory canal computed tomography (CT) is a unique study performed for problems, such as conductive hearing loss, chronic otitis media, mastoiditis, cholesteatoma, congenital hearing loss and cochlear implants. It is a modality of choice because it provides 3D positional information and offers a high degree of anatomic detail. It is rarely used for evaluation of VIIth or VIIIth nerve tumors.

POLICY HISTORY

Date	Summary
March 2022	Updated References Re-ordered indications Clarified: • Optic neuritis If atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery or recurrence • Clinical suspicion of Orbital Inflammatory Disease if MRI is contraindicated or cannot be performed • Pulsatile tinnitus with concern for osseous pathology of the temporal bone • Complex strabismus syndromes (with ophthalmoplegia or ophthalmoparesis)
April 2021	Updated References Reordered Indications Added: • Complex strabismus to aid in diagnosis, treatment and/or surgical planning

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	• Temporal Bone Fracture- Suspected based on mechanism of injury OR Indeterminate findings on initial imaging OR For further evaluation of a known fracture for treatment or surgical planning • If needed to confirm optic neuritis and rule out compressive lesions Clarified: • Documented visual defect if MRI is contraindicated or cannot be performed - *Unilateral or with abnormal optic disc(s) (i.e., Optic disc blurring, edema, or pallor);* • Clinical Suspicion of osteomyelitis: Direct visualization of bony deformity *OR* Abnormal X-rays • *Optic neuropathy* or unilateral optic disk swelling of unclear etiology (Combo Orbit/Brain CT) • CSF Otorrhea - *When looking to characterize a bony defect (for intermittent leaks and complex cases consider CT/MR/Nuclear Cisternography). CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)*
May 2020	<u>Clarified:</u> • Ophthalmoplegia with concern for orbital pathology • Documented visual field defect if MRI is contraindicated or cannot be performed • Orbital or ocular mass/tumor, suspected or known • Clinical Suspicion of orbital infection • Clinical Suspicion of Orbital Inflammatory Disease (eg, eye pain and restricted eye movement with suspected orbital pseudotumor) • Brain CT/Orbit CT if MRI is contraindicated or cannot be performed • Bilateral optic disk swelling (papilledema) with vision loss • Reworded: Unilateral optic disk swelling/optic neuropathy of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders • Under INDICATIONS FOR SELLA CT: clarified when MRI is contraindicated or cannot be performed • Unilateral non-pulsatile tinnitus and MRI is contraindicated or cannot be performed • Vascular Indications • Suspected or known with need for further evaluation • Dehiscence of the jugular bulb or carotid canal OR • Other vascular anomalies of the temporal bone (i.e. aberrant internal carotid artery, high jugular bulb, persistent stapedial artery, aberrant petrosal sinus) • Persistent symptoms after a trial of medication and four weeks of vestibular therapy (eg, Epley's maneuvers)

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	Added: • CT is preferred for visualizing bony detail and calcifications, MRI is superior for the evaluation of the visual pathways, globe and soft tissues • Unilateral optic disk swelling if MRI is contraindicated or cannot be performed • Under Orbital trauma o For further evaluation of a fracture seen on X-ray for treatment or surgical planning • Congenital orbital anomalies • Under indications for Sella CT: o Pituitary apoplexy with sudden onset of neurological and hormonal symptoms • Clinical Suspicion of acute mastoiditis as a complication of acute otitis o Systemic illness or toxic appearance o Signs of extracranial complications (e.g., postauricular swelling/erythema, auricular protrusion, retro-orbital pain, hearing loss, tinnitus, vertigo, nystagmus) o Not responding to treatment * MRI is also indicated if there are signs of intracranial complications (e.g., meningeal signs, cranial nerve deficits, focal neurological findings, altered mental status) * This is most common in the pediatric population • Cholesteatoma • CSF Otorrhea • Bell's Palsy/hemifacial spasm if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course) o If atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset Deleted: • Unilateral papilledema, approve dedicated Orbits CT even if Brain CT approved • "Or known" from Suspected or known pituitary gland disorder • Clinical Suspicion of acute mastoiditis with some of the following signs or symptoms o Ear infection o Postauricular swelling o Postauricular erythema o Protrusion of the auricle o Otalgia

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May 2019	<u>Orbit CT:</u> • Added clinical suspicion of osteomyelitis • Removed orbital asymmetry; vision loss with etiology not identified on ophthalmologic; diplopia; suspected hyperthyroidism such as Graves' disease <u>Combination Brain CT/Orbit CT:</u> • Added bilateral papilledema w/vision loss if MRI is contraindicated <u>Sella CT:</u> • Added suspected or known pituitary gland disorder <u>Temporal/Mastoid/IAC CT:</u> • Expanded peripheral vertigo indication to include persistent symptoms after four weeks of treatment, medication, and vestibular therapy • Removed: acoustic neuroma or peripheral cranial nerve palsy

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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MAGELLAN HAWAI'I

Specific policy administered by National Imaging Associates, Inc. (NIA)

Clinical guidelines SINUS & MAXILLOFACIAL CT LIMITED OR LOCALIZED FOLLOW UP SINUS CT	
CPT Codes: 70486, 70487, 70488, 76380	**Original Date:** September 1997
Guideline Number: NIA_CG_009	**Last Revised Date:** February 2023
	Last Reviewed Date (by NIA Committee): April 2023
	Implementation Date: April 2023

*** Refers to health plan specific language**

"IMPORTANT NOTE": CBCT is not covered for maxillofacial indications with the exception of oral surgery treatment planning when ordered by an oral surgeon."

A single authorization for CPT codes 70486, 70487, 70488, or 76380 includes imaging of the entire maxillofacial area, including face and sinuses. Multiple authorizations are not required.

INDICATIONS FOR SINUS & MAXILLOFACIAL CT

Rhinosinusitis[1-5]

- Clinical suspicion of fungal infection[6, 7]
- Clinical suspicion of complications,[8] such as
    - Preseptal, orbital, or intracranial infection[9]
    - Osteomyelitis
    - Cavernous sinus thrombosis
- Acute (<4weeks) or subacute (4-12 weeks) sinusitis (viral or bacterial)
    - Not responding to medical management including 2 or more courses of antibiotics at least 5 days each course

  Note: Imaging may be indicated in those predisposed to complications, including diabetes, immune-compromised state, or a history of facial trauma or surgery.

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- Recurrent acute rhinosinusitis with 4 or more annual episodes without persistent symptoms in between and is a possible surgical candidate
- Chronic recurrent sinusitis (>12 weeks) not responding to medical management*, is a possible surgical candidate, and with at least two of the following:
    - mucopurulent discharge
    - nasal obstruction and congestion
    - facial pain, pressure, and fullness
    - decreased or absent sense of smell

  *Note: Medical management for chronic sinusitis includes nasal saline irrigation and/or topical intranasal steroids. In chronic sinusitis, repeat imaging is not necessary unless clinical signs or symptoms have changed.
- Allergic Rhinitis – sinus imaging usually not indicated unless there are signs of complicated infection, signs of neoplasm, or persistence of symptoms/chronic rhinosinusitis despite treatment (including antihistamines) and is a possible surgical candidate[10]
- If suspected as a cause of poorly controlled asthma (endoscopic sinus surgery improves outcomes)[11]
- To evaluate in the setting of unilateral nasal polyps or obstruction (to evaluate for a potential neoplasm)[3]

Pediatrics Rhinosinusitis[12, 13]

- Persistent or recurrent sinusitis not responding to treatment (primarily antibiotics, treatment may require a change of antibiotics)
- Suspicion of orbital or central nervous system involvement (e.g., swollen eye, proptosis, altered consciousness, seizures, nerve deficit)
- Clinical suspicion of a fungal infection (more common in immunocompromised children)

Deviated nasal septum, polyp, or other structural abnormality seen on imaging or direct visualization

- Causing significant airway obstruction AND
- Imaging is needed to plan surgery or determine if surgery is appropriate[14, 15]

Suspected sinonasal mass based on exam, nasal endoscopy, or prior imaging with contraindication to MRI or if bony involvement suspected[3, 16, 17]

Refractory Asthma - these patients benefit from medical treatment and surgery together[11, 18, 19]

Anosmia or Dysosmia noted on objective testing, is persistent, of unknown origin and MRI cannot be performed[16, 17, 20, 21]

Suspected infection

- Osteomyelitis (after x-rays and MRI cannot be performed)[22]
- Abscess based on clinical signs and symptoms of infection

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Face mass[16, 17, 23]

- Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed; **OR**
- Known or highly suspected head and neck cancer on examination[16]; **OR**
- Failed 2 weeks of treatment for suspected infectious adenopathy[24]

Facial trauma[25-30]

- Severe facial trauma
- Suspected facial bone fracture with indeterminate x-ray
- For further evaluation of a known fracture for treatment or surgical planning
- CSF (cerebrospinal fluid) rhinorrhea when looking to characterize a bony defect
  Note: for CSF otorrhea should be a Temporal Bone CT; for intermittent leaks and complex cases, consider CT/MRI/Nuclear Cisternography. CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)

Salivary gland

- Sialadenitis (infection and inflammation of the salivary glands) with indeterminate ultrasound, bilateral symptoms or concern for abscess[31]
- Suspected or known salivary gland stones [32-34]

Granulomatosis with polyangiitis (Wegener's granulomatosis) disease[35]

Suspected Osteonecrosis of the Jaw[36]

- Possible etiologies: bisphosphonate treatment, dental procedures, Denosumab, radiation treatment

Lesion seen on x-ray or other study requiring further characterization (primary or secondary bone tumor, metabolic disorder)[37]

Trigeminal neuralgia/neuropathy if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course)

- If atypical features (i.e., bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain > 2min, pain outside trigeminal nerve distribution, progression)[6, 38]

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- When imaging, physical, or laboratory findings indicate surgical or procedural complications

COMBINATION OF STUDIES WITH SINUS & MAXILLOFACIAL CT

Sinus CT/Chest CT

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- Granulomatosis with polyangiitis (Wegener's granulomatosis) disease (GPA)[39]

BACKGROUND

Computed tomography (CT) primarily provides information about bony structures but may also be useful in evaluating soft tissue masses. It can help document the extent of facial bone fractures, facial infections, and abscesses, and can aid in diagnosing salivary stones. Additionally, CT may be useful in characterizing and identifying tumor extent in the face and may be used in the assessment of chronic osteomyelitis.

CT scans can provide more detailed information about the anatomy and abnormalities of the paranasal sinuses than plain films. A CT scan provides greater definition of the sinuses and is more sensitive than plain radiography for detecting sinus pathology, especially within the sphenoid and ethmoid sinuses. CT scan findings can be nonspecific, however, and should not be used routinely in the diagnosis of acute sinusitis. The primary role of CT scans is to aid in the diagnosis and management of recurrent and chronic sinusitis, or to define the anatomy of the sinuses prior to surgery.

CT vs MRI - MRI allows better differentiation of soft tissue structures within the sinuses. It is used occasionally in cases of suspected tumors or fungal sinusitis. Otherwise, MRI has no advantages over CT scanning in the evaluation of sinusitis. Disadvantages of MRI include high false-positive findings, poor bony imaging, and higher cost. MRI scans take considerably longer to accomplish than CT scans and may be difficult to obtain in patients who are claustrophobic.

Rhinosinusitis - Society consensus recommendation is not to order sinus computed tomography (CT) or indiscriminately prescribe antibiotics for uncomplicated acute rhinosinusitis.[42] Viral infections cause the majority of acute rhinosinusitis and only 0.5 percent to 2 percent progress to bacterial infections. Most acute rhinosinusitis resolves without treatment in two weeks. Uncomplicated acute rhinosinusitis is generally diagnosed clinically and does not require a sinus CT scan or other imaging. Antibiotics are not recommended for patients with uncomplicated acute rhinosinusitis who have mild illness and assurance of follow-up. If a decision is made to treat, amoxicillin should be first-line antibiotic treatment for most acute rhinosinusitis.

Anosmia - Nonstructural causes of anosmia include post viral symptoms, medications (Amitriptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Trifluoperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause. Anosmia and dysgeusia have been reported as common early symptoms in patients with COVID-19, occurring in greater than 80 percent of patients. For isolated anosmia, imaging is typically not needed once the diagnosis of COVID has been made, given the high association. As such, COVID testing should be done prior to imaging.[20, 40, 41]

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Suspected Osteonecrosis of the Jaw - CT can characterize the extension of the lesions and in detecting cortical involvement. MRI should be reserved for those patients who have soft tissue extension of the disease.[42]

Trigeminal Neuralgia - According to the International Headache Society, TN is defined as "a disorder characterized by recurrent unilateral brief electric shock-like pain, abrupt in onset and termination, limited to the distribution of one or more divisions of the trigeminal nerve and triggered by innocuous stimuli."[43]

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POLICY HISTORY

Date	Summary
March 2022	Reformatted and update references Reformatted and updated background Reformatted-structural abnormality, salivary gland, and trauma sections Clarified: • Sialadenitis (infection and inflammation of the salivary glands) with indeterminate ultrasound, bilateral symptoms, or concern for abscess • acute vs subacute sinusitis • described medical management for acute (including 2 or more courses of antibiotics at least 5 days each course) and chronic sinusitis (includes nasal saline irrigation and/or topical intranasal steroids) • Abscess Added: • Note: Imaging may be indicated in those predisposed to complications, including diabetes, immune-compromised state, or a history of facial trauma or surgery (Acute sinusitis) • And is a surgical candidate- for chronic sinusitis and recurrent acute rhinosinusitis • In chronic sinusitis, repeat imaging is not necessary unless clinical signs or symptoms have changed. • Indications for allergic rhinitis Removed: • 4 weeks of medical management for acute and chronic sinusitis
April 2021	Updated background section and references Added: • Chronic recurrent sinusitis (symptoms for >12 weeks) not responding to at least 4 weeks of medical management and with at least two of the following: o mucopurulent discharge o nasal obstruction and congestion o facial pain, pressure, and fullness o decreased or absent sense of smell • Facial Trauma- For further evaluation of a known fracture for treatment or surgical planning • Suspected sinonasal mass based on exam, nasal endoscopy, or prior imaging with contraindication to MRI or if bony involvement suspected • Dysosmia • Sialadenitis with indeterminate ultrasound or bilateral symptoms

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	Clarified: • Rhinosinusitis - Symptoms that persist for more than 4 weeks and are not responding to medical management (e.g. 2 or more courses of antibiotics or any combination of antibiotics, steroids or antihistamines for more than 4 weeks • CSF (cerebrospinal fluid) rhinorrhea *when looking to characterize a bony defect* (for CSF otorrhea should be a Temporal Bone CT; *for intermittent leaks and complex cases consider CT/MR/Nuclear Cisternography). CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)* • *Suspicion of* salivary gland stones Deleted: • For poorly controlled asthma associated with upper respiratory tract infection. May be performed without failing 4 consecutive weeks of treatment with medication. • Trigeminal neuralgia – if Age < 40
May 2020	• Updated references; Updated and reordered background information • Reordered and reformatted indications • Clarified: o Reworded: Rhinosinusitis: Clinical suspicion of complications, such Preseptal, orbital or intracranial infection, Osteomyelitis, Cavernous sinus thrombosis o Deviated nasal septum, polyp, or other structural abnormality seen on imaging or direct visualization that may be causing significant airway obstruction (if needed to plan surgery or determine if surgery is appropriate) o Refractory Asthma (Sinus CT) - these patients benefit from medical treatment and surgery together o Anosmia noted on objective testing, is persistent, of unknown origin and MRI cannot be done o Suspected infection: Osteomyelitis (after x-rays, MRI cannot be done) Facial trauma: Post traumatic CSF (cerebrospinal fluid) rhinorrhea (for CSF otorrhea should be a Temporal Bone CT) Added: • Rhinosinusitis o Recurrent acute rhinosinusitis with 4 or more annual episodes without persistent symptoms in between o If suspected as a cause of poorly controlled asthma (endoscopic sinus surgery improves outcomes) (Vashishta, 2013)

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	○ To evaluate in the setting of unilateral nasal polyps or obstruction (to evaluate for a potential neoplasm) (Rosenfeld, 2015) • Pediatrics Rhinosinusitis (ACR, 2018; Wald, 2013) ○ Persistent or recurrent sinusitis not responding to treatment (primarily antibiotics, treatment may require a change of antibiotics) ○ Suspicion of orbital or central nervous system involvement (e.g., swollen eye, proptosis, altered consciousness, seizures, nerve deficit) (Ward, 2013) ○ Clinical suspicion of a fungal infection (more common in immunocompromised children). Added: • Suspected Osteonecrosis of the Jaw (Popovic, 2010) ○ Possible etiologies: biphosphonate treatment, dental procedures, Denosumab, radiation treatment) ○ CT can characterize the extension of the lesions and in detecting cortical involvement. MRI should be reserved for those patients who have soft tissue extension of the disease • Lesion seen on xray or other study requiring further characterization (primary or secondary bone tumor, metabolic disorder) • Trigeminal neuralgia/neuropathy if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course) ○ If < 40 years of age or atypical features (ie bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain > 2min, pain outside trigeminal nerve distribution, progression) (Policeni, 2017; Hughes, 2016; ACR CN, 2017) Added: • Suspected infection: Abscess • Face mass: Known or highly suspected head and neck cancer on examination • Facial trauma: Severe facial trauma Deleted: • Symptoms persist after four (4) **consecutive** weeks of medication, e.g., antibiotics, steroids or anti-histamines • Clinical Suspicion of osteomyelitis: **Direct visualization of lesion over bone**

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	Deleted: • Face Mass o Unless increased risk for malignancy based on ▪ Any of these: ▪ Fixation to adjacent tissues ▪ Firm consistency ▪ Size >1.5 cm ▪ Ulceration of overlying skin o Clinical concern for abscess • Facial trauma: Physical findings of direct facial bone injury
May 2019	• Added: Suspected orbital trauma w/indeterminate x-ray or US • Added specifics to Face Mass: o Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed (Kuno, 2014) o Clinical concern for abscess o Failed 2 weeks of treatment for suspected infectious adenopathy (Haynes, 2015). • Removed: o Hyposmia • Immunocompromised patient

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **NECK CT (soft tissue)**	**Original Date: September 1997**
CPT Codes: 70490, 70491, 70492	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_008-1	**Implementation Date: January 2023**

INDICATIONS FOR NECK CT[1, 2]

Suspected tumor or cancer

- Suspicious lesions in mouth or throat[3]
- Suspicious mass/tumor found on another imaging study and needing clarification[1]
- Neck mass or lymphadenopathy (not parotid region and not thyroid region):
    - Present on physical exam and remains non-diagnostic after ultrasound is completed[3]
    - Mass or abnormality found on other imaging study and needing further evaluation
    - Increased risk for malignancy[4] with one or more of the following findings[5]:
        - Fixation to adjacent tissues
        - Firm consistency
        - Size >1.5 cm
        - Ulceration of overlying skin
        - Mass present ≥ two weeks (or uncertain duration) without significant fluctuation and not considered of infectious cause
        - History of cancer
    - Failed 2 weeks of treatment for suspected infectious adenopathy[6]
    - Pediatric (≤18 years old) considerations[7]
        - Ultrasound should be inconclusive or suspicious unless there is a history of malignancy[8]

  Note: For discrete cystic lesions of the neck, an ultrasound should be performed as initial imaging unless there is a high suspicion of malignancy
- Neck Mass (parotid region)[1]
    - Parotid mass found on other imaging study and needing further evaluation

  Note: US is the initial imaging study of a parotid region mass to determine if the location is inside or outside the gland[1, 9, 10]
- Neck Mass (thyroid region)[2]
    - Staging and monitoring for recurrence of known thyroid cancer[2]
    - To assess extent of thyroid tissue when other imaging suggests extension through the thoracic inlet into the mediastinum or concern for airway compression[11, 12]

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Note: US is the initial imaging study of a thyroid region mass. Biopsy is usually the next step. In the evaluation of known thyroid malignancy, CT is preferred over MRI since there is less respiratory motion artifact. Chest CT may be included for preoperative assessment in some cases.

Known or suspected deep space infections or abscesses of the pharynx or neck with signs or symptoms of infection[13]

Known tumor or cancer of skull base, tongue, larynx, nasopharynx, pharynx, or salivary glands

- Initial staging[3]
- Restaging during treatment
- Areas difficult to visualize on follow-up examination
- Suspected recurrence or metastases based on symptoms or examination findings[14]
    - New mass
    - Change in lymph nodes

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation (e.g., post neck dissection)

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other indications for a Neck CT

- Sialadenitis (infection and inflammation of the salivary glands) with indeterminate ultrasound, bilateral symptoms or concern for abscess[15]
- Suspected or known salivary gland stones [10, 15-18]
- To assess for foreign body when radiograph is inconclusive or negative[19]
- Vocal cord lesions or vocal cord paralysis[20]
- For evaluation of tracheal stenosis[21, 22]
- Dysphagia after appropriate work up including endoscopy and fluoroscopic studies (modified barium swallow, or biphasic esophogram)[23, 24]
- Unexplained throat pain for more than 2 weeks when ordered by a specialist with all of the following[25-27]
    - Complete otolaryngologic exam and laryngoscopy

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    - No signs of infection
    - Evaluation for and failed treatment of laryngopharyngeal reflux
    - Risk factor for malignancy, i.e., tobacco use, alcohol use, dysphagia, weight loss OR age older than 50 years
- Unexplained ear pain when ordered by a specialist and MRI is contraindicated with all of the following[28]
    - Otoscopic exam, nasolaryngoscopy, lab evaluation (ESR, CBC) AND
    - Risk factor for malignancy, i.e., tobacco use, alcohol use, dysphagia, weight loss OR age older than 50 years
- Diagnosed primary hyperparathyroidism when surgery is planned
    - Previous nondiagnostic ultrasound or nuclear medicine scan[29]
- Bell's palsy/hemifacial spasm, if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course)
    - If atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset[30]
- Objective cranial nerve palsy (CN IX-XII) if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course)[31, 32]

BACKGROUND

High resolution CT can visualize both normal and pathologic anatomy of the neck. It is used in the evaluation of neck soft tissue masses, abscesses, and lymphadenopathy. For neck tumors, it defines the extent of the primary tumor and identifies lymph node spread. CT provides details about the larynx and cervical trachea and its pathology. Additional information regarding airway pathology is provided by three-dimensional images created from the CT dataset. Neck CT can also accurately depict and characterize tracheal stenoses.

With the rise of human papillomavirus-related oral, pharyngeal, and laryngeal cancers in adults, contrast-enhanced neck CT has become more important for the evaluation of a neck mass, deemed at risk for malignancy, surpassing ultrasound for the initial evaluation in many cases. The American Academy of Otolaryngology-Head and Neck Surgery recently issued strong recommendations for neck CT or MRI, emphasizing the importance of a timely diagnosis.[5]

POLICY HISTORY

Date	Summary
March 2022	Reformatted indications Clarified: • Thyroid imaging • Abscess • Suspected or known salivary gland stones

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	Added: Sialadenitis (infection and inflammation of the salivary glands) with indeterminate ultrasound, bilateral symptoms, or concern for abscess
April 2021	Updated references Re-ordered indications Added: • Neck Mass or ***lymphadenopathy*** • Mass or abnormality found on other imaging study and needing further evaluation • Unexplained throat pain for more than 2 weeks when ordered by a specialist with all of the following o Complete otolaryngologic exam and laryngoscopy o No signs of infection o Evaluation for and/or failed treatment of laryngopharyngeal reflux o Risk factor for malignancy i.e. tobacco use, alcohol use, dysphagia, weight loss OR age older than 50 years • Unexplained ear pain when ordered by a specialist and MRI is contraindicated with all of the following (Earwood, 2018) o Otoscopic exam, nasolaryngoscopy, lab evaluation (ESR, CBC) AND o Risk factor for malignancy ie tobacco use, alcohol use, dysphagia, weight loss OR age older than 50 years Clarified: • Not parotid region and not thyroid region • Known or suspected deep space infections or abscesses of the pharynx or neck with ***signs or symptoms of infection*** • Pre-operative evaluation for a planned surgery or procedure
May 2020	Clarified: • Note: For discrete cystic lesions of the neck, an ultrasound should be performed as initial imaging **unless there is a high suspicion of malignancy** Added: • Neck Mass (non-parotid region or thyroid): o Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed o Increased risk for malignancy o Failed 2 weeks of treatment for suspected infectious adenopathy • Under increased risk for malignancy o History of cancer

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	Added: • Neck Mass (parotid) o Parotid mass found on other imaging study and needing further evaluation • Neck Mass (thyroid) - US is the initial imaging study of a thyroid region mass. CT is preferred over MRI in the evaluation of thyroid masses since there is less respiratory motion artifact o Staging and monitoring for recurrence of known thyroid cancer • Pediatric patients (≤18 years old) o Neck masses in the pediatric population if ultrasound is inconclusive or suspicious o History of malignancy • Under known tumor or cancer of skull base, tongue, larynx, nasopharynx, pharynx, or salivary glands o Areas difficult to visualize on follow-up examination Added: • Bell's palsy/hemifacial spasm, if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course) o If atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset • Objective cranial nerve palsy (CN IX-XII) if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course) Deleted: • **Palpable** from Palpable suspicious lesions in mouth or throat • Or found by physical exam from Suspicious mass/tumor found on another imaging study and needing clarification • For all other non-thyroid neck masses with high suspicion for malignancy start with neck CT Deleted: • Pediatric patients (≤ 18 years old, ultrasounds should be completed as initial imaging o Neck masses are a common presenting complaint in the pediatric population with malignant causes less likely than in adults • Suspected (salivary) gland abscess or mass • Thoracic Outlet Syndrome
April 2019	• Suspected Tumor or Cancer:

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	o Added specification: "Suspected tumor or cancer *(not parotid region or thyroid)"* and removed non-diagnostic specification: 'Suspicious mass/tumor found on imaging study and needing clarification or found by physical exam *and remains non-diagnostic after x-ray or ultrasound is completed'*. o Added: "*Ultrasound should be completed as the initial imaging*" o Indication: Increased risk of malignancy, removed: '*No known infection and unknown duration with no fluctuation on exam'*; Added: "*Mass present ≥ two weeks without significant fluctuation and not considered of infectious origin*" • For pediatric patients, added indication specifying an Ultrasound should be completed as initial imaging • Added indications: Foreign body, brachial plexus, dysphagia, extent of thyroid tissue affected after other imaging completed or concern for airway compression • Added Background information emphasizing the importance of timely diagnosis of neck mass with Neck CT, due to prevalence of HPV and associated oral, pharyngeal, and laryngeal cancers

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **BRAIN (HEAD) CTA**	**Original Date: September 1997**
CPT Codes: 70496	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_004-1	**Implementation Date: January 2023**

INDICATIONS FOR BRAIN CTA

Brain CT/CTA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain CT/Brain CTA combination studies section. If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the combination section as noted in the guidelines)

Patients with claustrophobia, limited ability to cooperate, an implanted device or in an urgent scenario may be better suited for CTA; whereas those with renal disease or iodine contrast allergy should have MRA.[1]

For evaluation of suspected intracranial vascular disease[2, 3]

Aneurysm screening

- Screening for suspected intracranial aneurysm in patient with first-degree family history (parent, brother, sister, or child) of intracranial aneurysm
  Note: Repeat study is recommended every 5 years[4]
- Screening for aneurysm in polycystic kidney disease (after age 30), Loeys-Dietz syndrome‡, fibromuscular dysplasia, spontaneous coronary arteries dissection (SCAD), or known aortic coarctation (after age 10)[5-9]
  ‡For Loeys-Dietz, imaging should be repeated at least every two years

Vascular abnormalities

- Suspected vascular malformation (arteriovenous malformation (AVM) or dural arteriovenous fistula) in patient with previous or indeterminate imaging study

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- Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset[10-13]
  Note: Negative brain CT < 6 hours after headache onset excludes subarachnoid hemorrhage in neurologically intact patients[13]
- Headache associated with exercise or sexual activity[14]
- Isolated third nerve palsy (oculomotor) with pupil involvement to evaluate for aneurysm[15]
- Pulsatile tinnitus to identify a suspected arterial vascular etiology[16, 17]

Note: MRI is the study of choice for detecting low flow malformations (see background) [18-20]

Cerebrovascular Disease

Ischemic

- Recent ischemic stroke or transient ischemic attack (See background section)[21, 22]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[23, 24]

Hemorrhagic

- Known subarachnoid hemorrhage (SAH)[25]
- Known cerebral intraparenchymal hemorrhage with concern for underlying vascular abnormality

Venous and MRV is contraindicated or cannot be performed[26]- CTV**

- Suspected venous thrombosis (dural sinus thrombosis)[27, 28]
- Distinguishing benign intracranial hypertension (pseudotumor cerebri) from dural sinus thrombosis[29, 30]

Sickle cells disease (ischemic and/or hemorrhagic) and MRA is contraindicated or cannot be performed[31]

- Neurological signs or symptoms in sickle cell disease
- Stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200

Vasculitis with initial laboratory workup (such as ESR, CRP, serology)[32]

- Suspected secondary CNS vasculitis based on neurological signs or symptoms in the setting of an underlying systemic disease with abnormal inflammatory markers or autoimmune antibodies
- Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up[33, 34]

Other intracranial vascular disease

- Suspected Moyomoya disease[35, 36]
- Suspected reversible cerebral vasoconstriction syndrome[37]
- Giant cell arteritis with suspected intracranial involvement[38]

For evaluation of known intracranial vascular disease[2, 3]

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- Known intracranial aneurysm, treated aneurysm, or known vascular malformation (i.e., AVM or dural arteriovenous fistula)
- Vascular abnormality visualized on previous brain imaging that is equivocal or needs further evaluation
- Known vertebrobasilar insufficiency with new or worsening signs or symptoms (VBI)[23, 24]
- Known vasculitis, reversible cerebral vasoconstriction syndrome or Moyomoya disease[33, 35-37]

Pre-operative/procedural evaluation for brain/skull surgery

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation[39, 40]

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Indications for Brain CTA/Neck CTA combination studies

- Recent ischemic stroke or transient ischemic attack[21]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[23, 24]
- Suspected carotid or vertebral artery dissection; secondary to trauma or spontaneous due to weakness of vessel wall[41, 42]
- Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[43-45]
- Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[43, 46]
- Pulsatile tinnitus to identify a suspected arterial vascular etiology[16, 17]

Indications for Brain CT/Brain CTA combination studies[2, 3]

- Recent ischemic stroke or transient ischemic attack (TIA) when MRI is contraindicated or cannot be performed
- Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
- Headache associated with exercise or sexual activity when MRI is contraindicated or cannot be performed[14]
- Suspected venous thrombosis (dural sinus thrombosis) and MRI is contraindicated or cannot be performed – CT/CTV**
- Neurological signs or symptoms in sickle cell patients when MRI is contraindicated or cannot be performed

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- High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200 when MRI is contraindicated or cannot be performed

Indications for Brain CT/Brain CTA/Neck CTA combination studies

- Recent ischemic stroke or transient ischemic attack (TIA)[2, 3] when MRI is contraindicated or cannot be performed
- Approved indications as noted above and being performed in high-risk populations (in whom MRI is contraindicated or cannot be performed) and will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology

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BACKGROUND

Computed tomography angiography (CTA) is recognized as a valuable diagnostic tool for the management of patients with cerebrovascular disease. With its three-dimensional reconstructions, CTA can simultaneously demonstrate the bony skull base and its related vasculature. CTA use of ionizing radiation and an iodine-based intravascular contrast medium is a disadvantage when compared to magnetic resonance angiography (MRA), but it is quicker and requires less patient cooperation than MRA. CTA is much less invasive than catheter angiography which involves injecting contrast material into an artery.

CTA for Evaluation of Aneurysm – CTA is useful in the detection of cerebral aneurysms. The sensitivity of CTA to detect cerebral aneurysms $\leq$ 5 mm is higher than that with digital subtraction angiography (DSA). Most aneurysms missed with CTA are $\leq$ 3mm. Aneurysms in the region of the anterior clinoid process may extend into the subarachnoid space where they carry the threat of hemorrhage. CTA can help delineate the borders of the aneurysm in relation to the subarachnoid space and may help detect acute ruptured aneurysms. It may be used in the selection of patients for surgical or endovascular treatment of ruptured intracranial aneurysms.

CTA for Screening of Patients with first-degree relative (parent, brother, sister or child) who have a history of aneurysm – Data has suggested that individuals with a parent, brother, sister, or child harboring an intracranial aneurysm are at increased risk of aneurysms. It is likely that multiple genetic and environmental risk factors contribute to the increased risk.

CTA for evaluation of Arteriovenous Malformation (AVM) – A good correlation has been found between catheter angiography and CTA in the detection of arteriovenous malformations. CTA allows calculation of the volume of an AVM nidus and identifies and quantifies embolic material within it. CTA may be used for characterization and stereotactic localization before surgical resection or radiosurgical treatment of arteriovenous malformations.

CTA and non-aneurysmal vascular malformations – Non-aneurysmal vascular malformations can be divided in low flow vascular malformations and high flow vascular malformations. Low flow vascular malformations include dural venous anomalies (DVA), cavernomas, and capillary telangiectasias. High flow vascular malformations include AVM and dural arteriovenous fistulas (dAVF). For low flow malformations, MRI is the study of choice. There is limited medical

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literature to support vascular imagining (CTA or MRA). CTA plays a limited role in the assessment of cavernoma but may be used to demonstrate a DVA. MRA is not usually helpful in the assessment of cavernoma, capillary telangiectasia, and DVA. Vascular imaging is indicated in high flow vascular malformations.[2, 3, 20]

MRA vs CTA for CVA – Preferred vascular imaging of the head and neck includes noncontrast head MRA and contrast-enhanced neck MRA. MRA may not be able to be performed in patients with claustrophobia, morbid obesity, or implanted device, but it can be useful in patients with renal failure or contrast allergies. In patients with high radiation exposure, MRA as an alternative should be considered. For acute stroke, CTA is preferred after CT (to rule of hemorrhage) and to look for thrombus/possible intervention that is time-sensitive.[47]

CTA and recent stroke or transient ischemic attack – A stroke or central nervous system infarction is defined as "brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. … Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms".[48] If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes.[49] TIAs in contrast, "are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging".[50] On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention.[51]

When revascularization therapy is not indicated or available in patients with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology, assess immediate complications and risk of future stroke. The majority of stroke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD (2) score ≥ 3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis.[50] Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors such as carotid stenosis atrial fibrillation as the cause of ischemic symptoms.[49] Diagnostic recommendations include neuroimaging evaluation as soon as possible, preferably with magnetic resonance imaging, including DWI; noninvasive imaging of the extracranial vessels should be performed, and noninvasive imaging of intracranial vessels is reasonable.[22]

Patients with a history of stroke and recent work-up with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Patients with remote or silent strokes discovered on imaging should be evaluated for

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high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.

CTA for Evaluation of Vertebrobasilar Insufficiency (VBI) – Multidetector CT angiography (MDCTA) may be used in the evaluation of vertebral artery pathologies. The correlation between MDCTA and color Doppler sonography is moderate. CTA is used for minimally invasive follow-up after intracranial stenting for VBI. It enables visualization of the patency of the stent lumen and provides additional information about all brain arteries and the brain parenchyma.

CTA and Intracerebral Hemorrhage – CTA is useful as a screening tool for an underlying vascular abnormality in the evaluation of spontaneous intracerebral hemorrhage (ICH). Etiologies of spontaneous ICH include tumor, vascular malformation, aneurysm, hypertensive arteriopathy, cerebral amyloid angiopathy, venous thrombosis, vasculitis, RCVS, drug-induced vasospasm, venous sinus thrombosis, Moyomoya disease, anticoagulant use and hemorrhagic transformation of an ischemic infarct. History can help point to a specific etiology. Possible risk factors for the presence of underlying vascular abnormalities include age younger than 65, female, lobar or intraventricular location, and the absence of hypertension or impaired coagulation.[52]

CTV and Central Venous Thrombosis** – a CT Venogram is indicated for the evaluation of a central venous thrombosis/dural sinus thrombosis. The most frequent presentations are isolated headache, intracranial hypertension syndrome, seizures, focal neurological deficits, and encephalopathy. Risk factors are hypercoagulable states inducing genetic prothrombotic conditions, antiphospholipid syndrome and other acquired prothrombotic diseases, such as cancer, oral contraceptives, pregnancy, puerperium (6 weeks postpartum), infections, and trauma. Since venous thrombosis can cause SAH, infarctions, and hemorrhage, parenchymal imaging with MRI/CT is also appropriate.[26, 53-55]

CTA and dissection- Craniocervical dissections can be spontaneous or traumatic. Patients with blunt head or neck trauma who meet Denver Screening criteria should be assessed for cerebrovascular injury (although about 20% will not meet criteria). The criteria include: focal or lateralizing neurological deficits (not explained by head CT), infarct on head CT, face, basilar skull, or cervical spine fractures, cervical hematomas that are not expanding, glasgow coma score less than 8 without CT findings, massive epistaxis, cervical bruit or thrill.[41, 56-58] Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms. There is often minor trauma or precipitating factor (i.e., exercise, neck manipulation). Dissection is thought to occur due to weakness of the vessel wall, and there may be an underlying connective tissue disorder. Dissection of the extracranial vessels can extend intracranially and/or lead to thrombus which can migrate into the intracranial circulation causing ischemia. Therefore, vascular imaging of the head and neck is warranted.[42, 59]

POLICY HISTORY

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Date	Summary
March 2022	Updated and reformatted references Added New combo statement Updated background Clarified: • Aneurysm screening in aortic coarctation after age 10 • MRI is the study of choice for detecting low flow vascular malformations (see background) • Follow-up of known intracranial aneurysm, treated aneurysm, or known vascular malformation • Pulsatile tinnitus to identify a suspected arterial vascular etiology • Combo studies- CVA/TIA when MRI is contraindicated or cannot be performed Changed: • Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset Added: • Brain MRI/Brain MRA combination (when MRI contraindicated) o Neurological signs or symptoms in sickle cell patients o High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200
June 2021	• Updated references • Reformatted and reordered indications Added: • Brain CT/CTA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain CT/Brain CTA combination studies section • Headache associated with exercise or sexual activity (also in combo section if MRI contraindicated) • Note: MRI is the study of choice for detecting cavernomas • Giant cell arteritis with suspected intracranial involvement • Pre-operative evaluation for a planned surgery or procedure Clarified: • *For Loeys-Dietz imaging should be repeated at least every two years • Known vertebrobasilar insufficiency with new or worsening signs or symptoms

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	• Vasculitis with initial laboratory workup (such as ESR, CRP, serology)
May 2020	• Updated background information references • Reordered and categorized indications and background information Clarified: • Screening for aneurysm: polycystic kidney disease (after age 30) • Suspected or known dural arteriovenous fistula as an example of a vascular malformation • Recent ischemic stroke or transient ischemic attack (also in all combo sections) • Cerebral intraparenchymal hemorrhage • Suspected secondary CNS vasculitis based on neurological sign or symptoms in the setting of an underlying systemic disease • Suspected primary CNS vasculitis based on neurological signs and symptoms • Vascular abnormality visualized on previous brain imaging that is equivocal or needs further evaluation • Reworded- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection – in the combo Neck/Brain CTA section • Approved indications as noted above and being performed in high risk populations (in whom MRI is contraindicated or cannot be performed) and will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology Added: • Patients with claustrophobia, limited ability to cooperate or an implanted device may be better suited for CTA, whereas those renal disease or iodine contrast allergy should have MRA • Screening for aneurysm: Loeys-Dietz syndrome • Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up o Negative Brain CT; AND o Negative Lumbar Puncture; OR o Negative Brain MRI • Isolated third nerve palsy (oculomotor) with pupil involvement to evaluate for aneurysm • Vasculitis with initial laboratory workup (such as ESR, CRP, plasma viscosity)

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	• For venous studies that MRV is contraindicated or cannot be performed- CTV • Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm – in combo Brain CT/CTA section Deleted • Screening for aneurysm: Ehlers-Danlos syndrome, neurofibromatosis • Clinical suspicion of subarachnoid hemorrhage (SAH) (i.e., thunderclap headache) • Known or suspected carotid or cerebral artery occlusion in patients with a sudden onset of one-sided weakness or numbness, abnormal speech, vision defects, incoordination or severe dizziness - in the combo Neck/Brain CTA section • Clinical suspicion of subarachnoid hemorrhage (SAH) (i.e., thunderclap headache) in the combo Brain CT/CTA section
August 2019	• Reversible cerebral vasoconstriction syndrome or Moyomoya disease • Clinical suspicion of subarachnoid hemorrhage (SAH) (i.e., thunderclap headache) • Spontaneous intracerebral hemorrhage with concern for underlying vascular abnormality • Suspected primary CNS vasculitis with infectious/inflammatory lab work-up, reversible cerebral vasoconstriction syndrome or Moyomoya disease • Stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity >200. • Neurological signs or symptoms in sickle cell disease • Further clarified: o Suspected vertebrobasilar insufficiency (VBI) symptoms o CTV for suspected central venous thrombosis • For Brain CTA/Neck CTA combination studies: o Removed the past two-week restriction from 'recent stroke or TIA' o Clarified CVA symptoms to include - known or suspected carotid or cerebral artery occlusion with sudden onset of numbness or incoordination o Added spontaneous injuries due to weakness of vessel wall leading to dissection o Added Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g.

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	carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate o Added Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g. carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate • Added section for Brain CT/Brain CTA combination studies, including: o Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache o Suspected venous thrombosis (dural sinus thrombosis) • Added section for Brain CT/Brain CTA/Neck CTA combination studies, including: o Recent stroke or transient ischemic attack (TIA) o Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology • Updated background info and refs

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **NECK CTA**	**Original Date: September 1997**
CPT Codes: 70498	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_012-1	**Implementation Date: January 2023**

INDICATIONS FOR NECK CTA

If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the combination section as noted in the guidelines)

Patients with claustrophobia, limited ability to cooperate, an implanted device or in an urgent situation may be better suited for CTA, whereas those with extensive calcification, renal disease iodine contrast allergy should have MRA.[1]

For evaluation of known or suspected extracranial vascular disease

Cerebrovascular Disease

- Recent ischemic stroke or transient ischemic attack[2-4]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[5-7]
- Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries)[8-10]
- Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries)[8, 11, 12]

Aneurysm screening

- Screening for aneurysm in Loeys-Dietz syndrome**, fibromuscular dysplasia or spontaneous coronary arteries dissection (SCAD)[13-16]
  **For Loeys-Dietz imaging should be repeated at least every two years

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Tumor/pulsatile mass

- Pulsatile mass on exam[17]
- Known or suspected carotid body tumors, or other masses such as a paraganglioma, arteriovenous fistula pseudoaneurysm, atypical lymphovascular malformation[18]
  Note: Ultrasound (US) may be used to identify a mass overlying or next to an artery in initial work up of a pulsatile mass.

Other extracranial vascular disease[19]

- Large vessel vasculitis (Giant cell or Takayasu arteritis) with suspected extracranial involvement[20-23]
- Subclavian steal syndrome when ultrasound is positive or indeterminate OR for planning interventions[24]
- Suspected carotid or vertebral artery dissection; secondary to trauma or spontaneous due to weakness of vessel wall[25, 26]
- To identity an arterial source of bleeding in patients with hemorrhage of the head and neck[27]
- Horner's syndrome (miosis, ptosis, and anhidrosis)[28]
- For evaluation of pulsatile tinnitus (subjective or objective) for suspected arterial vascular etiology[29]
- Known extracranial vascular disease that needs follow-up or further evaluation

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation (e.g., carotid endarterectomy)

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

INDICATIONS FOR COMBINATION STUDIES

Neck CTA/Brain CTA

- Recent ischemic stroke or transient ischemic attack (TIA)[2, 3, 30]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[5, 7]
- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall[25, 26]
- Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[8-10]

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- Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[8, 11, 12]
- Pulsatile tinnitus (subjective or objective) for suspected arterial vascular etiology[29]

BACKGROUND

For vascular disease, MRA and CTA are generally comparable. No current literature compares the efficacy of contrast enhanced CT to CTA or MRI and MRA for evaluation of pulsatile neck mass, so any are approvable.[31] CTA may be complementary to CT in the following settings: evaluation of a pulsatile neck mass to assess vascular detail when needed; assessment of relevant vascular anatomy for pre-procedural evaluation; vascular supply to tumors and vessel encasement and narrowing by tumors; extent of disease in vasculitis; and to help determine the nature and extent of congenital or acquired vascular anomalies.

MRA vs CTA for Carotid Artery Evaluation[32, 33] - MRA and CTA are generally comparable noninvasive imaging alternatives, each with their own advantages and disadvantages. Advantages of CTA over MRA include superior spatial resolution, rapid image acquisition, decreased susceptibility to motion artifacts and artifacts from calcification as well as being better able to evaluate slow flow and tandem lesions. However, CTA can also overestimate high-grade stenosis. Limitations of CTA include radiation exposure to the patient, necessity of IV contrast, and risk of contrast allergy and contrast nephropathy. MRA is an excellent screening test since it does not utilize ionizing radiation. Duplex US and contrast-MRA is a common choice for carotid artery evaluation. Limitations of MRA include difficulty in patients with claustrophobia and the risk of nephrogenic systemic sclerosis with gadolinium contrast agents in specific patients. In patients with high radiation exposure, MRA as an alternative imaging modality should be considered.

CTA and dissection - Craniocervical dissections can be spontaneous or traumatic. Patients with blunt head or neck trauma who meet Denver Screening criteria should be assessed for cerebrovascular injury (although about 20% will not meet criteria). The criteria include: focal or lateralizing neurological deficits (not explained by head CT), infarct on head CT, face, basilar skull, or cervical spine fractures, cervical hematomas that are not expanding, glasgow coma score less than 8 without CT findings, massive epistaxis, cervical bruit or thrill.[25, 34-36] Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms. There is often minor trauma or precipitating factor (e.g., exercise, neck manipulation). Dissection is thought to occur due to weakness of the vessel wall, and there may be an underlying connective tissue disorder. Dissection of the extracranial vessels can extend intracranially and/or lead to thrombus, which can migrate into the intracranial circulation causing ischemia. Therefore, MRA of the head and neck is warranted.[26, 37]

CTA and recent stroke or transient ischemic attack (TIA) - A stroke or central nervous system infarction is defined as “brain, spinal cord, or retinal cell death attributable to ischemia, based

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on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. … Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms."[38] If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes.[39] TIAs in contrast, "are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging."[40] On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention.[41]

When revascularization therapy is not indicated or available in patients with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology, assess immediate complications and risk of future stroke. The majority of stroke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD(2) score ≥3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis.[40] Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors, such as carotid stenosis atrial fibrillation, as the cause of ischemic symptoms.[39] Diagnostic recommendations include neuroimaging evaluation as soon as possible, preferably with magnetic resonance imaging, including DWI; noninvasive imaging of the extracranial vessels should be performed, and noninvasive imaging of intracranial vessels is reasonable.[30]

Patients with a history of stroke and recent work up with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Patients with remote or silent strokes discovered on imaging should be evaluated for high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.[30, 38-41]

POLICY HISTORY

Date	Summary
March 2022	Updated and reformatted references Expanded background on CTA vs MRA Clarified • Pulsatile tinnitus to identify a suspected arterial vascular etiology • Large vessel vasculitis with suspected extracranial involvement Added: • To identity an arterial source of bleeding in patients with hemorrhage of the head and neck

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	• New Combo statement
May 2021	Updated references Added: • Loeys-Dietz syndrome to aneurysm screening section • Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia and weakness in both sides of the body, or abnormal speech – which was before only in the combo section • Pulsatile mass on exam • For evaluation of pulsatile tinnitus (subjective or objective) for vascular etiology - which was before only in the combo section • Pre-operative evaluation for a planned surgery or procedure Clarified: • Giant cell arteritis *with suspected extracranial involvement* • *Known* carotid body tumors, or other masses such as a paraganglioma, arteriovenous fistula pseudoaneurysm, atypical lymphovascular malformation
May 2020	Clarified: • Patients with claustrophobia, limited ability to cooperate or an implanted device may be better suited for CTA, whereas those with extensive calcification, renal disease or iodine contrast allergy should have MRA • Recent ischemic stroke or transient ischemic attack (also in combo section) • Pulsatile mass on exam after ultrasound (US) • Takayasu arteritis based on findings in other blood vessels on previous imaging • Giant cell arteritis • Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia and weakness in both sides of the body, or abnormal speech • Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (combo section) Added: • Known extracranial vascular disease that needs follow-up or further evaluation • Spontaneous coronary arteries dissection (SCAD) in screening for aneurysm

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	• Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection • Horner's syndrome (miosis, ptosis, and anhidrosis) • Known extracranial vascular disease that needs follow-up or further evaluation Deleted: • Ehlers-Danlos syndrome and neurofibromatosis in screening for aneurysm
April 2019	• Added initial statement describing the use of CTA versus MRA • Suspected or known disease: Added "Giant cell arteritis" and "Subclavian steal syndrome when ultrasound is positive or indeterminate or for planning interventions • "Known or suspected tumor/*pulsatile* mass": Added 'pulsatile'; • Neck CTA/Brain CTA: Added Denver screening criteria to assess for cerebrovascular injury • Added background information describing CTA and MRA as complimentary information to CT or MRI

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **SINUS, FACE, ORBIT, NECK MRI**	**Original Date: November 2007**
CPT Codes: 70540, 70542, 70543	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_014	**Implementation Date: January 2023**

INDICATIONS FOR ORBIT MRI

If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the combination section as noted in the guidelines)

MRI is superior for the evaluation of the visual pathways, globe and soft tissues; CT is preferred for visualizing bony detail and calcifications[1,2]

- **Abnormal external or direct eye exam**
  - Exophthalmos (proptosis) or enophthalmos
  - Ophthalmoplegia with concern for orbital pathology
  - Unilateral optic disk swelling[3-5]
  - Documented visual field defect[6-9]
    - Unilateral or with abnormal optic disc(s) (e.g., optic disc blurring, edema, or pallor); **AND**
    - Not explained by underlying diagnosis, glaucoma, or macular degeneration

- **Optic neuritis[10-13]**
  - If atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery or recurrence)[14,15]
  - If needed to confirm optic neuritis and rule out compressive lesions

- **Orbital trauma[16,17]**

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- Physical findings of direct eye injury
- Suspected orbital trauma with indeterminate x-ray or ultrasound

- **Orbital or ocular mass/tumor, suspected or known**[1,7]

- **Clinical suspicion of orbital infection**[1,2]

- **Clinical suspicion of osteomyelitis**[18,19]
  - Direct visualization of bony deformity OR
  - Abnormal x-rays

- **Clinical suspicion of Orbital Inflammatory Disease** (e.g., eye pain and restricted eye movement with suspected orbital pseudotumor)[20]

- **Congenital orbital anomalies**

- **Complex strabismus syndromes** (with ophthalmoplegia or ophthalmoparesis) to aid in diagnosis, treatment and/or surgical planning[21-23]

NOTE: FOR ADDITIONAL ONCOLOGIC ORBIT MRI INDICATIONS, CLICK HERE

INDICATIONS FOR ORBIT AND BRAIN MRI COMBINATION STUDIES:

- Optic neuropathy or unilateral optic disk swelling of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders[24]
- Bilateral optic disk swelling (papilledema) with vision loss[3]
- Optic neuritis
  - if atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery or recurrence)[10-15]
  - If needed to confirm optic neuritis and rule out compressive lesions
- Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent, or bilateral optic neuritis[25]
- For approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[26]

INDICATIONS FOR FACE/SINUS MRI:

- **Rhinosinusitis**[27]
  - Clinical suspicion of fungal infection[28]

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    - Clinical suspicion of orbital or intracranial complications,[18,19] such as
        - Preseptal, orbital, or central nervous system infection
        - Osteomyelitis
        - Cavernous sinus thrombosis

- **Sinonasal obstruction, suspected mass,** based on exam, nasal endoscopy, or prior imaging[27,29]

- **Anosmia or Dysosmia** based on objective testing that is persistent and of unknown origin[30-32]
- **Suspected infection**
    - Osteomyelitis (after x-rays)[33]
    - Abscess based on clinical signs and symptoms of infection

- **Face mass[27,34,35]**
    - Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed
    - Known or highly suspected head and neck cancer on examination[27]
    - Failed 2 weeks of treatment for suspected infectious adenopathy[36]

- **Facial trauma[16,17,37,38]**
    - Concern for soft tissue injury to further evaluate for treatment or surgical planning[39]

- **Granulomatosis with polyangiitis (Wegener's granulomatosis) disease[31]**

- **Trigeminal neuralgia/neuropathy** (for evaluation of the extracranial nerve course)
    - If atypical features (e.g., bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain > 2min, pain outside trigeminal nerve distribution, progression)[30,40]

NOTE: FOR ADDITIONAL ONCOLOGIC FACE/SINUS MRI INDICATIONS, CLICK HERE

INDICATIONS FOR FACE/SINUS AND BRAIN MRI COMBINATION STUDIES:

- Anosmia or dysosmia on objective testing that is persistent and of unknown origin[30,32,41]
- Granulomatosis with polyangiitis (Wegener's granulomatosis) disease[42]
- Trigeminal neuralgia that meets the above criteria[30,40]
- For approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[26]

INDICATIONS FOR NECK MRI:

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Suspected tumor or cancer[43]:

- Suspicious lesions in mouth or throat[35]
- Suspicious mass/tumor found on another imaging study and needing clarification
- Neck mass or lymphadenopathy (non-parotid or non-thyroid)
    - Present on physical exam and remains non-diagnostic after ultrasound is completed[35]
    - Mass or abnormality found on other imaging study and needing further evaluation
    - Increased risk for malignancy with one or more of the following findings[44]:
        - Fixation to adjacent tissues
        - Firm consistency
        - Size >1.5 cm
        - Ulceration of overlying skin
        - Mass present ≥ two weeks (or uncertain duration) without significant fluctuation and not considered of infectious cause
        - History of cancer
    - Failed 2 weeks of treatment for suspected infectious adenopathy[36]
    - Pediatric (≤18 years old) considerations[10]
        - Ultrasound should be inconclusive or suspicious unless there is a history of malignancy[11]

  Note: For discrete cystic lesions of the neck, an ultrasound should be performed as initial imaging unless there is a high suspicion of malignancy
- Neck Mass (parotid)[43]
    - Parotid mass found on other imaging study and needing further evaluation (US is the initial imaging study of a parotid region mass)
- Neck Mass (thyroid)[45]
    - Staging and monitoring for recurrence of known thyroid cancer[45]
    - To assess extent of thyroid tissue when other imaging suggests extension through the thoracic inlet into the mediastinum or concern for airway compression[46,47]

  Note: US is the initial imaging study of a thyroid region mass. Biopsy is usually the next step. In the evaluation of known thyroid malignancy, CT is preferred over MRI since there is less respiratory motion artifact. Chest CT may be included for preoperative assessment in some cases

Known or suspected deep space infections or abscesses of the pharynx or neck with signs or symptoms of infection[48]

Other indications for a Neck MRI:

- MR Sialography to evaluate salivary ducts[49,50]
- Vocal cord lesions or vocal cord paralysis[51]
- Unexplained ear pain when ordered by a specialist with all of the following[52]
    - Otoscopic exam, nasolaryngoscopy, lab evaluation (ESR, CBC) AND

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    - Risk factor for malignancy i.e., tobacco use, alcohol use, dysphagia, weight loss OR age older than 50 years
- Diagnosed primary hyperparathyroidism when surgery is planned
    - Previous nondiagnostic ultrasound or nuclear medicine scan[53,54]
- Bell's palsy/hemifacial spasm (for evaluation of the extracranial nerve course)
    - If atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset[55]
- Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course)[30,56]
- Brachial plexopathy if mechanism of injury or EMG/NCV studies are suggestive[57,58]
  Note: Chest MRI is preferred study, but neck and/or shoulder (upper extremity) MRI can be ordered depending on the suspected location of injury

NOTE: FOR ADDITIONAL ONCOLOGIC NECK MRI INDICATIONS, CLICK HERE

INDICATIONS FOR NECK AND BRAIN MRI COMBINATION STUDIES:
- Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course)[30,56]
- For approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[26]

ADDITIONAL ONCOLOGIC INDICATIONS FOR ORBIT/FACE/SINUS/NECK MRI

Known tumor or cancer of skull base, orbits, sinuses, face, tongue, larynx, nasopharynx, pharynx, or salivary glands
- Initial staging[35]
- Restaging during treatment
- Suspected recurrence or new metastases based on symptoms or examination findings
    - New mass
    - Change in lymph nodes[59]
- Surveillance appropriate for tumor type and stage

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases
- < 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

Pre-operative/procedural evaluation
- Pre-operative evaluation for a planned surgery or procedure

Post- operative/procedural evaluation
- When imaging, physical, or laboratory findings indicate surgical or procedural complications

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BACKGROUND:
Magnetic resonance imaging (MRI) is used in the evaluation of face and neck region masses, trauma, and infection. The soft-tissue contrast between normal and abnormal tissues provided by MRI is sensitive for differentiating between inflammatory disease and malignant tumors and permits the precise delineation of tumor margins. MRI is used for therapy planning and follow-up of face and neck neoplasms. It is also used for the evaluation of neck lymphadenopathy and vocal cord lesions.

CT scanning remains the study of choice for the imaging evaluation of acute and chronic inflammatory diseases of the sinonasal cavities. MRI is not considered the first-line study for routine sinus imaging because of limitations in the definition of the bony anatomy and length of imaging time. MRI for confirmation of diagnosis of sinusitis is discouraged because of hypersensitivity (overdiagnosis) in comparison to CT without contrast. MRI, however, is superior to CT in differentiating inflammatory conditions from neoplastic processes. MRI may better depict intraorbital and intracranial complications in cases of aggressive sinus infection, as well as differentiating soft-tissue masses from inflammatory mucosal disease. MRI may also identify fungal invasive sinusitis or encephaloceles.

Anosmia – Nonstructural causes of anosmia include post viral symptoms, medications (Amitriptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Trifluoperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause. Anosmia and dysgeusia have been reported as common early symptoms in patients with COVID-19, occurring in greater than 80 percent of patients. For isolated anosmia, imaging is typically not needed once the diagnosis of COVID has been made given the high association. As such, COVID testing should be done prior to imaging.[60-62]

CSF (cerebrospinal fluid) leaks – For CSF rhinorrhea, Sinus CT is indicated when looking to characterize a bony defect. For CSF otorrhea, Temporal Bone CT is indicated. For intermittent leaks and complex cases, consider CT/MRI/Nuclear Cisternography. CSF fluid should always be confirmed with laboratory testing (i.e., Beta-2 transferrin assay).[63,64]

Trigeminal Neuralgia – According to the International Headache Society, TN is defined as "a disorder characterized by recurrent unilateral brief electric shock-like pain, abrupt in onset and termination, limited to the distribution of one or more divisions of the trigeminal nerve and triggered by innocuous stimuli."[65]

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POLICY HISTORY

Date	Summary
March 2022	Updated references Added New Combo statement <u>Orbit</u> • Clarified: o Optic neuritis ▪ If atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery or recurrence) ▪ If needed to confirm optic neuritis and rule out compressive lesions (combo section) o Complex strabismus syndromes (with ophthalmoplegia or ophthalmoparesis) <u>Sinus</u> • Re-ordered indications • Reformatted and updated backgrounds • Clarified: o Abscess o Facial trauma - Concern for soft tissue injury to further evaluate for treatment or surgical planning • Deleted: o Physical findings of direct facial bone injury <u>Neck</u> • Reformatted indications • Added: o Mass or abnormality found on other imaging study and needing further evaluation • Clarified o Non thyroid masses o Thyroid imaging o Abscess
May 2021	Updated References Reordered Indications Added hyperlinks to OTHER indications Orbit Added: • Complex strabismus to aid in diagnosis, treatment and/or surgical planning

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	• If needed to confirm optic neuritis and rule out compressive lesions Clarified: • Documented visual defect if MRI is contraindicated or cannot be performed - *Unilateral or with abnormal optic disc(s) (i.e. Optic disc blurring, edema, or pallor);* • Clinical Suspicion of osteomyelitis: Direct visualization of bony deformity *OR* Abnormal X-rays • *Optic neuropathy* or unilateral optic disk swelling of unclear etiology (Combo Orbit/Brain CT) Sinus/Face Added: • Facial Trauma- For further evaluation of a known fracture for treatment or surgical planning • Dysosmia Clarified: • Sinonasal obstruction, suspected mass, *based on exam, nasal endoscopy, or prior imaging* • Note: CSF (cerebrospinal fluid) rhinorrhea - Sinus CT is indicated when looking to characterize a bony defect. CSF otorrhea - Temporal Bone CT is indicated. For intermittent leaks and complex cases consider CT/MRI/Nuclear Cisternography). CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay) Deleted: • Trigeminal neuralgia – if Age < 40 Neck Added: • Neck Mass or *lymphadenopathy* (non-parotid region or thyroid) • Unexplained ear pain when ordered by a specialist with all the following (Earwood, 2018) o Otoscopic exam, nasolaryngoscopy, lab evaluation (ESR, CBC) AND o Risk factor for malignancy ie tobacco use, alcohol use, dysphagia, weight loss OR age older than 50 years

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	• Brachial Plexopathy (Vijayasarathi, 2016) if mechanism of injury or EMG/NCV studies are suggestive **Note**: Chest MRI is preferred study, but neck and/or shoulder (upper extremity) MRI can be ordered depending on the suspected location of injury All • Removed statement: A single authorization for CPT code 70540, 70542, or 70543 includes imaging of the Orbit, Face, Sinuses, and Neck. Multiple authorizations are not required
May 2020	<u>Clarified</u>: **Orbit** • Ophthalmoplegia **with concern for orbital pathology** • Documented visual field defect **if MRI is contraindicated or cannot be performed** • Orbital or ocular mass/tumor, suspected or known • Clinical Suspicion of **orbital** infection • Clinical Suspicion of Orbital Inflammatory Disease (e.g., eye pain and **restricted eye movement** with suspected **orbital** pseudotumor) **Face/Sinus** • Suspected infection o Osteomyelitis (after x-rays) o Abscess • Facial Trauma o Post traumatic CSF rhinorrhea (for CSF otorrhea Temporal Bone imaging is recommended) • Anosmia on objective testing that is persistent and of unknown origin (also in Brain and Sinus combo section) **Neck** • Neck mass (**non-parotid** or thyroid) o Note: For discrete cystic lesions of the neck, an ultrasound should be performed as initial imaging **unless there is a high suspicion of malignancy** • MR Sialography **to evaluate salivary ducts** • Objective cranial nerve palsy (**CN IX-XII) (for evaluation of the extracranial nerve course**) (also in Brain and Neck combo section) **Combo - Brain and Orbit** • Reworded: Unilateral **optic disk swelling/optic neuropathy of unclear etiology** to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or

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	non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders • Bilateral **optic disk swelling** (papilledema) with vision loss **<u>Added</u>:** **Orbit** • MRI is superior for the evaluation of the visual pathways, globe and soft tissues, CT is preferred for visualizing bony detail and calcifications • Unilateral optic disk swelling • Under documented visual field defect o Unilateral or with optic disc abnormality • Congenital orbital anomalies <u>Added</u>: **Face/Sinus** • Examples of orbital or intracranial complications o Preseptal, orbital, or central nervous system infection o Osteomyelitis o Cavernous sinus thrombosis • Face mass o Known or highly suspected head and neck cancer on examination • Trigeminal neuralgia/neuropathy (for evaluation of the extracranial nerve course) o If < 40 years of age or atypical features (e.g. bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain > 2min, pain outside trigeminal nerve distribution, progression) <u>Added</u>: **Neck** • Suspicious mass/tumor found on another imaging study and needing clarification • Under increased risk for malignancy o History of cancer o Mass present ≥ two weeks (or uncertain duration) without significant fluctuation and not considered of infectious cause • Neck Mass (parotid) o Parotid mass found on other imaging study and needing further evaluation <u>Added</u>: **Neck**

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	• Neck Mass (thyroid) - US is the initial imaging study of a thyroid region mass. CT is preferred over MRI in the evaluation of thyroid masses since there is less respiratory motion artifact o Staging and monitoring for recurrence of known thyroid cancer o To assess extent of thyroid tissue when other imaging suggests extension through the thoracic inlet into the mediastinum or concern for airway compression (Lin, 2016; Gharib 2016) **NOTE**: Chest CT may be included for preoperative assessment in some cases • Pediatric patients (≤18 years old) o Neck masses in the pediatric population if ultrasound is inconclusive or suspicious o History of malignancy <u>Added</u>: **Neck** • Known or suspected deep space infections or abscesses of the pharynx or neck **Combo** • Known tumor or cancer of skull base, orbits, sinuses, **face**, tongue, larynx, nasopharynx, pharynx, or salivary glands o Surveillance appropriate for tumor type and stage • For approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology <u>Added</u>: **Combo** • Added sub Combo sections o Brain and Orbit ▪ Optic Neuritis if atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset o Brain and Sinus o Brain and Neck <u>Deleted:</u> **Orbit** • Unilateral optic disk swelling papilledema approve dedicated Orbits MRI even if Brain MRI approved <u>Deleted:</u> **Face/Sinus**

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	• Clinical Suspicion of osteomyelitis o Direct visualization of lesion over bone o Abnormal x-ray • Face Mass o Prior history of tumor with suspicion of recurrence • Facial trauma o Suspected orbital trauma with indeterminate x-ray or ultrasound **Neck** • **Palpable** from Palpable suspicious lesions in mouth or throat • Salivary gland stones or clinical concern for abscess • Thoracic Outlet Syndrome **Combo** • Trigeminal neuralgia • Cranial neuropathy (weakness or sensory abnormalities of the head and neck
July 2019	<u>ORBIT MRI:</u> • Removed: Orbital asymmetry and Suspected hyperthyroidism (such as Graves' disease) • Added: Clinical suspicion of osteomyelitis <u>Face/Sinus MRI</u> • Added specifics to Face Mass: o Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed (Kuno, 2014) o Clinical concern for abscess o Failed 2 weeks of treatment for suspected infectious adenopathy (Haynes, 2015). o Prior history of tumor with suspicion of recurrence • Added: Facial trauma with physical findings of direct facial bone injury; suspected orbital trauma w/indeterminate x-ray or US; CSF leak (rhinorrhea or otorrhea) <u>Other Indications</u> • Added: Suspected recurrence or new metastases based on symptoms or examination findings with new mass or change in lymph nodes; Anosmia on objective testing; Trigeminal neuralgia if <40 years of age or atypical features; Objective cranial nerve palsy; and Granulomatosis with polyangiitis (Wegener's granulomatosis) disease Indications for combo studies orbit/face/sinus neck MRI with brain MRI

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	• Added: Bilateral papilledema with vision loss AND Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent, or bilateral optic neuritis

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **BRAIN (HEAD) MRA/MRV**	**Original Date: September 1997**
CPT Codes: 70544, 70545, 70546	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_004-2	**Implementation Date: January 2023**

INDICATIONS FOR BRAIN (HEAD) MR Angiography/MR Venography

Brain MRI/MRA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain MRI/Brain MRA combination studies section. If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of suspected intracranial vascular disease[1, 2]

- **Aneurysm screening**
  - Screening for suspected intracranial aneurysm in patient with a first-degree familial history (parent brother, sister, or child) of intracranial aneurysm
    Note: Repeat study is recommended every 5 years[3]
  - Screening for aneurysm in polycystic kidney disease (after age 30), Loeys-Dietz syndrome*, fibromuscular dysplasia, spontaneous coronary arteries dissection (SCAD), or known aortic coarctation (after age 10)[4-9]
    *For Loeys-Dietz imaging should be repeated at least every two years

- **Vascular abnormalities**
  - Suspected vascular malformation (arteriovenous malformation (AVM) or dural arteriovenous fistula) in patient with previous or indeterminate imaging study
  - Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset[10]
    Note: Negative brain CT < 6 hours after headache onset excludes subarachnoid hemorrhage in neurologically intact patients[11]

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- Headache associated with exercise or sexual activity[12]
- Isolated third nerve palsy (oculomotor) with pupil involvement to evaluate for aneurysm[13]
- Pulsatile tinnitus to identify a suspected arterial vascular etiology[14, 15]

Note: MRI is the study of choice for detecting cavernomas, developmental venous anomalies and capillary telangiectasia (see background)[16]

- **Cerebrovascular Disease**
  - Ischemic
    - Recent ischemic stroke or transient ischemic attack (See background)[17, 18]
    - Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[19-21]
  - Hemorrhagic
    - Known subarachnoid hemorrhage (SAH) – CTA is favored over MRI unless there is a contradiction[11]
    - Known cerebral intraparenchymal hemorrhage with concern for underlying vascular abnormality
  - Venous-MRV†
    - Suspected central venous thrombosis (dural sinus thrombosis)[22, 23]
    - Distinguishing benign intracranial hypertension (pseudotumor cerebri) from dural sinus thrombosis[24, 25]
  - Sickle cells disease (ischemic and/or hemorrhagic)[26, 27]
    - Neurological signs or symptoms in sickle cell patients
    - High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200

- **Vasculitis with initial laboratory workup (such as ESR, CRP, serology)[28]**
  - Suspected secondary CNS vasculitis based on neurological sign or symptoms in the setting of an underlying systemic disease with abnormal inflammatory markers or autoimmune antibodies
  - Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up[29, 30]
  - Giant cell arteritis with suspected intracranial involvement[31-34]

- **Other intracranial vascular disease**
  - Suspected Moyomoya disease[35, 36]
  - Suspected reversible cerebral vasoconstriction syndrome[37]

For evaluation of known intracranial vascular disease[1, 2]

- Known intracranial aneurysm, treated aneurysm, or known vascular malformation (i.e., AVM or dural arteriovenous fistula)
- Vascular abnormality visualized on previous brain imaging that is equivocal or needs further evaluation
- Known vertebrobasilar insufficiency with new or worsening signs or symptoms[19, 21]

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- Known vasculitis, reversible cerebral vasoconstriction syndrome or Moyomoya disease[29, 35-38]

Pre-operative/procedural evaluation for brain/skull surgery
- Pre-operative evaluation for a planned surgery or procedure
- Refractory trigeminal neuralgia when done for surgical planning[39]

Post-operative/procedural evaluation[40, 41]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested

Indications for Brain MRA/Neck MRA combination studies[1, 2]
- Recent ischemic stroke or transient ischemic attack (TIA)[18]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[19-21]
- Suspected carotid or vertebral artery dissection; secondary to trauma or spontaneous due to weakness of vessel wall[42, 43]
- Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[44-46]
- Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[44, 47]
- Pulsatile tinnitus to identify a suspected arterial vascular etiology[14, 15]

Indications for Brain MRI/Brain MRA combination studies[1, 2]
- Recent ischemic stroke or transient ischemic attack (TIA)
- Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset [7-9]
  Note: Negative brain CT < 6 hours after headache onset excludes subarachnoid hemorrhage in neurologically intact patients[11]
- Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
- Headache associated with exercise or sexual activity[12]
- Suspected venous thrombosis (dural sinus thrombosis) – MRI/MRV†
- Neurological signs or symptoms in sickle cell patients
- High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200

Indications for Brain MRI/Brain MRA/Neck MRA combination studies
- Recent ischemic stroke or transient ischemic attack (TIA)[1, 2, 48]
- Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[49]

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Any Combination of Brain MRA/Neck MRA/Brain MRI with IAC

- Pulsatile tinnitus with concern for a suspected arterial vascular and/or intracranial etiology[14, 48]

BACKGROUND

Magnetic resonance angiography (MRA) or magnetic resonance venography (MRV) can be used as a first-line investigation of intracranial vascular disease. It is an alternative to invasive intra-catheter angiography that was once the mainstay for the investigation of intracranial vascular disease. MRA/MRV may use a contrast agent, gadolinium, which is non-iodine-based, for better visualization. It can be used in patients who have history of contrast allergy and who are at high risk of kidney failure. A single authorization covers both MRA and MRV.

The three different techniques of MRA/MRV include time of flight (both 2D and 3D TOF), phase contrast (PC), and contrast-enhanced angiography. Time of flight MRA takes advantage of the phenomena of flow-related enhancement and is the preferred MRA technique due to the speed at which the exam can be acquired.

MRA and Cerebral Aneurysms – Studies that compared MRA with catheter angiography in detecting aneurysms found that MRA could find 77% - 94% of the aneurysms previously diagnosed by catheter angiography that were larger than 5 mm. For aneurysms smaller than 5 mm, MRI detected only 10% - 60% of those detected with catheter angiography. On the other hand, aneurysms that were missed by catheter angiography in patients with acute subarachnoid hemorrhage were detected with MRA due to the much larger number of projections available with MRA.[50] The decrease in specificity, when compared with CTA, is reported to have false-positive cases related to normal vascular variants of infundibular origin of vessels and vessel loops. Limitations of MRA head include required safety screening and relatively long acquisition time in urgent clinical scenario.

MRA and Cerebral Arteriovenous Malformations (AVM) – Brain arteriovenous malformation (AVM) may cause intracranial hemorrhage and is usually treated by surgery. 3D TOF-MRA is commonly used during the planning of radio-surgery to delineate the AVM nidus, but it is not highly specific for the detection of a small residual AVM after radio-surgery.

MRA and non-aneurysmal vascular malformations – Non-aneurysmal vascular malformations can be divided in low flow vascular malformations and high flow vascular malformations. Low flow vascular malformations include dural venous anomalies (DVA), cavernomas, and capillary telangiectasias. High flow vascular malformations include AVM and dural arteriovenous fistulas (dAVF). For low flow malformations, MRI is the study of choice. There is limited medical literature to support vascular imagining (CTA or MRA). CTA plays a limited role in the assessment of cavernoma but may be used to demonstrate a DVA. MRA is not usually helpful in the assessment of cavernoma, capillary telangiectasia, and DVA. Vascular imaging is indicated in high flow vascular malformations.[1, 2, 16]

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MRA vs CTA for CVA – Preferred vascular imaging of the head and neck includes noncontrast head MRA and contrast-enhanced neck MRA. MRA may not be able to be performed in patients with claustrophobia, morbid obesity, or implanted device, but it can be useful in patients with renal failure or contrast allergies. For acute stroke, CTA is preferred after CT (to rule out hemorrhage) and to look for thrombus/possible intervention that is time sensitive.[51]

MRA and recent stroke or transient ischemic attack – A stroke or central nervous system infarction is defined as "brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. … Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms."[52] If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes.[53] TIAs in contrast, "are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging."[54] On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention.[55]

Therefore, when revascularization therapy is not indicated or available in patients with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology, assess immediate complications and risk of future stroke. The majority of stroke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD(2) score ≥ 3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis (Easton, 2009). Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors, such as carotid stenosis atrial fibrillation, as the cause of ischemic symptoms.[53] Diagnostic recommendations include neuroimaging evaluation as soon as possible, preferably with magnetic resonance imaging, including DWI; noninvasive imaging of the extracranial vessels should be performed, and noninvasive imaging of intracranial vessels is reasonable.[17]

Patients with a history of stroke and recent workup with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Patients with remote or silent strokes discovered on imaging should be evaluated for high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.

MRA and Intracerebral Hemorrhage – MRA is useful as a screening tool for an underlying vascular abnormality[56] in the evaluation of spontaneous intracerebral hemorrhage (ICH). Etiologies of spontaneous ICH include tumor, vascular malformation, aneurysm, hypertensive arteriopathy, cerebral amyloid angiopathy, venous thrombosis, vasculitis, RCVS, drug-induced vasospasm, venous sinus thrombosis, Moyomoya disease, anticoagulant use and hemorrhagic transformation of an ischemic

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infarct. History can help point to a specific etiology. Possible risk factors for the presence of underlying vascular abnormalities include age younger than 65, female, lobar or intraventricular location, and the absence of hypertension or impaired coagulation.

MRV – A pitfall of the TOF technique, particularly 3D TOF, is that in areas of slowly flowing blood, turbulence, or blood which flows in the imaging plane there can be regions of absent or diminished signal. The signal loss can be confused with vascular occlusion or thrombi. To avoid this pitfall, MRA performed after the intravenous administration of gadolinium-based contrast agents is utilized at many facilities.

Intracranial magnetic resonance venography (MRV) is used primarily to evaluate the patency of the venous sinuses. The study can be performed with TOF, Phase contrast and IV contrast-enhanced techniques. Delayed images to allow for enhancement of the venous system are required to obtain images when intravenous gadolinium-enhanced studies are undertaken.

Saturation pulses are utilized in studies not undertaken with intravenous contrast to help eliminate flow-related signal in a specified direction and thus display the desired arterial or venous structures on their own. In cranial applications, saturation pulses applied at the inferior margin of the imaging field eliminate signal from arterial flow in order to visualize the veins. Conversely, superior saturation pulses are used to eliminate venous flow-related enhancement when evaluation of the arterial structures is desired.[57]

†MRV and Central Venous Thrombosis – a MR Venogram is indicated for the evaluation of a central venous thrombosis/dural sinus thrombosis. The most frequent presentations are isolated headache, intracranial hypertension syndrome (headache, nausea/vomiting, transient visual obscurations, pulsatile tinnitus, CN VI palsy, papilledema),[58] seizures, focal neurological deficits, and encephalopathy. Risk factors are hypercoagulable states inducing genetic prothrombotic conditions, antiphospholipid syndrome and other acquired prothrombotic diseases (such as cancer), oral contraceptives, pregnancy, puerperium (6 weeks postpartum), infections, and trauma. COVID-19 infection is associated with hypercoagulability, a thromboinflammatory response, and an increased incidence of venous thromboembolic events (VTE).[59, 60] Since venous thrombosis can cause SAH, infarctions, and hemorrhage, parenchymal imaging with MRI/CT is also appropriate.[61-63]

Combination MRI/MRA of the Brain – This is one of the most misused combination studies and other than what is indicated above these examinations should be ordered in sequence, not together. Vascular abnormalities can be visualized on the brain MRI.

Patients presenting with a new migraine with aura (especially an atypical or complex aura) can mimic a transient ischemic attack or an acute stroke. If there is a new neurologic deficit, imaging should be guided by concern for cerebrovascular disease, not that the patient has a headache.[10]

MRA and dissection- Craniocervical dissections can be spontaneous or traumatic. Patients with blunt head or neck trauma who meet Denver Screening criteria should be assessed for cerebrovascular injury (although about 20% will not meet criteria). The criteria include focal or lateralizing neurological

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deficits (not explained by head CT); infarct on head CT; face, basilar skull, or cervical spine fractures; cervical hematomas that are not expanding; glasgow coma score less than 8 without CT findings; massive epistaxis; cervical bruit or thrill.[42, 64-66] Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms. There is often minor trauma or precipitating factor (i.e., exercise, neck manipulation). Dissection is thought to occur due to weakness of the vessel wall, and there may be an underlying connective tissue disorder. Dissection of the extracranial vessels can extend intracranially and/or lead to thrombus which can migrate into the intracranial circulation, causing ischemia. Therefore, MRA of the head and neck is warranted.[43, 67]

POLICY HISTORY

Date	Summary
March 2022	Updated and reformatted references Updated background section Added New Combo statement Clarified: • Aneurysm screening in aortic coarctation after age 10 • MRI is the study of choice for detecting cavernomas, developmental venous anomalies and capillary telangiectasia (see background) • Follow up of known intracranial aneurysm, *treated aneurysm*, or known vascular malformation • Pulsatile tinnitus to identify *a suspected arterial* vascular etiology • **MRI/MRA combo** - Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up *Unless there is clear documentation of a contraindication to LP or that LP is unable to be performed due to extenuating circumstances Added: • Pulsatile tinnitus in new combo section (MRI Brain with IAC/MRA Head/MRA Neck) • Brain MRI/Brain MRA combination: o Neurological signs or symptoms in sickle cell patients o High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200 Changed: • Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset as well as in combo section
June 2021	Updated references Updated background section

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	Reformatted and reordered indications Added: • Brain MRI/MRA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain MRI/Brain MRA combination studies section • Headache associated with exercise or sexual activity (also in combo section) • Note: MRI is the study of choice for detecting cavernomas • Giant cell arteritis with suspected intracranial involvement • Pre-operative evaluation for a planned surgery or procedure Clarified: • *For Loeys-Dietz imaging should be repeated at least every two years • Known vertebrobasilar insufficiency with new or worsening signs or symptoms • Vasculitis with initial laboratory workup (such as ESR, CRP, serology)
May 2020	• Updated background information references • Reordered and categorized indications and background information Clarified: • Screening for aneurysm: polycystic kidney disease (after age 30) • Suspected or known dural arteriovenous fistula as an example of a vascular malformation • Recent ischemic stroke or transient ischemic attack (also in all combo sections) • Cerebral intraparenchymal hemorrhage • Suspected secondary CNS vasculitis based on neurological sign or symptoms in the setting of an underlying systemic disease • Suspected primary CNS vasculitis based on neurological signs and symptoms • Vascular abnormality visualized on previous brain imaging that is equivocal or needs further evaluation • Reworded- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection – in the combo Neck/Brain MRA section Added: • Screening for aneurysm: Loeys-Dietz syndrome • Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up o Negative Brain CT; AND o Negative Lumbar Puncture; OR

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	○ Negative Brain MRI • Isolated third nerve palsy (oculomotor) with pupil involvement to evaluate for aneurysm • Vasculitis with initial laboratory workup (such as ESR, CRP, plasma viscosity) • Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up – in combo Brain MRI/MRA section ○ Negative Brain CT; AND ○ Negative Lumbar Puncture; OR • Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm – in combo Brain MRI/MRA section Deleted • Screening for aneurysm: Ehlers-Danlos syndrome, neurofibromatosis • Clinical suspicion of subarachnoid hemorrhage (SAH) (i.e., thunderclap headache) • Known or suspected carotid or cerebral artery occlusion in patients with a sudden onset of one-sided weakness or numbness, abnormal speech, vision defects, incoordination or severe dizziness - in the combo Neck/Brain MRA section • Clinical suspicion of subarachnoid hemorrhage (SAH) (i.e., thunderclap headache) - in the combo MRI/MRA section
July 2019	• Added: ○ Reversible cerebral vasoconstriction syndrome or Moyomoya disease ○ Clinical suspicion of subarachnoid hemorrhage (SAH) (i.e., thunderclap headache) ○ Spontaneous intracerebral hemorrhage with concern for underlying vascular abnormality ○ Suspected primary CNS vasculitis with infectious/inflammatory lab work-up, reversible cerebral vasoconstriction syndrome or Moyomoya disease ○ Refractory trigeminal neuralgia when done for surgical planning • Further clarified: ○ Suspected vertebrobasilar insufficiency (VBI) symptoms ○ MRV for suspected central venous thrombosis • For Brain MRA/Neck MRA combo:

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	o Removed the past two-week restriction from 'recent stroke or TIA' o Clarified CVA symptoms to include - known or suspected carotid or cerebral artery occlusion with sudden onset of numbness or incoordination o Added spontaneous injuries due to weakness of vessel wall leading to dissection o Added asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g. carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate o Added symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g. carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate • Added section for Brain MRI/Brain MRA combination studies, including: o Recent stroke or transient ischemic attack o Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache o Suspected venous thrombosis (dural sinus thrombosis) • Added section for Brain MRI/Brain MRA/Neck MRA combination studies, including: o Recent stroke or transient ischemic attack (TIA) o Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology • Updated background info and refs

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **NECK MRA/MRV**	**Original Date: September 1997**
CPT Codes: 70547, 70548, 70549	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_012-2	**Implementation Date: January 2023**

INDICATIONS FOR NECK MRA

If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of known or suspected extracranial vascular disease

Cerebrovascular Disease

- Recent ischemic stroke or transient ischemic attack[1-3]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[4-6]
- Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries)[7-9]
- Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries)[7, 10, 11]

Aneurysm screening

- Screening for aneurysm in Loeys-Dietz syndrome**, fibromuscular dysplasia or spontaneous coronary arteries dissection (SCAD)[12-15]
  ** For Loeys-Dietz imaging should be repeated at least every two years

Tumor/pulsatile mass

- Pulsatile mass on exam[16]

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- Known carotid body tumors, or other masses such as a paraganglioma, arteriovenous fistula, pseudoaneurysm, atypical lymphovascular malformation[17, 18]
  Note: Ultrasound (US) may be used to identify a mass overlying or next to an artery in initial work up of a pulsatile mass.

Other extracranial vascular disease

- Large vessel vasculitis (Giant cell or Takayasu arteritis) with suspected extracranial involvement[19-23]
- Subclavian steal syndrome when ultrasound is positive or indeterminate OR for planning an intervention[24]
- Suspected carotid or vertebral artery dissection; secondary to trauma or spontaneous due to weakness of vessel wall[25, 26]
- Horner's syndrome (miosis, ptosis, and anhidrosis)[27]
- For evaluation of pulsatile tinnitus (subjective or objective) for suspected arterial vascular etiology[28]
- For further evaluation of a congenital vascular malformation of the head and neck
- Known extracranial vascular disease that needs follow-up or further evaluation[29-31]

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation (e.g., carotid endarterectomy)

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

INDICATIONS FOR COMBINATION STUDIES

Neck MRA/Brain MRA

- Recent ischemic stroke or transient ischemic attack (TIA)[1, 2, 32]
- Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia, weakness in both sides of the body, or abnormal speech[4, 5]
- Suspected carotid or vertebral artery dissection secondary to trauma or spontaneous due to weakness of vessel wall[25, 26]
- Asymptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., internal carotid stenosis > 70%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[7-9]
- Symptomatic patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g., carotid stenosis ≥ 50%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries) and patient is surgery or angioplasty candidate[7, 8, 10]
- For evaluation of pulsatile tinnitus (subjective or objective) for suspected arterial vascular etiology[28]

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Neck MRA/Brain MRA/Brain MRI

- Recent ischemic stroke or transient ischemic attack
- Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits
- Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent vascular and intracranial pathology[33]

Any Combination of Neck MRA/Brain MRA/Brain MRI with IAC

- Pulsatile tinnitus with concern for a suspected arterial vascular and/or intracranial etiology[28, 34]

BACKGROUND

For vascular disease, in general, MRA and CTA are comparable. No current literature compares the efficacy of contrast enhanced CT to CTA or MRI and MRA for evaluation of pulsatile neck mass, so any are approvable. MRA may be complementary to MRI in the following settings: evaluation of a pulsatile neck mass to assess vascular detail when needed; assessment of relevant vascular anatomy for pre-procedural evaluation; vascular supply to tumors and vessel encasement and narrowing by tumors; extent of disease in vasculitis; and to help determine the nature and extent of congenital or acquired vascular anomalies.[35]

MRA vs CTA for Carotid Artery Evaluation[36, 37] – MRA and CTA are generally comparable noninvasive imaging alternatives, each with their own advantages and disadvantages. MRA is an excellent screening test since it does not utilize ionizing radiation. Duplex US and contrast-MRA is a common choice for carotid artery evaluation. Limitations of MRA include difficulty in patients with claustrophobia and the risk of nephrogenic systemic sclerosis with gadolinium contrast agents in specific patients. Advantages of CTA over MRA include superior spatial resolution, rapid image acquisition, decreased susceptibility to motion artifacts and artifacts from calcification as well as being better able to evaluate slow flow and tandem lesions. However, it can also overestimate high-grade stenosis. Limitations of CTA include radiation exposure to the patient, necessity of IV contrast, and risk of contrast allergy and contrast nephropathy.

MRA and Carotid Body Tumor – Carotid body tumors are found in the upper neck at the branching of the carotid artery. Although most of them are benign, they may be locally aggressive with a small malignant potential. MRA may be used to identify a carotid body tumor due to its ability to define the extension of the tumor in relation to the carotid arteries, involvement of the base of the skull and bilateral tumors.

MRA and dissection – Craniocervical dissections can be spontaneous or traumatic. Patients with blunt head or neck trauma who meet Denver Screening criteria should be assessed for

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cerebrovascular injury (although about 20% will not meet criteria). The criteria include: focal or lateralizing neurological deficits (not explained by head CT), infarct on head CT, face, basilar skull, or cervical spine fractures, cervical hematomas that are not expanding, glasgow coma score less than 8 without CT findings, massive epistaxis, cervical bruit or thrill.[25, 38-40] Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms.

There is often minor trauma or precipitating factor (e.g., exercise, neck manipulation). Dissection is thought to occur due to weakness of the vessel wall, and there may be an underlying connective tissue disorder. Dissection of the extracranial vessels can extend intracranially and/or lead to thrombus, which can migrate into the intracranial circulation causing ischemia. Therefore, MRA of the head and neck is warranted.[26, 41]

Post-operative evaluation of carotid endarterectomy – Carotid endarterectomy is a vascular surgical procedure that removes plaque from the carotid artery. MRA with multiprojection volume reconstruction is a non-invasive imaging modality that is an alternative to postoperative angiography following carotid endarterectomy. It allows the surgeon to get informative and comparative data.

MRA and recent stroke or transient ischemic attack (TIA) – A stroke or central nervous system infarction is defined as "brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. … Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms."[42] If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes.[43] TIAs in contrast, "are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging."[44] On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention.[45]

When revascularization therapy is not indicated or available in patients with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology, assess immediate complications and risk of future stroke. The majority of stroke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD(2) score >or=3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis.[44] Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors, such as carotid stenosis atrial fibrillation, as the cause of ischemic

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symptoms.[43] Diagnostic recommendations include neuroimaging evaluation as soon as possible, preferably with magnetic resonance imaging, including DWI; noninvasive imaging of the extracranial vessels should be performed, and noninvasive imaging of intracranial vessels is reasonable.[32]

Patients with a history of stroke and recent work-up with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Patients with remote or silent strokes discovered on imaging should be evaluated for high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.

POLICY HISTORY

Date	Summary
March 2022	Updated background on MRA Vs CTA Clarified • Pulsatile tinnitus to identify *a suspected arterial* vascular etiology • Large vessel vasculitis with suspected extracranial involvement Added: • For further evaluation of a congenital vascular malformation of the head and neck • Pulsatile tinnitus in new combo section (MRI Brain with IAC/MRA Head/MRA Neck) • New Combo statement
May 2021	Updated references Added • Loeys-Dietz syndrome to aneurysm screening section • Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia and weakness in both sides of the body, or abnormal speech – which was before only in the combo section • Note: Ultrasound (US) may be used to identify a mass overlying or next to an artery in initial work up of a pulsatile mass. • For evaluation of pulsatile tinnitus (subjective or objective) for vascular etiology - which was before only in the combo section • Pre-operative evaluation for a planned surgery or procedure • Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent vascular and intracranial pathology (Lawson, 2000). Clarified • Giant cell arteritis *with suspected extracranial involvement*

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	Deleted*:* • After US (for pulsatile neck mass)
May 2020	Clarified: • Recent **ischemic** stroke or transient ischemic attack (also in combo section) • Pulsatile mass on exam after ultrasound (US) • Takayasu arteritis based on findings in other blood vessels on previous imaging • Giant cell arteritis • Known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as dizziness, vertigo, headaches, diplopia, blindness, vomiting, ataxia and weakness in both sides of the body, or abnormal speech • Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (combo section) Deleted: • Ehlers-Danlos syndrome and neurofibromatosis in screening for aneurysm Added: • Spontaneous coronary arteries dissection (SCAD) in screening for aneurysm • Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection • Horner's syndrome (miosis, ptosis, and anhidrosis) • Known extracranial vascular disease that needs follow-up or further evaluation
April 2019	• Suspected or known disease: Added "Giant cell arteritis" and "Subclavian steal syndrome when ultrasound is positive or indeterminate or for planning interventions • "Known or suspected tumor/*pulsatile* mass": Added 'pulsatile'; • Neck MRA/Brain MRA: Added Denver screening criteria to assess for cerebrovascular injury • Added background information describing MRA and CTA as complimentary information to MRI or CT

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **BRAIN (HEAD) MRI** **BRAIN (HEAD) MRI with IAC (Internal Auditory Canal)**	**Original Date: September 1997**
CPT Codes: **70551, 70552, 70553, +0698T – Brain MRI** **70540, 70542, 70543, +0698T – IAC**	**Last Revised Date: May 2022**
Guideline Number: NIA_CG_001	**Implementation Date: January 2023**

INDICATIONS FOR BRAIN MRI

Brain MR/MRA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain MR/Brain MRA combination studies section. If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- Inconclusive or show a need for additional or follow up imaging evaluation OR
- The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of headache[1-5]

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity, or duration)
- Cluster headaches or other trigeminal-autonomic cephalgias, i.e., paroxysmal hemicrania, hemicrania continua, short-lasting unilateral neuralgiform headache attacks (SUNCT/SUNA) imaging is indicated once to eliminate secondary causes[6]
- Acute headache, sudden onset:
    - With a personal or family history (brother, sister, parent, or child) of brain aneurysm or AVM (arteriovenous malformation) OR
    - < 48 hours of "worst headache in my life" or "thunderclap" headache.
        - Note: The duration of a thunderclap type headache lasts more than 5 minutes. Sudden onset new headache reaching maximum intensity within 2-3 minutes.
    - Prior history of stroke or intracranial bleed
    - Known coagulopathy or on anticoagulation
- New onset of headache with any of the following[1, 7, 8]:

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Acute, new, or fluctuating neurologic deficits, such as sensory deficits, limb weakness, abnormal reflexes, speech difficulties, visual loss, lack of coordination, or mental status changes or with signs of increased intracranial pressure (papilledema). (See background)
    - History of cancer or significantly immunocompromised
    - Fever
    - Subacute head trauma
    - Pregnancy or puerperium[9, 10]
    - Age ≥ 50
    - Severe unilateral headache with radiation to or from the neck, associated with suspicion of carotid or vertebral artery dissection
    - Related to activity or event (sexual activity, exertion, position), new or progressively worsening
    - Persistent or progressively worsening during a course of physician-directed treatment[1, 11, 12]

  Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)
- Special considerations in the pediatric population with persistent headache[13]:
    - Occipital location
    - Age < 6 years
    - Symptoms indicative of increased intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting
    - Documented absence of family history of headache
    - Severe headache in a child with an underlying disease that predisposes to intracranial pathology (e.g., immune deficiency, sickle cell disease, neurofibromatosis, history of neoplasm, coagulopathy, hypertension, congenital heart disease)

For evaluation of neurologic symptoms or deficits[14]

- Acute, new, or fluctuating neurologic symptoms or deficits such as, sensory deficits, limb weakness, abnormal reflexes, speech difficulties, visual loss, lack of coordination, or mental status changes (see background)

For evaluation of known or suspected stroke or vascular disease[15-17]

- Known or suspected stroke with any acute, new, or fluctuating symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes (see background)
- Suspected stroke with a personal or first-degree family history (brother, sister, parent, or child) of aneurysm or known coagulopathy or on anticoagulation
- Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes)
- Evaluation of suspected acute subarachnoid hemorrhage (SAH)
- Follow-up for known hemorrhage, hematoma, or vascular abnormalities
  Note: MRI is the study of choice for detecting cavernous malformations (CCM) and other low flow vascular malformations (see background). Follow-up imaging of known CCM should be done only to

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guide treatment decisions or to investigate new symptoms. First-degree relatives of patients with more than one family member with a CCM should have a screening MRI as well as genetic counseling[18-20]

- Suspected central venous thrombosis - see background[15, 21]
- 1-time screening for silent cerebral infarcts in school age children and adults with sickle cell disease[22]
- Evaluation of neurological signs or symptoms in sickle cell disease[23, 24]
- High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity >200[25, 26]

For evaluation of known or suspected trauma[27-29]

- Known or suspected trauma or injury to the head with documentation of one or more of the following acute, new, or fluctuating:
    - Focal neurologic findings
    - Motor changes
    - Mental status changes
    - Amnesia
    - Vomiting
    - Seizures
    - Headache
    - Signs of increased intracranial pressure
- Known coagulopathy or on anticoagulation
- Known or suspected skull fracture by physical exam and/or prior imaging
- Post concussive syndrome if persistent or disabling symptoms and imaging has not been performed
- Subacute or chronic traumatic brain injury with new cognitive and/or neurologic deficit

For evaluation of suspected brain tumor, mass, or metastasis[30, 31]

- Suspected brain tumor with any acute, new, or fluctuating neurologic symptoms or deficits such as sensory deficits, limb weakness, abnormal reflexes, speech difficulties, visual loss, lack of coordination, or mental status changes (see background)
- Suspected brain metastasis or intracranial involvement in patients with a history of cancer based on neurological symptoms or examination findings (may include new or changing lymph nodes)
- Histiocytic Neoplasms for screening and/or with neurological signs or symptoms[32, 33]
    - Erdheim-Chester Disease
    - Langerhans Cell Histiocytosis
    - Rosai-Dorfman Disease)
- Midline dermoid cysts/sinuses with concern for intracranial extension[34-37]
- Suspected Pituitary Tumors[38-41]
    - Neurologic findings (e.g., visual field deficit suggesting compression of the optic chiasm, diplopia, gaze palsy)
    - Suspected hypofunctioning pituitary gland based on hormonal testing
        - Hypopituitarism
        - Growth hormone deficiency

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        - Hypogonadotropic hypogonadism [low sex hormones and gonadotropins (FSH/LH)][42]
            - Total testosterone persistently < 150 with low or normal LH/FSH i.e., severe secondary hypogonadism **OR**
            - Total testosterone levels persistently borderline around the lower limits of normal range (200-400 ng/dL) with low or normal LH/FSH; **AND**
                - Neurological signs or symptoms; OR
                - Other pituitary hormonal abnormalities; OR
                - Low free testosterone and consideration of reversible functional causes of gonadotropin suppression (e.g., obesity, opioid use, diabetes, steroid use, or comorbid illness)
    - Suspected hyperfunctioning pituitary gland based on hormonal testing
        - Central hyperthyroidism (high TSH)
        - Cushing disease (high ACTH)
        - Acromegaly/gigantism (high GH/IGF-1)
        - Elevated prolactin[43-45]
            - ≥ 250 ng/mL OR
            - In the absence of another cause, e.g., stress, pregnancy, hypothyroidism, renal insufficiency, medication
                - ≥ 100 ng/mL OR
                - Persistently elevated OR
                - Neuroendocrine signs or symptoms (i.e., headache, galactorrhea, abnormal menses, infertility, or bitemporal hemianopsia)
    - Central Diabetes Insipidus (low ADH)
    - Precocious puberty in a child (male < 9; female < 8), with hormonal studies suggesting a central cause [46]
    - Pituitary apoplexy with sudden onset of neurological and hormonal symptoms
- For screening for known non-CNS Cancer[47-56] - see background
    - Default screening for
        - Kidney cancer
        - Lung cancer
        - Merkel cell carcinoma
        - Mucosal melanoma of the head and neck, especially of the oral cavity
        - Poorly differential neuroendocrine cancer (Large or Small cell/Unknown primary of neuroendocrine origin)
    - Screening with preconditions
        - AML…… Suspicion of leukemic meningitis
        - Cutaneous melanoma…….. Stage IIIC or higher
        - Testicular cancer-Seminoma…… High risk
        - Gestational Trophoblastic Neoplasia…….. Pulmonary metastasis
        - Bladder cancer…… High risk, i.e., small cell
    - All other cancer if CNS symptoms present
- For screening of Hereditary Cancer Syndromes - see background
    - Li Fraumeni syndrome- Annually[57]
    - Von Hippel Lindau – Every 2 years, starting at age of 8 years[58]

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- Tuberous Sclerosis – Every 1-3 years, until the age of 25 years[59]
- MEN1 – Every 3-5 years, starting at the age of 5 years[60]
- NF-2- Brain IAC: Annually starting at the age of 10 years[61]
- Sturge Weber Syndrome: Once, after age 1 to rule out intracranial involvement; in patients <1 year, only if symptomatic[62]

For evaluation of known brain tumor, mass, or metastasis

- Follow-up of known CNS cancer (either primary malignant brain tumor or secondary brain metastasis) as per NCCN[31]
- Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination findings
- Follow-up of known low grade tumor (WHO I-II) (i.e., meningioma, glioma, astrocytoma, oligodendroglioma)
  - For surveillance as per NCCN[31]
  - If symptomatic, new/changing signs or symptoms or complicating factors
- Follow-up of known pituitary adenoma
  - New neuroendocrine signs or symptoms
  - Functioning adenoma - to assess response to treatment and 1-year follow-up after drug holiday[63]
  - Asymptomatic Macroadenoma (≥ 10mm) follow-up every 6-18 months, post-surgical follow-up every 1-2 years after surgery[64]
  - Asymptomatic, non-functioning Microadenoma < 10mm repeat in one year; if stable, repeat every 2-3 years[65]
- Follow-up of known pineal cyst (≥ 5mm) if there are atypical features or symptoms (e.g., headaches, gaze paresis, ataxia, papilledema, nausea/vomiting)[66, 67]
- Follow-up of known arachnoid cyst[68-70]
  - < 4 years old, serial imaging is warranted
  - > 4 years old, repeat imaging only if newly symptomatic, i.e., headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction
- Tumor monitoring in neurocutaneous syndromes as per tumor type
- Histiocytic Neoplasms to assess treatment response and surveillance of known brain lesions[32, 33, 71]
  - Erdheim-Chester Disease
  - Langerhans Cell Histiocytosis
  - Rosai-Dorfman Disease

Indications for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases[31]

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of known or suspected seizure disorder[72-77]

- New onset of an unprovoked seizure in adults
- Newly identified change in seizure activity/pattern

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- Known seizure disorder without previous imaging
- Medically refractory epilepsy
- Imaging indications for new onset seizures in the pediatric population[78-81]
    - Abnormal neurological exam, especially a postictal focal deficit
    - Significant developmental delay
    - Focal onset
    - EEG shows focal or suspected structural abnormalities
    - <1 year of age

Note: Imaging is not indicated in simple febrile seizures

For evaluation of suspected multiple sclerosis (MS)[82-85]

- For evaluation of patient with neurologic symptoms or deficits suspicious for MS with
    - A clinically isolated syndrome (optic neuritis, transverse myelitis, or brain stem syndrome); **OR**
    - Recurrent episodes of variable neurological signs or symptoms not attributable to another cause
- To demonstrate dissemination in time for diagnosis (every 6-12 months)

For evaluation of known multiple sclerosis (MS)[82, 85, 86]

- To establish a new baseline (no recent imaging, postpartum, or 3-6 months after switching disease modifying therapy)
- Prior to starting or switching disease-modifying therapy
- 6-month repeat scan in patients with MRI disease activity that is not associated with clinical activity on a follow-up scan
- Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years
- New signs or symptoms suggested of an exacerbation or unexpected clinical worsening
- Progressive Multifocal Leukoencephalopathy (PML) surveillance for patients on natalizumab (Tsyabri)[87]
    - 12 months after the start of treatment in all patients
    - Further surveillance MRI scanning timing is based on risk
        - Annually, if anti-JCV antibody negative,
        - Every 3-4 months, if high risk of PML occurrence:
            - seropositive for JC virus and have been treated with natalizumab for ≥18 months OR
            - high anti-JC virus antibody index values (>0.9) OR
            - previously treated with immunosuppressive therapies
    - Brain MRI every 3–4 months for up to 12 months, in high-risk patients who switch from natalizumab to other therapeutics

Note: In the pediatric population, use a similar scan frequency for disease and therapeutic monitoring. Increase frequency of imaging (e.g., every 6 months) in children with highly active disease or in situations where imaging will change management.

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For evaluation of known or suspected infectious or inflammatory disease (e.g., meningitis or abscess)[88, 89]

- Suspected intracranial abscess or brain infection with acute altered mental status or with positive lab findings (such as elevated WBCs) OR follow-up assessment during or after treatment completed
- Meningitis with positive signs and symptoms (such as fever, headache, mental status changes, stiff neck) OR with positive lab findings (such as elevated white blood cells or abnormal lumbar puncture fluid exam)
- Suspected encephalitis with headache and altered mental status or follow-up as clinically warranted
- Endocarditis with suspected septic emboli
- Suspected temporal arteritis in a patient $\geq$ 50 with temporal headache, abrupt visual changes, jaw claudication, temporal artery tenderness, constitutional symptoms or elevated ESR;[90-94] **AND**
    - Negative initial work-up (color Doppler ultrasonography or biopsy); **OR**
    - Atypical features, failure to response to treatment or concern for intracranial involvement

  Note: Protocol should include high-resolution contrast-enhanced imaging the temporal artery
- Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with abnormal inflammatory markers or autoimmune antibodies
- Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up[95, 96]
- Immunocompromised patient (e.g., transplant recipients, HIV with CD4<200, primary immunodeficiency syndromes, hematologic malignancies) with focal neurologic symptoms, headaches, behavioral, cognitive or personality changes
- Neurosarcoid[97-99]
    - Initial Evaluation:
        - Suspected based on neurological sign/symptoms and lab work (ACE, CSF analysis) OR
        - Known history of sarcoidosis with neurological signs or symptoms
    - Follow-up of known neurosarcoidosis:
        - To assess treatment response
        - Worsening signs or symptoms

For evaluation of clinical assessment documenting cognitive impairment of unclear cause[100-102]

- Mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments*/formal neuropsychological testing showing at least mild cognitive impairment AND a completed basic metabolic workup (such as thyroid function testing, liver function testing, complete blood count, electrolytes, and B12)

*Other examples include: Mini-Cog, Memory Impairment Screen, Saint Louis University Mental Status Examination (SLUMS), Brief Alzheimer's Screen (BAS), Blessed Dementia Scale (BDS), Clinical Dementia Rating (CDR)[103, 104]

FDA labeling for the drug Aduhelm (for Alzheimer's disease) requires baseline imaging and monitoring with Brain MRI.[105] Criteria for coverage includes the following:

- Baseline study within 1 year of initiating treatment unless the patient has a more recent exacerbation, traumatic event [e.g., falls, etc.], or co-morbidity necessitating an evaluation within one-month preceding initiation

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- Prior to the 7th and 12th infusions
- Monitoring if radiographic severe Amyloid Related Imaging Abnormalities (ARIA) is suspected or observed

NOTE: Enhanced clinical vigilance for ARIA is recommended during the first 8 doses of treatment with Aduhelm, particularly during titration. If a patient experiences symptoms which could be suggestive of ARIA, clinical evaluation should be performed, including MRI testing if indicated.

For evaluation of movement disorders[106-111]

- For evaluation of suspected Parkinson's with atypical feature or unresponsive to levodopa
- For evaluation of new non-Parkinson neurological symptoms in known Parkinson's disease complicating the evaluation of the current condition
- For the evaluation of other movement disorder to exclude a structural lesion (i.e., suspected Huntington disease, chorea, atypical parkinsonian syndromes, hemiballismus, atypical dystonia)
  Note: MRI not indicated in essential tremor, Tourette' syndrome, or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer's dystonia)[107, 111, 112]

For evaluation of cranial nerve and visual abnormalities

- Anosmia (loss of smell) or dysosmia documented by objective testing that is persistent and of unknown origin[113-115]
- Optic neuritis
- Abnormal eye findings on physical or neurologic examination (papilledema, pathologic nystagmus, optic atrophy, ocular nerve palsies, new onset anisocoria, visual field deficit, etc.)[116]
  Note: See background
- Binocular diplopia with concern for intracranial pathology[117] after comprehensive eye evaluation[118]
- Childhood strabismus with development delay or abnormal fundoscopic exam to rule out intracranial abnormalities[119, 120]
- Horner's syndrome with symptoms localizing the lesion to the central nervous system[121]
- Trigeminal neuralgia or neuropathy, notably with an atypical presentation[5, 122, 123]
- Occipital Neuralgia to exclude a structural lesion, notably in atypical cases[124-126]
- Bell's Palsy- if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset[127]
- Hemifacial spasm[128]
- Other objective cranial nerve palsy (CN IX-XII)[114, 129]
- Bulbar symptoms, i.e., difficulty in chewing, weakness of the facial muscles, dysarthria, palatal weakness, dysphagia, and dysphonia and/or signs, i.e., atrophy and fasciculations of the tongue and absent gag reflex[130]
- Pseudobulbar symptoms, i.e., dysphagia, dysarthria, facial weakness, sudden, stereotyped emotional outbursts that are not reflective of mood and/or signs, i.e., spastic tongue and exaggerated gag/jaw jerk[131]

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For evaluation of known or suspected congenital abnormality (such as craniosynostosis, neural tube defects)[132, 133]

- Known or suspected congenital abnormality with any acute, new, or fluctuating neurologic, motor, or mental status changes
- Evaluation of macrocephaly in an infant/child <18 with previously abnormal US, abnormal neurodevelopmental examination, signs of increased ICP or closed anterior fontanelle[134]
- Evaluation of microcephaly in an infant/child < 18
- Evaluation of craniosynostosis and other skull deformities. CT is preferred imaging to assess bony structures; MRI imaging is preferred to assess intracranial soft tissue
- Evaluation of the corticomedullary junction in Achondroplasia[135, 136]
- Cerebral palsy if etiology has not been established in the neonatal period, there is change in the expected clinical or developmental profile or concern for progressive neurological disorder[137, 138]
- X-linked Adrenoleukodystrophy[139]
    - Baseline MRI between 12 and 18 months old
    - Second MRI 1 year after baseline
    - MRI every 6 months between 3 and 12 years old
    - Annual MRI after 12 years old
- Prior treatment OR treatment planned for congenital abnormality
  Note: For evaluation of known or suspected hydrocephalus please see section on CSF abnormalities.

Cerebral Spinal Fluid (CSF) Abnormalities

- Evaluation of suspected hydrocephalus with any acute, new, or fluctuating neurologic, motor, or mental status changes
- Known hydrocephalus†
- For initial evaluation of a suspected Arnold Chiari malformation†
- Follow-up imaging of a known type II or type III Arnold Chiari malformation. For Arnold Chiari type I, follow-up imaging only if new or changing signs/symptoms[140]
- Initial evaluation for a known syrinx or syringomyelia†
- Known or suspected normal pressure hydrocephalus (NPH)[141]
    - With symptoms of gait difficulty, cognitive disturbance, and urinary incontinence
- Follow-up shunt evaluation[142-145]
    - Post operativity if indicated based on underlying disease or pre-operative radiographic findings and/or
    - 6-12 months after placement and/or
    - With neurologic symptoms that suggest shunt malfunction
- Evaluation of known or suspected cerebrospinal fluid (CSF) leakage[146]
- Cisternography for intermittent and complex CSF rhinorrhea/otorrhea. CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)[147, 148]
- Suspected spontaneous intra-cranial hypotension with distinct postural headache (other symptoms include nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance)[149, 150]
- CSF flow study for evaluation and management of CSF flow disorders[151, 152]

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†Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection, etc.[153]

Pre-operative/procedural evaluation for brain/skull surgery

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other Indications for a Brain MRI

- Vertigo associated with any of the following[154-156]
    - Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness, or a change in sensation)
    - Progressive unilateral hearing loss
    - Risk factors for cerebrovascular disease with concern for stroke
    - After full neurologic examination and vestibular testing with concern for central vertigo (i.e., skew deviation, vertical nystagmus, head thrust test, videonystagmography (VNG)/ electronystagmography (ENG))
- Diagnosis of central sleep apnea on polysomnogram
    - Children > 1 year[157]
    - Adults in the absence of heart failure, chronic opioid use, high altitude, or treatment emergent central sleep apnea AND concern for a central neurological cause (Chiari malformation, tumor, infectious/inflammatory disease) OR with an abnormal neurological exam[158]
- Syncope with clinical concern for seizure or associated neurological signs or symptoms[159, 160]
- Cyclical vomiting syndrome or abdominal migraine with any localizing neurological symptoms[161-163]
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph)[164-166]
- Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause[167]
- Global developmental delay or developmental delay with abnormal neurological examination in a child < 18 years[168, 169]
- Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam[170]
  Note: Imaging is not indicated in low-risk patients

Indications for a Brain MRI with Internal Auditory Canal (IAC)

- Unilateral non-pulsatile tinnitus
- Pulsatile tinnitus
- Suspected acoustic neuroma (Schwannoma) or cerebellar pontine angle tumor with any of the following signs and symptoms: unilateral hearing loss by audiometry, headache, disturbed balance or gait, unilateral tinnitus, facial weakness, or altered sense of taste

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- Suspected cholesteatoma
- Suspected glomus tumor
- Asymmetric sensorineural hearing loss on audiogram
- Congenital/childhood sensorineural hearing loss suspected to be due to a structural abnormality[171-173] (CNVIII, the brain parenchyma, or the membranous labyrinth). CT is the preferred imaging modality for the osseous anatomy and malformations of the inner ear.
- CSF otorrhea (MRI for intermittent leak, CT for active leaks)[174]; CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)
- Clinical suspicion of acute mastoiditis as a complication of acute otitis media with intracranial complications (i.e., meningeal signs, cranial nerve deficits, focal neurological findings, altered mental status)[175, 176]
- Bell's Palsy for evaluation of the extracranial nerve course -if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset[127]

Indications for Combination Studies[15, 16]
Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the neuroaxis), patient history, and other available information, including prior imaging.

Exception: For approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology[177]

- **Brain MRI/Neck MRA***
    - Recent ischemic stroke or transient ischemic attack
    - Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

- **Brain MRI/Brain MRA***
    - Recent ischemic stroke or transient ischemic attack
    - Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset[178-180]
      Note: Negative brain CT < 6 hours after headache onset excludes subarachnoid hemorrhage in neurologically intact patients[181]
    - Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
    - Headache associated with exercise or sexual activity[6]
    - Suspected venous thrombosis (dural sinus thrombosis) – Brain MRV see background
    - Neurological signs or symptoms in sickle cell patients
    - High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200 [24]

- **Brain MRI/Brain MRA/Neck MRA***
    - Recent stroke or transient ischemic attack (TIA)

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- Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

- **Brain MRI with IAC/ Brain MRA/Neck MRA (any combination)***
  - Pulsatile tinnitus with concern for a suspected arterial vascular and/or intracranial etiology[182, 183]

*Note: MRA and CTA are generally comparable noninvasive imaging alternatives each with their own advantages and disadvantages. Brain MRI can alternatively be combined with Brain CTA/Neck CTA.

- **Brain MRI/Cervical MRI/Thoracic MRI (any combination)**
  - Combination studies for MS: These body regions might be evaluated separately or in combination as guided by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history (e.g., symptom(s), time course, and where in the CNS the likely localization(s) is/are), and other available information, including prior imaging.
  - For evaluation of neuromyelitis optica spectrum disorders (recurrent or bilateral optic neuritis; recurrent transverse myelitis)[184]
  - For known MS, prior to the initiation or change of disease modification treatments and assess disease burden (to establish a new baseline)[185]
  - Follow-up scans, including brain and spine imaging, if patients have known spine disease:
    - 6-12 months after starting/changing treatment
    - Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years

- **Brain MRI/Cervical MRI/Thoracic MRI/Lumbar MRI (any combination)**
  - For initial evaluation of a suspected Arnold Chiari malformation
  - Follow-up imaging of a known type II or type III Arnold Chiari malformation. For Arnold Chiari type I, follow-up imaging only if new or changing signs/symptoms[140, 186]
  - Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (see background)
    - Suspected leptomeningeal carcinomatosis (see background)[187]
    - Tumor evaluation and monitoring in neurocutaneous syndromes - See background
  - CSF leak highly suspected and supported by patient history and/or physical exam findings (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula)

- **Brain MRI/Orbit MRI**
  - Optic neuropathy or unilateral optic disk swelling of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion or optic nerve infitrative disorders[188]
  - Bilateral optic disk swelling (papilledema) with visual loss[189]
  - Optic Neuritis

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        - If atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery or recurrence)[190, 191]
        - If needed to confirm optic neuritis and rule out compressive lesions
    - Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent, or bilateral optic neuritis[184]

- **Brain MRI/FACE/SINUS/NECK MRI**
    - Anosmia or dysosmia on objective testing that is persistent and of unknown origin[113, 114, 192]
    - Granulomatosis with polyangiitis (Wegener's granulomatosis) disease[193]
    - Trigeminal neuralgia or neuropathy with an atypical presentation (for evaluation of the extracranial nerve course) [114, 194]
    - Bell's Palsy/hemifacial spasm for evaluation of the extracranial nerve course -if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset[127]
    - Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course)[114, 129]

BACKGROUND

Brain (head) MRI is the procedure of choice for most brain disorders. It provides clear images of the brainstem and posterior brain, which are difficult to view on a CT scan. It is also useful for the diagnosis of demyelinating disorders (such as multiple sclerosis (MS) that cause destruction of the myelin sheath of the nerve). The evaluation of blood flow and the flow of cerebrospinal fluid (CSF) is possible with this non-invasive procedure.

MRI for Headache – Generally, magnetic resonance imaging is the preferred imaging technique for evaluating the brain parenchyma, and CT is preferable for evaluating subarachnoid hemorrhage. CT is faster and more readily available than MRI and is often used in urgent clinical situations. Neurologic imaging is warranted in patients with headache disorders along with abnormal neurologic examination results or predisposing factors for brain pathology. Contrast-enhanced MRI is performed for evaluation of inflammatory, infectious, neoplastic, and demyelinating conditions.

Headache timeframes and other characteristics – Generally, acute headaches are present from hours to days, subacute from days to weeks and chronic headaches for more than 3 months. Acute severe headaches are more likely to be pathological (e.g., SAH, cerebral venous thrombosis) than non-acute (e.g., migraine, tension-type). Headaches can also be categorized as new onset or chronic/recurrent. Non-acute new onset headaches do not require imaging unless there is a red flag as delineated above. Incidental findings lead to additional medical procedures and expense that do not improve patient well-being. Primary headache syndromes, such as migraine and tension headaches, are often episodic with persistent or progressive headache not responding to treatment requiring further investigation (e.g., new daily persistent headache). Imaging is indicated in chronic headaches if there is a change in the headache frequency (number of headaches episodes/month), duration of each episode, severity of the headaches or new characteristics, such as changing aura or associated symptoms.[1, 6, 195-197]

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Migraine with aura[6, 7, 198] – The headache phase of a migraine is preceded and/or accompanied by transient neurological symptoms referred to as aura in at least a third of migraine attacks. The most common aura consists of positive and/or negative visual phenomena, present in up to 99% of the individuals. Somatosensory is the secondary most common type of aura (mostly paraesthesias in an upper limb and/or hemiface). Language/speech (mainly paraphasia and anomic aphasia) can also be affected. These neurological symptoms typically evolve over a period of minutes and may last up to 20 minutes or more. The gradual evolution of symptoms is thought to reflect spreading of a neurological event across the visual and somatosensory cortices. Characteristically, the aura usually precedes and terminates prior to headache, usually within 60 minutes. In others, it may persist or begin during the headache phase. ICHD-3 definition of the aura of migraine with typical aura consists of visual and/or sensory and/or speech/language symptoms, but no motor, brainstem or retinal symptoms and is characterized by gradual development, duration of each symptom no longer than one hour, a mix of positive and negative features and complete reversibility. Atypical or complex aura includes motor, brainstem, monocular visual disturbances, or ocular cranial nerve involvement (hemiplegic migraine, basilar migraine/brainstem aura, retinal migraine, ophthalmoplegic migraine) and secondary causes need to be excluded. Additional features of an aura that raise concern for an underlying vascular etiology include late age of onset, short duration, evolution of the focal symptoms, negative rather than positive visual phenomenon, and history of vascular risk factors.

Neurological Deficits – Examples of abnormal reflexes related to upper motor neuron lesion/central pathology include hyperreflexia, clonus, Hoffman sign and Babinski, snout, palmar grasp, and rooting reflexes.

Visual loss has many possible etiologies, and MRI is only indicated in suspected neurological causes of visual loss based on history and exam. Visual field defects, such as bitemporal hemianopsia, homonymous hemianopsia, or quadranopsia, require imaging as well as does suspected optic nerve pathology. Subjective symptoms such as blurred vision or double vision with no clear correlate on neurological examination requires a comprehensive eye evaluation to exclude more common causes, such as cataracts, refractive errors, retinopathy, glaucoma, or macular degeneration. Transient visual loss with history consistent with TIA but normal exam at time of examination also should be imaged. Positive visual phenomena, such as photopsias or scintillations that march across the visual field, suggest migraine whereas negative phenomenon, such as shaded or blurred, is more characteristic of ischemia.

Table 1: Gait and brain imaging[199-204]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**

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Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	**EMG, if there is foot drop, Lumbar spine MRI Pelvis MR appropriate evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

Non-neurological causes of gait dysfunction include pain (antalgic), side effects of drugs (analgesic, antihistamines, benzos, psych meds, antihypertensives), visual loss, hearing impairment, orthopedic disorders, rheumatologic disorders, psychogenic, and cardiorespiratory problems (orthostasis).[200, 202-204]

MRI and recent stroke or transient ischemic attack – A stroke or central nervous system infarction is defined as "brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. … Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms."[205] If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes.[206] TIAs in contrast, "are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging."[207] On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention.[208]

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Therefore, when revascularization therapy is not indicated or available in individuals with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology, assess immediate complications and risk of future stroke. The majority of stroke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD(2) score ≥3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis.[207] Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors, such as carotid stenosis atrial fibrillation as the cause of ischemic symptoms.[206] Diagnostic recommendations include neuroimaging evaluation as soon as possible, preferably with magnetic resonance imaging, including DWI; noninvasive imaging of the extracranial vessels should be performed, and noninvasive imaging of intracranial vessels is reasonable.[209]

Individuals with a history of stroke and recent work-up with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Individuals with remote or silent strokes discovered on imaging should be evaluated for high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.

Non-aneurysmal vascular malformations – Non-aneurysmal vascular malformations can be divided in low flow vascular malformations and high flow vascular malformations. Low flow vascular malformations include dural venous anomalies (DVA), cavernomas, and capillary telangiectasias. High flow vascular malformations include AVM and dural arteriovenous fistulas (dAVF). For low flow malformations, MRI is the study of choice. Limited medical literature is available to support vascular imagining (CTA or MRA). CTA plays a limited role in the assessment of cavernoma but may be used to demonstrate a DVA. MRA is not usually helpful in the assessment of cavernoma, capillary telangiectasia, and DVA. Vascular imaging is indicated in high flow vascular malformations.[210-212]

MRI and Central Venous Thrombosis – a MR Venogram is indicated for the definite evaluation of a central venous thrombosis/dural sinus thrombosis. The most frequent presentations are isolated headache, intracranial hypertension syndrome (headache, nausea/vomiting, transient visual obscurations, pulsatile tinnitus, CN VI palsy, papilledema),[213] seizures, focal neurological deficits, and encephalopathy. Risk factors are hypercoagulable states inducing genetic prothrombotic conditions, antiphospholipid syndrome and other acquired prothrombotic diseases (such as cancer), oral contraceptives, pregnancy, puerperium (6-weeks postpartum), infections, and trauma. COVID-19 infection is associated with hypercoagulability, a thromboinflammatory response, and an increased incidence of venous thromboembolic events (VTE).[214, 215] Since venous thrombosis can cause SAH, infarctions, and hemorrhage, parenchymal imaging with MRI/CT is also appropriate.[21, 216, 217]

Galactorrhea and MRI – Isolated galactorrhea without elevated prolactin (normoprolactinemic) is usually due to breast pathology, i.e., breast feeding, trauma, ill-fitting undergarments. Consider mammogram, breast ultrasound, and serial dilution of the individual's prolactin sample to correct for possible hook effect.[218, 219]

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Table 2: MRI and staging screening in Non-CNS Cancers[48, 49, 51, 53]

(NON-BRAIN/CNS) CANCER	PRECONDITION
Cutaneous melanoma	Stage IIIC or higher, default staging screening ≥ stage IIIC, surveillance with periodic brain MRI up to 3 years even if asymptomatic without prior brain mets; and if prior brain mets, surveillance every 3-6 months up to 3 years
Testicular cancer-Seminoma	If high risk, such as beta HCG >5000IU/L, or multiple lung or visceral mets, choriocarcinoma, neurological symptoms, or AFP>10,000ng/ml
Merkel cell carcinoma	Default staging screening, but especially for high risk (≥stage IIIb, immunosuppression)
Lung cancer	Default staging screening brain MRI also for surveillance in small cell every 3 months for 2 years if they have had no prophylactic cranial radiation

MRI and Neurocutaneous Syndromes

- In NF-1, clinical evaluation appears to be more useful to detect complications than is screening imaging in asymptomatic individuals. Imaging is indicated in evaluation of suspected tumors based on clinical evaluation and for follow-up of known intracranial tumors.[220]
- Conversely in NF-2, routine MR imaging screening is always indicated, given the high prevalence of CNS tumors, especially vestibular schwannomas. In individuals with NF-2, routine screening brain/IAC imaging is indicated annually starting from age 10 if asymptomatic or earlier with clinical signs/symptoms. Most individuals with NF2 eventually develop a spinal tumor, most commonly schwannomas, but meningioma and ependymomas are also seen. Spinal imaging at baseline and every 2 to 3 years is also advised with more frequent imaging, if warranted, based on sites of tumor involvement.[61]
- In individuals with Tuberous Sclerosis, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities.[59]
- In Von Hippel Lindau Syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years.[58]
- In Sturge Weber Syndrome, Brain MRI can rule out intracranial involvement only after age 1 and is recommended in individuals <1 year only if symptomatic.[62]

MRI and Positron Emission Tomography (PET) for Chronic Seizures – When MRI is performed in the evaluation of individuals for epilepsy surgery, almost a third of those with electrographic evidence of temporal lobe epilepsy have normal MRI scans. Interictal positron emission tomography (PET) may be used to differentiate individuals with MRI-negative temporal lobe epilepsy.

Multiple Sclerosis[83, 221, 222] – The diagnosis of MS requires demonstration of lesions in the CNS disseminated in time and space and the absence of fever, infection, or other more likely etiologies. An expanding amount of available disease-modifying treatments are effective in slowing down disease

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progression, especially in the early stages. These treatments can have serious side effects and can be costly; therefore, the accurate and expeditious diagnosis of MS is critical.

The diagnosis of MS can be made on clinical presentation alone with 2 clinical attacks and objective clinical evidence of more than 2 lesions. Attacks may be individual-reported or objectively observed and must last for a minimum of 24 hours and be 30 days apart. However, corroborating magnetic resonance imaging (MRI) is the diagnostic standard and is used, as well, to rule out other disorders. Additionally, MRI findings can replace certain clinical criteria in a substantial number of individuals. In the revised McDonald Criteria, MRI findings can be used to establish dissemination in both time and space.

Table 3: Variable Symptoms and Signs of MS

Symptoms	***Signs***
Depressed mood	Ataxia
Memory loss/cognitive changes	Dysmetria
Dizziness or vertigo	Decreased sensation (pain, vibration, position)
Fatigue	Decreased strength
Hearing loss and tinnitus	Hyperreflexia, spasticity
Heat sensitivity (Uhthoff Phenomenon)	Nystagmus
Incoordination and gait disturbances	Lhermitte's sign
Sensory disturbances (dysesthesias, numbness, paresthesias)	Visual defects (internuclear ophthalmoplegia, optic disc pallor, red color desaturation, reduced visual acuity)
Pain	
Urinary symptoms	
Visual disturbances (diplopia, oscillopsia)	
Weakness	

In the presence of a clear, clinically isolated syndrome such as optic neuritis, transverse myelitis, or brain stem syndrome, brain MRI is the next diagnostic step. MS can also have variable and often subjective symptoms that come and go (see Table 3). If there are recurrent episodes of variable

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neurological signs or symptoms not attributable to another cause with clinical concern for MS, imaging is warranted as well.

MRI and Neuromyelitis optica spectrum disorders (NMOSD)[184] – NMOSD are inflammatory disorders of the central nervous system characterized by severe, immune-mediated demyelination and axonal damage predominantly affecting the optic nerves and spinal cord, but also the brain and brainstem. NMOSD can be distinguished from multiple sclerosis and other inflammatory disorders by the presence of the aquaporin-4 (AQP4) antibody. Features of NMOSD include attacks of bilateral or sequential optic neuritis acute transverse myelitis and the area postrema syndrome (with intractable hiccups or nausea and vomiting). The evaluation of suspected NMOSD entails brain and spinal cord neuroimaging. In contrast to MS (in which spinal cord involvement tends to be incomplete and asymmetric), NMOSD have a longer extent of spinal cord demyelination generally involving three or more vertebral segments.

Temporal Arteritis – Giant cell arteritis (GCA) is an inflammatory disorder that should be considered in individuals over the age of 50 with the following signs or symptoms: new headaches, acute onset of visual disturbances (especially transient monocular visual loss), jaw claudication, constitutional symptoms, tenderness over the temporal artery, and elevated ESR and/or CRP. A diagnosis of polymyalgia rheumatica (PMR) is highly associated. Large vessel GCA denotes involvement of the aorta and its first-order branches, especially the subclavian arteries, and is common. Extra- and intracranial cerebral vasculitis can also be seen, but is more rare, and strokes are related to vasculitis of extracranial cerebral arteries causing vertebral or internal carotid arteries stenosis. Gold standard for diagnosis of GCA is temporal artery biopsy. Color Doppler ultrasound (CDUS) can be used as a surrogate for temporal artery biopsy in some cases. High-resolution magnetic resonance imaging (MRI) can visualize the temporal arteries when used with contrast. The presence of clinical manifestations unusual in GCA should prompt consideration of alternative diagnoses. Examples of such include adenopathy, pulmonary infiltrates, digital cyanosis, ulceration or gangrene, mononeuritis multiplex, stroke in the distribution of the middle cerebral artery, glomerulitis, and/or rapidly rising creatinine.[90-94, 223]

MMSE – The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The MMSE has been the most commonly used measure of cognitive function in dementia research, but researchers have recognized that it is relatively insensitive and variable in mildly impaired individuals. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is, therefore, practical to use repeatedly and routinely.

MoCA – The Montreal Cognitive Assessment (MoCA) was designed as a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. MoCA differs from the MMSE mainly by including tests of executive function and abstraction, and by putting less weight on orientation to time and place. Ten of the MMSE's 30 points are scored solely on the time-place orientation test, whereas the MoCA assigns it a maximum of six

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points. The MoCA also puts more weight on recall and attention-calculation performance, while de-emphasizing language skill. Time to administer the MoCA is approximately 10 minutes. The total possible score is 30 points; a score of 26 or above is considered normal.

MRI and Movement disorders – Atypical parkinsonian syndromes include progressive supranuclear palsy (PSP), multiple system atrophy (MSA), corticobasal degeneration (CBD), and dementia with Lewy bodies.

Anosmia – Nonstructural causes of anosmia include post-viral symptoms, medications (Amitriptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Trifluoperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause.

Anosmia and dysgeusia have been reported as common early symptoms in individuals with COVID-19, occurring in greater than 80 percent of individuals. For isolated anosmia, imaging is typically not needed once the diagnosis of COVID has been made given the high association. As such, COVID testing should be done prior to imaging.[224-226]

Evaluation of olfactory function is essential to determine the degree of chemosensory loss and confirm the individual's complaint. It also allows monitoring of olfactory function over time, helps to detect malingerers, and to establish compensation for disability. The two general types of olfactory testing include psychophysical and electrophysiologic testing. Psychophysical tests are used for clinical evaluation of olfactory loss; whereas, electrophysiologic tests, such as electro-olfactogram (EOG) or odor event–related potentials (OERPs) are used for research purposes only.

Olfactory threshold tests rely on measuring detection thresholds of a specific odorant, such as phenyl ethyl alcohol (PEA) or butyl alcohol. Odor identification tests are quantitative tests in which individuals are asked to identify the odorants at the suprathreshold level. Examples include *The Connecticut odor identification, The University of Pennsylvania Identification Test (UPSIT) and the Cross-Cultural Smell Identification Test (CC-SIT)*. In Europe, a commonly used test is a threshold- and odorant-identification forced-choice test that uses odorant-impregnated felt-tipped pens (Sniffin' Sticks). A simple olfactory screening test using a 70% isopropyl alcohol pad as a stimulant has also been well described in the literature.[227]

Trigeminal Neuralgia (TN) – According to the International Headache Society, TN is defined as "a disorder characterized by recurrent unilateral brief electric shock-like pain, abrupt in onset and termination, limited to the distribution of one or more divisions of the trigeminal nerve and triggered by innocuous stimuli."[6] Atypical features include bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain > 2min, pain outside trigeminal nerve distribution and progression.[114, 194]

Occipital Neuralgia – According to the International Headache Society, occipital neuralgia is defined "Unilateral or bilateral paroxysmal, shooting or stabbing pain in the posterior part of the scalp, in the distribution(s) of the greater, lesser and/or third occipital nerves, sometimes accompanied by diminished sensation or dysaesthesia in the affected area and commonly associated with tenderness over the involved nerve(s). Pain is eased temporarily by local anaesthetic block of the affected nerve(s).

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Occipital neuralgia must be distinguished from occipital referral of pain arising from the atlantoaxial or upper zygapophyseal joints or from tender trigger points in neck muscles or their insertions."[6]

MRI for Macrocephaly – Consider ultrasound in infants with macrocephaly and a normal neurological examination, no evidence of increased ICP and an open anterior fontanelle. If head US is normal, the infant should be monitored closely.[228] The anterior fontanelle generally closes between 10 and 24 months of age, with 3% closing between 5-9 months and 11% after 24 months.[229]

MRI and Normal Pressure Hydrocephalus (NPH) – Although diagnosis can be made based on CT findings alone, MRI is more accurate for disclosing associated pathologies (such as cerebrovascular disease), excluding other potential etiologies and for detecting NPH typical signs of prognostic value. A CT scan can exclude NPH and is appropriate for screening purposes and in individuals who cannot undergo MRI.[141]

MRI and Vertigo – The most common causes of vertigo seen are benign paroxysmal positional vertigo (BPPV), vestibular neuronitis (VN) and Ménière's disease. These peripheral causes of vertigo are benign, and treatment involves reassurance and management of symptoms. Central causes of vertigo, such as cerebrovascular accidents (CVAs), tumors and multiple sclerosis (MS), need to be considered if the individual presents with associated neurological symptoms, such as weakness, diplopia, sensory changes, ataxia, or confusion. Magnetic resonance imaging is appropriate in the evaluation of individuals with vertigo who have neurologic signs and symptoms, progressive unilateral hearing loss or risk factors for cerebrovascular disease. MRI is more appropriate than CT for diagnosing vertigo due to its superiority in visualizing the posterior portion of the brain, where most central nervous system disease that causes vertigo is found. A full neurologic and otologic evaluation including provocative maneuvers, vestibular function testing and audiogram can help evaluate vertigo of unclear etiology and differentiate between central and peripheral vertigo.

MRI and developmental delay – Significant developmental delay is defined as significant delay (more than two standard deviations below the mean) in one or more developmental domains: gross/fine motor, speech/language, cognition, social/personal, and activities of daily living. Isolated delay in social/language development is characteristic of autism spectrum disorders or hearing loss. Isolated delay in motor development is characteristic of cerebral palsy (a static encephalopathy) or myopathy. Global developmental delay (GDD) is a subset of developmental delay defined as significant delay (by at least 2 SD's) in two or more developmental categories. Note that the term "GDD" is usually reserved for children <5 years old, whereas in older children >5 years, disability is quantifiable with IQ testing. The yield of magnetic resonance imaging is low in children with autism spectrum disorder and no other neurologic findings; therefore, MRI is not recommended as a part of routine evaluation.[230]

Low risk brief resolved unexplained event (BRUE) formerly apparent life-threatening event (ALTE) requires all the following:

- Age > 60 days
- Gestational age ≥ 32 weeks or older and corrected gestational age ≥ 45 weeks
- First brief event
- Event lasting < 1 minute

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- No CPR required by the trained medical provider
- No concerning historical features or physical examination findings.

Combination MRI/MRA of the Brain – This is one of the most misused combination studies and other than what is indicated above these examinations should be ordered in sequence, not together. Vascular abnormalities can be visualized on the brain MRI.

Individuals presenting with a new migraine with aura (especially an atypical or complex aura) can mimic a transient ischemic attack or an acute stroke. If there is a new neurologic deficit, imaging should be guided by concern for cerebrovascular disease, not that the individual has a headache.[178, 231]

Leptomeningeal Carcinomatosis[232-235] – Leptomeningeal metastasis is an uncommon and typically late complication of cancer with poor prognosis and limited treatment options. Diagnosis is often challenging with nonspecific presenting symptoms ranging from headache and confusion to focal neurologic deficits such as cranial nerve palsies. Standard diagnostic evaluation involves a neurologic examination, MRI of the brain and spine with gadolinium, and cytologic evaluation of the cerebral spinal fluid (CSF). Hematologic malignancies (leukemia and lymphoma), primary brain tumors as well as solid malignancies can spread to the leptomeninges. The most common solid tumors giving rise to LM are breast cancer (12 - 35 %), small and non-small cell lung cancer (10-26 %), melanoma (5 -25 %), gastrointestinal malignancies (4-14 %), and cancers of unknown primary (1-7 %).

Drop Metastases – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.[236]

POLICY HISTORY

Date	Summary
May 2022	Updated and reformatted references Updated background section Combo statements added Reorganized indications Changed visual deficits section added to background Reorganized suspected tumor section Clarified: • Acute headache, sudden onset • New onset headache related to activity or event (sexual activity, exertion, position), new or progressively worsening • Visual loss in background/removed note • Low flow vascular malformations

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	• Histiocytic Neoplasms (Erdheim-Chester Disease, Langerhans Cell Histiocytosis, and Rosai-Dorfman Disease) for screening and/or with neurological signs or symptoms • Total testosterone levels persistently borderline around the lower limits of normal range (200-400 ng/dL) with low or normal LH/FSH; o *Low free testosterone* and consideration of reversible functional causes of gonadotropin suppression (e.g., obesity, opioid use, diabetes, steroid use or comorbid illness) • Follow-up of known CNS cancer (either primary malignant brain tumor or secondary brain metastasis) as per NCCN • Tumor monitoring in neurocutaneous syndromes as per tumor type • Histiocytic Neoplasms (Erdheim-Chester Disease, Langerhans Cell Histiocytosis, and Rosai-Dorfman Disease) To assess treatment response and surveillance of known brain lesions • To demonstrate dissemination in time for diagnosis (every 6-12 months) • To establish a new baseline (3-6 months after switching disease modifying therapy) • PML surveillance - Every 3-4 months, if high risk of PML occurrence; Brain MRI every 3–4 months for up to 12 months, in high-risk patients who switch from natalizumab to other therapeutics • Examples of mental status instruments to screen for cognitive impairment • For evaluation of new non-Parkinson neurological symptoms • Binocular diplopia with concern for intracranial pathology after comprehensive eye evaluation • Trigeminal neuralgia or *neuropathy*, notably with an atypical presentation • **MRI Brain/MRI Orbit Combo** – Optic Neuritis if atypical presentation (bilateral, absence of pain, optic nerve hemorrhages, severe visual impairment, lack of response to steroids, poor recovery, or recurrence • **MRI Brain/MRI Face/Sinus/Neck Combo**- Trigeminal neuralgia or neuropathy with an atypical presentation (for evaluation of the extracranial nerve course) Added: • Abnormal reflexes to neurologic deficit sections • 1-time screening for silent cerebral infarcts in school age children and adults with sickle cell disease • High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200 • Midline dermoid cysts/sinuses with concern for intracranial extension

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	• Elevated prolactin in the absence of other cause: ≥ 100, persistently elevated or neuroendocrine signs or symptoms • Follow-up of known low grade tumor (WHO I-II) (i.e., meningioma, glioma, astrocytoma, oligodendroglioma) o For surveillance as per NCCN o If symptomatic, new/changing signs or symptoms or complicating factors • 6-month repeat scan in patients with MRI disease activity that is not associated with clinical activity on a follow-up scan (MS) • Note about pediatric MS imaging – same as adults except Increase frequency of imaging (e.g., every 6 months) in children with highly active disease or in situations where imaging will change management • Neurosarcoid o Initial Evaluation: ▪ Suspected based on neurological sign/symptoms and lab work (ACE, CSF analysis) OR ▪ Known history of sarcoidosis with neurological signs or symptoms o Follow up of known neurosarcoidosis: ▪ To assess treatment response ▪ Worsening signs or symptoms • Tourette syndrome to list of movement disorders in which MRI is not indicated • Occipital Neuralgia • X-linked Adrenoleukodystrophy o Baseline MRI between 12 and 18 months old o Second MRI 1 year after baseline o MRI every 6 months between 3 and 12 years old o Annual MRI after 12 years old • Congenital/childhood sensorineural hearing loss suspected to be due to a structural abnormality (CNVIII, the brain parenchyma, or the membranous labyrinth). CT is the preferred imaging modality for the osseous anatomy and malformations of the inner. • Pulsatile tinnitus to combo section (MRI Brain with IAC/MRA Head/MRA Neck) • **General Combo statement** Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the neuroaxis), patient history, and other available information, including prior imaging.

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	• **Combo Brain MRI/MRA**: o Neurological signs or symptoms in sickle cell patients o High stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity > 200 • **Brain MRI with IAC/ Brain MRA/Neck MRA (any combination**) o Pulsatile tinnitus with concern for a suspected arterial vascular and/or intracranial etiology o Note: MRA and CTA are generally comparable noninvasive imaging alternatives each with their own advantages and disadvantages. Brain MRI can alternatively be combined with Brain CTA/Neck CTA. • **MRI Brain/MRI Face/Sinus/Neck Combo-** o Bell's Palsy/hemifacial spams for evaluation of the extracranial nerve course -if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset • **MRI Brain/Spine Combo section** o Drop metastasis from brain or spine o Combination studies for MS: These body regions might be evaluated separately or in combination as guided by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history (e.g., symptom(s), time course, and where in the CNS the likely localization(s) is/are), and other available information, including prior imaging Changed: • Thunderclap headache with continued concern for underlying vascular abnormality after initial negative brain imaging > 6 hours after onset (as well as in combo Brain MRI/MRA) Deleted: • Precocious puberty: and evidence of an accelerated bone age on x-y • Patient with history of CNS cancer (either primary or secondary) and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years • Follow-up of known meningioma section/background
November 2021	Added +0698T.
July 2021	**Reordered Indications** **Updated references** **Updated background section** **Added**

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	• Brain MR/MRA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain MR/Brain MRA combination studies section. • Cluster headaches or other trigeminal-autonomic cephalgias i.e. paroxysmal hemicrania, hemicrania continua, short-lasting unilateral neuralgiform headache attacks (SUNCT/SUNA) imaging is indicated once to eliminate secondary causes (IHS, 2018) • Note: MRI is the study of choice for detecting cavernous malformations (CCM). Follow-up imaging of known CCM should be done only to guide treatment decisions or to investigate new symptoms. First-degree relatives of patients with more than one family member with a CCM should also have a screening MRI as well as genetic counseling • Langerhans cell histiocytosis with visual, neurological, or endocrine abnormality; polyuria or polydipsia; suspected craniofacial bone lesions, aural discharge, or suspected hearing impairment/mastoid involvement • Langerhans cell histiocytosis -To assess treatment response and surveillance of known brain lesions • Progressive Multifocal Leukoencephalopathy (PML) surveillance for patients on natalizumab (Tsyabri) o 12 months after the start of treatment in all patients o Further surveillance MRI scanning timing is based on anti-JCV antibody status ▪ If anti-JCV antibody negative, annually ▪ If anti-JCV antibody positive and antibody index < 1.5. every 6 months ▪ If anti-JCV antibody positive and antibody index > 1.5, every 3-4 months • Temporal Arteritis: Note: Protocol should include high-resolution contrast-enhanced imaging the temporal artery • similar mental status instruments */formal neuropsychological *Other examples include Ottawa 3DY (O3DY), Brief Alzheimer's Screen (BAS), Blessed Dementia Scale (BDS), caregiver-completed AD8 (cAD8), Brief Cognitive Rating Scale (BCRS), Clinical Dementia Rating (CDR) (Carptenter, 2011; McDougall, 1990) • FDA labeling for the drug Aduhelm (for Alzheimer's disease) requires baseline imaging and monitoring with Brain MRI. Criteria for coverage includes the following: o Baseline study within 1 year of initiating treatment unless the patient has a more recent exacerbation, traumatic event [e.g., falls, etc.], or co-morbidity necessitating an evaluation within one-month preceding initiation

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	o Prior to the 7th and 12th infusions o Monitoring if radiographic severe Amyloid Related Imaging Abnormalities (ARIA) is suspected or observed NOTE: Enhanced clinical vigilance for ARIA is recommended during the first 8 doses of treatment with Aduhelm, particularly during titration. If a patient experiences symptoms which could be suggestive of ARIA, clinical evaluation should be performed, including MRI testing if indicated. • Optic atrophy as an abnormal eye finding • Childhood strabismus with development delay or abnormal fundoscopic exam to rule out intracranial abnormalities • Bulbar symptoms ie. difficulty in chewing, weakness of the facial muscles, dysarthria, palatal weakness, dysphagia, and dysphonia and/or signs i.e. atrophy and fasciculations of the tongue and absent gag reflex • Pseudobulbar symptoms i.e. dysphagia, dysarthria, facial weakness, sudden, stereotyped emotional outbursts that are not reflective of mood and/or signs i.e. spastic tongue and exaggerated gag/jaw jerk • Evaluation of the corticomedullary junction in Achondroplasia • Evaluation of suspected hydrocephalus with any acute, new, or fluctuating neurologic, motor, or mental status changes (separated this from known hydrocephalus) • Cisternography for intermittent and complex CSF rhinorrhea/otorrhea. CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay). • Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits to Brain MRI/Brain MRA/Neck MRA combo • Headache associated with exercise or sexual activity (Brain MRI/Brain MRA combo) • Pre-operative evaluation for a planned surgery or procedure **Brain MRI/ Cervical MRI/Thoracic MRI (any combination)** o For evaluation of neuromyelitis optica spectrum disorders (recurrent or bilateral optic neuritis; recurrent transverse myelitis) o For known MS, prior to the initiation or change of disease modification treatments and assess disease burden (to establish a new baseline) o Follow -up scans for known MS if patients have known spine disease: ▪ 6-12 months after starting/changing treatment ▪ Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years **Brain MRI/ Cervical MRI/Thoracic MRI/Lumbar (any combination)**

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	• Follow up imaging of a known Arnold Chiari malformation (II/III). For Chiari, I follow-up imaging only if new or changing signs/symptoms o Suspected Leptomeningeal carcinomatosis (LC) o Tumor evaluation and monitoring in neurocutaneous syndromes - See Background o CSF leak highly suspected and supported by patient history and/or physical exam findings (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula) **Brain MRI/Orbit MRI** Optic Neuritis- If needed to confirm optic neuritis and rule out compressive lesions **Clarified** • Symptoms indicative of increased intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting • Suspected stroke with a personal or first-degree family history (brother, sister, parent, or child) of aneurysm or known coagulopathy or on anticoagulation • Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes) • Known or suspected skull fracture by physical exam and/or prior imaging • Neurologic findings (e.g. visual field deficit suggesting compression of the optic chiasm, diplopia, gaze palsy) – Pituitary • Follow-up known of pituitary adenoma - New neuroendocrine signs or symptoms • Follow of known arachnoid cyst (Al-Holou, 2010, 2013; Mustansir, 2018) o > 4 years old, repeat imaging only if newly symptomatic i.e. headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction. • Temporal Arteritis - Atypical features, failure to response to treatment or concern for intracranial involvement • Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with abnormal inflammatory markers or autoimmune antibodies • Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up • Anosmia or dysosmia on objective testing that is persistent and of unknown origin (also in combo section)

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	• Trigeminal Neuralgia or other trigeminal autonomic cephalgias, notably in those with atypical presentation (also in combo section) • Clarified age < 18 for imaging of microcephaly and macrocephaly • For initial evaluation of a suspected Arnold Chiari malformation • For follow up imaging of a known Arnold Chiari malformation (II/III). For Chiari I follow-up imaging only if new or changing signs/symptoms • After full neurologic examination and vestibular testing with concern for central vertigo (i.e. skew deviation, vertical nystagmus, head thrust test, videonystagmography (VNG)/electronystagmography (ENG)) • Clarified age < 18 for imaging of developmental delay • Brain with IAC - CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay). • Optic neuropathy or unilateral optic disk swelling of unclear etiology (Brain MRI/Orbit MRI) **Deleted** • Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent vascular and intracranial pathology (redundant) • Brain MRI/Cervical MRI combo section (included in Brain MRI/ Cervical MRI/Thoracic MRI/Lumbar combos)
May 2020	Clarified: • New onset headache with (neurologic deficit) or with signs of increased intracranial pressure (papilledema) • Special additional considerations in the pediatric population with persistent headache o Documented absence of family history of headache • For evaluation of known or suspected stroke or vascular disease: • Suspected brain tumor • Suspected brain metastasis or intracranial involvement in patients with a history of cancer based on neurological symptoms or examination findings • Follow up of known malignant brain tumor Clarified: • Patient with history of CNS cancer (either primary or secondary) and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years

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	• Follow up of known non-malignant brain tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors • New onset of an unprovoked seizure in adults • Suspected intracranial abscess or brain infection • Suspected Encephalitis with headache and altered mental status or follow-up as clinically warranted • Mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments/neuropsychological testing Clarified: • Anosmia (loss of smell) documented by objective testing that is persistent and of unknown origin • Chiari malformation/syrinx Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection etc. • Vertigo associated with any of the following o Risk factors for cerebrovascular disease with concern for stroke o After full neurologic examination and vestibular testing with concern for central vertigo • Combo Brain MRI/Orbit MRI o Reworded: Unilateral optic disk swelling/optic neuropathy of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders o Bilateral optic disk swelling (papilledema) with vision loss Added: • Visual loss (as a neurological deficit) Not explained by underlying ocular diagnosis, glaucoma or macular degeneration • Under New acute headache, sudden onset: o With a personal or family history of brain aneurysm or AVM (arteriovenous malformation) o Known coagulopathy or on anticoagulation • Under New onset of headache and any of the following o Fever o Subacute head trauma o Pregnancy or puerperium o Age $\geq$ 50

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	○ Neurological deficits - Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background) Added: • Special additional considerations in the pediatric population with persistent headache ○ Symptoms indicative of intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting ○ Severe headache in a child with an underlying disease that predisposes to intracranial pathology (e.g.; immune deficiency, sickle cell disease neurofibromatosis, history of neoplasm, coagulopathy, hypertension, congenital heart disease) • Suspected stroke with a personal or family history (brother, sister, parent or child) of aneurysm or known coagulopathy/anticoagulation Added: • Suspected Pituitary Tumors: ○ With the following: ▪ Neurologic findings (e.g. visual field deficit suggesting compression of the optic chiasm) ▪ Suspected hypofunctioning pituitary gland based on hormonal testing e.g., hypo pituitarism, growth hormone deficiency, hypogonadotropic hypogonadism [i.e. low gonadotropins (FSH/LH) and sex hormones*] ▪ * severe secondary hypogonadism with total testosterone persistently < 150 and low or normal LH/FSH OR ▪ * testosterone levels below normal range with low or normal LH/FSH AND • neurological sign and symptoms OR • other pituitary hormonal abnormalities OR • consideration of reversible functional causes of gonadotropin suppression (e.g. obesity, opioid use, or comorbid illness) Added: • Suspected hyperfunctioning pituitary gland based on hormonal testing i.e., central hyperthyroidism (high TSH), Cushing disease (high ACTH), acromegaly/gigantism (high GH/IGF-1) or elevated prolactin (>250 ng/mL or persistently elevated in the absence of another cause eg. stress, pregnancy, hypothyroidism, medication) • Note: Galactorrhea without elevated prolactin, imaging is not indicated

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	• Central Diabetes Insipidus (low ADH) • Precocious puberty in a child (male < 9; female < 8), with hormonal studies suggesting a central cause and evidence of an accelerated bone age on X-ray • Pituitary apoplexy with sudden onset of neurological and hormonal symptoms • Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination Added: • Follow up of known meningioma o If <2cm or heavily calcified at 2 years and 5 years o > 2cm annually for 3 years and then scans at 5 years and 10 years. o Multiple meningiomas, annually o After treatment (surgery or radiotherapy), post-operative if concern for residual tumor, every 6-12 months then annually for 3-5 years based on WHO Grade (see background) • Follow-up known of pituitary adenoma o New signs or symptoms o Functioning adenoma - to assess response to treatment and 1-year follow-up after drug holiday Added: • Follow of known pineal cyst (≥ 5mm) if there are atypical features or symptoms (e.g., headaches, gaze paresis, ataxia, papilledema, nausea/vomiting) • Follow of known arachnoid cyst o < 4 years old, serial imaging is warranted o > 4 years old, repeat imaging is approvable if newly symptomatic i.e. headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction • For screening for known Non-CNS Cancer o Default screening for ▪ Kidney cancer ▪ Lung cancer ▪ Merkel cell carcinoma Added: • Mucosal melanoma of the head and neck, especially of the oral cavity • Poorly differential neuroendocrine cancer (Large or Small cell/Unknown primary of neuroendocrine origin) • Screening with preconditions o AML…….Suspicion of leukemic meningitis

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	○ Cutaneous melanoma….Stage IIIC or higher ○ Testicular Cancer-Seminoma….. High risk ○ Gestational Trophoblastic Neoplasia…Pulmonary metastasis ○ Bladder cancer……High risk, i.e. small cell • All other cancer if CNS symptoms present Added: • For screening of Hereditary Cancer Syndromes ○ Li Fraumeni syndrome- Annually ○ Von Hippel Lindau – Every 2 years, starting at age of 8 years ○ Tuberous Sclerosis – Every 1-3 years, until the age of 25 years ○ MEN1 – Every 3-5 years, starting at the age of 5 years ○ NF-2- Brain IAC: Annually starting, from age of 10 years ○ Sturge Weber Syndrome: Once, after age 1 to rule out intracranial involvement after; in patients <1 year, only if symptomatic • Known seizure disorder without previous imaging Added: • Imaging indications for new onset seizures in the pediatric population ○ Abnormal neurological exam, especially a postictal focal deficit ○ Significant developmental delay ○ Focal onset ○ EEG shows focal or suspected structural abnormalities ○ <1 year of age Note: Imaging is not indicated in simple febrile seizures • Suspected temporal arteritis in a patient > 50 with temporal headache, abrupt visual changes, jaw claudication, temporal artery tenderness, constitutional symptoms or elevated ESR AND ○ Negative initial work-up (color Doppler ultrasonography or biopsy) OR ○ Atypical features or failure to response to treatment with concern for large vessel involvement Added: • MRI indicted for atypical dystonia. Note: MRI not indicated in essential tremor or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer's dystonia) • Binocular diplopia with concern for intracranial pathology • Hemifacial spasm • Other objective cranial nerve palsy (CN IX-XII) • Follow up shunt evaluation (Pople, 2002, Reddy, 2014, Kamenova, 2018) ○ Post operatively if indicated based on underlying disease and pre-operative radiographic findings and/or ○ 6-12 months after placement and/or

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	○ With neurologic symptoms that suggest shunt malfunction Added: • Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance • CSF flow study for evaluation and management of CSF flow disorders • Diagnosis of central sleep apnea on polysomnogram ○ Children > 1 year ○ Adults in the absence of heart failure, chronic opioid use, high altitude, or treatment emergent central sleep apnea AND concern for a central neurological cause (Chiari malformation, tumor, infectious/inflammatory disease) OR with an abnormal neurological exam • Syncope with clinical concern for seizure or associated neurological signs or symptoms • Cyclical vomiting syndrome or abdominal migraine with any localizing neurological symptoms • Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph) Added: • Cerebral palsy if etiology has not been established the neonatal period, there is change in the expected clinical or developmental profile or concern for progressive neurological disorder • Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam Note: Imaging is not indicated in low risk patients • Under Indications for a Brain MRI with Internal Auditory Canal (IAC): ○ CSF otorrhea (MRI for intermittent leak, CT for active leaks) ○ Clinical Suspicion of acute mastoiditis as a complication of acute otitis media with intracranial complications (i.e. meningeal signs, cranial nerve deficits, focal neurological findings, altered mental status) ○ Bell's Palsy for evaluation of the extracranial nerve course - if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset Added: • Combo Brain MRI/MRA

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	○ Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up ▪ Negative Brain CT; ▪ AND Negative Lumbar Puncture ▪ Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm • Combo Brain MRI/Orbit MRI ○ Optic Neuritis if atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset • Combo Brain MRI/Face/Sinus/Neck MRI ○ Bells/hemifacial spasm that meets above criteria ○ Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course ○ Granulomatosis with polyangiitis (Wegener's granulomatosis) disease Deleted: • Under New onset of headache and any of the following ○ Temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery. • Known or suspected pituitary tumor with corroborating physical exam (i.e., galactorrhea or acromegaly) neurologic findings and/or lab abnormalities. • Known brain tumor and new onset of headache. • Follow up shunt evaluation within six (6) months of placement or one (1) year follow up and/or with neurologic symptoms • From combo Brain MRI/MRA Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache
August 2019	• For evaluation of patient with neurologic symptoms or deficits suspicious for MS: Added: "clinically isolated syndrome OR recurrent episodes of variable neurological signs or symptoms not attributable to another cause; And Removed time frame of 'within the last 4 weeks' • Removed: Stable condition with no prior imaging within the past ten (10) months or within the past six (6) months if patient has relapsing disease • Removed: Exacerbation of symptoms or change in symptom characteristics such as frequency or type and demonstrated compliance with medical therapy. • For evaluation of MS, added:

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	○ To establish a new baseline (no recent imaging, postpartum, or 6-12 months after switching disease modifying therapy) ○ Prior to starting or switching disease-modifying therapy ○ Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years ○ New signs or symptoms suggested of an exacerbation or unexpected clinical worsening ○ PML surveillance for patients on natalizumab • For evaluation of known or suspected seizure disorder, added: ○ Newly identified change in seizure activity/pattern • Renamed Parkinson's section to: Movement disorders and added: ○ For the evaluation of other movement disorder to exclude a structural lesion (i.e., suspected Huntington disease, chorea, atypical parkinsonian syndromes, hemiballismus, secondary dystonia). ○ * MRI not indicated in essential tremor or primary dystonia ○ For suspected Parkinson's, added 'with atypical feature or unresponsive to levodopa • For evaluation of neurologic symptoms or deficits, added: visual loss • For trauma, added: ○ On anticoagulation ○ Post concussive syndrome if persistent or disabling symptoms and imaging has not been performed ○ Subacute or chronic traumatic brain injury with new cognitive and/or neurologic deficit • For evaluation of headache, added or removed: ○ Prior history of stroke or intracranial bleed with sudden onset of severe headache (moved) ○ New headache and signs of increased intracranial pressure ○ Related to activity or event (sexual activity, exertion, position) (new or progressively worsening) ○ New headache and persistent or progressively worsening during a course of physician directed treatment ○ Special considerations in the pediatric population with persistent headache: ▪ Occipital location ▪ Age < 6 years ▪ No family history of headache • For evaluation of brain tumor: ○ Specified 'malignant' for f/u of known tumor

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	○ Added: Follow up of known benign tumor if symptomatic, new/changing signs or symptoms or complicating factors; Follow up of known meningioma; and tumor evaluation and monitoring in neurocutaneous syndromes ○ Removed: Known lung cancer or rule out metastasis and/or preoperative evaluation, Metastatic melanoma (not all melanomas) • For evaluation of suspected stroke: ○ Moved 'patient with history of a known stroke with new and sudden onset of severe headache' ○ Separated: Family history of aneurysm • For evaluation inflammatory disease or infections: ○ Changed meningitis with positive signs and symptoms from 'And' positive lab findings to 'OR' positive labs ○ For suspected encephalitis removed 'severe' headache • For evaluation of congenital abnormality: ○ Modified the age restriction of > 6 months age for eval of macrocephaly to include 'in an infant/child with previously abnormal US, abnormal neurodevelopmental exam, signs of increased ICP or closed anterior fontanelle' • For known or suspected normal pressure hydrocephalus (NPH): ○ Added - With symptoms of gait difficulty, cognitive disturbance and urinary incontinence • Other Indications: ○ Added detail to Vertigo including: ▪ Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness or a change in sensation) ▪ Progressive unilateral hearing loss ▪ Risk factors for cerebrovascular disease ▪ After full neurologic examination and ENT work-up with concern for central vertigo ○ Modified developmental delay to include: Global developmental delay or developmental delay with abnormal neurological examination ○ Added: ▪ Horner's syndrome with symptoms localizing the lesion to the central nervous system ▪ Trigeminal Neuralgia – if <40 years of age or atypical features (ie bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain >2min, pain outside trigeminal nerve distribution, progression)

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	▪ Bell's Palsy- if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset. ▪ Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause ▪ New onset anisocoria o Removed Objective cranial nerve palsy; and Cholesteatoma (duplicated) • For Brain MRI/Neck MRA: deleted 'confirmed carotid occlusion > 60%, surgery or angioplasty candidate' and added 'Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits' • Added Brain MRI/Brain MRA section, including: Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache; and Suspected venous thrombosis (dural sinus thrombosis) • Added Brain MRI/Brain MRA/Neck MRA section, including: Recent stroke or transient ischemic attack (TIA); and Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent vascular and intracranial pathology • For Brain MRI/Cervical MRI, added: Suspected MS with new or changing symptoms consistent with cervical spinal cord disease; and Follow up to the initiation or change in medication for patient with known Multiple Sclerosis • For Brain MRI/Orbit MRI, added: Bilateral papilledema with visual loss; and Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent or bilateral optic neuritis; AND changed age restriction from 3 years to 8 years for children requiring anesthesia for the procedure with suspicion of concurrent orbital and intracranial pathology or tumor • Added section for Brain MRI/Face/Sinus/Neck MRI, including: Anosmia on objective testing; and Trigeminal neuralgia or cranial nerve palsy that meets the above criteria • Updated background information and references

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National Imaging Associates, Inc.*	
Clinical guidelines **FUNCTIONAL BRAIN MRI**	**Original Date: June 2007**
CPT Codes: 70554, 70555	**Last Revised Date: May 2022**
Guideline Number: NIA_CG_013	**Implementation Date: January 2023**

INDICATIONS FOR FUNCTIONAL BRAIN MRI[1]

Pre-operative/procedural Evaluation[1]

In the following where fMRI may have a significant role in the mapping of a lesion in relation to eloquent cortex (i.e., language, motor, sensory and visual centers)

- Focal brain lesion (i.e., tumor or vascular malformation) for presurgical planning[2-5]
- Pre-operative evaluation for epilepsy surgery[6,7]
- Brain tumor for radiation treatment planning[8,9]

Post-operative/procedural Evaluation

- Therapeutic follow-up. A documented medical reason must clearly explain the medical necessity for follow up (i.e., evaluation of post-treatment eloquent cortex).

BACKGROUND

Functional MRI (fMRI) of the brain is a non-invasive imaging technique, using radio waves and a strong magnetic field, to image the brain activity of a patient prior to undergoing brain surgery for tumors or epilepsy. It is based on the increase in blood flow to the local vasculature when parts of the brain are activated and helps to determine the location of vital areas of brain function. fMRI images capture blood oxygen levels in parts of the brain that are responsible for perception, cognition, and movement allowing neurosurgeons to operate with less possibility of harming areas that are critical to the patient's quality of life. fMRI is primarily used for presurgical planning, operative risk assessment and therapeutic follow-up.

fMRI as an Alternative to the Invasive Wada test and Direct Electrical Stimulation – fMRI is considered an alternative to the Wada test and direct electrical stimulation as it is a non-invasive method for location of vital brain areas. The Wada test is used for the pre-operative evaluations of patients with brain tumors and seizures to determine which side of the brain is responsible for vital cognitive functions, e.g., speech and memory. It can assess the surgical risk of damaging the vital areas of the brain. The Wada test is invasive, involving an angiography

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procedure to guide a catheter to the internal carotid where a barbiturate is injected, putting one hemisphere of the brain to sleep. Direct electrical stimulation mapping is invasive requiring the placement of electrodes in the brain. The electrodes are used to stimulate multiple cortical sites in the planned area of resection to allow the surgeons to identify and mark which areas can be safely resected.[10,11]

fMRI and Brain Tumors – fMRI may significantly affect therapeutic planning in patients who have potentially resectable brain tumors. Due to its non-invasiveness, its relatively high spatial resolution, and its pre-operative results, fMRI is used before surgery in the evaluation of patients with brain tumors. fMRI may have a significant role in mapping lesions that are located in close proximity to vital areas of brain function (language, sensory motor, and visual). It can determine the precise spatial relationship between the lesion and adjacent functionally essential parenchyma, allowing removal of as much pathological tissue as possible during resection of brain tumors without compromising essential brain functions. fMRI provides an alternative to other invasive tests, such as the Wada test and direct electrical stimulation.[12]

fMRI and Seizures – Brain fMRI can influence the diagnostic and therapeutic decisions of the seizure team, thereby affecting the surgical approach and outcomes. Brain surgery is often the treatment for patients with refractory epilepsy, especially patients with a single seizure focus. fMRI can be used to image and localize abnormal brain function in patients with seizures. fMRI can help determine brain functions (language, sensory motor, and visual) of areas bordering the lesion, resulting in better outcomes with less neurologic deficit.[7]

POLICY HISTORY

Date	Summary
May 2022	Updated background and references
February 2021	Updated references
May 2020	• Updated references • Reordered indications
August 2019	• Modified pre-operative/procedural evaluation section to include focal brain lesion for pre-surgical planning, brain tumor for radiation treatment planning AND epilepsy surgery pre-operative evaluation.

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National Imaging Associates, Inc.*	
Clinical guidelines **CHEST (Thorax) CT**	**Original Date: September 1997**
CPT Codes: 71250, 71260, 71270, 71271	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_020	**Implementation Date: January 2023**

This Chest CT Guideline covers CPT codes 71250 (CT chest without contrast), CT chest with contrast (71260), CT chest without and with contrast (71270) and Low dose CT scan (LDCT) for lung cancer screening (71271). **When the case is listed as CT chest in BBI and the clinical scenario or request for LDCT in the office notes meets appropriate use criteria for a LDCT, the LDCT is approvable due to these overlapping CPT codes. Reprocessing of the case to a separate LDCT request is not required.**

INDICATIONS FOR CHEST CT

For Annual Lung Cancer Screening
The use of low-dose, non-contrast spiral (helical) multi-detector CT imaging as an annual screening technique for lung cancer is considered **medically necessary ONLY** when used to screen for lung cancer for certain high-risk **asymptomatic** individuals when **ALL** of the following criteria are met[1]:

- Individual is between 50-80 years of age; AND
- There is at least a 20 pack-year history of cigarette smoking; AND
- If the individual is a former smoker, that individual had quit smoking within the previous 15 years

Nodule on Initial LDCT[2]
- If multiple nodules, the largest and type is used for decision
- Follow-up with LDCT as per Lung-Rads criteria[3, 4] (Table 1)

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Table 1: Lung-RADS® Assessment Categories[5]

Category Descriptor	Lung-RADS Score	Findings	Management
Incomplete	**0**	Prior chest CT examination(s) being located for comparison Part or all of lungs cannot be evaluated	Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed
Negative No nodules and definitely benign nodules	**1**	No lung nodules Nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules	Continue annual screening with LDCT in 12 months
Benign Appearance or Behavior Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth	**2**	**Perifissural nodule(s)** *(See Footnote 11)* < 10 mm (524 mm^3) **Solid nodule(s):** < 6 mm (< 113 mm^3) new < 4 mm (< 34 mm^3) **Part solid nodule(s):** < 6 mm total diameter (< 113 mm^3) on baseline screening **Non solid nodule(s) (GGN):** <30 mm (<14137 mm^3) **OR** ≥ 30 mm (≥ 14137 mm^3) and unchanged or slowly growing **Category 3 or 4 nodules unchanged for ≥ 3 months**	
Probably Benign Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	**3**	**Solid nodule(s):** ≥ 6 to < 8 mm (≥ 113 to < 268 mm^3) at baseline **OR** new 4 mm to < 6 mm (34 to < 113 mm^3) **Part solid nodule(s)** ≥ 6 mm total diameter (≥ 113 mm^3) with solid component < 6 mm (< 113 mm^3) **OR** new < 6 mm total diameter (< 113 mm^3) **Non solid nodule(s)** (GGN) ≥ 30 mm (≥ 14137 mm^3) on baseline CT or new	6 month LDCT
Suspicious Findings for which additional diagnostic testing is recommended	**4A**	**Solid nodule(s):** ≥ 8 to < 15 mm (≥ 268 to < 1767 mm^3) at baseline **OR** growing < 8 mm (< 268 mm^3) **OR** new 6 to < 8 mm (113 to < 268 mm^3) **Part solid nodule(s):** ≥ 6 mm (≥ 113 mm^3) with solid component ≥ 6 mm to < 8 mm (≥ 113 to < 268 mm^3) **OR** with a new or growing < 4 mm (< 34 mm^3) solid component **Endobronchial nodule**	3 month LDCT; PET/CT may be used when there is a ≥ 8 mm (≥ 268 mm^3) solid component
Very Suspicious Findings for which additional diagnostic testing and/or tissue sampling is recommended	**4B**	**Solid nodule(s)** ≥ 15 mm (≥ 1767 mm^3) **OR** new or growing, and ≥ 8 mm (≥ 268 mm^3) **Part solid nodule(s) with:** a solid component ≥ 8 mm (≥ 268 mm^3) **OR** a new or growing ≥ 4 mm (≥ 34 mm^3) solid component	Chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm (≥ 268 mm^3) solid component. *For new large nodules that develop on an annual repeat screening CT, a 1 month LDCT may be recommended to address potentially infectious or inflammatory conditions*
	4X	Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy	
Other Clinically Significant or Potentially Clinically Significant Findings (non lung cancer)	**S**	**Modifier - may add on to category 0-4 coding**	As appropriate to the specific finding

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Incidental Lung Nodules[6]

- Incidental pulmonary nodules detected on a nonscreening Chest CT (use Fleischner Table)
    - Age ≥ 35 years old – use Fleischner table
    - Excludes
        - Lung cancer screening (see lung cancer screening guidelines above)
        - History of primary cancer (imaging follow-up for surveillance is 3 months to detect interval nodule growth)
        - Immunosuppression (may require a shorter follow-up, such as 1 month, if suspicion of fulminant infection)

Note: These should not be ordered as Low Dose CT

- **Incidental pulmonary nodules on non-chest CT**
    - Nodules >8mm or those with very suspicious features need further Chest CT as early as possible
    - Nodules ≤ 8mm should follow the Fleischner table

Incidental pulmonary nodules on chest x-ray that are indeterminate (not typical of granulomatous disease) as noted by the radiologist. No time delay between the chest x-ray and the subsequent Chest CT needed).

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Table 2: 2017 Fleischner Society Guidelines for Management of Incidentally Detected Pulmonary Nodules[6]

A: Solid Nodules*

Nodule Type	Nodules <6 mm (<100 mm³)	Nodules 6–8 mm (100–250 mm³)	Nodules >8 mm (>250 mm³)	Comments
Single				
Low risk	No routine follow-up	CT at 6–12 mo, then consider CT at 18–24 mo	Consider CT at 3 mo, PET/CT, or tissue sampling	Nodules <6 mm do not require routine follow-up in low-risk patients (recommendation 1A)
High risk	Optional CT at 12 mo	CT at 6–12 mo, then at 18–24 mo	Consider CT at 3 mo, PET/CT, or tissue sampling	Certain patients at high risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-mo follow-up (recommendation 1A)
Multiple				
Low risk	No routine follow-up	CT at 3–6 mo, then consider CT at 18–24 mo	CT at 3–6 mo, then consider CT at 18–24 mo	Use most suspicious nodule as guide to management; follow-up intervals may vary according to size and risk (recommendation 2A)
High risk	Optional CT at 12 mo	CT at 3–6 mo, then at 18–24 mo	CT at 3–6 mo, then at 18–24 mo	Use most suspicious nodule as guide to management; follow-up intervals may vary according to size and risk (recommendation 2A)

B: Subsolid Nodules*

Nodule Type	Nodules <6 mm (<100 mm³)	Nodules ≥6 mm (≥100 mm³)	Comments
Single			
Ground glass	No routine follow-up	CT at 6–12 mo to confirm persistence, then CT every 2 y until 5 y	For certain suspicious nodules <6 mm, consider follow-up at 2 y and 4 y; if solid component(s) develops or growth occurs, consider resection (recommendations 3A and 4A)
Partly solid	No routine follow-up	CT at 3–6 mo to confirm persistence; if lesion is unchanged and solid component remains <6 mm, annual CT should be performed for 5 y	In practice, partly solid nodules cannot be defined as such until they are ≥6 mm, and nodules <6 mm usually do not require follow-up; persistent partly solid nodules with a solid component ≥6 mm should be considered highly suspicious (recommendations 4A–4C)
Multiple	CT at 3–6 mo; if lesion is stable, consider CT at 2 y and 4 y	CT at 3–6 mo; subsequent management based on the most suspicious nodule(s)	Multiple <6-mm pure GGNs† usually are benign, but consider follow-up at 2 y and 4 y in select patients at high risk (recommendation 5A)

Known Cancer[7-9]

- For follow-up intervals for malignancies[10]
- Cancer staging (includes unknown primary)
- Cancer restaging
- Suspicious signs or symptoms of recurrence
- Suspected cancer based on prior imaging[11]

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Chest Mass (non-lung parenchymal)[12]
(Preference should be given to MRI over chest CT for chest wall mass)
- Mass or lesion, including lymphadenopathy, after non-diagnostic initial imaging
- Thymoma screening in Myasthenia Gravis patients[13]

Interstitial Lung Disease[14, 15]
- Suspected or known based on restrictive pattern pulmonary function test or signs or symptoms after initial chest x-ray
- Signs or symptoms unresponsive to treatment such as:
    - Shortness of breath
    - Persistent dyspnea
    - Persistent cough
- Monitoring treatment response of known interstitial lung disease
- Patients with known collagen vascular disease[16]
- Guidance in selection of the most appropriate site for biopsy of diffuse lung disease[17]

Chronic Cough (> 8 weeks) and chest x-ray completed[18]
- After evaluation for other causes and failed treatment for those diagnosed with:
    - Asthma
    - Gastroesophageal Reflux Disease
    - Discontinuation of ACE inhibitors
    - Postnasal drip
- Clinical concern for bronchiectasis

Tuberculosis (TB)[19]
- Known or suspected tuberculosis and initial chest x-ray done

Infection Follow-up Imaging
- Abscess, empyema, or pleural effusions on chest x-ray[20]
- For evaluation of non-resolving pneumonia or inflammatory disease documented by **at least two** imaging studies:
    - Unimproved with 4 weeks of antibiotic treatment; **OR**
    - Unresolved at 8 weeks[21, 22]

Pneumothorax on Chest X-ray[23]

Vocal Cord Paralysis on Endoscopic Exam[24]
- Neck and Chest CT is an approvable combo

Granulomatosis with Polyangiitis (Wegener's Granulomatosis)[25]

Vascular Disease
- CT chest is not preferred study for vascular disease, CTA should be considered. See Chest CTA guideline.

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- Chest CT can be used to detect and follow-up thoracic aortic aneurysms. See Background section.

Suspected Pulmonary Embolism (PE)[26]
- Chest CT not approvable for PE

Congenital Malformations
- Thoracic malformation on chest x-ray[27]
- Congenital Heart Disease with pulmonary hypertension[28]

Hemoptysis after x-ray completed[29, 30]

Pre-operative/procedural evaluation
- Pre-operative evaluation for a planned surgery or procedure
- Pre-operative evaluation for Electromagnetic Navigation Bronchoscopy[31]

Post-operative/procedural evaluation
- Post-surgical follow-up when records document medical reason requiring additional imaging

Chest Wall Pain (after initial evaluation with chest x-ray and/or rib films)[32]
- History of known or suspected cancer
- Signs and symptoms of infection, such as:
    - Accompanying fever
    - Elevated inflammatory markers
    - Known infection at other sites

Chest CT and COVID-19 (Coronavirus)
- Acute COVID
    - Imaging is not indicated in patients suspected of having coronavirus disease (COVID-19) and mild clinical features unless they are at risk for disease progression
    - Imaging is indicated in a patient with COVID-19 and worsening respiratory status
    - In a resource-constrained environment, imaging is indicated for medical triage of patients suspected of having COVID-19 who present with moderate-to-severe clinical features and a high pretest probability of disease
- Long (Chronic) COVID (See Overview)
    - Prior history of Covid with hypoxia or impaired lung function of follow-up[33]
        - Restricted diffusion on Pulmonary Function Test (would need a HRCT – High Resolution CT)
        - Low oxygen saturation and a Chest x-ray was done
    - Known fibrosis with continued symptoms

Combination of studies with Chest CT

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- **Abdomen CT/Pelvis CT/Chest CT/Neck MRI/Neck CT with MUGA** – known tumor/cancer for initial staging or evaluation before starting chemotherapy or radiation treatment
- **Neck and Chest CT -** Neck and Chest CT is an approvable combo with vocal cord paralysis and concern for recurrent laryngeal nerve lesion

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BACKGROUND

Computed tomography (CT) scans provide greater clarity than regular x-rays and are used to further examine abnormalities found on chest x-rays. They may be used for detection and evaluation of various disease and conditions in the chest, e.g., tumor, inflammatory disease, vascular disease, congenital abnormalities, trauma, and symptoms such as hemoptysis.

OVERVIEW

LDCT for Lung Cancer Screening - Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery.

CT and Aneurysm

- Initial evaluation of aneurysm[34-36]
    - Echocardiogram shows aneurysm
    - Echocardiogram inconclusive of proximal aorta and first-degree relative with thoracic aneurysm
    - Chest x-ray shows possible aneurysm
- Follow-up after established Thoracic Aneurysm (above these sizes surgery is usually recommended)[34-36]
    - Aortic Root or Ascending Aorta
        - 3.5 to 4.5 Annual
        - 4.5 to 5.4 Every 6 months
    - Genetically mediated (Marfans syndrome, Aortic Root or Ascending Aorta
        - 3.5 to 4.0 Annual
        - 4.0 to 5.0 Every 6 months
    - Descending Aorta
        - 4.0 to 5.0 Annual
        - 5.0 to 6.0 Every 6 months

CT and Interstitial Lung Disease[14] – Radiography of the chest is usually appropriate for the initial imaging of patients who undergo screening and surveillance for lung disease when occupational exposure is present.

Costochondritis[37] – If physical exam findings are suggestive of costochondritis but the pain is persistent despite conservative care, it should be kept in mind that costochondritis can be recurrent and persistent. It is associated with fibromyalgia. Chest CT should be considered if the findings are not consistent with typical costochondritis, such as fever or elevated inflammatory markers, suggestive of infection or a suspicion of cancer based on history or current findings.

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CT for Management of Hemoptysis[29, 30] – High-resolution CT (HRCT) is useful for estimating the severity of hemoptysis, localizing the bleeding site and determining the cause of the bleeding. Its results can be related to the severity of bleeding. The volume of expectorated blood and the amount of blood that may be retained within the lungs without being coughed up are important. HRCT is a way to evaluate the amount of bleeding and its severity. It may also help in the localization of bleeding sites and help in detecting the cause of bleeding.

CT and Solitary Pulmonary Nodules – Solitary Pulmonary nodules are abnormalities that are solid, semisolid and non-solid; another term to describe a nodule is focal opacity. CT makes it possible to find smaller nodules and contrast-enhanced CT is used to differentiate benign from malignant pulmonary modules. When a nodule is increasing in size or has spiculated margins or mixed solid and ground-glass attenuation, malignancy should be expected. Patients who have pulmonary nodules and who are immunocompromised may be subject to inflammatory processes.

CT and Empyema – Contrast-enhanced CT used in the evaluation of the chest wall may detect pleural effusion and differentiate a peripheral pulmonary abscess from a thoracic empyema. CT may also detect pleural space infections and help in the diagnosis and staging of thoracic empyema.

CT and Rib fractures[38] – Chest CT may be useful for characterizing a pathologic fracture, and some features may be helpful in differentiating a primary malignant tumor of bone from metastasis. CT may also be helpful to search for a primary malignancy in patients with a suspected pathologic fracture; however, there is no strong indication that CT serves a significant use as the initial imaging modality to detect pathologic rib fractures.

CT and Occupational Lung Disease[14] – The chest radiograph and CT are complementary in the initial workup of suspected occupational lung disease. When patients with occupational exposures present with respiratory symptoms, chest radiography serves as the primary function of excluding alternative diagnoses, such as infectious pneumonia or pulmonary edema, with HRCT findings offering the best characterization of lung disease.

CT and Tuberculosis – "The chest radiograph is usually the first study performed in patients suspected of having TB. Although frontal and lateral radiographs are often performed in this setting, it has been shown that the lateral radiograph does not improve the detection of findings related to TB. In those with signs or symptoms of disease, the radiographic pattern of upper-lobe or superior-segment lower-lobe fibrocavitary disease in the appropriate clinical setting is sufficient to warrant respiratory isolation and sputum culture for definitive diagnosis. Using radiographs in combination with clinical evaluation results in a high sensitivity for the diagnosis but a relatively low specificity for both latent and active TB. In addition, radiographs may reveal ancillary findings of TB such as pleural effusion or spondylitis. For immunocompromised hosts, particularly those with a low CD4 count, computed tomography (CT) should be considered."[39] CT may be of value in the severely immunocompromised patient

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with a normal or near-normal radiograph by revealing abnormal lymph nodes or subtle parenchymal disease. Finally, CT may also have a role in identifying patients with latent TB who will be at risk for reactivation disease.

CT and Superior Vena Cava (SVC) Syndrome – SVC is associated with cancer, e.g., lung, breast and mediastinal neoplasms. These malignant diseases cause invasion of the venous intima or an extrinsic mass effect. Adenocarcinoma of the lung is the most common cause of SVC. SVC is a clinical diagnosis with typical symptoms of shortness of breath along with facial and upper extremity edema. Computed tomography (CT), often the most readily available technology, may be used as confirmation and may provide information including possible causes.

CT and Family History of Lung Cancer[40] – Family history is equally important. Individuals with a family history of lung cancer among first-degree relatives have been consistently shown to have a two-fold higher risk of developing lung cancer themselves. Those with multiple affected family members diagnosed at younger age appear to be at greater risk.

CT and COVID-19 – Chest CT is not recommended by the American College of Radiology either as a screening test for COVID-19 or as a first-line test to diagnose COVID-19.[41] The chest imaging pattern is nonspecific to COVID-19 and may be dependent on radiographic interpretation.[42-48] The CDC differentiates long COVID—also known as long-haul COVID, post-acute COVID-19, long-term effects of COVID, or chronic COVID—as post-COVID conditions that "are a wide range of new, returning, or ongoing health problems people can experience four or more weeks after first being infected with the virus that causes COVID-19. Even people who did not have COVID-19 symptoms in the days or weeks after they were infected can have post-COVID conditions. These conditions can present as different types and combinations of health problems for different lengths of time."[49]

POLICY HISTORY

Date	Summary
March 2022	• Clarified that no time delay required between chest x-ray and subsequent Chest CT for indeterminate incidental pulmonary nodules on chest x-ray (not typical of granulomatous disease) • Moved "Pre-operative evaluation for Electromagnetic Navigation Bronchoscopy" from Post-operative/procedural evaluation to Pre-operative/procedural evaluation • Added known fibrosis with continued symptoms to Long (Chronic) COVID
April 2021	• Added details for the following: incidental lung nodules as per the Fleischner Society; when not to use the Fleischner criteria; ordering of a Chest CT in the setting of coronavirus infection • Clarified when to use Lung Rads versus Fleischner criteria • Clarified pre-operative evaluation for a planned surgery or procedure • Added indications on what to image in setting of Covid 19

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March 10, 2021	• Eliminated groupings (group 1 and group 2) for lung cancer screening and changed age of 55-80 years to 50-80 years; removed 30 pack year history of cigarette smoking (USPSTF 2021)
November 9, 2020	• Replaced CPT code G0297 with 71271
May 2020	• For Annual Lung Cancer Screening: o Changed upper age limit from 77 to 80 yrs old o Added: • *Age ≥ 50 years old; AND* • *≥ 20 pack-year history of smoking; AND* • *Additional risk factors (other than second-hand smoke)** (see pg 2) **Additional risk factors include: Survivors of lung cancer, lymphoma, cancers of the head and neck and bladder (smoking related cancers), first degree family members with a history of lung cancer, history of COPD or pulmonary fibrosis, radon exposure, retinoblastoma, Li Fraumeni syndrome, occupational exposure to arsenic, chromium, asbestos, nickel, cadmium, beryllium, silica, diesel fumes, coal smoke and soot* • Expanded lung nodules section to include: o *Incidental pulmonary nodules detected on CT (use Fleischner Table)* • *Age ≥ 35 years old – use Fleischner table* • *Excludes lung cancer screening, patients with history of primary cancer, or immunosuppression (see specific section in current guideline)* o *Incidental pulmonary nodules on non-chest CT:* • *Nodules >8mm or those with very suspicious features need further Chest CT as early as possible* • Nodules ≤ 8mm should follow the Fleischner table • For Known Cancer, added: *For follow-up intervals for malignancies* • For Lung or Chest Wall Mass: o Added statement: *Preference should be given to MRI over chest CT for chest wall mass* • Removed descriptive variables for 'Mass with increased risk for malignancy' including: *Fixation to adjacent tissues; Firm consistency; Size > 1.5 cm; Ulceration of overlying skin* • Expanded Interstitial Lung Disease section to include: o *Suspected or known based on restrictive pattern pulmonary function test or signs or symptoms after* initial chest x-ray o *Signs or symptoms unresponsive to treatment such as:* ▪ *Shortness of breath* ▪ *Persistent dyspnea*

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	▪ *Persistent cough* o *Patients with known collagen vascular disease* o *Guidance in selection of the most appropriate site for biopsy of diffuse lung disease* • Infection f/u imaging: added *inflammatory disease* • Vocal Cord Paralysis on Endoscopic Exam: added '*Neck and Chest CT is an approvable combo*' • Removed Vascular Disease section and added the following: o CT chest is not preferred study for vascular disease, CTA should be considered. See Chest CTA guideline. o Chest CT can be used to detect and follow-up thoracic aortic aneurysms. • Added indication: Chest Wall Pain o *Chest Wall Pain (after initial evaluation with chest x-ray and/or rib films)* ▪ *History of known or suspected cancer* ▪ *Signs and symptoms of infection, such as:* • *Accompanying fever* • *Elevated inflammatory markers* • *Known infection at other sites* • Added Neck and Chest CT combo study
May 2019	• Added chart for f/u interval at which LDCT can be approved • Removed pulmonary embolism indication • Added statement about CPT codes • Separate diagnostic criteria for Thoracic aneurysm • Separated individual diagnoses. • Expanded criteria for chronic cough. • Updated references.

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LOW-DOSE CT FOR LUNG CANCER SCREENING**	**Original Date: January 2015**
CPT Codes: 71271	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_020-1	**Implementation Date: January 2023**

INDICATIONS FOR LOW-DOSE CT (LDCT) FOR LUNG CANCER SCREENING

For Annual Lung Cancer Screening:
The use of low-dose, non-contrast spiral (helical) multi-detector CT imaging as a screening technique for lung cancer is considered **medically necessary ONLY** when used to screen for lung cancer for certain high-risk, **asymptomatic** individuals, i.e., no acute lung-related symptoms, when **ALL** of the following criteria are met[1]:

Group 1:

- Individual is between 50-80 years of age*; AND
- There is at least a 20 pack-year history of cigarette smoking; AND
- If the individual is a former smoker, that individual had quit smoking within the previous 15 years.

*May approve for individuals over the age limit if the individual is a candidate for and willing to undergo curative treatment

Group 2:
Yearly Low-Dose CT surveillance after completion of definitive treatment of non-small cell lung cancer as per these parameters[2]:

- Stage I-II (treated with surgery +/- chemotherapy)
    - starts at year 2-3 of surveillance
- Stage I-II (treated primarily with radiation) or stage III-IV with all sites treated with definitive intent
    - starts at year 5 of surveillance

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Nodule on initial LDCT (Follow-up low dose CT is approvable)[3]:

- **Table 1** shows the follow-up interval at which LDCT can be approved to reduce radiation dose[4]
- If multiple nodules, the largest and type is used for decision

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Table 1: Lung-RADS® Assessment Categories[4]

Category Descriptor	Lung-RADS Score	Findings	Management
Incomplete	0	Prior chest CT examination(s) being located for comparison Part or all of lungs cannot be evaluated	Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed
Negative No nodules and definitely benign nodules	1	No lung nodules Nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules	Continue annual screening with LDCT in 12 months
Benign Appearance or Behavior Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth	2	**Perifissural nodule(s)** *(See Footnote 11)* < 10 mm (524 mm^3) **Solid nodule(s):** < 6 mm (< 113 mm^3) new < 4 mm (< 34 mm^3) **Part solid nodule(s):** < 6 mm total diameter (< 113 mm^3) on baseline screening **Non solid nodule(s) (GGN):** <30 mm (<14137 mm^3) **OR** ≥ 30 mm (≥ 14137 mm^3) and unchanged or slowly growing **Category 3 or 4 nodules unchanged for ≥ 3 months**	
Probably Benign Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	3	**Solid nodule(s):** ≥ 6 to < 8 mm (≥ 113 to < 268 mm^3) at baseline **OR** new 4 mm to < 6 mm (34 to < 113 mm^3) **Part solid nodule(s)** ≥ 6 mm total diameter (≥ 113 mm^3) with solid component < 6 mm (< 113 mm^3) **OR** new < 6 mm total diameter (< 113 mm^3) **Non solid nodule(s)** (GGN) ≥ 30 mm (≥ 14137 mm^3) on baseline CT or new	6 month LDCT
Suspicious Findings for which additional diagnostic testing is recommended	4A	**Solid nodule(s):** ≥ 8 to < 15 mm (≥ 268 to < 1767 mm^3) at baseline **OR** growing < 8 mm (< 268 mm^3) **OR** new 6 to < 8 mm (113 to < 268 mm^3) **Part solid nodule(s):** ≥ 6 mm (≥ 113 mm^3) with solid component ≥ 6 mm to < 8 mm (≥ 113 to < 268 mm^3) **OR** with a new or growing < 4 mm (< 34 mm^3) solid component **Endobronchial nodule**	3 month LDCT; PET/CT may be used when there is a ≥ 8 mm (≥ 268 mm^3) solid component
Very Suspicious Findings for which additional diagnostic testing and/or tissue sampling is recommended	4B	**Solid nodule(s)** ≥ 15 mm (≥ 1767 mm^3) **OR** new or growing, and ≥ 8 mm (≥ 268 mm^3) **Part solid nodule(s) with:** a solid component ≥ 8 mm (≥ 268 mm^3) **OR** a new or growing ≥ 4 mm (≥ 34 mm^3) solid component	Chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm (≥ 268 mm^3) solid component. *For new large nodules that develop on an annual repeat screening CT, a 1 month LDCT may be recommended to address potentially infectious or inflammatory conditions*
	4X	Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy	
Other Clinically Significant or Potentially Clinically Significant Findings (non lung cancer)	S	**Modifier - may add on to category 0-4 coding**	As appropriate to the specific finding

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BACKGROUND

Smoking-related lung cancer is the leading cause of cancer deaths in both men and women in the United States. Treatment for most lung cancer is focused on surgery which is usually curative only when the tumors are very small. Screening for early lung cancer with sputum cytology and chest x-rays has not been successful in reducing deaths from lung cancer. However, in 2011, a large, prospective, multicenter trial was published that showed CT Chest screening identified early cancers better than other approaches and reduced the death rate from lung cancer. In 2014, the United States Preventive Service Task Force (USPSTF) recommended annual low-dose CT Chest screening (CPT® code 71271) for people with current or recent past smoking histories.

All screening and follow-up chest CT scans to be performed at low dose (100-120 kVp and 40-60 mAs), unless evaluating mediastinal findings or lymph nodes, where standard dose CT with IV contrast may be more appropriate.[2]

OVERVIEW

Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery.

POLICY HISTORY

Date	Summary
March 2022	Reviewed data. No significant updates since prior revision.
April 2021	• Added data about expanding screening to older patients that are willing to have and that are candidates for definitive treatment for lung cancer, based on NCCN recommendations • Added long term surveillance in patients who received definitive treatment for non small cell lung cancer
March 10, 2021	• Eliminated groupings (group 1 and group 2) for lung cancer screening and changed age of 55-80 years to 50-80 years; changed to 20 pack year history of cigarette smoking and requirement of additional risk factors (USPSTF 2021)
November 9, 2020	• Replaced CPT code G0297 with 71271
May 2020	• Lung Cancer Screening: o Changed upper age limit from 77 to 80 yrs old o Added: • *Age ≥ 50 years old; AND* • *≥ 20 pack-year history of smoking; AND* • *Additional risk factors (other than second-hand smoke)**

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	**Additional risk factors include: Survivors of lung cancer, lymphoma, cancers of the head and neck and bladder (smoking related cancers), first degree family members with a history of lung cancer, history of COPD or pulmonary fibrosis, radon exposure, retinoblastoma, Li Fraumeni syndrome, occupational exposure to arsenic, chromium, asbestos, nickel, cadmium, beryllium, silica, diesel fumes, coal smoke and soot* • Updated the follow-up interval for LDCT information, using the ACR 2019 Lung RADS chart • Updated background information
May 2019	• Criteria for repeating at less than one year were added. • Upper age range changed from 80 to 77 years of age • Chart added for the f/u interval at which LDCT can be approved to reduce radiation dose

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ADDITIONAL RESOURCE(S)

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National Imaging Associates, Inc.*	
Clinical guidelines **CHEST CTA**	**Original Date: September 1997**
CPT Codes: 71275	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_022-1	**Implementation Date: January 2023**

INDICATIONS FOR CHEST CTA

Chest Computed Tomography Angiography (CTA) is ordered for evaluation of the intrathoracic blood vessels. Chest CT and Chest CTA should not be approved at the same time.

Suspected Pulmonary Embolism (PE)[1-5]

- High risk for PE based on shock or hypotension
- Intermediate or high risk as determined by the parameters detailed in Overview section
- Positive D-dimer[2, 4]

Vascular Disease

- Superior vena cava (SVC) syndrome[6]
- Subclavian Steal Syndrome after positive or inconclusive ultrasound[7, 8]
- Thoracic Outlet Syndrome[9, 10]
- Takayasu's arteritis[11]
- Clinical concern for Acute Aortic dissection[12, 13]
    - Sudden painful ripping sensation in the chest or back and may include
        - New diastolic murmur
        - Cardiac tamponade
        - Distant heart sounds
        - Hypotension or shock

Initial/Screening for Thoracic Aortic Disease[14-16]

- Echocardiogram or chest x-ray show aneurysm
- Initial study for a suspected aneurysm
- Screening of first-degree relatives of individuals with a thoracic aortic aneurysm (defined as > 50% above normal) or dissection

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    - Known connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (e.g., Marfan syndrome, Ehlers Danlos or Loeys-Dietz syndromes)
- Screening of the thoracic aorta after a diagnosis of a bicuspid aortic valve (dilation of the ascending aorta may not be seen on echocardiogram)[17]
    - If normal, re-image every three to five years
- Screening of first-degree relatives of patients with a bicuspid aortic valve
- Turner's syndrome – Screen for coarctation or aneurysm of the thoracic aorta
    - If normal results, screen every 5-10 years
    - If abnormal, screen annually
- Suspected vascular cause of dysphagia or expiratory wheezing with other imaging is suggestive or inconclusive

Follow-up after established Thoracic Aneurysm[14-16]

- Six months follow-up after initial finding of a dilated thoracic aorta, for assessment of rate of change
    - Aortic Root or Ascending Aorta (in cm)
        - 3.5 to 4.4 Annual
        - 4.5 to 5.5 or growth rate $\geq$ 0.5 cm/year - Every 6 months
    - Genetically mediated (Marfans syndrome, Aortic Root or Ascending Aorta) (in cm)
        - 3.5 to 4.4 Annual
        - 4.5 to 5.0 or growth rate $\geq$ 0.5 cm/year Every 6 months
        - Surgery generally recommended over 5.0 cm
    - Descending Aorta (in cm)[18]
        - 4.0 to 5.0 Annual
        - 5.0 to 6.0 Every 6 months
- Follow-up post medical treatment of aortic dissection:
    - Acute dissection: 1 month, 6 months, then annually
    - Chronic dissection: annually
- Follow-up post either root repair or AVR plus ascending aortic root/arch repair: baseline post-op, then annually
- Re-evaluation of known ascending aortic dilation or history of aortic dissection with a change in clinical status or cardiac exam or when findings may alter management

Congenital Malformations (Chest Magnetic Resonance Angiography preferred if pediatrics or repeat imaging)

- Thoracic malformation on other imaging (chest x-ray, echocardiogram, gastrointestinal study, or inconclusive CT)[19-22]
- Congenital heart disease with pulmonary hypertension[23] or vascular anomalies
- Pulmonary sequestration[24]

Pulmonary Hypertension based on other testing[25, 26]

- Echocardiogram

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- Right heart catheterization

Atrial fibrillation with ablation planned[27]

Preoperative/procedural evaluation
- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation
- Post-operative complications[28, 29]
- Routine post-operative[30, 31]
    - Thoracic endovascular or open surgical aneurysm repair
        - 1 month
        - More frequent follow-up/possible intervention if complication detected
        - If stable, annual for 5 years

Chest CTA and Abdomen CTA or Abdomen/Pelvis CTA
- Transcatheter Aortic Valve Replacement (TAVR)13, 32
- Acute aortic dissection12
- Takayasu's arteritis[11]
- Post-operative complications[28, 29]

BACKGROUND

Computed tomography angiography is a non-invasive imaging modality that may be used in the evaluation of thoracic vascular problems. Chest CTA (non-coronary) may be used to evaluate vascular conditions, e.g., pulmonary embolism, thoracic aneurysm, thoracic aortic dissection, aortic coarctation, or pulmonary vascular stenosis. The vascular structures as well as the surrounding anatomical structures are depicted by CTA.

OVERVIEW

CTA and Coarctation of the Aorta – Coarctation of the aorta is a common vascular anomaly characterized by a constriction of the lumen of the aorta distal to the origin of the left subclavian artery near the insertion of the ligamentum arteriosum. The clinical sign of coarctation of the aorta is a disparity in the pulsations and blood pressures in the legs and arms. Chest CTA may be used to evaluate either suspected or known aortic coarctation and patients with significant coarctation should be treated surgically or interventionally.

CTA and Pulmonary Embolism (PE) – **Note**: D-Dimer blood test in patients at low risk for DVT is indicated prior to CTA imaging. Negative D-Dimer suggests alternative diagnosis in these patients.

CTA has high sensitivity and specificity and is the primary imaging modality to evaluate patients suspected of having acute pulmonary embolism. When high suspicion of pulmonary embolism

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on clinical assessment is combined with a positive CTA, there is a strong indication of pulmonary embolism. Likewise, a low clinical suspicion and a negative CTA can be used to rule out pulmonary embolism.

Low risk is not approved. Low risk is defined as **NO** to **ALL** of the following questions with intermediate and high risk defined based on the number of positive responses[33]:

- Evidence of current or prior DVT;
- HR > 100;
- Cancer diagnosis;
- Recent surgery or prolonged immobilization;
- Hemoptysis;
- History of PE;
- Oral hormone use;
- Another diagnosis beside PE is less likely

CTA and Thoracic Aortic Aneurysms – Computed tomographic angiography (CTA) allows the examination of the precise 3-D anatomy of the aneurysm from all angles and shows its relationship to branch vessels. This information is very important in determining the treatment: endovascular stent grafting or open surgical repair.

CTA and Thoracic Aorta Endovascular Stent-Grafts – CTA is an effective alternative to conventional angiography for postoperative follow-up of aortic stent grafts. It is used to review complications after thoracic endovascular aortic repair. CTA can detect luminal and extraluminal changes to the thoracic aorta after stent-grafting and can be performed efficiently with fast scanning speed and high spatial and temporal resolution.

POLICY HISTORY

Date	Summary
March 2022	• For Suspected Pulmonary Embolism, clarified 'intermediate or high risk' as determined by parameters detailed in Overview section and included hyperlink to Overview section
April 2021	• Follow-up recommendations for bicuspid aortic valve. • Added suspected vascular cause of dysphagia or expiratory wheezing • Combined follow-up surveillance recommendations for endovascular and open ascending aorta repair as per literature review • Clarified pre-operative evaluation for a planned surgery or procedure
May 2020	• For Suspected Pulmonary Embolism, removed: 'Low Risk is not approved' section • Moved Vascular Disease content from Chest CT to Chest CTA, including: o *Initial evaluation of aneurysm*

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	▪ *Echocardiogram shows aneurysm* ▪ *Echocardiogram inconclusive of proximal aorta and first degree relative with thoracic aneurysm* ▪ *Chest x-ray shows possible aneurysm* • *Follow-up after established Thoracic Aneurysm (above these sizes surgery is usually recommended)* o *Aortic Root or Ascending Aorta* ▪ *3.5 to 4.5 Annual* ▪ *4.5 to 5.4 Every 6 months* o *Genetically mediated (Marfans syndrome, Aortic Root or Ascending Aorta* ▪ *3.5 to 4.0 Annual* ▪ *4.0 to 5.0 Every 6 months* o *Descending Aorta* ▪ *4.0 to 5.0 Annual* ▪ *5.0 to 6.0 Every 6 months* • Thoracic Aortic Disease o Organized into two sections: ▪ Initial/Screening ▪ Follow-up of known aneurysm/vascular pathology o Removed: *'Annual follow up of enlarged thoracic aorta that is above top normal for age, gender, and body surface area'*
May 2019	• Expanded vascular indications including: o Superior vena cava syndrome o Takayasu's arteritis o Subclavian steal syndrome after positive or inconclusive ultrasound • Expanded indications for congenital anomalies to include pulmonary sequestration • Updated thoracic aortic section to match cardiac guidelines

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GENERAL INFORMATION

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National Imaging Associates, Inc.*	
Clinical guidelines **CHEST (THORAX) MRI**	**Original Date: September 1997**
CPT Codes: 71550, 71551, 71552	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_021	**Implementation Date: January 2023**

INDICATIONS FOR CHEST MRI

The combination of superior soft tissue contrast and lack of ionizing radiation may make Chest Magnetic Resonance Imaging (MRI) preferable for the pediatric population or evaluation of the non-lung parenchyma. This must be weighed against a longer acquisition time and greater likelihood of artifact from patient motion. Chest Computed Tomography (CT) is generally better for lung evaluation. Chest Magnetic Resonance Angiography (MRA) is ordered for evaluation of the intrathoracic blood vessels. Chest MRI and Chest MRA should not be approved at the same time.

Chest Mass (non-lung parenchymal)[1-7]

- Mass or lesion, including lymphadenopathy, after non-diagnostic x-ray or ultrasound (Chest CT indicated for pulmonary nodule)
- Thymoma screening in Myasthenia Gravis patients[8]
- Congenital thoracic malformation on other imaging (chest x-ray, echocardiogram, gastrointestinal study, or inconclusive CT)[9-12]

Chest Wall Pain (after initial evaluation with chest x-ray and/or rib series radiographs)

- History of known or suspected cancer
- Signs and symptoms of infection (non-lung parenchymal), such as:
    - Accompanying fever
    - Elevated inflammatory markers
    - Known infection at other sites
- Suspected muscle or tendon tear where imaging would change treatment

Brachial Plexopathy[13, 14]

- If mechanism of injury or Electromyography/Nerve Conduction Velocity (EMG/NCV) studies are suggestive
- Chest MRI is preferred study, but neck and/or shoulder (upper extremity) MRI can be ordered depending on the suspected location of injury

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Cystic Fibrosis[15]

- Can be an alternative to Chest CT to evaluate perfusion abnormalities, bronchiectasis, and mucus plugging if needed for treatment planning

Vascular Diseases are better evaluated with Chest CTA or MRA[16]

- Superior vena cava (SVC) syndrome[17]
- Subclavian Steal Syndrome after positive or inconclusive ultrasound[18, 19]
- Thoracic Outlet Syndrome[16, 20, 21]
- Takayasu's arteritis[22]
- Acute or chronic aortic dissection[23, 24]
- Pulmonary hypertension - To evaluate for cause after echocardiogram or right heart catheterization[25, 26]

Congenital Malformations

- Congenital heart disease with pulmonary hypertension[27]
- Pulmonary sequestration[28]

Atrial fibrillation with ablation planned[29]

Preoperative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- Post-surgical follow-up when records document medical reason requiring additional imaging

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BACKGROUND

Magnetic Resonance Imaging (MRI) is a noninvasive imaging technique for detection and evaluation of various disease and conditions in the chest, e.g., congenital anomalies and aneurysms. MRI may be used instead of computed tomography (CT) in patients with allergies to radiographic contrast or with impaired renal function.

OVERVIEW

MRI and Myasthenia Gravis – Myasthenia Gravis is a chronic autoimmune disease characterized by weakness of the skeletal muscles causing fatigue and exhaustion that is aggravated by activity and relieved by rest. It most often affects the ocular and other cranial muscles and is thought to be caused by the presence of circulating antibodies. Symptoms include ptosis, diplopia, chewing difficulties, and dysphagia. Thymoma has a known association with myasthenia. Contrast-enhanced MRI may be used to identify the presence of a mediastinal mass suggestive of myasthenia gravis in patients with renal failure or allergy to contrast material.

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MRI and Thoracic Outlet Syndrome – Thoracic outlet syndrome is a group of disorders involving compression at the superior thoracic outlet that affects the brachial plexus, the subclavian artery, and veins. It refers to neurovascular complaints due to compression of the brachial plexus or the subclavian vessels. Magnetic resonance multi-plane imaging shows bilateral images of the thorax and brachial plexus and can demonstrate the compression of the brachial plexus and venous obstruction.

MRI and Brachial Plexus - MRI is the only diagnostic tool that accurately provides high resolution imaging of the brachial plexus. The brachial plexus is formed by the cervical ventral rami of the lower cervical and upper thoracic nerves which arise from the cervical spinal cord, exit the bony confines of the cervical spine, and traverse along the soft tissues of the neck, upper chest, and course into the arms.

POLICY HISTORY

Date	Summary
March 2022	• Updated references
April 2021	• Added details on brachial plexopathy imaging • Expanded introduction section • Added Cystic Fibrosis imaging (alternative to CT) • Clarified pre-operative evaluation for a planned surgery or procedure
May 2020	• Added Chest Wall Pain section: o *Chest Wall Pain (after initial evaluation with chest x-ray and/or rib series radiographs)* • *History of known or suspected cancer* • *Signs and symptoms of infection (non-lung parenchymal), such as:* o *Accompanying fever* o *Elevated inflammatory markers* o *Known infection at other sites* • *Suspected muscle or tendon tear where imaging would change treatment* • Thoracic Aortic Disease: removed section and added note: *Chest CTA or MRA is preferred for vascular pathology* • Thoracic Outlet Syndrome: removed section and added note: *Chest CTA or MRA is preferred for vascular pathology* • Brachial Plexopathy: added note: *Chest MRI is preferred study vs. neck or shoulder MRI*
May 2019	• Expanded indications including: vascular and congenital anomalies

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	• Updated thoracic aortic section and reformatted to match other guidelines.

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Reviewed / Approved by NIA Clinical Guideline Committee

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National Imaging Associates, Inc.*	
Clinical guidelines **CHEST MRA/MRV**	**Original Date: September 1997**
CPT Codes: 71555	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_022-2	**Implementation Date: January 2023**

INDICATIONS FOR CHEST MRA

Chest Magnetic Resonance Angiography (MRA) is ordered for evaluation of the intrathoracic blood vessels. Chest MRI and Chest MRA should not be approved at the same time.

Vascular Disease

- Superior vena cava (SVC) syndrome[1]
- Subclavian Steal Syndrome after positive or inconclusive ultrasound[2, 3]
- Thoracic Outlet Syndrome[4-6]
- Takayasu's arteritis[7]
- Clinical concern for acute aortic dissection[8, 9]
    - Sudden painful ripping sensation in the chest or back and may include
        - New diastolic murmur
        - Cardiac tamponade
        - Distant heart sounds
        - Hypotension or shock
- For MRPA (MR Pulmonary Angiography) in patients with intermediate pretest probability with a positive D-dimer or high pretest probability (but only at centers that routinely perform it well and only for patients for whom standard tests are contraindicated)
    - Risk can be determined by the parameters detailed in Background section

Initial/Screening for Thoracic Aortic Disease[10-12]

- Echocardiogram or chest x-ray show aneurysm
- Screening of first-degree relatives of individuals with a thoracic aortic aneurysm (defined as ≥ 50% above normal) or dissection
    - Known connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (e.g., Marfan syndrome, Ehlers Danlos or Loeys-Dietz syndromes)

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- Screening of the thoracic aorta after a diagnosis of a bicuspid aortic valve (dilation of the ascending aorta may not be seen on echocardiogram)[13, 14]
    - If normal, reimage every three to five years
- Screening of first-degree relatives of patients with a bicuspid aortic valve
- Turner's syndrome – Screen for coarctation or aneurysm of the thoracic aorta
    - If normal results, screen every 5-10 years
    - If abnormal, screen annually
- Suspected vascular cause of dysphagia or expiratory wheezing with other imaging is suggestive or inconclusive

Follow-up after established Thoracic Aneurysm[10-12]

- Six months follow-up after initial finding of a dilated thoracic aorta, for assessment of rate of change
    - Aortic Root or Ascending Aorta
        - 3.5 to 4.4 Annual
        - 4.5 to 5.5 or growth rate > 0.5 cm/year - Every 6 months
    - Genetically mediated (Marfans syndrome, Aortic Root or Ascending Aorta)
        - 3.5 to 4.4 Annual
        - 4.5 to 5.0 or growth rate > 0.5 cm/year Every 6 months
        - Surgery generally recommended over 5.0 cm
    - Descending Aorta (Braverman, 2011)
        - 4.0 to 5.0 Annual
        - 5.0 to 6.0 Every 6 months
- Follow-up post medical treatment of aortic dissection
    - Acute dissection: 1 month, 6 months, then annually
    - Chronic dissection: annually
- Follow-up post either root repair or AVR plus ascending aortic root/arch repair: baseline post-op, then annually
- Re-evaluation of known ascending aortic dilation or history of aortic dissection with a change in clinical status or cardiac exam or when findings may alter management

Congenital Malformations

- Thoracic malformation on other imaging (chest x-ray, echocardiogram, gastrointestinal study, or inconclusive CT)[15-18]
- Congenital heart disease with pulmonary hypertension[19] or vascular anomalies
- Pulmonary Sequestration[20]

Pulmonary Hypertension based on other testing[21, 22]

- Echocardiogram
- Right heart catheterization

Atrial fibrillation with ablation planned[23]

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Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- Post-operative complications[24, 25]
- Routine post-operative[26, 27]
    - Thoracic endovascular or open surgical aneurysm repair
        - 1 month
        - More frequent follow-up/possible intervention if complication detected
        - If stable, annual for 5 years

Chest MRA and Abdomen MRA or Abdomen/Pelvis MRA

- Acute aortic dissection[8]
- Takayasu's arteritis[7]

BACKGROUND

Magnetic resonance angiography (MRA) is a noninvasive technique used to provide cross-sectional and projection images of the thoracic vasculature, including large- and medium-sized vessels, e.g., the thoracic aorta. MRA provides images of both normal and diseased blood vessels, and it quantifies blood flow through these vessels. Successful vascular depiction relies on the proper imaging pulse sequences. MRA may use a contrast agent, gadolinium, which is non-iodine-based, for better visualization. It can be used in patients who have history of contrast allergy and who are at high risk of kidney failure.

OVERVIEW

MRA and Coarctation of the Aorta – One of the most common congenital vascular anomalies is coarctation of the aorta, characterized by obstruction of the juxtaductal aorta. Clinical symptoms, e.g., murmur, systemic hypertension, difference in blood pressure in upper and lower extremities, absent femoral or pedal pulses, may be present. Gadolinium-enhanced 3D MRA may assist in preoperative planning as it provides angiographic viewing of the aorta, the arch vessels, and collateral vessels. It may also assist in the identification of postoperative complications.

MRA and Pulmonary Embolism (PE) – Note: D-Dimer blood test in patients at low risk* for DVT is indicated prior to MRA imaging. Negative D-Dimer suggests alternative diagnosis in these patients.

*Low risk is not approved. Low risk is defined as **NO** to **ALL** of the following questions with intermediate and high risk defined based on the number of positive responses[28]:

- Evidence of current or prior DVT;

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- HR > 100;
- Cancer diagnosis;
- Recent surgery or prolonged immobilization;
- Hemoptysis;
- History of PE;
- Oral hormone use;
- Another diagnosis beside PE is less likely

Studies show mixed results regarding the value of MRA versus CTA in detecting pulmonary embolism. A systematic review and meta-analysis found MRA to be inferior to CTA in detecting PE. Therefore, MRA should be used only if CTA is not available or contraindicated in a specific patient.[29]

MRA and Thoracic Aortic Aneurysm – One of the most common indications for thoracic MRA is thoracic aortic aneurysm, most often caused by atherosclerosis. These aneurysms may also be due to aortic valvular disease. Aneurysms are defined by their enlargement, and patients with rapidly expanding aortas, or with aortic diameters greater than five or six centimeters, are at high risk of rupture and may require surgery.

MRA and Thoracic Aortic Dissection – The most common clinical symptom of aortic dissection is tearing chest pain, and the most common risk factor is hypertension. An intimal tear is the hallmark for aortic dissection and intramural hematoma may also be detected. Unfortunately, patients with aortic dissection may be unstable and not good candidates for routine MR evaluation; MRA may be indicated as a secondary study. 3D MRA is also useful in postoperative evaluation of patients with repaired aortic dissections.

MRA and Central Venous Thrombosis – MRA is useful in the identification of venous thrombi. Venous thrombosis can be evaluated by gadolinium-enhanced 3D MRA as an alternative to CTA, which may not be clinically feasible due to allergy to iodine contrast media or renal insufficiency.

MRI and Patent Ductus Arteriosus – Patent ductus arteriosus (PDA) is a congenital heart problem in which the ductus arteriosus does not close after birth. It remains patent allowing oxygen-rich blood from the aorta to mix with oxygen-poor blood from the pulmonary artery. MRI can depict the precise anatomy of a PDA to aid in clinical decisions. It allows imaging in multiple planes without a need for contrast administration. Patients are not exposed to ionizing radiation.

Other MRA Indications – MRA is useful in the assessment for postoperative complications of pulmonary venous stenosis.

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POLICY HISTORY

Date	Summary
March 2022	• No significant changes
April 2021	• Follow-up recommendations for bicuspid aortic valve • Added suspected vascular cause of dysphagia or expiratory wheezing • Combined follow-up surveillance recommendations for endovascular and open ascending aorta repair as per literature review • Added indications for combination studies and for ordering combination studies • Added Pulmonary Embolism criteria to Overview • Clarified pre-operative evaluation for a planned surgery or procedure
May 2020	• Thoracic Aortic Disease o Organized into two sections: ▪ Initial/Screening ▪ Follow-up of known aneurysm/vascular pathology • Removed: 'Annual follow up of enlarged thoracic aorta that is above top normal for age, gender, and body surface area'
May 2019	• Removed pulmonary embolism indication • Added indications specifying criteria for follow-up of thoracic aneurysm • Added statement: "For MRPA (MR Pulmonary Angiography) in patients with intermediate pretest probability with a positive D-dimer or high pretest probability (but only at centers that routinely perform it well and only for patients for whom standard tests are contraindicated)" • Expanded criteria for congenital malformations • Updated thoracic aortic disease section for consistency with cardiac guidelines • Added greater specificity for post op complications

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guideline **CERVICAL SPINE CT**	**Original Date: September 1997**
CPT Codes: 72125, 72126, 72127	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_041	**Implementation Date: January 2023**

INDICATIONS FOR CERVICAL SPINE CT

[+]If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months), the results of the prior study should be:

- **Inconclusive or show a need for additional or follow-up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits when Cervical Spine MRI is contraindicated or inappropriate[1-4]

- With any of the following new neurological deficits documented on physical exam
    - Extremity muscular weakness (and not likely caused by plexopathy or peripheral neuropathy)
    - Pathologic (e.g., Babinski, Lhermitte's sign, Chaddock Sign, Hoffman's) or abnormal reflexes
    - Absent/decreased sensory changes along a particular cervical dermatome (nerve distribution): pin prick, touch, vibration, proprioception, or temperature
    - Upper or lower extremity increase muscle tone/spasticity
    - New onset bowel or bladder dysfunction (e.g., retention or incontinence)—not related to an inherent bowel or bladder process
    - Gait abnormalities (see Table 1 below for more details)
- Suspected cord compression with any neurological deficits as listed above

For evaluation of neck pain with any of the following when Cervical Spine MRI is contraindicated[5]

- With new or worsening objective neurologic deficits on exam, as above
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months[6]
- With progression or worsening of symptoms during the course of conservative treatment*

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- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a cervical radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain)[7]
- Isolated neck pain in pediatric population[8] – conservative care not required if red flags present
    - Red flags that prompt imaging should include the presence of the following: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; fever; weight loss [9, 10]

As part of initial pre-operative/post-operative/procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion"[11, 12] and MRI for cord, nerve root compression, disc pathology, or post-op infection)

Note: If ordered by Neurosurgeon or orthopedic surgeon for purposes of surgical planning, a contraindication to MRI is not required.

- For preoperative evaluation/planning
- CT discogram
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram))[13]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively[11, 14] - see neurological deficit section above.
- When combo requests (see above statement[+]) are submitted (i.e., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously (e.g., the need for both soft tissue and bony anatomy is required)[15]
    - Combination requests where both cervical spine CT and MRI cervical spine are both approvable (not an all-inclusive list):
        - OPLL (Ossification of posterior longitudinal ligament)[16]
        - Pathologic or complex fractures
        - Malignant process of spine with both bony and soft tissue involvement
        - Unstable craniocervical junction
        - Clearly documented indication for bony and soft tissue abnormality where assessment will change management for the patient

For evaluation of suspected myelopathy when Cervical Spine MRI is contraindicated[17-21]

- Does **NOT** require conservative care

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- Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with grasping and holding objects, diffuse numbness in the hands, pins and needles sensation, increasing difficulty with balance and ambulation
- Any of the neurological deficits as noted above

For evaluation of trauma or acute injury[22]

- Presents with any of the following neurological deficits as above
- With progression or worsening of symptoms during the course of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis) (Both MRI and CT are approvable)[23, 24]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation
- When office notes specify the patient meets NEXUS (National Emergency X-Radiography Utilization Study) or CCR (Canadian Cervical Rules) criteria for imaging[22]:
    - CT for initial imaging
    - MRI when suspect spinal cord or nerve root injury or when patient is obtunded, and CT is negative
    - CT or MRI for treatment planning of unstable spine

("MRI and CT provide complementary information. When indicated it is appropriate to perform both examinations"[22])

For evaluation of known fracture or known/new compression fractures with worsening neck pain[22, 25]

- To assess union of a fracture when physical examination, plain radiographs, or prior imaging suggest delayed or non-healing
- To determine the position of fracture fragments
- With history of malignancy (if MRI is contraindicated or cannot be performed)
- With an associated new focal neurologic deficit as above[26]
- Prior to a planned surgery/intervention or if the results of the CT will change management

CT myelogram: When MRI cannot be performed/contraindicated/surgeon preference[13, 27-31]

- When signs and symptoms inconsistent or not explained by the MRI findings
- Demonstration of the site of a CSF leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula)
- Surgical planning, especially regarding to the nerve roots or evaluation of dural sac
- Evaluation of suspected brachial plexus or nerve root injury in the neonate

For evaluation of tumor, cancer, or metastasis with any of the following:
(MRI is usually the preferred study- CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[32-34]

- **Primary tumor**
    - Initial staging or re-staging of a known primary spinal tumor[35]

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- Known spinal tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
- With an associated new focal neurologic deficit as above[26]

- **Metastatic tumor**
  - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
  - With an associated new focal neurologic deficit[26]
  - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or neck pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine[34, 36]

- **For evaluation of inconclusive/indeterminate finding on prior imaging that requires further clarification**
  - One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam. When MRI cannot be performed, is contraindicated, or CT is preferred to characterize the finding[34]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine, or Lumbar Spine

For evaluation of known or suspected infection/abscess when Cervical Spine MRI is contraindicated[37]

- As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[38]
- Follow-up imaging of infection
  - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[39]

For evaluation of known or suspected inflammatory disease or atlantoaxial instability when MRI is contraindicated or for surgical treatment planning:

- In rheumatoid arthritis with neurologic signs/symptoms, or evidence of subluxation on radiographs (lateral radiograph in flexion and neutral should be the initial study)[40, 41]
  - Patients with negative radiographs but symptoms suggestive of cervical instability or in patients with neurologic deficits
- High-risk disorders affecting the atlantoaxial articulation, such as Down syndrome, Marfan syndrome with neurological signs/symptoms, abnormal neurological exam, or evidence of abnormal or inconclusive radiographs of the cervical spine[42]
- Spondyloarthropathies, known or suspected

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- Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and appropriate rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma when Cervical Spine MRI is contraindicated[37, 43]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

Other Indications for a Cervical Spine CT, when MRI is contraindicated or cannot be performed

(Note- See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord or spinal dysraphism (known or suspected), based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[44-46]
- Known Arnold-Chiari syndrome- (For initial imaging see combination below)
  - Known Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis with new or changing signs/symptoms or exam findings consistent with spinal cord pathology[47]
  - Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation
  - Achondroplasia (one Cervical Spine MRI to assess the craniocervical junction, as early as possible (even in asymptomatic cases)[48, 49]
- Syrinx or syringomyelia (known or suspected)
  - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis)[50]
  - To further characterize a suspicious abnormality seen on prior imaging
  - Known syrinx with new/worsening symptoms
- Toe walking in a child with signs/symptoms of myelopathy localized to the Cervical Spine
- Suspected neuroinflammatory Conditions/Diseases (e.g., sarcoidosis, Behcet's)
  - After detailed neurological exam and basic testing completed

COMBINATION STUDIES WITH CERVICAL SPINE CT WHEN MRI IS CONTRAINDICATED OR CANNOT BE PERFORMED OR SURGEON PREFERENCE

Brain CT/Cervical CT

- For evaluation of known Arnold-Chiari Malformation

Cervical and Thoracic CT

- Initial evaluation of known syrinx or syringomyelia
  - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[50])
  - To further characterize a suspicious abnormality seen on prior imaging
  - Known syrinx with new/worsening symptom

Any combination of Cervical and/or Thoracic and/or Lumbar CTs:

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Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

Exception- Indications for combination studies[51, 52]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
    - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[53-55] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
    - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[56]
    - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging
    - Scoliosis with any of the following[57]:
        - Progressive spinal deformity;
        - Neurologic deficit (new or unexplained);
        - Early onset;
        - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
        - Pre-operative planning; OR
        - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[58, 59]
    - Arnold-Chiari I
        - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[44, 53]
    - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
        - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele)
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[44-46] when anesthesia required for imaging[60] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)
- Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram)- See Overview
    - Suspected leptomeningeal carcinomatosis (LC)[61]- See Overview
    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post

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lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram))[13]
- CT myelogram when meets above guidelines and MRI is contraindicated or for surgical planning
- Post-procedure (discogram) CT

BACKGROUND

Computed tomography (CT) is performed for the evaluation of the cervical spine. CT may be used as the primary imaging modality, or it may complement other modalities. Primary indications for CT include conditions, e.g., traumatic, neoplastic, and infectious. CT is often used to study the cervical spine for conditions such as degenerative disc disease when MRI is contraindicated. CT provides excellent depiction of bone detail and is used in the evaluation of known fractures of the cervical spine and for evaluation of postoperative patients.

OVERVIEW

***Conservative Therapy** – (Spine) should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or osteopathic manipulative medicine (OMT) or chiropractic care when considered safe and appropriate.

****Home Exercise Program - (HEP)/ Therapy** – the following elements are required to meet guidelines for completion of conservative therapy[12, 62]:
- Information provided on exercise prescription/plan AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).
- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Infection, Abscess, or Inflammatory disease
- Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%)[63]
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

Myelopathy – Symptom severity varies, and a high index of suspicion is essential for making the proper diagnosis in early cases. Symptoms of pain and radiculopathy may not be present. The natural history of myelopathy is characterized by neurological deterioration. The most

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frequently encountered symptom is gait abnormality (86%) followed by increased muscular reflexes (79.1%), pathological reflexes (65.1%), paresthesia of upper limb (69.8%) and pain (67.4%).[18]

CT and Infection of the spine – Infection of the spine is not easy to differentiate from other spinal disorders, e.g., degenerative disease, spinal neoplasms, and non-infective inflammatory lesions. Infections may affect different parts of the spine, e.g., vertebrae, intervertebral discs, and paraspinal tissues. Imaging is important to obtain early diagnosis and treatment to avoid permanent neurologic deficits. When MRI is contraindicated, CT may be used to evaluate infections of the spine.

Table 1: Gait and spine imaging[64-69]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

CT and Degenerative Disc Disease – Degenerative disc disease is very common, and CT may be indicated when MRI is contraindicated, when chronic degenerative changes are accompanied

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by conditions, e.g., new neurological deficits; onset of joint tenderness of a localized area of the spine; new abnormal nerve conductions studies; exacerbation of chronic neck or back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

Ossification Posterior Longitudinal Ligament (OPLL)[16] – Most common in cervical spine (rare but more severe in thoracic spine).

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Table 2: MRI and Cutaneous Stigmata[70]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Atretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
‡LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

Back Pain with Cancer History – Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history, but without known active cancer or a tumor that tends to metastasize to the spine. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

"Neoplasms causing VCF (vertebral compression fractures) include: primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms."[25]

Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumors can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process.[36]

Cervical Spine Trauma Imaging[22] – The National Emergency X-Radiography Utilization Study (NEXUS) and the Canadian Cervical Rules (CCR) represent clinical criteria used to help determine the presence of significant cervical spine injury. Although the criteria are highly sensitive (99.6% for NEXUS), specificity is low (12.9% for Nexus).

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A patient not meeting any of the NEXUS criteria of focal neurologic deficit, midline spinal tenderness, altered consciousness, intoxication or distracting injury is unlikely to have a significant cervical spine injury. Imaging evaluation of the cervical spine in these patients is not necessary. In the CCR criteria, a patient without any high risk factors (Age >65 years; paresthesias in extremities; dangerous mechanism; falls from ≥3 feet/5 stairs; axial load to head; motor vehicle crash with high speed, rollover, or ejection; bicycle collision; motorized recreational vehicle accident) is next evaluated for low risk factors (simple rear-end motor vehicle crash, patient in sitting position in emergency center, patient ambulatory at any time after trauma, delayed onset of neck pain, absence of midline cervical spine tenderness). If the patient meets a low-risk criteria, they are asked to move their head 45 degrees from midline in both directions. If the patient can accomplish this, the spine is cleared, and imaging is not necessary.

CT Myelogram – Myelography is the instillation of intrathecal contrast media under fluoroscopy. Patients are then imaged with CT to evaluate for spinal canal pathology. Although this technique has diminished greatly due to the advent of MRI due to its non-invasiveness and superior soft-tissue contrast, myelography is still a useful technique for conventional indications, such as spinal stenosis, when MRI is contraindicated or nondiagnostic, brachial plexus injury in neonates, radiation therapy treatment planning, and cerebrospinal fluid (CSF) leak.[71, 72]

Drop Metastases[73] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[74] – Leptomeningeal carcinomatosis is a complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, melanoma, gastrointestinal, and primary central nervous system tumors.

POLICY HISTORY

Date	Summary
March 2022	• Added o Combination request for overlapping body part statement o Clarified muscle weakness no related to plexopathy or peripheral neuropathy o Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem o Clarified isolated neck pain in pediatric patient o Clarified CT myelogram section o Added subsection for cervical and thoracic spine section for syrinx and syringomyelia

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	○ Descriptions for tethered cord ○ Background section of Drop Metastases ○ Background section of Leptomeningeal Carcinomatosis ○ Clarified toe walking in pediatric patient with myelopathy for cervical spine • Removed ○ Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section ○ Removed pediatric back pain from the total spine combination section
April 2021	• Added/modified ○ Modified section on neurological deficits ○ Back pain in a child added/modified red flags ○ Gait table in background ○ Post-surgical modified/clarified surgical criteria for combination exams and surgeon preference for exam type ○ Removed myelopathy combination studies ○ Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS ○ Modified known tumor imaging into primary and metastatic disease ○ Added toe walking for pediatric patients ○ Modified Combination exam wording ○ Added Achondroplasia to criteria
May 2020	• Added ○ For evaluation of neurologic deficits when Cervical Spine MRI is contraindicated or inappropriate, added “new” deficits ○ Expanded CT myelogram indications ○ Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL) ○ Added imaging in high risk patients predisposed to spinal injury ○ Added imaging in high risk patients for atlantoaxial injury ○ Added to background of imaging of infection ○ Modified Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or to include pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine

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	○ Added Osteopathic Manipulative medicine to conservative care therapy
June 2019	• Added: ○ new or worsening objective neuro deficits for chronic and acute back pain; CSF leak ○ last 6 months for allowable post op f/u period and removed EMG comment ○ red flags specifically for peds back pain and pain related to malignancy, infection, inflammation ○ new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain; ○ For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism ○ CT myelogram ○ Rheumatoid arthritis ○ Specifics on neuro deficits including pathologic reflexes and spasticity, sensory, or motor level ○ Spinal trauma ○ New or increasing back pain in cancer patients with high suspicion of mets

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **THORACIC SPINE CT**	**Original Date: September 1997**
CPT Codes: 72128, 72129, 72130	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_043	**Implementation Date: January 2023**

INDICATIONS FOR THORACIC SPINE CT

+If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- **Inconclusive or show a need for additional or follow up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient (the entire spinal cord and/or autonomic postganglionic chain must be assessed)**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits when Thoracic Spine MRI is contraindicated or inappropriate[1-3]

- With any of the following new neurological deficits documented on physical exam
    - Extremity muscular weakness (and not likely caused by plexopathy, or peripheral neuropathy)[4, 5]
    - Pathologic (e.g., Babinski, Chaddock Sign) or abnormal reflexes[6]
    - Absent/decreased sensory changes along a particular thoracic dermatome (nerve distribution): pin prick, touch, vibration, proprioception, or temperature
    - Upper or lower extremity increase muscle tone/spasticity and likely localized to the thoracic spinal cord
    - New onset bowel or bladder dysfunction (e.g., retention or incontinence) - not related to an inherent bowel or bladder process
    - Gait abnormalities (see Table 1 for more details)
- Suspected cord compression with any neurological deficits as listed above
- Toe walking in a child when associated with upper motor neuron signs including hyperreflexia, spasticity; or orthopedic deformity with concern for spinal cord pathology (e.g., pes cavus, clawed toes, leg or foot length deformity (excluding tight heel cords))

For evaluation of back pain with any of the following when Thoracic Spine MRI is contraindicated[7-10]

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- With new or worsening objective neurologic deficits on exam, as above
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months[11]
- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a thoracic radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain)[12]
- Isolated thoracic pain in pediatric population[13] – conservative care not required if red flags present
    - Red flags that prompt imaging should include the presence of: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; radicular pain; fever; weight loss; malaise; postural changes (e.g., kyphosis or scoliosis); and limp (or refusal to walk in a younger child <5yo) AND initial radiographs have been performed[14, 15]

As part of initial pre-operative/post-operative/procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion"[16, 17] and MRI for cord, nerve root compression, disc pathology, or post-op infection)

If ordered by Neurosurgeon or orthopedic surgeon for purposes of surgical planning. A contraindication to MRI is not required

- For preoperative evaluation/planning
- CT discogram
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram)[18]
- Prior to spinal cord stimulator to exclude canal stenosis if no prior imaging of the thoracic spine has been done recently and MRI is contraindicated
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively [16, 19] - see neurological deficit section above
- When combo requests are submitted (i.e., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously, i.e., the need for both soft tissue and bony anatomy is required[20]
    - Combination requests where both thoracic spine CT and MRI thoracic spine are both approvable (not an all-inclusive list):
        - OPLL (Ossification of posterior longitudinal ligament)

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        - Most common in cervical spine (rare but more severe in thoracic spine)[21]
    - Pathologic or complex fractures
    - Malignant process of spine with both bony and soft tissue involvement
    - Clearly documented indication for bony and soft tissue abnormality where assessment will change management for the patient

For evaluation of suspected myelopathy when Thoracic Spine MRI is contraindicated[22-26]

- Does NOT require conservative care
- Progressive symptoms including unsteadiness; broad-based gait; increased muscle tone; pins and needles sensation; weakness and wasting of the lower limbs; diminished sensation to light touch, temperature, proprioception, and vibration; limb hyperreflexia and pathologic reflexes; bowel and bladder dysfunction in more severe cases
- Any of the neurological deficits as noted above

For evaluation of trauma or acute injury[27]

- Presents with any of the following neurological deficits as above
- With progression or worsening of symptoms during the course of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis) (Both MRI and CT would be approvable)[28-30]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation

("MRI and CT provide complementary information. When indicated It is appropriate to perform both examinations")[27]

For evaluation of known fracture or known/new compression fractures with worsening back pain[27, 31]

- To assess union of a fracture when physical examination, plain radiographs, or prior imaging suggest delayed or non-healing
- To determine the position of fracture fragments
- With history of malignancy (if MRI is contraindicated or cannot be performed)
- With an associated new focal neurologic deficit as above[32]
- Prior to a planned surgery/intervention or if the results of the CT will change management

CT myelogram: When MRI cannot be performed/contraindicated/surgeon preference[33-37]

- When signs and symptoms are inconsistent or not explained by the MRI findings
- Demonstration of the site of a CSF leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula)
- Surgical planning, especially regarding to the nerve roots or evaluation of dural sac

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For evaluation of tumor, cancer, or metastasis with any of the following:
(MRI is usually the preferred study- CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[38]

- **Primary tumor**
  - Initial staging or re-staging of a known primary spinal tumor[39]
  - Known spinal tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
  - With an associated new focal neurologic deficit as above[32]

- **Metastatic tumor**
  - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
  - With an associated new focal neurologic deficit[32]
  - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or neck pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine[40, 41]

- **For evaluation of inconclusive/indeterminate finding on prior imaging that requires further clarification**
  - One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam. When MRI cannot be performed or is contraindicated or CT is preferred to characterize the finding[41]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine, or Lumbar Spine

For evaluation of known or suspected infection/abscess when Thoracic MRI is contraindicated[42, 43]

- As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[44]
- Follow-up imaging of infection
  - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[45]

For evaluation of known or suspected inflammatory disease when MRI is contraindicated or cannot be performed[28]

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- Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and appropriate rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma when Thoracic MRI is contraindicated[42]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

Other Indications for a Thoracic Spine CT when MRI is contraindicated or cannot be performed

(Note- See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[46-48]
- Known Arnold-Chiari syndrome (For initial imaging see combination below)
    - Known Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis with new or changing signs/symptoms or exam findings consistent with spinal cord pathology[49]
    - Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation
- Syrinx or syringomyelia (known or suspected)
    - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis)[50]
    - To further characterize a suspicious abnormality seen on prior imaging
    - Known syrinx with new/worsening symptoms
- Toe walking in a child with signs/symptoms of myelopathy localized to the Thoracic Spine
- Suspected neuroinflammatory Conditions/Diseases (e.g., sarcoidosis, Behcet's)
    - After detailed neurological exam and basic testing completed

COMBINATION STUDIES WITH THORACIC SPINE CT WHEN MRI IS CONTRAINDICATED OR CANNOT BE PERFORMED OR SURGEON PREFERENCE

Cervical and Thoracic CT

- Initial evaluation of known syrinx or syringomyelia
    - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[50])
    - To further characterize a suspicious abnormality seen on prior imaging
    - Known syrinx with new/worsening symptom

Any combination of Cervical and/or Thoracic and/or Lumbar CTs

Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

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Exception- Indications for combination studies[51, 52]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
    - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[53-55] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
    - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[56]
    - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging
    - Scoliosis with any of the following[57]:
        - Progressive spinal deformity;
        - Neurologic deficit (new or unexplained);
        - Early onset;
        - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
        - Pre-operative planning; OR
        - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[58, 59]
    - Arnold-Chiari I
        - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[47, 53]
    - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
        - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele)
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[46-48] when anesthesia required for imaging[60] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)
- Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram)- See Overview
    - Suspected leptomeningeal carcinomatosis (LC)[61]- See Overview
    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram))[18]

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- CT myelogram when meets above guidelines and MRI is contraindicated or for surgical planning
- Post-procedure (discogram) CT

BACKGROUND

Computed tomography is used for the evaluation, assessment of severity, and follow-up of diseases of the spine. Its use in the thoracic spine is limited, however, due to the lack of epidural fat in this part of the body. CT myelography improves the contrast severity of CT, but it is also invasive. CT may be used for conditions, e.g., degenerative changes, infection, and immune suppression, when magnetic resonance imaging (MRI) is contraindicated. It may also be used in the evaluation of tumors, cancer, or metastasis in the thoracic spine, and it may be used for preoperative and post-surgical evaluations. CT obtains images from different angles and uses computer processing to show a cross-section of body tissues and organs. CT is fast and is often performed in acute settings. It provides good visualization of cortical bone.

OVERVIEW

Ankylosing Spondylitis/Spondyloarthropathies can cause back or sacroiliac pain of insidious onset (usually > 3 month), associated with morning stiffness not relieved with rest (usually age at onset <40). They are associated with any of the following[62-65]:

- Sedimentation rate and/or C-reactive protein (not an essential criteria)
- HLA B27 (not an essential criteria)
- Non-diagnostic or indeterminate x-ray
- Personal or family history of sacroiliitis, peripheral inflammatory arthritis, and/or inflammatory bowel disease

***Conservative Therapy** – (Spine) should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, regular osteopathic manipulative medicine treatments (OMT), and/or chiropractic care when considered safe and appropriate.

****Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy[10, 17]:

- Information provided on exercise prescription/plan AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

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- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Table 1: Gait and spine imaging[66-71]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

Myelopathy – Symptom severity varies, and a high index of suspicion is essential for making the proper diagnosis in early cases. Symptoms of pain and radiculopathy may not be present. The natural history of myelopathy is characterized by neurological deterioration. The most frequently encountered symptom is gait abnormality (86%), followed by increased muscular reflexes (79.1%), pathological reflexes (65.1%), paresthesia of upper limb (69.8%), and pain (67.4%).[72]

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CT and Infection of the spine – Infection of the spine is not easy to differentiate from other spinal disorders, e.g., degenerative disease, spinal neoplasms, and non-infective inflammatory lesions. Infections may affect different parts of the spine, e.g., vertebrae, intervertebral discs, and paraspinal tissues. Imaging is important to obtain early diagnosis and treatment to avoid permanent neurology deficits. When MRI is contraindicated, CT may be used to evaluate infections of the spine.

CT and Degenerative Disc Disease – Degenerative disc disease is very common. CT may be indicated when MRI is contraindicated and when chronic degenerative changes are accompanied by conditions, e.g., new neurological deficits; onset of joint tenderness of a localized area of the spine; new abnormal nerve conductions studies; exacerbation of chronic back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

Infection, Abscess, or Inflammatory disease

- Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%) (Graeber, 2019)
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

CT Myelogram – Myelography is the instillation of intrathecal contrast media under fluoroscopy. Patients are then imaged with CT to evaluate for spinal canal pathology. Although this technique has diminished greatly due to the advent of MRI and its non-invasiveness and superior soft-tissue contrast, myelography is still a useful technique for conventional indications, such as spinal stenosis, when MRI is contraindicated or nondiagnostic, brachial plexus injury in neonates, radiation therapy treatment planning, and cerebrospinal fluid (CSF) leak.[73]

Cauda Equina Syndrome

- Symptoms include severe back pain or sciatica along with one or more of the following:
    - Saddle anesthesia - loss of sensation restricted to the area of the buttocks, perineum, and inner surfaces of the thighs (areas that would sit on a saddle)
    - Recent bladder/bowel dysfunction
    - Achilles reflex absent on both sides
    - Sexual dysfunction that can come on suddenly
    - Absent anal reflex and bulbocavernosus reflex

Back Pain with Cancer History – Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history, but without known active cancer or a tumor that tends to metastasize to the spine. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

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"Neoplasms causing VCF (vertebral compression fractures) include: primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms."[31]

Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumors can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process.[40]

Drop Metastases[74] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[75] – Leptomeningeal carcinomatosis is a complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, melanoma, gastrointestinal, and primary central nervous system tumors.

Table 2: MRI and Cutaneous Stigmata[76]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Atretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
‡LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

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POLICY HISTORY

Date	Summary
March 2022	Added • Combination request for overlapping body part statement • Clarified muscle weakness not related to plexopathy or peripheral neuropathy • Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem • Descriptions for tethered cord • Clarified CT myelogram section • Background section of Drop Metastases • Background section of Leptomeningeal Carcinomatosis • Clarified toe walking in pediatric patient with myelopathy for thoracic spine Removed • Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section • Removed pediatric back pain from the total spine combination section
April 2021	• Added/modified o Modified section on neurological deficits o Back pain in a child added/modified red flags o Gait table in background o Post-surgical modified/clarified surgical criteria for combination exams and surgeon preference for exam type o Removed myelopathy combination studies o Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS o Modified known tumor imaging into primary and metastatic disease o Added toe walking for pediatric patients o Modified Combination exam wording
May 2020	• For evaluation of neurologic deficits when new deficits are present • Removed pars defect section • Added ankylosing spondylitis for evaluation of trauma/acute injury

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	• Modified Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine • Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL) • Added Osteopathic Manipulative medicine to conservative care therapy
June 2019	• Added: o new or worsening objective neuro deficits for chronic and acute back pain; CSF leak o last 6 months for allowable post op f/u period and removed EMG comment o red flags specifically for peds back pain and pain related to malignancy, infection, inflammation o new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain; o For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism o Spinal cord stimulator o New or increasing back pain in cancer patients with high suspicion of mets

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines: **LUMBAR SPINE CT**	**Original Date: September 1997**
CPT Codes: 72131, 72132, 72133	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_045	**Implementation Date: January 2023**

INDICATIONS FOR LUMBAR SPINE CT

+If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- **Inconclusive or show a need for additional or follow up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits when Lumbar Spine MRI is contraindicated or inappropriate

- With any of the following new neurological deficits documented on physical exam
  - Extremity muscular weakness (and not likely caused by plexopathy, or peripheral neuropathy)[1, 2]
  - Pathologic or abnormal reflexes
  - Absent/decreased sensory changes along a particular lumbar dermatome (nerve distribution): pin prick, touch, vibration, proprioception or temperature
  - Lower extremity increased muscle tone/spasticity
  - New onset bowel or bladder dysfunction (e.g., retention or incontinence)- not related to an inherent bowel or bladder process
  - Gait abnormalities (see Table 1 below for more details)
  - New onset foot drop (Not related to a peripheral nerve injury e.g., peroneal nerve)
- Cauda Equina Syndrome as evidence by severe back pain/sciatica along with one of the defined symptoms (see Overview)

For evaluation of back pain with any of the following when Lumbar Spine MRI is contraindicated[3-11]

- With new or worsening objective neurologic deficits* on exam, as above
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months

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- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a lumbar radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain[12])
- Isolated low back pain in pediatric population[13] – conservative care not required if red flags present
    - Red flags that prompt imaging should include the presence of: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; radicular pain; fever; weight loss; malaise; postural changes (e.g., kyphosis or scoliosis); and limp (or refusal to walk in a younger child <5yo) AND initial radiographs have been performed[14, 15]

As part of initial pre-operative/post-operative/procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion"[11, 16] and MRI for cord, nerve root compression, disc pathology, or post-op infection)
[Note: If ordered by Neurosurgeon or orthopedic surgeon for purposes of surgical planning, a contraindication to MRI is not required.]

- For preoperative evaluation/planning
- CT discogram
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram))[17]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively[16, 18] - see neurological deficit section above
- When combo requests are submitted (see above statement[+]) (i.e., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously, i.e., the need for both soft tissue and bony anatomy is required[19]
    - Combination requests where both lumbar spine CT and MRI lumbar spine are both approvable (not an all-inclusive list):
        - Pathologic or complex fractures
        - Malignant process of spine with both bony and soft tissue involvement
        - Clearly documented indication for bony and soft tissue abnormality where assessment will change management for the patient

For evaluation of trauma or acute injury[20]

- Presents with any of the following neurological deficits as above

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- With progression or worsening of symptoms during the course of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis) (Both MRI and CT would be approvable)[21]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation

("MRI and CT provide complementary information. When indicated it is appropriate to perform both examinations")[20]

For evaluation of known fracture or known/new compression fractures[22]
- To assess union of a fracture when physical examination, plain radiographs, or prior imaging suggest delayed or non-healing
- To determine the position of fracture fragments
- With history of malignancy (if MRI is contraindicated or cannot be performed)
- With an associated new focal neurologic deficit as above[23]
- Prior to a planned surgery/intervention or if the results of the CT will change management

CT myelogram: When MRI cannot be performed/contraindicated/surgeon preference
- When signs and symptoms are inconsistent or not explained by the MRI findings[24-28]
- Demonstration of the site of a CSF leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula)
- Surgical planning, especially regarding to the nerve roots or evaluation of dural sac

Pars defect (spondylolysis) or spondylolisthesis
- Pars defect (spondylolysis) or spondylolisthesis in adults when Flexion/Extension x-rays show instability
- Clinically suspected Pars defect (spondylolysis) which is not seen on plain films in pediatric population (<18 yr) (flexion extension instability not required) and imaging would change treatment[29-31] when MRI is contraindicated/cannot be performed or surgeon preference

NOTE: Initial imaging (x-ray, or planar bone scan without SPECT; Bone scan with SPECT is superior to MRI and CT in the detection of pars intrarticularis pathology including spondylolysis)[32]

For evaluation of tumor, cancer, or metastasis with any of the following:
(MRI is usually the preferred study- CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[33, 34]

- **Primary tumor**
    - Initial staging or re-staging of a known primary spinal tumor[35]

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- Known primary tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
- With an associated new focal neurologic deficit as above[23]

- **Metastatic tumor**
  - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
  - With an associated new focal neurologic deficit[23]
  - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine[36, 37]

- **For evaluation of inconclusive/indeterminate finding on prior imaging that requires further clarification**
  - One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam. When MRI cannot be performed or is contraindicated or CT is preferred to characterize the finding[36]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of known or suspected infection/abscess disease when Lumbar Spine MRI is contraindicated[4, 38, 39]

- Infection:
  - As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[40]
  - Follow-up imaging of infection
    - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[41]

For evaluation of known or suspected inflammatory disease when MRI is contraindicated or cannot be performed[42]

- Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma, and Lumbar Spine MRI is contraindicated[38]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

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Other Indications for a Lumbar Spine CT, when MRI is contraindicated or cannot be performed

(Note- See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[43-45]
- Known anorectal malformations[46, 47]
- Suspicious sacral dimple (those that are deep, larger than 0.5 cm, located within the superior portion of the gluteal crease or above the gluteal crease, multiple dimples, or associated with other cutaneous markers) (D'Alessandro, 2009) or duplicated or deviated gluteal cleft[48]
    - in patients ≤3 months should have ultrasound
- Toe walking in a child when associated with upper motor neuron signs, including hyperreflexia, spasticity; or orthopedic deformity with concern for spinal cord pathology (e.g., pes cavus, clawed toes, leg or foot length deformity (excluding tight heel cords))
- Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation
- For follow-up/repeat evaluation of Arnold-Chiari I with new signs or symptoms suggesting recurrent spinal cord tethering (For initial diagnosis see below)
- Suspected neuroinflammatory Conditions/Diseases (e.g., sarcoidosis, Behcet's)
    - After detailed neurological exam and basic testing completed

COMBINATION STUDIES WITH LUMBAR SPINE CT WHEN MRI IS CONTRAINDICATED OR CANNOT BE PERFORMED OR SURGEON PREFERENCE

Any combination of Cervical and/or Thoracic and/or Lumbar CTs

Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

Exception- Indications for combination studies[49, 50]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
    - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[51-53] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
    - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[54]
    - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging

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    - Scoliosis with any of the following[55]:
        - Progressive spinal deformity;
        - Neurologic deficit (new or unexplained);
        - Early onset;
        - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
        - Pre-operative planning; OR
        - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[56, 57]
    - Arnold-Chiari I
        - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[45, 51]
    - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
        - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele)
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[43-45] when anesthesia required for imaging[58] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)
- Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram)- See Overview
    - Suspected leptomeningeal carcinomatosis (LC)[59]- See Overview
    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram))[17]
- CT myelogram when meets above guidelines and MRI is contraindicated or for surgical planning
- Post-procedure (discogram) CT

BACKGROUND

Computed tomography is used for the evaluation, assessment of severity, and follow-up of diseases of the spine. Its use in the thoracic spine is limited, however, due to the lack of epidural fat in this part of the body. CT myelography improves the contrast severity of CT, but it is also invasive. CT may be used for conditions, e.g., degenerative changes, infection, and immune suppression, when magnetic resonance imaging (MRI) is contraindicated. It may also be used in the evaluation of tumors, cancer, or metastasis in the thoracic spine, and it may be

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used for preoperative and post-surgical evaluations. CT obtains images from different angles and uses computer processing to show a cross-section of body tissues and organs. CT is fast and is often performed in acute settings. It provides good visualization of cortical bone.

OVERVIEW

Table 1: Gait and spine imaging[60-65]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

Ankylosing Spondylitis/Spondyloarthropathies is a cause of back or sacroiliac pain of insidious onset (usually > 3 month), associated with morning stiffness not relieved with rest (usually age at onset <40). It is associated with any of the following[66-69]:

- Sedimentation rate and/or C-reactive protein (not an essential criteria)
- HLA B27 (not an essential criteria)

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- Non-diagnostic or indeterminate x-ray
- Personal or family history of sacroilitis, peripheral inflammatory arthritis, and/or inflammatory bowel disease

***Conservative Therapy** – This should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, regular Osteopathic Manipulative medicine treatments or chiropractic care when considered safe and appropriate.

****Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy[4, 11]:

- Information provided on exercise prescription/plan; AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).
- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

CT and Fracture of the Lumbar Spine – CT scans of the lumbar spine generate high-resolution spinal images; this and the absence of superimposed structures allow accurate diagnosis of lumbar fractures.

CT and Radiculopathy – Lumbar radiculopathy is caused by compression of a nerve root and/or inflammation that has progressed enough to cause neurologic symptoms, e.g., numbness, tingling, and weakness in leg muscles. These are warning signs of a serious medical condition that needs medical attention. Multidetector CT may be performed to rule out or localize lumbar disk herniation before surgical intervention, when MRI is contraindicated. Radiation dose should be kept as low as possible in young individuals undergoing CT of the lumbar spine.

CT and Infection of the spine – Infection of the spine is not easy to differentiate from other spinal disorders, e.g., degenerative disease, spinal neoplasms, and non-infective inflammatory lesions. Infections may affect different parts of the spine, e.g., vertebrae, intervertebral discs, and paraspinal tissues. Imaging is important to obtain to early diagnose and treat to avoid permanent neurology deficits. When MRI is contraindicated, CT may be used to evaluate infections of the spine.

CT and Degenerative Disease of the Lumbar Spine – Stenosis of the lumbar canal may result from degenerative changes of the discs, ligaments and facet joints surrounding the lumbar canal. Compression of the microvasculature of the bundle of nerve roots in the lumbosacral

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spine may lead to significant effects on the cauda equina. This is a surgical emergency, and CT may be performed to help assess the problem when MRI is contraindicated or inappropriate. CT scans can provide visualization of the vertebral canal and may demonstrate encroachment of the canal by osteophytes, facets, pedicles, or hypertrophied lamina.

Infection, Abscess, or Inflammatory disease

- Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%)[70]
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

CT and Low Back Pain – Low back pain by itself is a self-limited condition which does not warrant any imaging studies. One of the "red flags" signifying a more complicated status is focal neurologic deficit with progressive or disabling symptoms. When magnetic resonance imaging (MRI) is contraindicated, CT of the lumbar spine with or without contrast is indicated for low back pain accompanied by a "red flag" symptom. Myelography combined with post-myelography CT is accurate in diagnosing disc herniation and may be useful in surgical planning. CT may be indicated when MRI is contraindicated, and chronic back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

Table 2: CT and Cutaneous Stigmata[71]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Atretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
‡LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

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Tethered spinal cord syndrome – a neurological disorder caused by tissue attachments that limit the movement of the spinal cord within the spinal column. Although this condition is rare, it can continue undiagnosed into adulthood. The primary cause is myelomeningocele and lipomyelomeningocele; the following are other causes that vary in severity of symptoms and treatment.

- Dermal sinus tract (a rare congenital deformity)
- Diastematomyelia (split spinal cord)
- Lipoma
- Tumor
- Thickened/tight filum terminale
- History of spine trauma/surgery
- Arnold-Chiari Malformation

Sacral Dimples – Simple midline dimples are the most commonly encountered dorsal cutaneous stigmata in neonates and indicate low risk for spinal dysraphism. Only atypical dimples are associated with a high risk for spinal dysraphism, particularly those that are large (>5 mm), high on the back (>2.5 cm from the anus), or appear in combination with other lesions.[72] High-risk cutaneous stigmata in neonates include hemangiomas, upraised lesions (i.e., masses, tails, and hairy patches), and multiple cutaneous stigmata (Table 2).

Spina Bifida Occulta[73]

- Called the hidden spina bifida, as the spinal cord and the nerves are usually normal and there is no opening on the skin on the back
- This subtype occurs in about 12% of the population, and the majority of people are not aware that they have spina bifida occulta, unless it is discovered on an x-ray performed for an unrelated reason.
- Approximately 1 in 1,000 individuals can have an occult structural finding that leads to neurological deficits or disabilities as bowel or bladder dysfunction, back pain, leg weakness or scoliosis.

Back Pain with Cancer History – Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

"Neoplasms causing VCF (vertebral compression fractures) include: primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to multiple myeloma and lymphoma, and metastatic neoplasms."[22]

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Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumor can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process.[37]

CT Myelogram – Myelography is the instillation of intrathecal contrast media under fluoroscopy. Patients are then imaged with CT to evaluate for spinal canal pathology. Although this technique has diminished greatly due to the advent of MRI due to its non-invasiveness and superior soft-tissue contrast, myelography is still a useful technique for conventional indications, such as spinal stenosis, when MRI is contraindicated or nondiagnostic, brachial plexus injury in neonates, radiation therapy treatment planning, and cerebrospinal fluid (CSF) leak.

Cauda Equina Syndrome

- Symptoms include severe back pain or sciatica along with one or more of the following:
    - Saddle anesthesia - loss of sensation restricted to the area of the buttocks, perineum and inner surfaces of the thighs (areas that would sit on a saddle).
    - Recent bladder/bowel dysfunction
    - Achilles reflex absent on both sides
    - Sexual dysfunction that can come on suddenly
    - Absent anal reflex and bulbocavernosus reflex
- This is a "Red Flag" situation and Lumbar Spine MRI is approvable.

Drop Metastases[74] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[75] – Leptomeningeal carcinomatosis is a complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, melanoma, gastrointestinal, and primary central nervous system tumors.

POLICY HISTORY

Date	Summary
March 2022	Added • Combination request for overlapping body part statement • Clarified muscle weakness no related to plexopathy or peripheral neuropathy • Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem • Descriptions for tethered cord

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	• Clarified CT myelogram section • Background section of Drop Metastases • Background section of Leptomeningeal Carcinomatosis • Clarified toe walking in pediatric patient • Added section on neuroinflammatory conditions Removed • Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section • Removed pediatric back pain from the total spine combination section
April 2021	• Added/modified o Modified section on neurological deficits o Back pain in a child added/modified red flags o Gait table in background o Post-surgical modified/clarified surgical criteria for combination exams and surgeon preference for exam type o Removed myelopathy combination studies o Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS o Modified known tumor imaging into primary and metastatic disease o Added toe walking for pediatric patients o Modified Combination exam wording o Added anorectal malformations
May 2020	• For evaluation of neurologic deficits added new deficits • Added ankylosing spondylitis for evaluation of trauma/acute injury • Added Osteopathic Manipulative medicine to conservative care therapy • Modified Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine • Modified Pars fracture to not seen on radiograph and imaging would change management • Combined the acute and chronic back pain sections • Added spina bifida occulta to background section
June 2019	• Added CT myelogram

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	• Added new or worsening objective neuro deficits for chronic and acute back pain • Added last 6 months for allowable post op follow up period and removed EMG comment • Added section on pars defect • Added section on compression fractures • In other indications removed myelogram since covered previously • Added congenital anomalies • Added sacral dimple and scoliosis • Added red flags specifically for peds back pain and pain related to malignancy, infection, inflammation • Added CSF leak indication • For combination studies C/T/L added drop metastasis, tethered cord, Arnold Chiari

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guideline **CERVICAL SPINE MRI**	**Original Date: September 1997**
CPT Codes: 72141, 72142, 72156, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_040	**Implementation Date: January 2023**

INDICATIONS FOR CERVICAL SPINE MRI

+ If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- **Inconclusive or show a need for additional or follow up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits[1-6]

- With any of the following new neurological deficits documented on physical exam
    - Extremity muscular weakness (and not likely caused by plexopathy, or peripheral neuropathy)
    - Pathologic (e.g., Babinski, Lhermitte's sign, Chaddock Sign, Hoffman's) or abnormal reflexes
    - Absent/decreased sensory changes along a particular cervical dermatome (nerve distribution): pin prick, touch, vibration, proprioception, or temperature
    - Upper or lower extremity increase muscle tone/spasticity
    - New onset bowel or bladder dysfunction (e.g., retention or incontinence)- not related to an inherent bowel or bladder process
    - Gait abnormalities (see Table 1 for more details)
- Suspected cervical cord compression with any neurological deficits as listed above

For evaluation of neck pain with any of the following[7-9]

- With new or worsening objective neurologic deficits (as listed above) on exam
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months[10]
- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a cervical radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain.)[11]
- Isolated neck pain in pediatric population[12, 13] – conservative care not required if red flags present

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- Red flags that prompt imaging should include the presence of the following: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; fever; weight loss[14, 15]

As part of initial pre-operative / post-operative / procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion"[12, 16] and MRI for cord, nerve root compression, disc pathology or post-op infection)

- For preoperative evaluation/planning
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula))
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively[16, 17] - see neurological deficit section above
- When combo requests (see above statement[+]) are submitted (e.g., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously (e.g., the need for both soft tissue and bony anatomy is required)[18]
    - Combination requests where both cervical spine CT and MRI cervical spine are both approvable (not an all-inclusive list):
        - OPLL (Ossification of posterior longitudinal ligament)[19]
        - Pathologic or complex fractures
        - Malignant process of spine with both bony and soft tissue involvement
        - Unstable craniocervical junction
        - Clearly documented indication for bony and soft tissue abnormality where assessment will change management (i.e., surgical approach) for the patient

For evaluation of suspected myelopathy[20-24]

- Does **NOT** require conservative care
- Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with grasping and holding objects, diffuse numbness in the hands, pins and needles sensation, increasing difficulty with balance and ambulation
- Any of the neurological deficits as noted above

For evaluation of known or suspected multiple sclerosis (MS)[20, 25-27]

- Evidence of MS on recent baseline Brain MRI
- Suspected or known MS with new or changing symptoms consistent with cervical spinal cord disease (focal neurologic deficit or clinical sign, e.g., Lhermitte sign)

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- Suspected or known pediatric demyelinating diseases (MS/ADEM)

Combination studies MS[28]

- **These body regions might be evaluated separately or in combination as guided by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history (e.g., symptom(s), time course, and where in the CNS the likely localization(s) is/are), and other available information, including prior imaging.**
    - Cervical **and/or** Thoracic MRI for evaluation of highly suspected multiple sclerosis (MS) when Brain MRI has indeterminate findings and/or does not fulfill the McDonald criteria for the diagnosis of MS[26]
    - Cervical **and/or** Thoracic MRI with suspected transverse myelitis - with appropriate clinical symptoms (e.g., bilateral weakness, sensory disturbance, and autonomic dysfunction which typically evolve over hours or days)
    - Brain MRI with Cervical **and/or** Thoracic MRI for evaluation of neuromyelitis optica spectrum disorders (recurrent or bilateral optic neuritis; recurrent transverse myelitis)[29]
    - Known MS, entire CNS axis (Brain, **and/or** Cervical **and/or** Thoracic spine) is approvable prior to the initiation or change of disease modification treatments and assess disease burden (to establish a new baseline)
    - Known MS- Follow-up scans, including brain and spine imaging, if patients have known spine disease:
        - 6-12 months after starting/changing treatment
        - Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years

For evaluation of trauma or acute injury[12, 30]

- Presents with any of the following neurological deficits noted above
- With progression or worsening of symptoms during the course of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis) (Both MRI and CT would be approvable)[31-33]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation
- When office notes specify the patient meets NEXUS (National Emergency X-Radiography Utilization Study) or CCR (Canadian Cervical Rules) criteria for imaging:
    - CT for initial imaging
    - MRI when suspect spinal cord or nerve root injury or when patient is obtunded, and CT is negative
    - CT or MRI for treatment planning of unstable spine

("MRI and CT provide complementary information. When indicated it is appropriate to perform both examinations")[31]

For evaluation of known or new compression fractures with worsening neck pain[12]

- With history of malignancy
    - To aid in differentiation of benign osteoporotic fractures from metastatic disease

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        - A follow-up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher (indeterminate) benign osteoporotic fracture from metastatic disease (Kumar, 2016)
- With an associated new focal neurologic deficit as above[34]
- Prior to a planned surgery/intervention or if the results of the MRI will change management

For evaluation of tumor, cancer, or metastasis with any of the following:
(MRI is usually the preferred study, but CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[12, 35-37]

- **Primary tumor**
    - Initial staging or re-staging of a known primary spinal tumor[38]
    - Known spinal tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
    - With an associated new focal neurologic deficit as above[34]

- **Metastatic tumor**
    - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
    - With an associated new focal neurologic deficit[34]
    - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or neck pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine[12, 39]

- **For evaluation of inconclusive finding on prior imaging that requires further clarification**
    - One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam[12]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases
- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of known or suspected infection/abscess[12]
- Infection
    - As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[40]
    - Follow-up imaging of infection
        - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[41]

For evaluation of known or suspected inflammatory disease or atlantoaxial instability

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- In rheumatoid arthritis with neurologic signs/symptoms, or evidence of subluxation on radiographs (lateral radiograph in flexion and neutral should be the initial study)[42, 43]
    - Patients with negative radiographs but symptoms suggestive of cervical instability or in patients with neurologic deficits MRI is indicated[44]
- High-risk disorders affecting the atlantoaxial articulation, such as Down syndrome, Marfan syndrome with neurological signs/symptoms, abnormal neurological exam, or evidence of abnormal or inconclusive radiographs of the cervical spine[45]
- Spondyloarthropathies, known or suspected
    - Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and appropriate rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma[46, 47]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

Other Indications for a Cervical Spine MRI

(Note- See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord or spinal dysraphism (known or suspected), based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[48-50]
- Known Arnold-Chiari syndrome (For initial imaging see combination below)
    - Known Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis with new or changing signs/symptoms or exam findings consistent with spinal cord pathology[51]
    - Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation
- Achondroplasia (one Cervical Spine MRI to assess the craniocervical junction, as early as possible, even in asymptomatic cases)[52, 53]
- Syrinx or syringomyelia (known or suspected)
    - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[54])
    - To further characterize a suspicious abnormality seen on prior imaging
    - Known syrinx with new/worsening symptoms
- Toe walking in a child with signs/symptoms of myelopathy localized to the Cervical Spine
- Suspected neuroinflammatory Conditions/Diseases (e.g., sarcoidosis, Behcet's)
    - After detailed neurological exam and basic testing completed

COMBINATION OF STUDIES WITH CERVICAL SPINE MR

Brain MRI/Cervical MRI

- For evaluation of known Arnold-Chiari Malformation

Cervical and Thoracic MRI

- Initial evaluation of known syrinx or syringomyelia

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- With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[54])
- To further characterize a suspicious abnormality seen on prior imaging
- Known syrinx with new/worsening symptom

Any combination of Cervical and/or Thoracic and/or Lumbar MRIs
Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

Exception- Indications for combination studies[55, 56]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
  - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[57-59] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
  - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[60]
  - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging
  - Scoliosis with any of the following[61]:
    - Progressive spinal deformity;
    - Neurologic deficit (new or unexplained);
    - Early onset;
    - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
    - Pre-operative planning; OR
    - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[62, 63]
  - Arnold-Chiari I
    - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[50, 57]
  - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
    - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[48-50] when anesthesia required for imaging[64] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)
- Oncological applications (e.g., primary nervous system, metastatic)
  - Drop metastasis from brain or spine (imaging also includes brain)- see Overview section
  - Suspected leptomeningeal carcinomatosis (LC)[65] -see Overview section

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    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes - See Overview section
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula))

BACKGROUND

Magnetic resonance imaging (MRI) produces high quality multiplanar images of organs and structures within the body without radiation. It is the preferred modality for evaluating the internal structure of the spinal cord, providing assessment of conditions such as degenerative disc pathology, osteomyelitis, and discitis.

OVERVIEW

***Conservative Therapy** – (Spine) should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or osteopathic manipulative medicine (OMT) or chiropractic care when considered safe and appropriate.

****Home Exercise Program** – **(HEP)/ Therapy:** The following elements are required to meet guidelines for completion of conservative therapy[66, 67]:

- Information provided on exercise prescription/plan AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).
- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Cervical myelopathy – Symptom severity varies, and a high index of suspicion is essential for making the proper diagnosis in early cases. Symptoms of pain and radiculopathy may not be present. The natural history of myelopathy is characterized by neurological deterioration. The most frequently encountered symptom is gait abnormality (86%) followed by increased muscular reflexes (79.1%), pathological reflexes (65.1%), paresthesia of upper limb (69.8%), and pain (67.4%).[24]

Infection, Abscess, or Inflammatory disease

- Infection:
    - Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%)[68]

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- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

Table 1: Gait and spine imaging[69-74]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

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MRI for Evaluation of Discitis – Discitis is a known complication of cervical discography. Postoperative discitis in the cervical spine does not occur frequently but can result from accidental inoculation of bacteria into the disc space intra-operatively by a contaminated spinal needle being used as a radiological marker. There may be other causes for postoperative discitis, e.g., esophageal perforation, hematogenous spread, inoculation of bacteria during surgery. Patients with an alteration in the nature of their symptoms after cervical discectomy and fusion may have discitis. Symptoms may include complaints of mild paresthesia in extremities and neck pain. MRI may be performed to reveal feature of discitis with associated abscesses and may help to confirm the diagnosis and decide on further management.

MRI for Cervical Radiculopathy – MRI is a useful test to evaluate the spine because it can show abnormal areas of the soft tissues around the spine; in addition to the bones, it can also show pictures of the nerves and discs and is used to find tumors, herniated discs, or other soft-tissue disorders. MRI has a role both in the pre-operative screening and post-operative assessment of radicular symptoms due to either disc or osteophyte.

Table 2: MRI and Cutaneous Stigmata[75]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Atretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
‡LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

MRI and Multiple Sclerosis (MS) – MRI is a sensitive method of detecting the white matter lesions of MS. These plaques on MRI generally appear as multiple, well-demarcated, homogeneous, small ovoid lesions which often lack mass effect and are oriented perpendicular to the long axis of the lateral ventricles. Sometimes they present as large, space occupying lesions that may be misinterpreted as tumors, abscesses, or infarcts.

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MRI and Neck Pain – Neck pain is common in the general population and usually relates to musculoskeletal causes, but it may also be caused by spinal cord tumors. When neck pain is accompanied by extremity weakness, abnormal gait, or asymmetric reflexes, spinal MRI may be performed to evaluate the cause of the pain. MRI may reveal areas of cystic expansion within the spinal cord. Enhancement with gadolinium contrast may suggest that the lesion is neoplastic.

Ossification Posterior Longitudinal Ligament (OPLL)[19] – Most common in cervical spine (rare but more severe in thoracic spine)

Back Pain with Cancer History – Bone is the third most common site of metastases after the liver and the lungs, and approximately two-thirds of all osseous metastases occur in the spine. Approximately 60–70% of patients with systemic cancer will have spinal metastasis. Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history, but without known active cancer or a tumor that tends to metastasize to the spine. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

"Neoplasms causing VCF (vertebral compression fractures) include: primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms."[76]

Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumors can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process. Spinal metastasis is more commonly found in the thoracic region, followed by the lumbar region, while the cervical region is the least likely site of metastasis.[39]

Cervical Spine Trauma Imaging[30] – The National Emergency X-Radiography Utilization Study (NEXUS) and the Canadian Cervical Rules (CCR) represent clinical criteria used to help determine the presence of significant cervical spine injury. Although the criteria are highly sensitive (99.6% for NEXUS), specificity is low (12.9% for Nexus).

A patient not meeting any of the NEXUS criteria of focal neurologic deficit, midline spinal tenderness, altered consciousness, intoxication, or distracting injury is unlikely to have a significant cervical spine injury. Imaging evaluation of the cervical spine in these patients is not necessary. In the CCR criteria, a patient without any high risk factors (Age >65 years; paresthesias in extremities; dangerous mechanism; falls from ≥3 feet/5 stairs; axial load to head; motor vehicle crash with high speed, rollover, or ejection; bicycle collision; motorized recreational vehicle accident) is next evaluated for low risk factors (Simple rear-end motor vehicle crash, patient in sitting position in emergency center, patient ambulatory at any time after trauma, delayed onset of neck pain, absence of midline cervical spine tenderness). If the patient meets a low-risk criteria, they are asked to move their head 45

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degrees from midline in both directions. If the patient can accomplish this, the spine is cleared, and imaging is not necessary.

MRI and Neurocutaneous Syndromes

- In NF-1, clinical evaluation appears to be more useful to detect complications than is screening imaging in asymptomatic patients. Imaging is indicated in evaluation of suspected tumors based on clinical evaluation and for follow-up of known intracranial tumors.[77]
- Conversely in NF-2, routine MR imaging screening is always indicated, given the high prevalence of CNS tumors, especially vestibular schwannomas. In patients with NF-2, routine screening brain/IAC imaging is indicated annually starting from age 10, if asymptomatic, or earlier with clinical signs/symptoms. Most individuals with NF2 eventually develop a spinal tumor, mostly commonly schwannomas, but meningioma and ependymomas are also seen. Spinal imaging at baseline and every 2 to 3 years is also advised with more frequent imaging, if warranted, based on sites of tumor involvement.[78]
- In patients with Tuberous Sclerosis, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities.[79]
- In Von Hippel Lindau Syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years.[80]
- In Sturge Weber Syndrome, Brain MRI can rule out intracranial involvement after only age 1 and is recommended in patients <1 year old only if symptomatic.[81]

Drop Metastases[82] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas, and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[83] – Leptomeningeal carcinomatosis is complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, melanoma, gastrointestinal, and primary central nervous system tumors.

POLICY HISTORY

Date	Summary
March 2022	Added • Combination request for overlapping body part statement • Clarified muscle weakness no related to plexopathy or peripheral neuropathy • Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem • Clarified isolated neck pain in pediatric patient • Clarified combination MS for cervical and/or thoracic spine combination requests

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	• Added subsection for cervical and thoracic spine section for syrinx and syringomyelia • Descriptions for tethered cord • Background section of Drop Metastases • Background section of Leptomeningeal Carcinomatosis • Clarified toe walking in pediatric patient with myelopathy for cervical spine Removed • Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section • Removed pediatric back pain from the total spine combination section
November 2021	• Added +0698T
April 2021	• Added/modified o Modified section on neurological deficits o Back pain in a child added/modified red flags o Gait table in background o Post-surgical modified/clarified surgical criteria for combination exams and surgeon preference for exam type o Removed myelopathy combination studies o Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS o Modified known tumor imaging into primary and metastatic disease o Added toe walking for pediatric patients o Modified Combination exam wording o Added Achondroplasia to criteria
May 2020	• Added**:** o For evaluation of neurologic deficits are new o Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL) o Added imaging in high risk patients predisposed to spinal injury o Added imaging in high risk patients for atlantoaxial injury o Added transverse myelitis o Modified Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or neck pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine

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	○ Added to background of imaging of infection ○ Added Osteopathic Manipulative medicine to conservative care therapy
June 2019	• Added: ○ new or worsening objective neuro deficits for chronic and acute back pain ○ CSF leak ○ last 6 months for allowable post op f/u period and removed EMG comment ○ red flags specifically for peds back pain and pain related to malignancy, infection, inflammation ○ new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain; ○ For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism • Improved section for evaluation of multiple sclerosis including NMO disorders and recurrent transverse myelitis; Lhermitte sign • Modified section on evaluation of neurologic deficits; added specific pathologic findings; spasticity, sensory, or motor level changes • Included signs in section on myelopathy including hyperreflexia and pathologic reflexes • Enhanced sections on trauma; rheumatoid arthritis; back pain in cancer patients with known active cancer in tumors that tend to metastasize to spine • Expanded on tethered cord in Other Indications for imaging and added section on sacral dimple • For combination studies Brain/Cervical Spine added suspected MS with new or changing symptoms and follow up to initiation of treatment with known MS

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **THORACIC SPINE MRI**	**Original Date: September 1997**
CPT Codes: 72146, 72147, 72157, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_042	**Implementation Date: January 2023**

INDICATIONS FOR THORACIC SPINE MRI

+If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- **Inconclusive or show a need for additional or follow-up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient (the entire spinal cord and/or autonomic postganglionic chain must be assessed)**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits[1-4]

- With any of the following new neurological deficits documented on physical exam
  - Extremity muscular weakness (and not likely caused by plexopathy or peripheral neuropathy)[5, 6]
  - Pathologic (e.g., Babinski, Chaddock Sign) or abnormal reflexes[7]
  - Absent/decreased sensory changes along a particular thoracic dermatome (nerve distribution): pin prick, touch, vibration, proprioception, or temperature
  - Upper or lower extremity increase muscle tone/spasticity, and likely localized to the thoracic spinal cord
  - New onset bowel or bladder dysfunction (e.g., retention or incontinence)- not related to an inherent bowel or bladder process
  - Gait abnormalities, most likely cause by a suspected or known myelopathy (see Table 1 for more details)
- Suspected thoracic cord compression with any neurological deficits as listed above

For evaluation of back pain with any of the following[8-10]

- With new or worsening objective neurologic deficits (as listed above) on exam
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months
- With progression or worsening of symptoms during the course of conservative treatment*

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- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a thoracic radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain)[11]
- Isolated thoracic back pain in pediatric population[12] – conservative care not required if red flags present
    - Red flags that prompt imaging should include the presence of: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; radicular pain; fever; weight loss; malaise; postural changes (e.g., kyphosis or scoliosis); and limp (or refusal to walk in a younger child <5yo) AND initial radiographs have been performed[13, 14]

As part of initial pre-operative / post-operative / procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion"[15, 16] and MRI for cord, nerve root compression, disc pathology or post-op infection)

- For preoperative evaluation/planning
- Prior to spinal cord stimulator to exclude canal stenosis if no prior MRI imaging of the thoracic spine has been done recently[17, 18]
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula or dural fistula))
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively[15, 19]- see neurological deficit section above
- When combo requests (see above statement[+]) are submitted (i.e., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously, i.e., the need for both soft tissue and bony anatomy is required[20]
    - Combination requests where both thoracic spine CT and MRI thoracic spine are both approvable (not an all-inclusive list):
        - OPLL (Ossification of posterior longitudinal ligament)-
            - Most common in cervical spine (rare but more severe in thoracic spine)[21]
        - Pathologic or complex fractures
        - Malignant process of spine with both bony and soft tissue involvement
        - Clearly documented indication for bony and soft tissue abnormality where assessment will change management for the patient

For evaluation of suspected myelopathy[22-26]

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- Does **NOT** require conservative care
- Progressive symptoms including unsteadiness, broad-based gait, increased muscle tone, pins and needles sensation, weakness and wasting of the lower limbs, and diminished sensation to light touch, temperature, proprioception, and vibration; limb hyperreflexia and pathologic reflexes; bowel and bladder dysfunction in more severe cases
- Any of the neurological deficits as noted above

For evaluation of known or suspected multiple sclerosis (MS)[26-29]

- Suspected or known MS with new or changing symptoms suggesting underlying thoracic spinal cord disease (i.e., transverse myelitis, progressive myelopathy)
- Suspected or known pediatric demyelinating diseases (MS/ADEM)

Combination studies for MS

- **These body regions might be evaluated separately or in combination as guided by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history (e.g., symptom(s), time course, and where in the CNS the likely localization(s) is/are), and other available information, including prior imaging.**
    - Cervical **and/or** Thoracic MRI for evaluation of highly suspected multiple sclerosis (MS) when Brain MRI has indeterminate findings and/or does not fulfill the McDonald criteria for the diagnosis of MS[28]
    - Cervical **and/or** Thoracic MRI with suspected transverse myelitis-with appropriate clinical symptoms (e.g., bilateral weakness, sensory disturbance, and autonomic dysfunction which typically evolve over hours or days)
    - Brain MRI with Cervical **and/or** Thoracic MRI for evaluation of neuromyelitis optica spectrum disorders (recurrent or bilateral optic neuritis; recurrent transverse myelitis)[30]
    - Known MS- entire CNS axis (Brain, **and/or** Cervical **and/or** Thoracic spine) is approvable prior to the initiation or change of disease modification treatments and assess disease burden (to establish a new baseline)
    - Known MS- Follow-up scans, including brain and spine imaging, if patients have known spine disease:
        - 6-12 months after starting/changing treatment
        - Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years

For evaluation of trauma or acute injury[31]

- Presents with any of the following neurological deficits as above
- With progression or worsening of symptoms during the course of a trial of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis) (Both MRI and CT would be approvable)[32-34]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation

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("MRI and CT provide complementary information. When indicated it is appropriate to perform both examinations").[31]

For evaluation of known or new compression fractures with worsening back pain[31, 35]

- With history of malignancy
    - To aid in differentiation of benign osteoporotic fractures from metastatic disease
        - A follow-up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher (indeterminate) benign osteoporotic fracture from metastatic disease[36]
- With an associated new focal neurologic deficit as above
- Prior to a planned surgery/intervention or if the results of the MRI will change management

For evaluation of tumor, cancer, or metastasis with any of the following:
(MRI is usually the preferred study, but CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[37-39]

- **Primary tumor**
    - Initial staging or re-staging of a known primary spinal tumor[40]
    - Known primary tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
    - With an associated new focal neurologic deficit as above[41]

- **Metastatic tumor**
    - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
    - With an associated new focal neurologic deficit[41]
    - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine [33-35]

- **For evaluation of inconclusive finding on prior imaging that requires further clarification**
    - One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam[39]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of known or suspected infection, abscess, or inflammatory disease[42, 43]

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- **Infection**
  - As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[44]
  - Follow-up imaging of infection
    - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[45]
- **Spondyloarthropathies**
  - Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and appropriate rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma[43]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

Other Indications for a Thoracic Spine MRI

(Note- See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[46-48]
- Known Arnold-Chiari syndrome (For initial imaging (one-time initial MRI-modality assessment) see combination below)
  - Known Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis with new or changing signs/symptoms or exam findings consistent with spinal cord pathology[49]
  - Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation
- Syrinx or syringomyelia (known or suspected)
  - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[50])
  - To further characterize a suspicious abnormality seen on prior imaging
  - Known syrinx with new/worsening symptoms
- Toe walking in a child with signs/symptoms of myelopathy localized to the Thoracic Spine
- Suspected neuroinflammatory Conditions/Diseases (e.g., sarcoidosis, Behcet's)
  - After detailed neurological exam and basic testing completed

COMBINATION STUDIES WITH THORACIC SPINE MRI

Cervical and Thoracic MRI

- Initial evaluation of known syrinx or syringomyelia
  - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[50])
  - To further characterize a suspicious abnormality seen on prior imaging
  - Known syrinx with new/worsening symptom

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Any combination of Cervical and/or Thoracic and/or Lumbar MRIs
Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

Exception- Indications for combination studies[51, 52]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
    - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[53-55] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
    - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[56]
    - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging
    - Scoliosis with any of the following[57]:
        - Progressive spinal deformity;
        - Neurologic deficit (new or unexplained);
        - Early onset;
        - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
        - Pre-operative planning; OR
        - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[58, 59]
    - Arnold-Chiari I
        - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[47, 53]
    - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
        - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[46-48] when anesthesia required for imaging[60] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)
- Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (imaging also includes brain)- see Overview
    - Suspected leptomeningeal carcinomatosis (LC)[61] -see Overview
    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes

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- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula))

BACKGROUND

Magnetic resonance imaging (MRI) produces high quality multiplanar images of organs and structures within the body without using ionizing radiation. It is used for evaluation, assessment of severity, and follow-up of diseases of the spine and is the preferred modality for imaging intervertebral disc degeneration. High contrast resolution (soft tissue contrast) and multiplanar imaging (sagittal as well as axial planes) are helpful in the evaluation of possible disc herniation and detecting nerve root compression. MRI is one of the most useful techniques to evaluate spine infection and is also used to evaluate tumors, cancer, and immune system suppression.

OVERVIEW

Ankylosing Spondylitis/Spondyloarthropathies is a cause of back or sacroiliac pain of insidious onset (usually > 3 month), associated with morning stiffness not relieved with rest (usually age at onset < 40). It is associated with any of the following[62-65]:

- Sedimentation rate and/or C-reactive protein (not an essential criteria)
- HLA B27 (not an essential criteria)
- Non-diagnostic or indeterminate x-ray
- Personal or family history of sacroiliitis, peripheral inflammatory arthritis, and/or inflammatory bowel disease

***Conservative Therapy** – (Spine) should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or osteopathic manipulative medicine (OMT) or chiropractic care when considered safe and appropriate.

****Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy[16, 66]:

- Information provided on exercise prescription/plan AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

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- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Infection, Abscess, or Inflammatory disease

- Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%)[67]
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

Table 1: Gait and spine imaging[68-73]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

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Table 2: MRI and Cutaneous Stigmata[74]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Artretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
‡LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

Myelopathy – Symptom severity varies, and a high index of suspicion is essential for making the proper diagnosis in early cases. Symptoms of pain and radiculopathy may not be present. The natural history of myelopathy is characterized by neurological deterioration. The most frequently encountered symptom is gait abnormality (86%) followed by increased muscular reflexes (79.1%), pathological reflexes (65.1%), paresthesia of upper limb (69.8%), and pain (67.4%).[75]

Ossification Posterior Longitudinal Ligament (OPLL)[21] – Most common in cervical spine (rare but more severe in thoracic spine)

Tethered spinal cord syndrome – a neurological disorder caused by tissue attachments that limit the movement of the spinal cord within the spinal column. Although this condition is rare, it can continue undiagnosed into adulthood. The primary cause is myelomeningocele and lipomyelomeningocele; the following are other associations that vary in severity of symptoms and treatment.

- Dermal sinus tract (a rare congenital deformity)
- Diastematomyelia (split spinal cord)
- Lipoma
- Tumor
- Thickened/tight filum terminale
- History of spine trauma/surgery
- Arnold-Chiari Malformation

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Magnetic resonance imaging (MRI) can display the low level of the spinal cord and a thickened filum terminale, the thread-like extension of the spinal cord in the lower back. Treatment depends upon the underlying cause of the tethering. If the only abnormality is a thickened, shortened filum, then limited surgical treatment may suffice.

MRI and Spinal Infections – Infection of the spine is not easy to differentiate from other spinal disorders, e.g., degenerative disease, spinal neoplasms, and noninfectious inflammatory lesions. Infections may affect different parts of the spine, e.g., vertebrae, intervertebral discs and paraspinal tissues, or the spinal cord tissue and/or roots themselves. Imaging is important in obtaining an early diagnosis and treatment to avoid permanent neurologic deficits. MRI is the preferred imaging technique to evaluate infections of the spine. With its high contrast resolution and direct multiplanar imaging, MRI can detect and delineate infective lesions irrespective of their spinal location.

Back Pain with Cancer History – Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history, but without known active cancer or a tumor that tends to metastasize to the spine. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

"Neoplasms causing VCF (vertebral compression fractures) include: primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms."[35]

Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumors can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process.[76]

Cauda Equina Syndrome – Symptoms include severe back pain or sciatica along with one or more of the following:

- Saddle anesthesia - loss of sensation restricted to the area of the buttocks, perineum, and inner surfaces of the thighs (areas that would sit on a saddle)
- Recent bladder/bowel dysfunction
- Achilles reflex absent on both sides
- Sexual dysfunction that can come on suddenly
- Absent anal reflex and bulbocavernosus reflex

Spinal MRI and Neuromyelitis optica spectrum disorders (NMOSD) – NMOSD are inflammatory disorders of the central nervous system characterized by severe, immune-

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mediated demyelination and axonal damage predominantly affecting the optic nerves and spinal cord, but NMOSD may also affect the brain and brainstem. NMOSD can typically be distinguished from multiple sclerosis and other inflammatory disorders by the presence of the aquaporin-4 (AQP4) antibody; although, up to 10% of patients with NMOSD can be seronegative.[77, 78] Features of NMOSD include attacks of bilateral or sequential optic neuritis acute transverse myelitis and the area postrema syndrome (with intractable hiccups or nausea and vomiting). The evaluation of suspected NMOSD entails brain and spinal cord neuroimaging. In contrast to MS (in which spinal cord involvement tends to be incomplete and asymmetric), NMOSD have a longer extent of spinal cord demyelination generally involving three or more vertebral segments.

MRI and Neurocutaneous Syndromes

- In NF-1, clinical evaluation appears to be more useful to detect complications than is screening imaging in asymptomatic patients. Imaging is indicated in evaluation of suspected tumors based on clinical evaluation and for follow-up of known intracranial tumors.[79]
- Conversely in NF-2, routine MR imaging screening is always indicated, given the high prevalence of CNS tumors, especially vestibular schwannomas. In patients with NF-2, routine screening brain/IAC imaging is indicated annually starting from age 10, if asymptomatic, or earlier with clinical signs/symptoms. Most individuals with NF2 eventually develop a spinal tumor, mostly commonly schwannomas, but meningioma and ependymomas are also seen. Spinal imaging at baseline and every 2 to 3 years is also advised with more frequent imaging, if warranted, based on sites of tumor involvement.[80]
- In patients with Tuberous Sclerosis, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities.[81]
- In Von Hippel Lindau Syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years.[82]
- In Sturge Weber Syndrome, Brain MRI can rule out intracranial involvement after only age 1 and is recommended in patients <1 year old only if symptomatic.[83]

Drop Metastases[84] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[85] – Leptomeningeal carcinomatosis is complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, and melanoma, gastrointestinal, and primary central nervous system tumors.

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POLICY HISTORY

Date	Summary
March 2022	Added • Combination request for overlapping body part statement • Clarified muscle weakness not related to plexopathy or peripheral neuropathy • Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem • Clarified combination MS for cervical and/or thoracic spine combination requests • Descriptions for tethered cord • Background section of Drop Metastases • Background section of Leptomeningeal Carcinomatosis • Clarified toe walking in pediatric patient with myelopathy for thoracic spine Removed • Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section • Removed pediatric back pain from the total spine combination section
November 2021	• Added +0698T
April 2021	• Added/modified o Modified section on neurological deficits o Back pain in a child added/modified red flags o Gait table in background o Post-surgical modified/clarified surgical criteria for combination exams o Removed myelopathy combination studies o Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS o Modified known tumor imaging into primary and metastatic disease o Added toe walking for pediatric patients o Modified Combination exam wording
May 2020	• Added o For evaluation of neurologic deficits when new deficits are present o Removed pars defect section o Added ankylosing spondylitis for evaluation of trauma/acute injury

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	o Added follow up of osteoporotic fracture from metastatic disease o Added transverse myelitis o Modified Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine o Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL) o Added Osteopathic Manipulative medicine to conservative care therapy
June 2019	• Added: o new or worsening objective neuro deficits for chronic and acute back pain o CSF leak o last 6 months for allowable post op f/u period and removed EMG comment o red flags specifically for peds back pain and pain related to malignancy, infection, inflammation o new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain; o For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism o Myelopathy o Pre op for spinal cord stimulator o Evaluation of MS including NMO disorders and recurrent transverse myelitis o Back pain in cancer patients with known active cancer in tumors that tend to metastasize o Expanded on tethered cord in Other Indications for Imaging and added content on sacral dimple

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LUMBAR SPINE MRI**	**Original Date: September 1997**
CPT Codes: 72148, 72149, 72158, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_044	**Implementation Date: January 2023**

INDICATIONS FOR LUMBAR SPINE MRI

[+]If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- **Inconclusive or show a need for additional or follow up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient.**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits[1-4]

- With any of the following new neurological deficits documented on physical exam
    - Extremity muscular weakness (and not likely caused by plexopathy, or peripheral neuropathy)[5, 6]
    - Pathologic or abnormal reflexes
    - Absent/decreased sensory changes along a particular lumbar dermatome (nerve distribution): pin prick, touch, vibration, proprioception or temperature
    - Lower extremity increased muscle tone/spasticity
    - New onset bowel or bladder dysfunction (e.g., retention or incontinence)- not related to an inherent bowel or bladder process
    - Gait abnormalities (see Table 1 for more details)
    - New onset foot drop (Not related to a peripheral nerve injury, e.g., peroneal nerve)
- Cauda Equina Syndrome as evidence by severe back pain/sciatica along with one of the defined symptoms (see Overview section)

For evaluation of back pain with any of the following[7-16]

- With new or worsening objective neurologic deficits on exam, as above
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months[16]
- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a lumbar radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain.)[15]

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- Isolated back pain in pediatric population[17] – conservative care not required if red flags present
    - Red flags that prompt imaging should include the presence of: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; radicular pain; fever; weight loss; malaise; postural changes (e.g., kyphosis or scoliosis); and limp (or refusal to walk in a younger child <5yo) AND initial radiographs have been performed[18, 19]

As part of initial pre-operative / post-operative / procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion"[16, 20] and MRI for cord, nerve root compression, disc pathology or post-op infection)

- For preoperative evaluation/planning
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula))
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively [20, 21] - see neurological deficit section above
- When combo requests (see above statement[+]) are submitted (i.e., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously, i.e., the need for both soft tissue and bony anatomy is required[22]
    - Combination requests where both lumbar spine CT and MRI lumbar spine are both approvable (not an all-inclusive list)
        - Pathologic or complex fractures
        - Malignant process of spine with both bony and soft tissue involvement
        - Clearly documented indication for bony and soft tissue abnormality where assessment will change management for the patient

For evaluation of trauma or acute injury[23]

- Presents with any of the neurological deficits as above
- With progression or worsening of symptoms during the course of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis) (Both MRI and CT would be approvable) [24]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation

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("MRI and CT provide complementary information. When indicated it is appropriate to perform both examinations").[23]

Pars defect (spondylolysis) or spondylolisthesis

- Pars defect (spondylolysis) or spondylolisthesis in adults when Flexion/Extension x-rays show instability
- Clinically suspected Pars defect (spondylolysis) which is not seen on plain films in pediatric population (<18 yr) (flexion extension instability not required) and imaging would change treatment[25-27]

NOTE: Initial imaging (x-ray, or planar bone scan without SPECT; Bone scan with SPECT is superior to MRI and CT in the detection of pars intrarticularis pathology including spondylolysis).[28]

For evaluation of known or new compression fractures with worsening back pain[29]

- With history of malignancy
    - To aid in differentiation of benign osteoporotic fractures from metastatic disease
        - A follow up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher benign osteoporotic fracture from metastatic disease
- With an associated new focal neurologic deficit as above
- Prior to a planned surgery/intervention or if the results of the MRI will change management.

For evaluation of tumor, cancer, or metastasis with any of the following:
(MRI is usually the preferred study, but CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[30-32]

- **Primary tumor**
    - Initial staging or re-staging of a known primary spinal tumor[33]
    - Known primary tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
    - With an associated new focal neurologic deficit as above[34]

- **Metastatic tumor**
    - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
    - With an associated new focal neurologic deficit[34]
    - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine[35, 36]

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- **For evaluation of inconclusive/indeterminate finding on prior imaging that requires further clarification:**
    - One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam[36]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of known or suspected infection, abscess, or inflammatory disease[37, 38]

- **Infection**
    - As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[39]
    - Follow-up imaging of infection
        - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[40]
- **Spondyloarthropathies**
    - Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma[38]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

Other Indications for a Lumbar Spine MRI

(Note: See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[41-43]
- Known anorectal malformations[44, 45]
- Suspicious sacral dimple (those that are deep, larger than 0.5 cm, located within the superior portion of the gluteal crease or above the gluteal crease, multiple dimples, or associated with other cutaneous markers)[46] or duplicated or deviated gluteal cleft[47]
    - in patients ≤3 months should have ultrasound
- Toe walking in a child when associated with upper motor neuron signs, including hyperreflexia, spasticity; or orthopedic deformity with concern for spinal cord pathology (e.g., pes cavus, clawed toes, leg or foot length deformity (excluding tight heel cords))
- Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation.
- For follow-up/repeat evaluation of Arnold-Chiari I with new signs or symptoms suggesting recurrent spinal cord tethering (For initial diagnosis see below)

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- Suspected neuroinflammatory Conditions/Diseases (e.g**.,** sarcoidosis, Behcet's)
    - After detailed neurological exam and basic testing completed

COMBINATION OF STUDIES WITH LUMBAR SPINE MRI

Any combination of Cervical and/or Thoracic and/or Lumbar MRIs
Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

Exception- Indications for combination studies[48, 49]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
    - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[50-52] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
    - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[53]
    - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging
    - Scoliosis with any of the following[54]:
        - Progressive spinal deformity;
        - Neurologic deficit (new or unexplained);
        - Early onset;
        - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
        - Pre-operative planning; OR
        - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[55, 56]
    - Arnold-Chiari I
        - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[42, 50]
    - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
        - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele)
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[41-43] when anesthesia required for imaging[57] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)

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- Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (imaging also includes brain)- see Overview
    - Suspected leptomeningeal carcinomatosis (LC)[58] -see Overview
    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes - See Overview
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula))

BACKGROUND

Magnetic resonance imaging (MRI) is used in the evaluation, diagnosis, and management of spine-related conditions, e.g., degenerative disc disease, cauda equine compression, radiculopathy, infections, or cancer in the lumbar spine. MRI provides high quality multiplanar images of organs and structures within the body without the use of x-rays or radiation. In the lumbar area where gonadal exposure may occur, MRI's lack of radiation is an advantage.

OVERVIEW

Ankylosing Spondylitis/Spondyloarthropathies is a cause of back or sacroiliac pain of insidious onset (usually > 3 months), associated with morning stiffness not relieved with rest (usually age at onset < 40). It is associated with any of the following[59-62]:

- Sedimentation rate and/or C-reactive protein (not an essential criteria)
- HLA B27 (not an essential criteria)
- Non-diagnostic or indeterminate x-ray
- Personal or family history of sacroiliitis, peripheral inflammatory arthritis, and/or inflammatory bowel disease

***Conservative Therapy** – (Spine) should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or osteopathic manipulative medicine (OMT) or chiropractic care.

****Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy[10, 16]:

- Information provided on exercise prescription/plan; AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient

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inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).

- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Table 1: Gait and spine imaging[63-68]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI as per GL**

Infection, Abscess, or Inflammatory disease

- Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%)[69]
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

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MRI and Back Pain – MRI is the initial imaging modality of choice in the evaluation of complicated low back pain. Contrast administration may be used to evaluate suspected inflammatory disorders, e.g., discitis, and it is useful in evaluating suspected malignancy. Radiculopathy, disease of the nerve roots, is the most common indication for MRI of patients with low back pain. The nerve roots become irritated and inflamed, due to direct pressure from degenerative changes in the lumbar spine, creating pain and numbness. Symptoms of radiculopathy also include muscle weakness. MRI is indicated for this condition if the symptoms do not improve after conservative treatment over six weeks. MRI is also performed to evaluate cauda equina syndrome, severe spinal compression.

Table 2: MRI and Cutaneous Stigmata[70]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Atretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
‡LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

Sacral Dimples – Simple midline dimples are the most commonly encountered dorsal cutaneous stigmata in neonates and indicate low risk for spinal dysraphism. Only atypical dimples are associated with a high risk for spinal dysraphism, particularly those that are large (>5 mm), high on the back (>2.5 cm from the anus) or appear in combination with other lesions.[46] High-risk cutaneous stigmata in neonates include hemangiomas, upraised lesions (i.e., masses, tails, and hairy patches), and multiple cutaneous stigmata (Table 2).

Tethered spinal cord syndrome – This is a neurological disorder caused by tissue attachments that limit the movement of the spinal cord within the spinal column. Although this condition is rare, it can continue undiagnosed into adulthood. The primary cause is myelomeningocele and lipomyelomeningocele; the following are other associations that vary in severity of symptoms and treatment.

- Dermal sinus tract (a rare congenital deformity)

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- Diastematomyelia (split spinal cord)
- Lipoma
- Tumor
- Thickened/tight filum terminale
- History of spine trauma/surgery
- Arnold-Chiari malformation

Magnetic resonance imaging (MRI) can display the low level of the spinal cord and a thickened filum terminale, the thread-like extension of the spinal cord in the lower back. Treatment depends upon the underlying cause of the tethering. If the only abnormality is a thickened, shortened filum, then limited surgical treatment may suffice.

Spina Bifida Occulta[71]

- Called the hidden spina bifida, as the spinal cord and the nerves are usually normal and there is no opening on the skin on the back
- This subtype occurs in about 12% of the population, and the majority of people are not aware that they have spina bifida occulta unless it is discovered on an x-ray performed for an unrelated reason.
- Approximately 1 in 1,000 individuals can have an occult structural finding that leads to neurological deficits or disabilities as bowel or bladder dysfunction, back pain, leg weakness or scoliosis.

Back Pain with Cancer History – Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

"Neoplasms causing VCF (vertebral compression fractures) include: primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms."[29]

Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumors can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process.[35]

Cauda Equina Syndrome

- Symptoms include severe back pain or sciatica along with one or more of the following:
    - Saddle anesthesia - loss of sensation restricted to the area of the buttocks, perineum, and inner surfaces of the thighs (areas that would sit on a saddle)

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- Recent bladder/bowel dysfunction
- Achilles reflex absent on both sides
- Sexual dysfunction that can come on suddenly
- Absent anal reflex and bulbocavernosus reflex

MRI and Neurocutaneous Syndromes

- In NF-1, clinical evaluation appears to be more useful to detect complications than is screening imaging in asymptomatic patients. Imaging is indicated in evaluation of suspected tumors based on clinical evaluation and for follow-up of known intracranial tumors.[72]
- Conversely in NF-2, routine MR imaging screening is always indicated, given the high prevalence of CNS tumors, especially vestibular schwannomas. In patients with NF-2, routine screening brain/IAC imaging is indicated annually starting from age 10, if asymptomatic, or earlier with clinical signs/symptoms. Most individuals with NF2 eventually develop a spinal tumor, mostly commonly schwannomas, but meningioma and ependymomas are also seen. Spinal imaging at baseline and every 2 to 3 years is also advised with more frequent imaging, if warranted, based on sites of tumor involvement.[73]
- In patients with tuberous sclerosis, brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities.[74]
- In Von Hippel Lindau syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years.[75]
- In Sturge Weber Syndrome, brain MRI can rule out intracranial involvement only after age 1 and is recommended in patients <1 year only if symptomatic.[76]

Drop Metastases[77] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[78] – Leptomeningeal carcinomatosis is a complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, melanoma, gastrointestinal, and primary central nervous system tumors.

POLICY HISTORY

Date	Summary
March 2022	Added • Combination request for overlapping body part statement • Clarified muscle weakness not related to plexopathy or peripheral neuropathy • Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem

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	• Descriptions for tethered cord • Background section of Drop Metastases • Background section of Leptomeningeal Carcinomatosis • Clarified toe walking in pediatric patient • Added section on neuroinflammatory conditions Removed • Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section • Removed pediatric back pain from the total spine combination section
November 2021	• Added +0698T
April 2021	• Added/modified o Modified section on neurological deficits o Back pain in a child added/modified red flags o Gait table in background o Post-surgical modified/clarified surgical criteria for combination exams o Removed myelopathy combination studies o Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS o Modified known tumor imaging into primary and metastatic disease o Added toe walking for pediatric patients o Modified Combination exam wording
May 2020	• Added: o For evaluation of neurologic deficits added new deficits o Added ankylosing spondylitis for evaluation of trauma/acute injury o Added follow up of osteoperotic fracture from metastatic disease o Added Osteopathic Manipulative medicine to conservative care therapy o Added suspected leptomeningeal carcinomatosis to combination spine imaging o Modified Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine

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	○ Modified Pars fracture to not seen on radiograph and imaging would change management ○ Added spina bifida occulta to background section
June 2019	• Added: ○ new or worsening objective neuro deficits for chronic and acute back pain ○ CSF leak ○ last 6 months for allowable post op f/u period and removed EMG comment ○ red flags specifically for peds back pain and pain related to malignancy, infection, inflammation ○ new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain; ○ For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism • Expanded on tethered cord in Other Indications for imaging and added section on sacral dimple

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It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **SPINAL CANAL MRA/MRV**	**Original Date: May 2008**
CPT Codes: 72159	**Last Revised Date: May 2022**
Guideline Number: NIA_CG_046	**Implementation Date: January 2023**

INDICATIONS FOR SPINAL CANAL MAGNETIC RESONANCE ANGIOGRAPHY (MRA)

- For the evaluation of spinal arteriovenous malformation (AVM)[1-5]
- Myelopathy when the suspected etiology is a compromise of blood flow or drainage to the spinal cord[6,7]
- For the evaluation of a known cervical spine fracture, disc herniation, infection, or venous thrombosis where there is concern for vascular pathology (compression or thrombosis) compromising spinal cord blood flow or venous drainage[6,7]
- For the evaluation of known or suspected vertebral artery injury when there is also concern for vascular compromise to the spinal canal and its contents (otherwise neck MRA or CTA is sufficient to evaluate vertebral artery injury)[8,9]
- Preoperative evaluation (e.g., localization of the spinal arteries prior to complex spinal surgery, aortic aneurysm repair, or characterization of suspected vascular lesion of the spinal canal and its contents)[10-12]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.[2]

BACKGROUND

Application of spinal magnetic resonance angiography (MRA) allows for more effective and noninvasive screening for vascular lesions than magnetic resonance imaging (MRI) alone. It may improve characterization of normal and abnormal intradural vessels while maintaining good spatial resolution. Spinal MRA may be used for the evaluation of spinal arteriovenous malformations, as well as injuries to blood vessels supplying the spine and cord.

OVERVIEW

Spinal MR Angiography/MR Venography[13] - Typically, contrast-enhanced 3D time of flight techniques and contrast-enhanced CT angiography (CTA) are used for evaluation of the spinal arteries, veins, and related pathology as a non-invasive alternative to the gold standard catheter angiography. The detection rate of the Adamkiewicz artery (AKA) by MRA is in the

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range of 69-100%, but with modern equipment both MRA and CTA detection rates should approach 100%.[11] Magnetic resonance angiography is well suited to patients who cannot receive iodinated contrast and undergo CTA. CTA has the advantage over MRA of providing greater spatial resolution, can image the entire spine during one contrast bolus, and provides for a faster exam time that is less prone to motion artifact. MRA is limited by a finite field of view, typically ≤ 50 cm.[11] MRI has the advantage over CT of detecting areas of ischemia via diffusion weighted imaging. Mathur et al showed a 100% sensitivity in detecting recurrent spinal arteriovenous fistulas post-treatment.[2]

Spinal Arteriovenous Malformations (AVMs) – Spinal cord arteriovenous malformations are comprised of snarled tangles of arteries and veins that affect the spinal cord. They are fed by spinal cord arteries and drained by spinal cord veins. Spinal dural arteriovenous (AV) fistulas are the most encountered vascular malformation of the spinal cord and are a treatable cause of progressive paraparesis. Magnetic resonance angiography (MRA) can record the pattern and velocity of blood flow through vascular lesions as well as the flow of cerebrospinal fluid throughout the spinal cord. MRA can define the vascular malformation and may assist in determining treatment.[5]

Spinal Arteries/Veins - Vascular malformations, trauma, disc herniations, neoplasms, and coagulopathies or infection causing thrombosis can compromise the spinal cord blood supply and drainage. The spinal cord arterial supply is derived from the anterior spinal artery, posterolateral spinal artery, and the arteria radicularis magna or artery of Adamkiewicz (AKA). The anterior spinal artery supplies the anterior two-thirds of the cord and arises from the vertebral arteries. It receives contributions from the ascending cervical artery, the inferior thyroid artery, the intercostal arteries, the lumbar artery, the iliolumbar artery, lateral sacral arteries, and the AKA. The AKA arises on the left side of the aorta between the T8 and L1 segments, to anastomose with the anterior spinal artery and supply the lower two-thirds of the spinal cord. Two posterolateral spinal arteries arise from the posteroinferior cerebellar arteries and supply the posterior third (posterior columns, posterior roots, and dorsal horns) of the spinal cord. The spinal venous system is divided into intrinsic and extrinsic veins differentiated by their location within the spinal canal or extrinsic to the canal, respectively. They drain into the radiculomedullary veins, subsequently to paravertebral and intervertebral plexuses, then to the segmental veins that eventually drain into the ascending lumbar veins, azygos system, and pelvic venous plexuses.[6]

POLICY HISTORY

Date	Summary
May 2022	Updated references
February 2021	Updated background information and references
May 2020	• Reordered indications and background information • Updated references
June 2019	Updated background information and references

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National Imaging Associates, Inc.*	
Clinical guidelines **PELVIS CTA (Angiography)**	**Original Date: July 2008**
CPT Codes: 72191	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_038	**Implementation Date: January 2023**

INDICATIONS FOR PELVIS CT Angiography / CT Venography (CTA/CTV) - when both the abdomen and pelvis are involved (or suspected to be), should be ordered as Abdomen/Pelvis CTA (CPT Code: 74174)

For evaluation of known or suspected vascular disease[1]

- For pelvic extent of known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, arteriovenous malformations (AVMs), fistulas, intramural hematoma, and vasculitis
- Evidence of vascular abnormality seen on prior imaging studies
- For suspected pelvic extent of aortic dissection
- Evaluation of known or suspected aneurysms limited to the pelvis or in evaluating pelvic extent of aortic aneurysm[2-4]
    - Known or suspected iliac artery aneurysm **AND** equivocal or indeterminate Doppler ultrasound results
    - If repeat Doppler ultrasound is indeterminate
    - Suspected complications of known aneurysm as evidenced by clinical findings such as new onset of pelvic pain
- Follow-up of iliac artery aneurysm:
    - Every three years for diameter 2.0 – 2.9 cm
    - Annually for 3.0-3.4 cm if Doppler ultrasound is inconclusive
    - If > 3.5 cm, < six-month follow-up (and consider intervention)[4]
- Suspected retroperitoneal hematoma or hemorrhage: to determine vascular source of hemorrhage, in setting of trauma, tumor invasion, fistula or vasculitis, otherwise CT/MR abdomen and pelvis (rather than CTA/MRA) may be sufficient and the modality of choice for diagnosing hemorrhage[5]
- For evaluation of suspected pelvic vascular disease or pelvic congestive syndrome when findings on ultrasound are indeterminate (MR or CT venography may be used as the initial study for pelvic thrombosis or thrombophlebitis)[6, 7]
- For evaluation of venous thrombosis in the inferior vena cava[8]

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- Venous thrombosis if previous studies have not resulted in a clear diagnosis[9]
- Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate)[10, 11]
- For evaluation of suspected mesenteric ischemia/ischemic colitis (can approve CTA/MRA abdomen and pelvis)[12]

Other vascular indications

- For suspected May-Thurner Syndrome (iliac vein compression syndrome) (can include abdomen CTA)[13, 14]
- Lower gastrointestinal hemorrhage: Active bleeding in a hemodynamically stable patient or non-localized intermittent bleeding as an alternative to Tc-99m RBC scan when colonoscopy did not localize the bleeding, is contraindicated, or unavailable[15, 16]
- For evaluation of erectile dysfunction when a vascular cause is suspected and Doppler ultrasound is inconclusive[17]
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis[18] so should be Abdomen/Pelvis CTA (CPT 74174)
- For patients with vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time vascular study of the abdomen and pelvis so should be Abdomen/Pelvis CTA (CPT 74174)
- For Loeys-Dietz vascular imaging every two years (include abdomen CTA)[19]
- For spontaneous coronary artery dissection (SCAT) at time of coronary arteriography (includes CTA abdomen)[20] so should be Abdomen/Pelvis CTA (CPT 74174)

Pre-operative evaluation[21, 22]

- Evaluation of interventional vascular procedures prior to endovascular aneurysm repair (EVAR), or for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Imaging of the deep inferior epigastric arteries for surgical planning (breast reconstruction surgery) include abdomen CTA/MRA[22]
- Prior to uterine artery embolization for fibroids (MRA preferred)[23]

Post-operative or post-procedural evaluation

- Evaluation of post-operative complications of renal transplant allograft[24]
- Evaluation of endovascular/interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Evaluation of post-operative complications, e.g., pseudoaneurysms related to surgical bypass grafts, vascular stents, and stent-grafts in the pelvis
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA) and iliac artery aneurysms typically needs to include abdominal imaging, therefore Abdomen Pelvis CTA would usually be the appropriate study

Chest CTA and Abdomen CTA or Abdomen/Pelvis CTA combo

- For evaluation of extensive vascular disease involving the chest and abdominal cavities

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- For preoperative or preprocedural evaluation, such as TAVR (transcatheter aortic valve replacement) or transcatheter venous ablation[21, 25]
- Acute aortic dissection[26]
- Takayasu's arteritis[27]
- Marfan syndrome
- Loeys-Dietz syndrome
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post-operative complications[28, 29]
- Significant post-traumatic or post-procedural vascular complications

IMPORTANT NOTE: When encountering requests for Abd/Pelvis CTA & Lower Extremity CTA (Runoff) requests, these should be Abdominal Arteries CTA. Only one authorization request is required, using CPT Code 75635. This study provides for imaging of the abdomen, pelvis, and both legs and is the noninvasive equivalent to an "aortogram and run-off".

BACKGROUND

Computed tomographic angiography (CTA) is used in the evaluation of many conditions affecting the veins and arteries of the pelvis or lower extremities. It is not appropriate as a screening tool for asymptomatic patients without a previous diagnosis.

OVERVIEW

CT/MRI and acute hemorrhage: MRI is not indicated and MRA/MRV (MR Angiography/Venography) is rarely indicated for evaluation of intraperitoneal or retroperitoneal hemorrhage, particularly in the acute setting. **CT is the study of choice** due to its availability, speed of the study and less susceptibility to artifact from patient motion. Advances in technology have allowed conventional CT to not just detect hematomas but also the source of acute vascular extravasation. In special cases, finer vascular detail to assess the specific source vessel responsible for hemorrhage may require the use of CTA. CTA in diagnosis of lower gastrointestinal bleeding is such an example.[15]

MRA/MRV is often utilized in non-acute situations to assess vascular structure involved in atherosclerotic disease and its complications, vasculitis, venous thrombosis, vascular congestion, or tumor invasion. Although some of these conditions may be associated with hemorrhage, it is usually not the primary reason why MRI/MRA/MRV is selected for the evaluation. A special condition where MRI may be superior to CT for evaluating hemorrhage is to detect an underlying neoplasm as the cause of bleeding.[30]

Follow-up of asymptomatic, incidentally detected iliac artery aneurysms: The definition of an iliac artery aneurysm (IAA) is dilatation to more than 1.5 times its normal diameter; in general, a common iliac artery ≥18 mm in men and ≥15 mm in women; an internal iliac artery (IIA) > 8

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mm is considered aneurysmal. Four types of isolated iliac aneurysms are classified by Reber. Suggested surveillance is extrapolated from AAA surveillance and can be done by Doppler ultrasound or CTA if hard to visualize by ultrasound.[4, 31]

POLICY HISTORY

Date	Summary
April 2022	• Removed follow-up intervals for EVAR and AAA since Abdomen Pelvis CTA is usually appropriate study
April 2021	• No substantial changes
May 2020	• Added important note for runoff requests and authorizations • Added note that abdominal CTA can be added when indicated • Removed iliac artery aneurysm size restriction of >2.5cm in diameter and changed to 'if repeat Doppler US is indeterminate • For retroperitoneal hematoma or hemorrhage, specified 'when an underlying neoplasm is suspected and prior imaging is inconclusive' • Added pelvic congestive syndrome; suspected May-Thurner Syndrome; erectile dysfunction when vascular cause is suspected and Doppler US inconclusive; post-operative complications of renal transplant allograft • Modified combo study from 'Chest CTA/Pelvis CTA' to 'Chest CTA and Abdomen CTA or Abdomen/Pelvis CTA combo' • Updated background information and references
June 2019	• Added evaluation of FMD, Vascular Ehlers-Danlos syndrome, Loetz-Dietz and SCAD • Added uterine artery embolization • Added combo studies

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guideline **PELVIS CT**	**Original Date: September 1997**
CPT Codes: 72192, 72193, 72194	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_036	**Implementation Date: January 2023**

Note: For syndromes for which imaging starts in the pediatric age group, MRI preferred

Note: PELVIS CT **ALONE** SHOULD ONLY BE APPROVED WHEN DISEASE PROCESS IS SUSPECTED TO BE LIMITED TO THE PELVIS. CT Abdomen/Pelvis Combo (CPT Codes: 74176, 74177, 74178) is the correct study when the indication(s) include both the abdomen AND pelvis, such as CTU (CT Urography), CTE (CT Enterograpy), acute abdominal pain, widespread inflammatory disease or neoplasm. Otherwise, the exam should be limited to the appropriate area (i.e., Abdomen OR Pelvis) which includes the specific organ, area of known disease/abnormality or the area of concern.

INDICATIONS FOR PELVIS CT

Pelvic Pain for Unknown Etiology

- CT allowed after initial workup is inconclusive and must include results of the following:
    - Initial imaging, such as ultrasound (although ultrasound does have limitations, it is a common misconception that ultrasound is not a good tool in ALL obese patients, such that it is often useful even in obese patients and quite reasonable to attempt as a first-line imaging modality particularly given the benefit of no radiation), scope study, or x-ray AND
    - Appropriate laboratory testing (chemistry profile, complete blood count, and urinalysis)
- For acute pelvic pain in a patient over the age of 65[1, 2]

Initial staging of prostate cancer

- High Risk and above (T3a or higher, PSA >20*, Gleason 8-10)
- Intermediate Risk (T2b-T2c or PSA 10-20* or Gleason 7) when Nomogram predicts >10% probability of lymph node involvement (MSKCC/Kattan is the nomogram recommended by NCCN 2022)[3]

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*Note: In patients who have been on a 5-alpha reductase inhibitor (such as proscar) in the past 12 months, an "adjusted PSA" should be used. To adjust, multiply PSA by a factor of 2 (e.g., PSA 6 on finasteride adjusts to a PSA of 12)

Known prostate cancer for workup of recurrence and response to treatment when there is a contraindication for MRI[4]

- Initial treatment by radical prostatectomy
    - Failure of PSA to fall to undetectable levels or PSA detectable and rising on at least 2 subsequent determinations
- Initial treatment radiation therapy
    - Post-RT rising PSA or positive digital exam and is candidate for local therapy

Evaluation of suspicious or known mass/tumors

- Initial evaluation of suspicious pelvic masses/tumors found only in the pelvis by physical exam and ultrasound has been performed
- Further evaluation of abnormality seen on ultrasound (US) or when US would be inconclusive[5]
- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the pelvis. No further surveillance CT unless tumor(s) are specified as highly suspicious or change was found on exam or last follow-up imaging
- Initial staging of known cancer
- Follow-up of known cancer[4, 6]
    - Follow-up of known cancer of patient undergoing active treatment within the past year.
        - Known cancer with suspected pelvis metastasis based on a sign, symptom (e.g., anorexia, early satiety, intestinal obstruction, night sweats, pelvic pain, weight loss, vaginal bleeding), or an abnormal lab value (alpha-fetoprotein, CEA, CA 19-9, p53 mutation)
- For abnormal incidental pelvic lymph nodes when follow-up is recommended based on prior imaging (initial 3-month follow-up)[7]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases

- < 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of suspected infection or inflammatory disease[8, 9]

- Suspected perianal fistula or occult anorectal abscess (MRI preferred)[10-12]
- Suspected infection in the pelvis (based on elevated WBC, fever, anorexia, or nausea and vomiting)
- CT cystourethrography (CTCUG) in the preoperative setting[13]

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- For suspected urethral stricture or periurethral pathology only if MRI cannot be done[14, 15]

For evaluation of known infection or inflammatory disease follow-up[16]
- Any known infection to have created an abscess in the pelvis that requires re-evaluation
- Any history of fistula limited to the pelvis that requires re-evaluation or is suspected to have recurred
- For patients with recurrent fistula in anal or perianal Crohn's disease (MRI preferred)[12]
- Abnormal fluid collection seen on prior imaging that needs follow-up evaluation and limited to the pelvis

For evaluation of suspected inflammatory bowel disease or follow-up (includes CT enterography and can also approve abdomen CT/CTE)
- For suspected inflammatory bowel disease (Crohn's disease or ulcerative colitis) with abdominal pain **AND** one of the following[16-18]:
    - Chronic diarrhea
    - Bloody diarrhea

  Note: For patients under 35 years old, consider MRE
- High clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy[16-19]
- For CT enterography (CTE), if CT or MRI of the abdomen and pelvis are inconclusive
- Known inflammatory bowel disease (Crohn's or ulcerative colitis) with signs/symptoms (e.g., abdominal pain, diarrhea, or hematochezia) requiring re-evaluation or for monitoring therapy[16]

For suspected or known hernia
- For pelvic pain due to a suspected occult, spigelian, or incisional hernia when physical exam and prior imaging are non-diagnostic or equivocal or if requested as a preoperative study
- For confirming the diagnosis of a recurrent hernia when ultrasound is negative or non-diagnostic
- Hernia with suspected complications (e.g., bowel obstruction or strangulation, or non-reducible) based on symptoms (e.g., diarrhea, hematochezia, vomiting, severe pain), physical exam (guarding, rebound) or prior imaging[20]

For evaluation of known or suspected vascular disease (e.g., aneurysms, hematomas)[21, 22]
NOTE: CT/MRI should not be approvable without a contraindication to CTAngiography /MRAngiography, such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI (rather than CTA/MRA) is preferred
- Evidence of vascular abnormality identified on imaging studies and limited to the pelvis
- Evaluation of suspected or known aneurysms limited to the pelvis or in evaluating pelvic extent of aortic aneurysm
    - Known or suspected iliac artery aneurysm > 2.5 cm AND equivocal or indeterminate ultrasound results

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    - Prior imaging (e.g., ultrasound) demonstrating iliac artery aneurysm > 2.5 cm in diameter
    - Suspected complications of known aneurysm as evidenced by clinical findings, such as new onset of pelvic pain
    - Follow-up of iliac artery aneurysm (CTA preferred): Every three years for diameter 2.0-2.9 cm and annually for 3.0-3.4 cm. If > 3.5 cm, < six-month follow-up (and consider intervention)[23]
- Scheduled follow-up evaluation of aorto/iliac endograft or stent
    - Routine, baseline study (post-op/intervention) is warranted within 1-3 months[24]
    - Asymptomatic at six (6)-month intervals, for one (1) year, then annually
    - Symptomatic/complications related to stent graft – more frequent imaging may be needed

Musculoskeletal Indications

- Known or suspected aseptic/avascular necrosis of hip(s) and MRI is contraindicated after completion of initial x-ray[25]
- Sacroiliitis (infectious or inflammatory, such as Ankylosing Spondylitis/Spondyloarthropathies) with non-diagnostic or indeterminate x-ray and rheumatology workup and MRI is contraindicated[26-28]
- Sacroiliac joint dysfunction and MRI contraindicated when there is:
    - Persistent back and/or sacral pain unresponsive to four (4) weeks of conservative treatment, received within the past six (6) months, including physical therapy or physician-supervised home exercise plan (HEP)

For evaluation of trauma[29]

- For evaluation of trauma with lab or physical findings of pelvic bleeding
- For evaluation of physical or radiological evidence of complex or occult pelvic fracture or for pre-operative planning of complex pelvic fractures

Other Indications for Pelvic CT:

- For assessment of pelvic congestion syndrome when findings on ultrasound are indeterminate (CTA/MRA preferred)[30]
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound[31]
- For evaluation of suspected May-Thurner syndrome (CTV/MRV preferred)[32]
- For further evaluation of an isolated right varicocele with additional signs and symptoms (e.g., jaundice, lymphadenopathy, night sweats or weight loss) that suggest malignancy or suspicious prior imaging[33]
- To provide an alternative to initial or follow-up of an indeterminate or inconclusive finding on ultrasound and MRI cannot be performed
- To locate an intrauterine device after ultrasound and plain x-ray are equivocal or non-diagnostic (imaging of the abdomen may also be indicated)[34, 35]
- For diagnosis or to guide treatment of urachal anomalies when ultrasound is non-diagnostic[36, 37]

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Pre-operative evaluation

- For diagnostic purposes prior to pelvic surgery or procedure

For post-operative/procedural evaluation

- Follow-up of known or suspected post-operative complication involving the hips or the pelvis[38, 39] within six months
- A follow-up study to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed

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BACKGROUND

CT provides direct visualization of anatomic structures in the abdomen and pelvis and is a fast imaging tool used to detect and characterize disease involving the abdomen and pelvis. Pelvic imaging begins at the iliac crests through pubic symphysis. It has an ability to demonstrate abnormal calcifications or fluid/gas patterns in the viscera or peritoneal space.

In general, ionizing radiation from CT should be avoided during pregnancy. Ultrasound is clearly a safer imaging option and is the first imaging test of choice; although, CT after equivocal ultrasound has been validated for diagnosis. Clinicians should exercise increased caution with CT imaging in children, pregnant women, and young adults due to the risks of exposure to ionizing radiation. Screening for pregnancy as part of a work-up is suggested to minimize the number of unexpected radiation exposures for women of childbearing age.

OVERVIEW

***Conservative Therapy**: This should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program** - **(HEP)/Therapy:** the following elements are required to meet guidelines for completion of conservative therapy[40]:

- Information provided on exercise prescription/plan AND
- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 4 week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).

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- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Ultrasound should be considered prior to a request for Pelvis CT for the following:
- Initial evaluation or follow-up of ovarian mass or abnormal physical finding

Combination request of Abdomen CT/Chest CT - A Chest CT will produce images to the level of L3. Documentation for combo is required.

Helical CT of Prostate Cancer – Conventional CT is not useful in detecting prostate cancer as it does not allow direct visualization. Contrast-enhanced MRI is more useful in detecting prostate cancer. MRI is recommended in patients with suspected cancer but prior negative biopsy because MRI alone can miss up to 26% of clinically significant cancers that would be detected on systemic biopsy.[41] Helical CT of the prostate may be a useful alternative to MRI in patients with an increasing PSA level and negative findings on biopsy but is not the imaging study of choice.

Pelvic Trauma and CT Imaging – Helical CT is useful in the evaluation of low- or high-flow vascular injuries in patient with blunt or penetrating pelvic trauma. It provides detailing of fractures and position of fracture fragments along with the extent of diastasis of the sacroiliac joints and pubic symphysis. CT helps determine whether pelvic bleeding is present and can identify the source of bleeding. With CT, high flow hemorrhage can be distinguished from low flow hemorrhage aiding the proper treatment.

Imaging of hernias – Most hernias are diagnosed clinically with imaging recommended for the diagnosis of occult hernias or in the evaluation of hernia complications, such as bowel obstruction or strangulation. Groin hernias are at increased risk for incarceration/strangulation in women, right femoral hernias, and when there is a hernia-related hospitalization in the year preceding hernia repair. Morbidity and mortality are increased for strangulated hernias in patients over 65, prolonged symptoms, incarceration of over 24 hours, symptoms of > 3 days, bowel obstruction, anticoagulant use.[42] To detect occult hernias, ultrasound is a first-line study with a sensitivity of 86% and specificity of 77% compared to 80% sensitivity and 65% specificity for CT.[43] According to Miller et al, "Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias…".[44] Based on this analysis MRI is recommended only when ultrasound and CT have been performed and fail to make a diagnosis.

POLICY HISTORY

Date	Summary
April 2022	• Added abnormal incidental pelvic lymph nodes when follow-up is recommended based on prior imaging (initial 3-month follow-up) to "Evaluation of suspicious or known mass/tumors" • Within sacroiliitis, clarification of non-diagnostic or indeterminate findings

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April 2021	• Updated prostate cancer imaging section to reflect current NCCN 2021 changes and adjusted PSA
May 2020	• Perianal fistula or abscess (MR preferred) • CT cystourethrography for pre op • Urethral stricture (MR preferred) • IBD for CTE • Hernia section • Pelvic congestion syndrome • To find an IUD after other studies completed • Urachal anomalies • Added for diffuse LE edema with neg or inconclusive US • May-Thurner • LE edema and isolated right varicocele • Updated background section
June 2019	• Changed PSA levels from ≥ 20 ng/mL to ≥ 10 ng/mL or clinically advanced disease (T2b, T2c, T3, or T4) AND nomogram per NCCN; deleted Gleason score • Modified guideline to align with abdomen pelvis CT guideline • Added 'routine, baseline study (post-op/intervention) is warranted within 1-3 months for scheduled f/u evaluation of aorto/iliac endograft or stent • Specified pelvic pain by adding subacute or chronic • Added: o to provide an alternative to initial or f/u of an indeterminate or inconclusive finding on US and MRI cannot be performed o suspected perianal fistula; o hernia with suspected complications • Added 'within 6 months' time specification for f/u of known or suspected post-operative complication involving hips or pelvis • Updated background information and references

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **PELVIS MRI**	**Original Date: September 1997**
CPT Codes: 72195, 72196, 72197, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_037	**Implementation Date: January 2023**

Note: There is no MRI Abdomen/Pelvis combo (comparable to a CT Abdomen/Pelvis) such that if imaging of both the abdomen and pelvis are indicated, two separate exams (and authorization) are required (i.e., MRI Abdomen and MRI Pelvis)

INDICATIONS FOR PELVIC MRI (Click here for Fetal MRI indications)

Initial pelvic imaging for staging of prostate cancer

- High Risk and above (T3a or higher, PSA >20*, Gleason 8-10)
- Intermediate Risk (T2b-T2c or PSA 10-20* or Gleason 7) when Nomogram predicts >10% probability of lymph node involvement (MSKCC/Kattan is the nomogram recommended by NCCN 2021)[1]

*In patients who have been on a 5-alpha reductase inhibitor (such as Proscar) in the past 12 months, an "adjusted PSA" should be used. To adjust, multiply PSA by a factor of 2 (i.e., PSA 6 on finasteride adjusts to a PSA of 12)

Known prostate cancer for workup of recurrence and response to treatment[1, 2]

- Initial treatment by active surveillance (asymptomatic very low, low, or intermediate risk with expected patient survival ≥ 10 years):
  - Initial multiparametric MRI (mpMRI) for patients who chose active surveillance
  - mpMRI to be repeated no more than every 12 months unless clinically indicated
- Initial treatment by radical prostatectomy:
  - Failure of PSA to fall to undetectable level or PSA detectable and rising on at least 2 subsequent determinations
- Initial treatment radiation therapy:
  - Post-radiation therapy (Post-RT) rising PSA or positive digital exam and is candidate for local therapy

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Indication for prostate MRI (suspected prostate cancer)[1, 3-8]

- Prior to prostate biopsy when notes indicate that biopsy is planned[9]
- In individuals with previous negative biopsy and ongoing concerns of increased risk of prostate cancer (i.e., rising or persistent elevated PSA with lab reports on 2 or more separate days OR suspicious digital rectal exam (DRE))
- When the MRI is requested to potentially avoid a prostate biopsy:
    - If there are risk factors/comorbidities associated with the biopsy, AND there is intent to biopsy if a high-risk lesion is seen on MRI prostate OR
    - If a thorough risk assessment has been done and the patient is considered low risk for cancer AND the PIRADS classification would be used to help risk stratify the patient before making a final decision on biopsy. (Typically, this risk assessment would be done by the person performing the biopsy (i.e., urologist) and imaging done at the facility where the fusion biopsy would be performed should a higher risk lesion be identified.)

Evaluation of suspicious or known mass/tumors for further evaluation of indeterminate or questionable findings

- Initial evaluation of suspicious pelvic masses/tumors found only in the pelvis by physical exam or imaging study, such as ultrasound (US), or CT[1]
- Further evaluation of abnormality seen on ultrasound (US) or when US is inconclusive[10]
- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the pelvis. No further surveillance MR unless tumor(s) is/are specified as highly suspicious or change was found on exam or last follow-up imaging.
- Initial staging of known cancer
- Follow-up of known cancer[2, 11]:
    - Of patient undergoing active treatment within the past year
    - With suspected pelvic metastasis based on a sign, symptom, (e.g., anorexia, early satiety, intestinal obstruction, night sweats, pelvic pain, weight loss, vaginal bleeding) or an abnormal lab value (alpha-fetoprotein, CEA, CA 19-9, p53 mutation)
- For abnormal incidental pelvic lymph nodes when follow-up is recommended based on prior imaging (initial 3-month follow-up)[3]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

For evaluation of suspected infection or inflammatory disease after preliminary imaging (such as CT, US, or nuclear medicine) has been performed or is contraindicated (includes MR urography (MRU) which includes abdomen MRI when indicated)[10, 12-14]

- Suspected perianal fistula

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- Suspected infection (based on elevated WBC, fever, anorexia, or nausea and vomiting) in the pelvis
- For suspected urethral stricture or periurethral pathology[15]
- Suspected peritonitis (would typically need to include MRI Abdomen), abdominal pain and tenderness to palpation is present, and at LEAST one of the following:
    - Rebound, guarding or rigid abdomen, OR
    - Severe tenderness to palpation over the entire abdomen
- Complications of diverticulitis with severe abdominal pain or severe tenderness or mass, not responding to antibiotic treatment (prior imaging study is not required for diverticulitis diagnosis)

For evaluation of known infection or inflammatory disease follow-up[13, 16, 17]

- Any known infection that is clinically suspected to have created an abscess in the pelvis and preliminary imaging has been performed or is contraindicated
- Any history of fistula limited to the pelvis that requires re-evaluation or is suspected to have recurred
- For patients with recurrent fistula-in-ano or perianal Crohn's disease
- Abnormal fluid collection seen on prior imaging that needs follow-up evaluation and is limited to the pelvis

For evaluation of suspected inflammatory bowel disease or follow-up (includes MR enterography and can also approve Abdomen MRI/MRE)

- For suspected inflammatory bowel disease (Crohn's disease or ulcerative colitis) with abdominal pain **AND** one of the following[17-19]:
    - Chronic diarrhea
    - Bloody diarrhea
- High clinical suspicion after complete work-up including physical exam, labs, endoscopy with biopsy[17-20]
- Known inflammatory bowel disease (Crohn's or ulcerative colitis) with signs/symptoms (e.g., abdominal pain, diarrhea, or hematochezia) requiring re-evaluation, or for monitoring therapy[17]

For suspected or known hernia

- For pelvic pain due to a suspected occult, spigelian, or incisional hernia when physical exam and prior imaging (ultrasound AND CT) are non-diagnostic or equivocal[21-24] and limited to the pelvis
- Hernia with suspected complications, such as strangulation or incarceration, based on physical exam (guarding, rebound) or prior imaging[25] (CT preferred)
- Suspected athletic pubalgia (sports hernia) in a patient with persistent groin pain that occurs with exertion, who has not responded to conservative treatment for four weeks, when other imaging is inconclusive[26, 27]

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Indications for Musculoskeletal Pelvic MRI

- Initial evaluation of suspicious mass/tumor of the bones, muscles or soft tissues of the pelvis found on an imaging study, and needing clarification, or found by physical exam and after x-ray or ultrasound is completed
- Evaluation of suspected fracture and/or injury when initial imaging is completed or for confirmed stress (fatigue) fracture for "return to play" evaluation[28]
- For evaluation of known or suspected aseptic/avascular necrosis of hip(s) after completion of initial x-ray[29]
- Known or suspected sacroiliitis (infectious or inflammatory) after abnormal x-ray[30]
- Sacroiliac Joint Dysfunction (after initial X-ray) when there is[30]:
    - Persistent back and/or sacral pain unresponsive to four (4) weeks of conservative treatment, received within the past six (6) months, including physical therapy or physician supervised home exercise plan (HEP)
- For evaluating the lumbosacral plexus[31, 32]:
    - To confirm involvement in symptomatic patients with known tumor
    - To assess extent of injuries in the setting of pelvic trauma
    - To exclude the presence of masses in patients with unilateral changes, or inconclusive or abnormal findings on EMG when there are persistent symptoms
    - For evaluation when lumbar spine MRI is suspicious or indeterminate
- For suspicion of pudendal neuralgia in the setting of chronic pelvic pain with genital numbness and erectile dysfunction when other causes have been ruled out (see Background regarding diagnosis)[33]
- For suspicion of meralgia paresthetica when prior testing is inconclusive (diagnostic nerve block; electrodiagnostic testing; AND somatosensory evoked potentials)[34, 35]
- Persistent Pain:
    - For evaluation of persistent pain unresponsive to four (4) weeks of conservative treatment received within the past six (6) months
    - For suspected piriformis syndrome after failure of 4 weeks conservative treatment[36]
- For further evaluation of congenital anomalies of the sacrum and pelvis and initial imaging has been performed

Other Indications for a Pelvic MRI

- Pelvic pain not explained by previous imaging/preprocedure[37]
    - Appropriate laboratory testing (chemistry profile, complete blood count, and urinalysis) and initial imaging, such as ultrasound
- For B symptoms of fevers more than 101 F, drenching night sweats, or unexplained weight loss of more than 10% of body weight over 6 months when CT is inconclusive or cannot be completed (can approve abdomen MRI, too, when appropriate)
- For location or evaluation of undescended testes in adults and in children, including determination of location of testes, if ordered by a specialist[38]
- For evaluation and characterization of uterine and adnexal masses, (e.g., fibroids, ovaries, tubes, and uterine ligaments) or congenital uterine or renal abnormality where ultrasound has been done previously[37]

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- For evaluation of abnormal uterine bleeding when ultrasound findings are indeterminate[39]
    - Age ≤ 50 – Vascular stalk or focal doppler signal on US
    - Age > 50 – Thickened endometrium, vascular stalk or focal doppler signal on US
- For evaluation of uterus prior to and after embolization (MRA preferred)[40]
- For evaluation of endometriosis when preliminary imaging has been completed or to follow up known endometriosis[41, 42]
- For further evaluation of suspected adenomyosis when ultrasound is inconclusive,[43] such as the following:
    - Uterine abnormality on US
        - Anechoic spaces/cysts in myometrium
        - Heterogeneous echotexture
        - Obscured endometrial/myometrial border
        - Sub-endometrial echogenic linear striations
        - Thickening of the transition zone
        - Uterine enlargement
        - Uterine wall thickening
- Prior to uterine surgery if there is abnormality suspected on prior ultrasound
- For suspected placenta accreta or percreta when ultrasound is indeterminate[44]
- For further assessment of a scrotal or penile mass when ultrasound is inconclusive[45, 46]
- For investigation of a malfunctioning penile prosthesis
- Suspected urethral diverticula and other imaging is inconclusive[47]
  (MRI may be indicated without prior ultrasound in limited situations as suggested, such as when there is compelling evidence suggestive of urethral diverticulum (i.e., ostia on cystoscopy or tender cystic lesion on anterior vaginal wall overlying the urethra) or for surgical planning.)
- For suspected pelvic congestion syndrome in women with chronic pelvic pain when other imaging is non-diagnostic[48]
- For suspected patent urachus or other urachal abnormalities when ultrasound is non-diagnostic[49, 50]
- MR defecography for suspected structural cause of defecatory outlet obstruction to confirm diagnosis if other testing is equivocal (anorectal manometry and balloon expulsion testing)[51]
- For evaluation of enlargement of organ abnormality seen on previous imaging - to provide an alternative to an indeterminate or inconclusive ultrasound
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound
- For May-Thurner syndrome (MRV preferred)
- For further evaluation of an isolated right varicocele with additional signs and symptoms that suggest malignancy or suspicious prior imaging findings[52]
- Surveillance MRI (include abdomen) every 2-3 years for patients with Hereditary Paraganglioma syndromes Type 1-5[53]
- In hematospermia in men over 40, if transrectal ultrasound is negative or inconclusive[54]

Pre-operative evaluation

- For diagnostic purposes prior to pelvic surgery or procedure

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Post-operative/procedural evaluation

- Follow-up of known or suspected post-operative complication involving the hips or the pelvis[55, 56] within six months
- A follow-up study to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed.

Note: If an Abdomen/Pelvis MRI is indicated and the Abdomen MRI has already been approved, then the Pelvis MRI may be approved.

Fetal MRI (CPT codes 74712-74713) - To better define or confirm a known for suspected abnormality of the fetus after ultrasound has been performed during the second trimester[57] or when fetal surgery is planned and/or to make a decision about therapy, delivery or to advise the family about prognosis.[58] Also includes evaluation of the maternal pelvis and placenta.

BACKGROUND

Magnetic resonance imaging of the pelvis is a noninvasive technique for the evaluation, assessment of severity, and follow-up of diseases of the male and female pelvic organs. MRI provides excellent contrast of soft tissues and provides multiplanar and 3D depiction of pathology and anatomy. Patients undergoing MRI do not have exposure to ionizing radiation or iodinated contrast materials. MRI techniques utilize body coils to image the entire pelvis or endoluminal coils for evaluation of the rectum, prostate, and genitourinary system.

OVERVIEW

PI-RADS Assessment Categories for Prostate Cancer[59]:

The assignment of a PI-RADS category is based on mpMRI findings only and does not incorporate other factors, including PSA testing, DRE (digital rectal exam), or clinical history.

PIRADS 1 – Very low (clinically significant cancer is highly unlikely to be present)
PIRADS 2 – Low (clinically significant cancer is unlikely to be present)
PIRADS 3 – Intermediate (the presence of clinically significant cancer is equivocal)
PIRADS 4 – High (clinically significant cancer is likely to be present)
PIRADS 5 – Very high (clinically significant cancer is highly likely to be present)

***Conservative Therapy** – Conservative therapy should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and

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diathermy can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy[60, 61]:

- Information provided on exercise prescription/plan AND
- Follow up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 4-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).
- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

MRI and Undescended Testes – The most common genital malformation in boys is undescended testis. In one series, 70% of undescended testes are palpable. Despite the advances in ultrasound technology, ultrasound cannot reliably identify intra-abdominal testes, which comprise 20% of all undescended testes.[62] The timely management of undescended testis is important to potentially minimize the risk of infertility and lessen the risk of malignancy. MRI is used as a diagnostic tool in the detection of undescended testes and can reveal information for both anatomic and tissue characterization. It is noninvasive, non-ionizing, and can obtain multiplanar images.

MRI and Adnexal Masses – MRI is used in the evaluation of adnexal masses. It can identify and characterize different neoplastic and nonneoplastic abnormalities, e.g., exophytic leiomyoma, endometrioma, dermoid cyst, and ovarian edema. It is a useful adjunct when sonography is inconclusive in the evaluation of adnexal masses.

MRI and Endometriosis – MRI manifestations of endometriosis vary including endometrioma, peritoneal endometrial implant, adhesion, and other rare features. The data obtained from imaging must be combined with clinical data to perform preoperative assessment of endometriosis.

MRI and Lumbosacral Plexopathy – Complete lumbar (L1-L4) or sacral plexopathy (L5-S3) may present with weakness, sensory loss, and flaccid loss of tendon reflexes. Clinical diagnosis is confirmed by EMG. Acute and chronic plexopathies may be caused by nerve sheath tumors; infectious, autoimmune, hereditary, or idiopathic neuropathies; extrinsic compression; or trauma.[32] There is no CPT® code specifically for imaging of the LS plexus.
Pudendal neuralgia may be considered in chronic pain patients who meet the Nantes criteria: pain in the area innervated by the pudendal nerve, pain more severe with sitting, pain that does not awaken the patient from sleep, pain with no objective sensory impairment, and pain relieved by pudendal block. All five criteria must be met for diagnosis.[33]

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MRI and Prostate Cancer – Although prostate cancer is the second leading cause of cancer in men, most cases do not lead to a prostate cancer-related death. Aggressive treatment of prostate cancer can have side effects, such as incontinence, rectal injury, and impotence. It is very important to do an evaluation that will assist in making decisions about therapy or treatment. MRI can non-invasively assess prostate tissue, functionally and morphologically. MRI evaluation may use a large array of techniques, e.g., T1-weighted images, T2-weighted images, and dynamic contrast enhanced T1-weighted images.

Prostate Cancer – MRI is not recommended in patients with suspected cancer but prior negative biopsy because MRI alone can miss up to 26% of clinically significant cancers that would be detected on TRUS biopsy.[5] Patients with suspected prostate cancer should first undergo a systematic biopsy and if that fails to demonstrate tumor, an MRI can then be obtained to guide future biopsy attempts.[4, 8]

Per NCCN,[63, 64] for asymptomatic patients with prostate cancer, in very low, low, or intermediate groups with life expectancy ≤ 5 years, no further treatment or work-up indicated (unless the patient becomes symptomatic). Active surveillance is indicated if life expectancy is determined to be ≥ 10 years.

MRI and Rectal Cancer – MRI is used in the evaluation of rectal cancer to visualize not only the intestinal wall but also the surrounding pelvic anatomy. MRI is an excellent imaging technique due to its high soft-tissue contrast, powerful gradient system, and high resolution. It provides accurate evaluation of the topographic relationship between lateral tumor extent and the mesorectal fascia.

Imaging of hernias – Most hernias are diagnosed clinically with imaging recommended for the diagnosis of occult hernias or in the evaluation of hernia complications, such as bowel obstruction or strangulation. To detect occult hernias, ultrasound is a first-line study with a sensitivity of 86% and specificity of 77%, compared to 80% sensitivity and 65% specificity for CT.[24] According to Miller et al, "Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias…."[23] Both MRI and US can be valuable for diagnosing pathology in athletes with groin pain when a sports hernia is suspected. Pain usually occurs with exertion with tenderness over the pubic symphysis or tubercle and exquisite tenderness on direct palpation of the superficial inguinal ring (positive direct stress test).This term initially denoted a posterior inguinal wall deficiency due to disruption of fascia and/or muscle but more recently given the label "core injury" to also include adductor tendon tears, injury to the aponeurosis of the rectus abdominus and adductor longus tendons, and osteitis pubis.[26]

Elevated CA-125 and pelvic imaging – There is no evidence that isolated levels of CA-125 with no other clinical or radiologic evidence of pathology is sensitive or specific and should not be performed as an isolated test as it can lead to unnecessary studies and anxiety. It is elevated in most cases of epithelial ovarian cancer and is used in monitoring response to treatment as an

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adjunct to pelvic US. CA-125 has been shown to be increased in many conditions such as fibroids, adenomyosis, pancreatic cancer, endometriosis, tuberculosis, and interstitial lung disease. MRI is not indicated as a first-line test.[65]

POLICY HISTORY

Date	Summary
March 2022	• Added when MRI is requested to potentially avoid a prostate biopsy • Added abnormal incidental pelvic lymph nodes when follow-up is recommended based on prior imaging (initial 3-month follow-up) • Within section concerning evaluation of suspected infection or inflammatory disease, added: o Suspected peritonitis (typically needing to include MRI Abd) with abd pain, tenderness to palpation, and at least one of the following: ▪ Rebound, guarding or rigid abdomen, OR ▪ Severe tenderness to palpation over entire abdomen o Complications of diverticulitis with severe abdominal pain or severe tenderness or mass, not responding to antibiotic treatment (prior imaging study is not required for diverticulitis diagnosis) • Removed "For MR Enterography (MRE) if CT or MRI of the abdomen and pelvis are inconclusive" from the section on evaluation of suspected IBD • Clarified pelvic pain due to suspected occult, spigelian, or incisional hernia • Clarified hernia with suspected complications • Added "after initial x-ray" to Sacroiliac Joint Dysfunction • Removed "For evaluation of suspected pelvic floor weakness in women with functional disorders, such as urinary or fecal incontinence, obstructed defecation, and pelvic organ prolapse" from "Other Indications for a Pelvic MRI" • Added B symptoms to "Other Indications for a Pelvic MRI"
November 2021	• Added +0698T
July 2021	• Clarified language in Indication for prostate MRI (suspected prostate cancer) based on updates to Version 2.2021 NCCN guidelines and 2020 publication of updated AUA-SAR SOPs regarding MRI
April 2021	• Updated the initial imaging for prostate cancer to reflect 2021 NCCN changes and "adjusted PSA"

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	• Revised indication for prostate MRI (suspected prostate cancer) to clarify criteria related to a negative prior biopsy and added criteria for when imaging is appropriate prior to biopsy • Included criteria for ultrasound abnormalities for adenomyosis • Added limited circumstances when prior imaging is not needed before MRI for the evaluation of urethral diverticula
May 2020	• Mention MRU which includes MRI abd • Perianal fistula including with Crohn's • Urethral eval • Added section on MRE for IBD • Added section on Lumbosacral plexus, pudendal neuralgia, maralgia paresthetica, piriformis syndrome • Added separate section on hernia including sports hernia • Added abnormal uterine bleeding; adenomyosis; pelvic floor weakness; urachal anomalies; MR defecography; surveillance for paraganglioma syndromes; hematospermia; LE edema; right varicocele; May-Thurner • Added the Fetal MR GL to page • Comment section on Lumbar plexopathy, sports hernia, elevated CA-125
June 2019	● Added the following indications: o rising or persistent elevated PSA OR suspicious DRE and at least 15 years life expectancy and negative prior biopsy o suspected perianal fistula o 6 months time specification for f/u of known or suspected post-operative complication involving hips or pelvis o for confirmed stress (fatigue) fracture for "return to play" evaluation o post operative complications after pelvic floor surgery o For known prostate cancer: Initial treatment by active surveillance w/initial mpMRI and mpMRI to be repeated no more than every 12 months unless clinically indicated o suspected placenta accrete or percreta when US is indeterminate o further assessment of a scrotal or penile mass when ultrasound is inconclusive o investigation of a malfunctioning penile prosthesis o suspected urethral diverticula and other imaging is inconclusive

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	o evaluation of adenomyosis when ultrasound is equivocal, especially in the case of suspected focal adenomyoma when it will help determine if surgery is indicated o suspected pelvic congestion syndrome in patients with chronic pelvic pain when other imaging is non-diagnostic o suspected patent urachus when ultrasound is non diagnostic o evaluation of enlargement of organ abnormality seen on previous imaging - to provide an alternative to an indeterminate or inconclusive ultrasound o PI-RADS information to background section o Home exercise program information updated to include dates and duration of failed PT and other

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ADDITIONAL RESOURCES

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **PELVIS MRA/MRV (Angiography/Venography)**	**Original Date: May 2008**
CPT Codes: 72198	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_039	**Implementation Date: January 2023**

IMPORTANT NOTE: Abdomen/Pelvis Magnetic Resonance Angiography (MRA) & Lower Extremity MRA Runoff Requests: **Two authorization requests are required, one Abdomen MRA, CPT code 74185 and one for Lower Extremity MRA, CPT code 73725 (a separate Pelvic MRA request is not required).** This will provide imaging of the abdomen, pelvis, and both legs.

INDICATIONS FOR PELVIS MR ANGIOGRAPHY / MR VENOGRAPHY (MRA/MRV)

Arterial

Evaluation of known or suspected pelvic vascular disease

- Evidence of vascular abnormality seen on prior imaging studies
- For pelvic extent of known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, arteriovenous malformations (AVMs), fistulas, intramural hematoma, and vasculitis
- For suspected pelvic extent of aortic dissection (approve CTA/MRA abdomen and pelvis)
- For evaluation of known or suspected aneurysms limited to the pelvis or evaluating pelvic extent of aortic aneurysm[1-3]
    - Known or suspected iliac artery aneurysm **AND** equivocal or indeterminate Doppler ultrasound results and contraindication to CTA
    - If repeat Doppler ultrasound is indeterminate
    - Suspected complications of known aneurysm as evidenced by clinical findings such as new onset of pelvic pain
- Follow-up of iliac artery aneurysm:
    - Every three years for diameter 2.0 – 2.9 cm
    - Annually if between 3.0-3.4 if Doppler ultrasound is inconclusive
    - If >3.5 cm, < six month follow-up (and consider intervention)[3]
- To determine a vascular source of retroperitoneal hematoma or hemorrhage in the setting of trauma, tumor invasion, fistula or vasculitis when CTA is contraindicated (CT rather than MRA/CTA is the modality of choice for diagnosing hemorrhage[4])

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- For known or suspected mesenteric ischemia/ischemic colitis when CTA is contraindicated (can approve MRA abdomen and pelvis)[5]
- Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate)[6]
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (CTA or MRA)[7]
- For patients with Vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time study of the abdomen and pelvis (CTA/MRA)
- For Loeys-Dietz imaging at least every two years[8]
- For assessment in patients with spontaneous coronary artery dissection (SCAD) can be done at time of coronary angiography (also approve CTA pelvis)[9]

Venous

- For evaluation of suspected pelvic vascular disease or pelvic congestive syndrome when findings on ultrasound are indeterminate (MR or CT venography (CTV) may be used as the initial study for evaluating pelvic thrombosis or thrombophlebitis)[10, 11]
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound[12]
- For evaluation of venous thrombus in the inferior vena cava[13]
- Venous thrombosis if previous studies have not resulted in a clear diagnosis[14]
- Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate)[6]
- For known/suspected May-Thurner Syndrome (iliac vein compression syndrome)[15, 16]

Pre-operative evaluation[17-19]
- Evaluation prior to interventional vascular for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Evaluation prior to endovascular aneurysm repair (EVAR)
- Imaging of the deep inferior epigastric arteries for surgical planning (breast reconstruction surgery) include CTA/MRA abdomen[18]
- Prior to uterine artery embolization for fibroids[20]

Post-operative or post-procedural evaluation
- Post-operative complications of renal transplant allograft[21]
- Endovascular/ interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Post-operative complications, e.g., pseudoaneurysms related to surgical bypass grafts, vascular stents, and stent-grafts in the pelvis
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA) and iliac artery aneurysms
    - Routine, baseline study (post-op/intervention) is warranted within 1-3 months[2, 22] (abdomen and pelvis MRA when CTA is inconclusive or cannot be performed)
    - Asymptomatic at six (6) month intervals, for one (1) year, then annually

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    - Symptomatic/complications related to stent graft – more frequent imaging may be needed
- Follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Chest MRA, Abdomen MRA, or Abdomen/Pelvis MRA combo

- Acute aortic dissection (CTA or CT preferred)
- Takayasu's arteritis
- Marfan sydrome
- Loeys-Dietz syndrome
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post-operative complications
- Significant post-traumatic or post-procedural vascular complications reasonably expected to involve the chest and/or abdomen and/or pelvis

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BACKGROUND

Magnetic resonance angiography (MRA) generates images of the arteries that can be evaluated for evidence of stenosis, occlusion, or aneurysms. It is used to evaluate the arteries of the abdominal aorta and the renal arteries. Contrast-enhanced MRA requires the injection of a contrast agent which results in very high quality images. It does not use ionizing radiation, allowing MRA to be used for follow-up evaluations.

OVERVIEW

Bruits: Blowing vascular sounds heard over partially occluded blood vessels. Abdominal bruits may indicate partial obstruction of the aorta or other major arteries such as the renal, iliac, or femoral arteries. Associated risks include but are not limited to; renal artery stenosis, aortic aneurysm, atherosclerosis, AVM, or coarctation of aorta.

MRA and Chronic Mesenteric Ischemia – Contrast-enhanced MRA is used for the evaluation of chronic mesenteric ischemia, including treatment follow-up. Chronic mesenteric ischemia is usually caused by severe atherosclerotic disease of the mesenteric arteries, e.g., celiac axis, superior mesenteric artery, inferior mesenteric artery. At least two of the arteries are usually affected before the occurrence of symptoms such as abdominal pain after meals and weight loss. MRA is the technique of choice for the evaluation of chronic mesenteric ischemia in patients with impaired renal function.

MRA and Abdominal Aortic Aneurysm Repair – MRA may be performed before endovascular repair of an abdominal aortic aneurysm. Endovascular repair of abdominal aortic aneurysm is a minimally invasive alternative to open surgical repair, and its success depends on precise measurement of the dimensions of the aneurysm and vessels. This helps to determine selection of an appropriate stent-graft diameter and length to minimize complications, such as

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endoleakage. MRA provides images of the aorta and branches in multiple 3D projections and may help to determine the dimensions needed for placement of an endovascular aortic stent graft. MRA is noninvasive and rapid and may be used in patients with renal impairment.

MRI/CT and acute hemorrhage: MRI is not indicated and MRA/MRV (MR Angiography/Venography) is rarely indicated for evaluation of intraperitoneal or retroperitoneal hemorrhage, particularly in the acute setting. CT is the study of choice due to its availability, speed of the study, and less susceptibility to artifact from patient motion. Advances in technology have allowed conventional CT to not just detect hematomas but also the source of acute vascular extravasation. In special cases, finer vascular detail to assess the specific source vessel responsible for hemorrhage may require the use of CTA. CTA in the diagnosis of lower gastrointestinal bleeding is such an example.[23]

MRA/MRV is often utilized in non-acute situations to assess vascular structure involved in atherosclerotic disease and its complications, vasculitis, venous thrombosis, vascular congestion, or tumor invasion. Although some of these conditions may be associated with hemorrhage, it is usually not the primary reason why MRI/MRA/MRV is selected for the evaluation. A special condition where MRI may be superior to CT for evaluating hemorrhage is to detect an underlying neoplasm as the cause of bleeding.[4]

POLICY HISTORY

Date	Summary
April 2022	• Added "(abdomen and pelvis MRA when CTA is inconclusive or cannot be performed)
April 2021	• Updated for concordance w/ CTA abdomen/pelvis
May 2020	• Added suspected vascular cause of retroperitoneal hemorrhage or hematoma • Added pelvic congestion syndrome • Added for evaluation of diffuse unexplained LE edema with neg ultrasound • Added FMD, Ehlers-Danlos, Marfans, Loeys-Dietz • Added for surgical planning breast reconstruction Deep inferior epigastric arteries • Added prior to uterine artery embolization • Added indications for combo imaging
May 2019	• Modified the follow up for iliac aneurysm • Added 'chronic' to mesenteric ischemia indication; added acute mesenteric ischemia should be assessed with CTA unless contraindicated • Added indications for post-operative complications of renal transplant allograft; venous thrombus in inferior vena cava; suspected May-Thurner syndrome

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Clinical guidelines **UPPER EXTREMITY CT** **(Hand, Wrist, Elbow, Long bone, or Shoulder CT)**	**Original Date: September 1997**
CPT Codes: 73200, 73201, 73202	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_057-1	**Implementation Date: January 2023**

INDICATIONS FOR UPPER EXTREMITY CT (HAND, WRIST, ARM, ELBOW, OR SHOULDER) (Plain radiographs must precede CT evaluation)

Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time.

If a CT Arthrogram fits approvable criteria below, approve as CT.

Joint specific provocative orthopedic examination and MRI is contraindicated or cannot be performed
Note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging.

- Shoulder[1-4]
  - Any positive test listed
    - Rotator cuff weakness[5]
    - Bear hug test
    - Belly press test
    - Drop arm test
    - Full can test
    - Hornblower's sign
    - Internal rotation lag sign
    - Supraspinatus test (aka Empty Can Test) when positive because of weakness

- Elbow[6, 7]
  - Any positive test listed
    - Valgus stress
    - Varus stress

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        - Posterolateral rotatory drawer test
        - Milking maneuver
        - Push-up test
        - Popeye sign

- Wrist[8, 9]
    - Any positive test listed
        - Watson test (scaphoid shift test)
        - Scapholunate ballottement test
        - Reagan test (lunotriquetral ballottement test)
        - Snuff box pain (after initial x-ray)

Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed and an MRI is contraindicated or cannot be performed[10, 11] (does not apply to young children)

- Persistent joint or musculotendinous pain unresponsive to conservative treatment*, within the last 6 months which includes active medical therapy (physical therapy, chiropractic treatments, and/or physician-supervised exercise**) of at least four (4) weeks; **OR**
- With progression or worsening of symptoms during the course of conservative treatment

Clinical suspicion of injury with clinical findings, which may be nonspecific, based on mechanism of injury, x-ray completed, and MRI is contraindicated or cannot be performed

- TFCC (triangular fibrocartilage complex) injury[12, 13]
- SLAP (superior labral anterior to posterior complex) lesions[4]

Shoulder Dislocations[14, 15]

- Recurrent
- First time in any of the situations below that increase the risk or repeated dislocation
    - Glenoid or humeral bone loss on x-ray
    - 14-35 year-old competitive contact sport athlete

Extremity Mass

- Mass or lesion after non-diagnostic x-ray or ultrasound[16]
    - If superficial, then ultrasound is the initial study
    - If deep, then x-ray is the initial study
    - CT is better than MRI to evaluate mass calcification or bone involvement and may complement or replace MRI[17]
    - If there is a contraindication to MRI

Known Cancer of the Extremity[18-22]

- Cancer staging

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- Cancer restaging
- Signs or symptoms of recurrence

Infection of Bone or Joint[23, 24]

MRI and nuclear medicine studies are recommended for acute infection as they are more sensitive in detecting early changes of osteomyelitis.[25] CT is better at demonstrating findings of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) as well as detecting soft tissue gas and foreign bodies.[26]

- Abnormal x-ray or ultrasound
- Negative x-ray but with a clinical suspicion of infection
    - Signs and symptoms of joint or bone infection include:
        - Pain and swelling
        - Decrease range of motion
        - Fever
    - Laboratory findings of infection include:
        - Elevated ESR or CRP
        - Elevated white blood cell count
        - Positive joint aspiration
- Ulcer (diabetic, pressure, ischemic, traumatic) with signs of infection (redness, warm, swelling, pain, discharge which may range from white to serosanguineous) that is not improving despite treatment and bone or deep infection is suspected
    - Increased suspicion if size or temperature increases, bone is exposed/positive probe-to-bone test, new areas of breakdown, new smell[27]

Osteonecrosis (Avascular necrosis (AVN)) [MRI is contraindicated or cannot be performed][28-31]

- Abnormal x-ray
- Normal or indeterminate x-rays but symptomatic and high-risk (e.g., glucocorticosteroid use, renal transplant recipient, glycogen storage disease, alcohol abuse,[32] sickle cell anemia[33])

Inflammatory Arthropathy (e.g., rheumatoid arthritis) and MRI is contraindicated or cannot be performed[34, 35]

- Further evaluation of an abnormality or non-diagnostic findings on prior imaging
- Initial imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR)
- Follow-up to determine treatment efficacy in the following:
    - Early rheumatoid arthritis
    - Advanced rheumatoid arthritis if x-ray and ultrasound are equivocal or noncontributory

Crystalline Arthropathy

- Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD[36]

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Bone Fracture or Ligament Injury

- Suspected stress or insufficiency fracture with a negative initial x-ray[37, 38]
    - Repeat x-rays in 10-14 days if negative or non-diagnostic.
- Intraarticular fractures or carpal bone fractures or instability that may require surgery[39]
- Suspected scaphoid fracture with negative x-ray
- Other upper extremity fractures that may require surgery
- Nonunion or delayed union as demonstrated by no healing between two sets of x-rays. If a fracture has not healed by 4-6 months, there is delayed union. Incomplete healing by 6-8 months is nonunion[40, 41]
- Clinical suspicion based on mechanism of injury and physical findings, x-ray completed and MRI contraindicated
    - TFCC (triangular fibrocartilage complex) injury[12, 13]
    - SLAP (superior labral anterior to posterior complex) lesions[4]

    Note: Imaging approvable in the setting of known trauma; otherwise, active conservative therapy is recommended (see background).

Osteochondral lesions (defects, fractures, osteochondritis dissecans) and x-ray completed[42-45]

- Clinical suspicion based on mechanism of injury and physical findings
- Loose bodies or synovial chondromatosis seen on x-ray or ultrasound
    - In the setting of joint pain[46]

Foreign Body[47]

- Indeterminate x-ray and ultrasound

Tendon or Muscle Rupture after x-ray and MRI is contraindicated or cannot be performed[48-50]

- Clinical suspicion based on mechanism of injury and physical findings (i.e., Popeye, Hook, Yergasons sign)

Peripheral Nerve Entrapment (e.g., carpal tunnel) and MRI is contraindicated or cannot be performed, including any of the following[51-55]:

- Abnormal electromyogram or nerve conduction study
- Abnormal x-ray or ultrasound
- Clinical suspicion and failed 4 weeks conservative treatment including at least two of the following (active treatment with physical therapy is not required):
    - Activity modification
    - Rest, ice, or heat
    - Splinting or orthotics
    - Medication

Brachial Plexopathy and MRI is contraindicated or cannot be performed[56, 57]

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- If mechanism of injury or EMG/NCV studies are suggestive
- Chest MRI is preferred study, but neck and/or shoulder (upper extremity) MRI can be ordered depending on the suspected location of injury

Pre-operative/procedural evaluation:
- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation:
- When imaging, physical, or laboratory findings indicate joint infection, delayed or non-healing, or other surgical/procedural complications
- Joint prosthesis loosening or dysfunction, x-rays non-diagnostic[58, 59]

Note: Any test that suggest joint impingement or instability requires further imaging (list is not all inconclusive)

BACKGROUND

Computed tomography (CT) may be used for the diagnosis, evaluation, and management of conditions of the hand, wrist, elbow, and shoulder. CT is not usually the initial imaging test, but it is performed after standard radiographs. CT is used for preoperative evaluation or to evaluate specific abnormalities of the bones, joints, and soft tissues of the upper extremities.

OVERVIEW

***Conservative Therapy** – (Musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components, such as rest, ice, heat, modified activities, medical devices, (including crutches, immobilizer, metal braces, orthotics, rigid stabilizer, or splints, etc. and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program - (HEP)** – The following two elements are required to meet guidelines for completion of conservative therapy:
- Information provided on exercise prescription/plan AND
- Follow-up with member with information provided regarding completion of HEP (after suitable 4-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

Joint Implants and Hardware – Dual-energy CT may be useful for metal artifact reduction if available, but it is also imperfect as the correction is based on a projected approximation of x-ray absorption and does not correct for scatter.[60] Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD.[36]

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CT to Evaluate Shoulder Pain – The initial work-up for chronic shoulder pain includes plain radiographs. When the diagnosis remains unclear, further testing including may include computed tomography. CT is the preferred imaging technique for evaluating bony disorders of the shoulders, e.g., arthritis, tumors, occult fractures. CT may be useful in patients with suspected rotator cuff tears who cannot undergo magnetic resonance imaging (MRI).

Shoulder Dislocation – Glenoid bone loss occurs in anterior shoulder dislocation. Severe degrees of glenoid bone loss are shown on axial radiography, but it can be quantified more definitively using CT. This information is important as it helps to predict the likelihood of further dislocation and the need for bone augmentation surgery. The number of dislocations cannot reliably predict the degree of glenoid bone loss; it is important to quantify glenoid bone loss, initially by arthroscopy and later by CT. In the CT examination, both glenoids can be examined simultaneously, resulting in a comparison of the width of the glenoid in the dislocating shoulder and in the non-dislocating shoulder.

Shoulder fractures – CT may be used to characterize shoulder fractures when more information is needed preoperatively. CT can show the complexity of the fracture, the displacement, and angulation.

CT and Wrist Fractures – CT is indicated for wrist fractures where there is fracture comminution, displacement, or complex intraarticular extension. CT can provide a detailed evaluation of radiocarpal articular step-off and gap displacement which can predict the development of radiocarpal osteoarthritis. CT can be performed in several planes, providing soft-tissue and bone detail. CT is also useful in determining the position of known fracture fragments and in assessing the union or status of fracture healing.

CT for Preoperative Evaluation – Where more information is needed preoperatively, CT is used to demonstrate fracture complexity, displacement, and angulation.

CT and Scaphoid Fractures – CT is accurate in depicting occult cortical scaphoid fractures. It may be used as a second-choice diagnostic method when patients are clinically suspected of having a scaphoid fracture, but radiographs are negative or equivocal. Usually, the diagnosis of a scaphoid fracture of the wrist is based upon clinical presentation and conventional radiographs. However, a large percentage of patients with a high clinical probability of a scaphoid fracture have unremarkable radiographs. Multidetector CT allows coverage of the whole wrist with excellent spatial resolution. It has been proven to be superior to MRI in the detection of cortical involvement of occult scaphoid fractures.

CT and Avascular Necrosis Complicating Chronic Scaphoid Nonunion – Preoperative CT of a scaphoid nonunion may be helpful in identifying avascular necrosis and predicting subsequent fracture union. If the results of CT suggest avascular necrosis, treatment options may include vascularized bone grafts or limited wrist arthrodesis.

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CT and Posttraumatic Elbow Effusions – Multidetector computed tomography (MDCT) may help to detect occult fractures of the elbow when posttraumatic elbow effusions are shown on radiographs without any findings of fracture. Effusions may be visualized on radiographs as fat pads, which can be elevated by the presence of fluid in the joint caused by an acute fracture. MDCT may be useful when effusions are shown on radiographs without a visualized fracture, but there is a clinical suspicion of a lateral condylar or radial head fracture.

CT and Avascular Necrosis – Sports, such as racquetball and gymnastics, may cause repeated microtrauma due to the compressive forces between the radial head and capitellum. Focal avascular necrosis and osteochondritis dissecans of the capitellum may result. CT may show the extent of subchondral necrosis and chondral abnormalities. The images may also help detect intraarticular loose bodies.

CT and Acute Osseous Trauma – Many elbow injuries result from repetitive microtrauma rather than acute trauma and the injuries are sometimes hard to diagnose. Non-displaced fractures are not always evident on plain radiographs. When fracture is suspected, CT may improve diagnostic specificity and accuracy.

CT and Wrist Tumor – Osteoma does not often occur in the wrist. Symptoms may resemble atypical tenosynovitis. Pain may seem to be related to an injury. CT, however, may be used to evaluate a suspected tumor and may visualize a round lucency surrounded by a rim of sclerosis. CT can give details about the location of the tumor, relative to joints.

Upper Extremity Osteomyelitis and Septic Arthritis – CT helps to distinguish among the types of musculoskeletal infections. Its specific imaging features help identify the forms of infection in the bones and soft tissue. Osteomyelitis, a bone infection most commonly associated with an open fracture or direct trauma, is often not detected in the initial conventional radiographic evaluation because bone changes are not evident for 14-21 days after the onset of infection. CT is also used to help diagnose septic arthritis; CT features include joint effusion and bone erosions around the joint.

Adhesive Capsulitis a.k.a. Frozen Shoulder[61-63] – MRI is the preferred modality for imaging after a failure of improvement with active conservative therapy. Affected patients have impaired range of shoulder motion with forward flexion, abduction, and external and internal rotation which may be associated with pain. Clinically, it can be distinguished from rotator cuff pathology where passive range of motion is preserved, or neoplasm which may also have associated fever or weight loss. Treatment is with a combination of intracapsular steroid injection and active conservative care. Anti-inflammatory medications are also given to facilitate active treatment. When nonsurgical management, including anti-inflammatory medication, active care (physical therapy, a supervised home exercise program or manipulations), and injections, have failed to provide relief of symptoms by 9 to 12 months, surgical intervention is indicated, but this represents the minority of patients.

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Shoulder Impingement, Non-Traumatic Shoulder Instability, and Glenoid Labral tears – require active conservative therapy* and x-ray (orthopedic signs listed below):

- Shoulder Impingement—Hawkin's, Neer's, Painful arc, Load and shift, and Yocum tests
- Non-Traumatic Shoulder Instability—Sulcus, Surprise, Anterior or Posterior draw, Apprehension, Anterior slide, Clunk, Crank, Empty can, HERI (hyperextension-internal rotation) tests
- Glenoid labral tear (i.e., SLAP lesion)—Apprehension, Relocation, Surprise, Jobe's, O'Brien's, Superior labral, Anterior slide, Jerk, Compression rotation, Crank tests

American Academy of Pediatrics "Choosing Wisely" Guidelines advise against ordering advanced imaging studies (MRI or CT) for most musculoskeletal conditions in a child until all appropriate clinical, laboratory and plain radiographic examinations have been completed. **"**History, physical examination, and appropriate radiographs remain the primary diagnostic modalities in pediatric orthopedics, as they are both diagnostic and prognostic for the great majority of pediatric musculoskeletal conditions. Examples of such conditions would include, but not be limited to, the work up of injury or pain (spine, knees, and ankles), possible infection, and deformity. MRI examinations and other advanced imaging studies frequently require sedation in the young child (5 years old or less) and may not result in appropriate interpretation if clinical correlations cannot be made. Many conditions require specific MRI sequences or protocols best ordered by the specialist who will be treating the patient… if you believe findings warrant additional advanced imaging, discuss with the consulting orthopedic surgeon to make sure the optimal studies are ordered."[64]

POLICY HISTORY

Date	Summary
March 2022	• Simplified orthopedic sign section to include only the most robust signs and removed Table 1 • Clarified the Supraspinatus Test • Moved the section on shoulder impingement, non-traumatic shoulder instability and glenoid labral tears to the background information section • Expanded Bone or Ligament Injury section to include triangular fibrocartilage injury and superior labral anterior to posterior complex lesions when MRI cannot be done • Removed occult wrist ganglion section • Added Snuff box pain after initial x-ray to wrist section and Popeye sign to elbow section
May 2021	• Additional signs for rotator cuff tear that are considered useful • Removed signs for impingement, shoulder instability and glenoid labral tear since active conservative therapy should be done first

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	• Added section about impingement, nontraumatic shoulder instability and glenoid labral tear requiring active conservative therapy • Added the following information: shoulder dislocation, suspected bone infection in the setting of ulcers and neuropathy, brachial plexopathy
May 2020	• Expanded the list of orthopedic signs and Added note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging. • Added information about adhesive capsulitis • Clarified that if an CT Arthrogram fits approvable criteria, approve as CT. • Revised the information about an evaluation of an extremity mass. • Expanded information about osteomyeltis • Added information about crystalline arthropathy and dual energy CT • Added information about nonunion/delayed union • Included loose bodies or synovial chondromatosis
May 2019	• Added initial statement about approvals: 'Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time'. • Expanded Extremity mass indications including adenopathy; and mass with increased risk for malignancy • Modified Known Cancer indication to be more broad – 'cancer staging, cancer restaging, signs or symptoms of recurrence' • Expanded sections for bone fracture and infection of bone or joint to include list of signs or symptoms and laboratory findings (elevated ESR or CRP, elevated white blood cell count, positive joint aspiration)

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ADDITIONAL RESOURCES

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National Imaging Associates, Inc.*	
Clinical guidelines **UPPER EXTREMITY CTA/CTV**	**Original Date: July 2008**
CPT Codes: 73206	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_061-2	**Implementation Date: January 2023**

When a separate CTA and CT exam is requested, documentation requires a medical reason that clearly indicates why additional CT imaging of the upper extremity is needed.

INDICATIONS FOR UPPER EXTREMITY CTA/CTV (Computed Tomography Angiogram/Computed Tomography Venogram)

Hand Ischemia[1, 2]

- Arterial Doppler not needed with any of these acute symptoms:
  - Ischemic ulceration without segmental temperature change
  - Ischemic ulceration with painful ischemia
  - Acute sustained loss of perfusion with or without acral ulceration
  - Imminent loss of digit
- Clinical symptoms with arterial Doppler abnormal and will change management
  - Includes Raynaud's (can be associated with scleroderma), Buerger disease, and other vasculopathies[3]
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound[4]
- After stenting or surgery with signs of recurrence or indeterminate ultrasound[5]

Deep Venous Thrombosis or Embolism after abnormal ultrasound[6, 7]

- After abnormal ultrasound of arm veins if it will change management, or negative or indeterminate ultrasound to rule out other causes
- For evaluation of central veins
- Clinical suspicion of upper arterial emboli[8, 9]

Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound[8, 9]

- Tumor invasion[10, 11]
- Trauma[12]
- Vasculitis[1, 13]
- Aneurysm[14]
- Stenosis/occlusions[15, 16]

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Hemodialysis Graft Dysfunction, after Doppler ultrasound not adequate for treatment decisions[17]

Vascular Malformation - If MRA is contraindicated[18, 19]

- Non-diagnostic doppler ultrasound

Note: CTA useful in delineating high flow lesions such as an arteriovenous malformation.

Traumatic injuries with clinical findings suggestive of arterial injury[12]

Assessment/evaluation of known vascular disease/condition

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure[20]

Post-operative/procedural evaluation

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.[21, 22]

Special Circumstances[23]

- High suspicion of an acute arterial obstruction - Arteriography preferred (the gold standard)
- Renal impairment
    - Not on dialysis
        - Mild to moderate, GFR 30-45 ml/min MRA with contrast can be performed
        - Severe, GFR < 30 ml/min MRA without contrast
    - On dialysis
        - CTA with contrast can be performed
- Doppler ultrasound can be useful in evaluating bypass grafts

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BACKGROUND

Computed tomography angiography (CTA) can visualize blood flow in arterial and venous structures throughout the upper extremity using a computerized analysis of x-ray images. It is enhanced by contrast material that is injected into a peripheral vein to promote visualization. CTA is much less invasive than catheter angiography which involves injecting contrast material into an artery. CTA is less expensive and carries lower risks than catheter angiography.

OVERVIEW

UPPER EXTREMITY DVT – "Secondary UEDVT is far more common. Indwelling venous devices, such as catheters, pacemakers, and defibrillators, put patients at the highest risk of thrombus. Other risk factors include advanced age, previous thrombophlebitis, postoperative state,

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hypercoagulability, heart failure, cancer, right-heart procedures, intensive care unit admissions, trauma, and extrinsic compression."[6]

CTA and Raynaud's Syndrome – Raynaud's syndrome is evidenced by episodic waxy pallor or cyanosis of the fingers caused by vasoconstriction of small arteries or arterioles in the fingers. It usually occurs due to a response to cold or to emotional stimuli. CTA may be used in the evaluation of Raynaud's syndrome.

CTA and Dialysis Graft – The management of the hemodialysis access is important for patients undergoing dialysis. With evaluation and interventions, the patency of hemodialysis fistulas may be prolonged. In selected cases, CTA is useful in the evaluation of hemodialysis graft dysfunction due to its speed and high resolution. Rapid data acquisition during the arterial phase, improved visualization of small vessels and lengthened anatomic coverage increase the usefulness of CTA.

CTA and Stenosis or Occlusion – CTA of the central veins of the chest is used for the detection of central venous stenoses and occlusions. High-spatial resolution CTA characterizes the general morphology and degree of stenosis. Enlarged and well-developed collateral veins in combination with the non-visualization of a central vein may be indicative of chronic occlusion, whereas less-developed or absent collateral veins are suggestive of acute occlusions. A hemodynamically significant stenosis may be indicated by the presence of luminal narrowing with local collaterals.

POLICY HISTORY

Date	Summary
March 2022	• Added a background section for upper extremity DVT. • Clarified renal impairment, not on dialysis, mild to moderate, GFR 30-45 ml/min MRA with contrast can be performed
May 2021	No changes
May 2020	• Added CT Venography to the title • Clarified that CTA does not include a baseline CT exam • Expanded section about vascular malformation to include initial testing • Added information about renal function and contrast agents • Added acute arterial obstruction and renal impairment • Simplified language • Updated references
May 2019	• Reformatted/modified indications to include hand ischemia; deep venous thrombosis or embolism and clinical suspicion of vascular disease • Updated background information and references

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ADDITIONAL RESOURCES

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National Imaging Associates, Inc.*	
Clinical guidelines **UPPER EXTREMITY MRI** **(Hand, Wrist, Arm, Elbow, Long bone, or Shoulder MRI)**	**Original Date: September 1997**
CPT Codes: 73218, 73219, 73220, 73221, 73222, 73223, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_057-3	**Implementation Date: January 2023**

INDICATIONS FOR UPPER EXTREMITY MRI (HAND, WRIST, ARM, ELBOW or SHOULDER) (Plain radiographs must precede MRI evaluation)

Some indications are for <u>MRI, CT, or MR or CT Arthrogram</u>. More than one should not be approved at the same time.

If an MR Arthrogram fits approvable criteria below, approve as MRI.

Joint specific provocative orthopedic examination
Note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging.

- Shoulder[1-4]
  - Any positive test listed
    - Rotator cuff weakness[5]
    - Bear hug test
    - Belly press test
    - Drop arm test
    - Full can test
    - Hornblower's sign
    - Internal rotation lag sign
    - Supraspinatus test (aka Empty Can Test) when positive because of weakness
- Elbow[6, 7]
  - Any positive test listed
    - Valgus stress
    - Varus stress
    - Posterolateral rotatory drawer test

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        - Milking maneuver
        - Push-up test
        - Popeye sign
- Wrist[8, 9]
    - Any positive test listed
        - Watson test (scaphoid shift test)
        - Scapholunate ballottement test
        - Reagan test (lunotriquetral ballottement test)
        - Snuff box pain (after initial x-ray)

Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed[10, 11]

- Persistent joint or musculotendinous pain unresponsive to conservative treatment*, within the last 6 months which includes active medical therapy (physical therapy, chiropractic treatments, and/or physician-supervised exercise**),of at least four (4) weeks, **OR**
- With progression or worsening of symptoms during the course of conservative treatment

Shoulder Dislocations[12, 13]

- Recurrent
- First time in any of the situations below that increase the risk or repeated dislocation
    - Glenoid or humeral bone loss on x-ray
    - 14-35 year-old competitive contact sport athlete

Extremity Mass

- Mass or lesion after non-diagnostic x-ray or ultrasound[14]
    - If superficial, then ultrasound is the initial study
    - If deep, then x-ray is the initial study

Known Cancer of the Extremity[15-19]

- Cancer staging
- Cancer restaging
- Signs or symptoms of recurrence

Infection of Bone or Joint[20-22]

- Abnormal x-ray or ultrasound
- Negative x-ray but with a clinical suspicion of infection
    - Signs and symptoms of joint or bone infection include:
        - Pain and swelling
        - Decrease range of motion
        - Fever
    - Laboratory findings of infection include:
        - Elevated ESR or CRP

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        - Elevated white blood cell count
        - Positive joint aspiration
- Ulcer (diabetic, pressure, ischemic, traumatic) with signs of infection (redness, warm, swelling, pain, discharge which may range from white to serosanguineous) that is not improving despite treatment and bone or deep infection is suspected
    - Increased suspicion if size or temperature increases, bone is exposed/positive probe-to-bone test, new areas of breakdown, new smell[23]

Osteonecrosis (e.g., Avascular necrosis (AVN))[24-26]
- Abnormal x-ray
- Normal x-rays but symptomatic and high-risk (e.g., glucocorticosteroid use, renal transplant recipient, glycogen storage disease, alcohol abuse,[27] sickle cell anemia[28])

For evaluation of known or suspected autoimmune disease (e.g., rheumatoid arthritis)[29, 30]
- Further evaluation of an abnormality or non-diagnostic findings on prior imaging
- Initial imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR)
- Follow-up to determine treatment efficacy in the following:
    - Early rheumatoid arthritis
    - Advanced rheumatoid arthritis if x-ray and ultrasound are equivocal or noncontributory

Bone Fracture or Ligament Injury
- Suspected stress or insufficiency fracture with a negative initial x-ray[31-33]
    - Repeat x-rays in 10-14 days if negative or non-diagnostic
- Pathologic fracture on x-ray[34]
- Intraarticular fractures that may require surgery
- Suspected scaphoid fracture with negative x-rays
- Nonunion or delayed union as demonstrated by no healing between two sets of x-rays. If a fracture has not healed by 4-6 months, there is delayed union. Incomplete healing by 6-8 months is nonunion.[35]
- Clinical suspicion based on mechanism of injury and physical findings and x-ray completed
    - TFCC (triangular fibrocartilage complex) injury[36, 37]
    - SLAP (superior labral anterior to posterior complex) lesions[4]

    Note: Imaging approvable in the setting of known trauma; otherwise, active conservative therapy is recommended (see background).

Osteochondral Lesions (defects, fractures, osteochondritis dissecans) and x-ray completed[38-41]
- Clinical suspicion based on mechanism of injury and physical findings
- Loose bodies or synovial chondromatosis seen on x-ray or ultrasound
    - In the setting of joint pain[42]

Foreign Body[43]

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- Indeterminate x-ray and ultrasound

Tendon or Muscle Rupture after x-ray[44-46]
- Clinical suspicion based on mechanism of injury and physical findings (i.e., Popeye, Hook, Yergasons sign)

Peripheral Nerve Entrapment (e.g., carpal tunnel)[47-51]
- Abnormal electromyogram or nerve conduction study
- Abnormal x-ray or ultrasound
- Clinical suspicion and failed 4 weeks conservative treatment including at least two of the following (active treatment with physical therapy is not required):
    - Activity modification
    - Rest, ice, or heat
    - Splinting or orthotics
    - Medication

Brachial Plexopathy[52, 53]
- If mechanism of injury or EMG/NCV studies are suggestive
- Chest MRI is preferred study, but neck and/or shoulder (upper extremity) MRI can be ordered depending on the suspected location of injury

Pre-operative/procedural evaluation
- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation
- When imaging, physical or laboratory findings indicate joint infection, delayed or non-healing or other surgical/procedural complications
- Joint prosthesis loosening or dysfunction, x-rays non-diagnostic[54, 55]

BACKGROUND

Magnetic resonance imaging shows the soft tissues and bones. With its multiplanar capabilities, high contrast, and high spatial resolution, it is an accurate diagnostic tool for conditions affecting the joint and adjacent structures. MRI can positively influence clinicians' diagnoses and management plans for patients with conditions such as primary bone cancer, fractures, abnormalities in ligaments/tendons/cartilage, septic arthritis, and infection/inflammation.

OVERVIEW

***Conservative Therapy** – (musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components such as rest, ice, heat, modified activities, medical devices, (including crutches, immobilizer, metal braces, orthotics, rigid stabilizer, or splints, etc. and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized.

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Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program - (HEP)** – the following two elements are required to meet guidelines for completion of conservative therapy:

- Information provided on exercise prescription/plan AND
- Follow up with member with information provided regarding completion of HEP (after suitable 4-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).

Rotator Cuff Tears – 3.0 Tesla MRI has been found valuable for the detection of partial thickness rotator cuff tendon tears and small rotator cuff tendon tears. It is especially useful in detecting the partial tears due to increased spatial resolution. Increased spatial resolution results in precise measurements of rotator cuff tendon tears in all 3 planes, and it also reduces acquisition time which reduces motion artifacts. 3.0 Tesla makes it possible to adequately evaluate tendon edges and avoid underestimation of tears. MRI is less invasive than MR arthrography, and it is faster and less expensive. MRI may be useful in the selection of patients that may benefit from arthroscopy.

MRI and Occult Fractures – Magnetic resonance imaging may help to detect occult fractures of the elbow when posttraumatic elbow effusions are shown on radiographs without any findings of fracture. Effusions may be visualized on radiographs as fat pads, which can be elevated by the presence of fluid in the joint caused by an acute fracture. MRI may be useful when effusions are shown on radiographs without a visualized fracture, but there is a clinical suspicion of a lateral condylar or radial head fracture.

MRI and Avascular Necrosis – Sports, such as racquetball and gymnastics, may cause repeated microtrauma due to the compressive forces between the radial head and capitellum. Focal avascular necrosis and osteochondritis dissecans of the capitellum may result. MRI can be used to evaluate the extent of subchondral necrosis and chondral abnormalities. The images may also help detect intraarticular loose bodies.

MRI and Acute Osseous Trauma – Many elbow injuries result from repetitive microtrauma rather than acute trauma, and the injuries are sometimes hard to diagnose. Non-displaced fractures are not always evident on plain radiographs. When fracture is suspected, MRI may improve diagnostic specificity and accuracy. T1-weighted images can delineate morphologic features of the fracture.

MRI and Brachial Plexus – MRI is the only diagnostic tool that accurately provides high resolution imaging of the brachial plexus. The brachial plexus is formed by the cervical ventral rami of the lower cervical and upper thoracic nerves which arise from the cervical spinal cord, exit the bony confines of the cervical spine, and traverse along the soft tissues of the neck, upper chest, and course into the arms.

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Adhesive Capsulitis a.k.a. Frozen Shoulder[56-58] – MRI is the preferred modality for imaging after a failure of improvement with active conservative therapy. Affected patients have impaired range of shoulder motion with forward flexion, abduction, and external and internal rotation which may be associated with pain. Clinically, it can be distinguished from rotator cuff pathology, where passive range of motion is preserved, or neoplasm which may also have associated fever or weight loss. Treatment is with a combination of intracapsular steroid injection and active conservative care. Anti-inflammatory medications are also given to facilitate active treatment. When nonsurgical management, including anti-inflammatory medication, active care (physical therapy, a supervised home exercise program or manipulations), and injections, have failed to provide relief of symptoms by 9 to 12 months, surgical intervention is indicated, but this represents the minority of patients.

Shoulder Impingement, Non-Traumatic Shoulder Instability, and Glenoid Labral tears – require active conservative therapy and x-ray (orthopedic signs listed below):

- Shoulder Impingement—Hawkin's, Neer's, Painful arc, Load and shift, and Yocum tests
- Non-Traumatic Shoulder Instability—Sulcus, Surprise, Anterior or Posterior draw, Apprehension, Anterior slide, Clunk, Crank, Empty can, HERI (hyperextension-internal rotation) tests
- Glenoid labral tear (i.e., SLAP lesion)—Apprehension, Relocation, Surprise, Jobe's, O'Brien's, Superior labral, Anterior slide, Jerk, Compression rotation, Crank tests

The American Academy of Pediatrics "Choosing Wisely" Guidelines advise against ordering advanced imaging studies (MRI or CT) for most musculoskeletal conditions in a child until all appropriate clinical, laboratory and plain radiographic examinations have been completed. **"**History, physical examination, and appropriate radiographs remain the primary diagnostic modalities in pediatric orthopedics, as they are both diagnostic and prognostic for the great majority of pediatric musculoskeletal conditions. Examples of such conditions would include, but not be limited to, the work up of injury or pain (spine, knees, and ankles), possible infection, and deformity. MRI examinations and other advanced imaging studies frequently require sedation in the young child (5 years old or less) and may not result in appropriate interpretation if clinical correlations cannot be made. Many conditions require specific MRI sequences or protocols best ordered by the specialist who will be treating the patient. If you believe findings warrant additional advanced imaging, discuss with the consulting orthopedic surgeon to make sure the optimal studies are ordered."[59]

POLICY HISTORY

Date	Summary
March 2022	• Simplified orthopedic sign section to include only the most robust signs and removed Table 1 • Clarified the Supraspinatus Test

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	• Moved the section recommending active conservative care for shoulder impingement, non traumatic shoulder instability and glenoid labral tears to the background information section • Removed occult wrist ganglion section • Added Snuff box pain after initial x-ray to wrist section and Popeye sign to Elbow section
November 2021	• Added +0698T
May 2021	• Additional signs for rotator cuff tear that are considered useful • Removed signs for impingement, shoulder instability and glenoid labral tear since active conservative therapy should be done first • Added section about impingement, nontraumatic shoulder instability and glenoid labral tear requiring active conservative therapy • Added information for the following: shoulder dislocation; suspected bone infection in the setting of ulcers and neuropathy; brachial plexopathy; treatment for rheumatoid arthritis
May 2020	• Expanded the list of orthopedic signs and Added note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging. • Added information about adhesive capsulitis • Clarified that if an MR Arthrogram fits approvable criteria, approve as MRI. • Revised the information about an evaluation of an extremity mass.
May 2019	• Added initial statement about approvals: 'Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time'. • Expanded Extremity mass indications including peripheral lymphadenopathy; and mass with increased risk for malignancy • Added indications for foreign body and peripheral nerve entrapment • Modified Known Cancer indication to be more broad – 'cancer staging, cancer restaging, signs or symptoms of recurrence' • Expanded sections for bone fracture and infection of bone or joint to include list of signs or symptoms and laboratory findings (elevated ESR or CRP, elevated white blood cell count, positive joint aspiration)

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **UPPER EXTREMITY MRA/MRV**	**Original Date: July 2008**
CPT Codes: 73225	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_058-2	**Implementation Date: January 2023**

When a separate MRA and MRI exam is requested, documentation requires a medical reason that clearly indicates why additional MRI imaging of the upper extremity is needed.

INDICATIONS FOR UPPER EXTREMITY MRA/MRV

Hand Ischemia[1-3]

- Arterial Doppler not needed with any of these acute symptoms:
  - Ischemic ulceration without segmental temperature change
  - Ischemic ulceration with painful ischemia
  - Acute sustained loss of perfusion with or without acral ulceration
  - Imminent loss of digit
- Clinical symptoms without the above features, arterial Doppler abnormal and will change management
  - Includes Raynaud's (can be associated with scleroderma), Buerger disease, and other vasculopathies[4]
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound[5]
- After stenting or surgery with signs of recurrence or indeterminate ultrasound[6]

Deep Venous Thrombosis or Embolism[7, 8]

- After abnormal ultrasound of arm veins if it will change management, or negative or indeterminate ultrasound to rule out other causes
- For evaluation of central veins
- Clinical suspicion of upper arterial emboli[9, 10]

Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound or other imaging[9, 10]

- Tumor invasion[11, 12]
- Trauma[13]
- Vasculitis[2, 14]
- Aneurysm[15]

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- Stenosis/occlusions[16]

Vascular Malformation[17, 18]
- Non-diagnostic doppler ultrasound

Traumatic injuries with clinical findings suggestive of arterial injury – CTA preferred emergently[13]

Assessment/evaluation of known vascular disease/condition

Pre-operative/procedural evaluation
- Pre-operative evaluation for a planned surgery or procedure[19]

Post-operative/procedural evaluations
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Special Circumstances[20]
- High suspicion of an acute arterial obstruction - Arteriography preferred (the gold standard)
- Renal impairment
    - Not on dialysis
        - Mild to moderate, GFR 30-45 ml/min MRA with contrast can be performed
        - Severe, GFR < 30 ml/min MRA without contrast
    - On dialysis
        - CTA with contrast can be performed
- Doppler ultrasound can be useful in evaluating bypass grafts

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BACKGROUND

Magnetic resonance angiography (MRA) is a noninvasive alternative to catheter angiography for evaluation of vascular structures in the upper extremity. Magnetic resonance venography (MRV) is used to image veins instead of arteries. MRA and MRV are less invasive than conventional x-ray digital subtraction angiography.

OVERVIEW

UPPER EXTREMITY DVT – "Secondary UEDVT is far more common. Indwelling venous devices, such as catheters, pacemakers, and defibrillators, put patients at the highest risk of thrombus. Other risk factors include advanced age, previous thrombophlebitis, postoperative state, hypercoagulability, heart failure, cancer, right-heart procedures, intensive care unit admissions, trauma, and extrinsic compression."[7]

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MRA and Raynaud's Syndrome – Raynaud's syndrome is evidenced by episodic waxy pallor or cyanosis of the fingers caused by vasoconstriction of small arteries or arterioles in the fingers. It usually occurs due to a response to cold or to emotional stimuli. MRA may be used in the evaluation of Raynaud's syndrome.

MRV and Stenosis or Occlusion – MRA of the central veins of the chest is used for the detection of central venous stenoses and occlusions. High-spatial resolution MRA characterizes the general morphology and degree of stenosis. Enlarged and well-developed collateral veins in combination with the non-visualization of a central vein may be indicative of chronic occlusion, whereas less-developed or absent collateral veins are suggestive of acute occlusions. A hemodynamically significant stenosis may be indicated by the presence of luminal narrowing with local collaterals.[21, 22]

MRA and arterial obstructive disease – Catheter angiography is the standard of reference for assessing arterial disease but MRA with contrast-enhanced media has gained acceptance and can image the entire vascular system. Contrast agents such as high dose gadolinium have been associated with the development of nephrogenic systemic fibrosis in patients with chronic renal insufficiency, but newer agents are safer in this regard. Gadolinium dosage may be decreased without compromising image quality in high-spatial-resolution contrast-enhanced MRA of the upper extremity.

POLICY HISTORY

Date	Summary
March 2022	• Clarified renal impairment, not on dialysis, mild to moderate, GFR 30-45 ml/min MRA with contrast can be performed • Updated background section for upper extremity DVT
May 2021	No changes
May 2020	• Clarified that MRA does not include a baseline MR exam • Expanded section about vascular malformation to include initial testing. • Added information about renal function and contrast agents • Simplified language • Updated references
May 2019	• Reformatted/modified indications to include hand ischemia; deep venous thrombosis or embolism and clinical suspicion of vascular disease • Updated background information and references

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LOWER EXTREMITY CT** **(Foot, Ankle, Knee, Leg or Hip CT)**	**Original Date: September 1997**
CPT Codes: 73700, 73701, 73702	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_057-2	**Implementation Date: January 2023**

INDICATIONS FOR LOWER EXTREMITY CT (FOOT, ANKLE, KNEE, LEG or HIP)
(Plain radiographs must precede CT evaluation)

Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time.

If a CT Arthrogram fits approvable criteria below, approve as CT.

Joint-specific provocative orthopedic examination when MRI is contraindicated or cannot be performed (see Table 1)
Note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging.

- Ankle
  - Unstable syndesmotic injury (high ankle injury)
    - With inconclusive stress x-rays (a standing CT is preferred)
    - Can have positive fibular translation, squeeze or cotton test, but imaging may be needed to confirm diagnosis
- Knee[1-7]
  - Any positive test listed
    - McMurray's
    - Apley's
    - Lachman's
    - Anterior or Posterior Drawer sign
    - Varus or valgus stress
    - Acute mechanical locking of the knee not due to guarding[8]
- Hip
  - Anterior Impingement sign (labral tear)[9-11]
- Posterior Impingement sign (labral tear)[12]

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Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed and an MRI is contraindicated or cannot be performed - (does not apply to young children)[3, 13]

- Persistent joint or musculotendinous pain unresponsive to conservative treatment*, within the last 6 months which includes active medical therapy (physical therapy, chiropractic treatments, and/or physician-supervised exercise**) of at least four (4) weeks, **OR**
- With progression or worsening of symptoms during the course of conservative treatment
- Persistent hip mechanical symptoms including clicking, locking, catching, giving way or hip instability with a clinical suspicion of labral tear, with or without clinical findings suggestive of impingement[12, 14]

Ankle instability and suspected anterior talofibular ligament rupture (anterior and posterior drawer tests) as a result of a sprain requires initial active conservative therapy (above) and x-ray

Painful acquired or congenital flatfoot deformity in an adult, after x-ray completed and MRI is contraindicated

- After failure of active conservative therapy listed above[15, 16]

Extremity Mass

- Mass or lesion after non-diagnostic x-ray or ultrasound[17] and MRI cannot be performed. CT is better than MRI to evaluate mass calcification or bone involvement and may complement or replace MRI[18]
    - Baker's cyst should be initially evaluated with ultrasound
    - If superficial, then ultrasound is the initial study
    - If deep, then x-ray is the initial study

Known Cancer of the Extremity[19-23]

- Cancer staging
- Cancer Restaging
- Signs or symptoms of recurrence

Infection of Bone or Joint[24, 25]

Note: MRI and nuclear medicine studies are recommended for acute infection as they are more sensitive in detecting early changes of osteomyelitis.[26, 27] CT is better at demonstrating findings of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) as well as detecting soft tissue gas and foreign bodies.[28]

- Abnormal x-ray or ultrasound
- Negative x-ray but with a clinical suspicion of infection
    - Signs and symptoms of joint or bone infection include:
        - Pain and swelling
        - Decrease range of motion
        - Fevers

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    - Laboratory findings of infection include:
        - Elevated ESR or CRP
        - Elevated white blood cell count
        - Positive joint aspiration
- Ulcer (diabetic, pressure, ischemic, traumatic) with signs of infection (redness, warm, swelling, pain, discharge which may range from white to serosanguineous) that is not improving despite treatment and bone or deep infection is suspected[29]
    - Increased suspicion if size or temperature increases, bone is exposed/positive probe-to-bone test, new areas of breakdown, new smell[30]
- Neuropathic foot with friable or discolored granulation tissue, foul odor, non-purulent discharge, and delayed wound healing[31]

Osteonecrosis (Avascular necrosis (AVN), Legg-Calve-Perthes Disease) when MRI is contraindicated or cannot be performed[32-34]

- Abnormal x-ray
- Normal or indeterminate x-rays but symptomatic and high risk (e.g., glucocorticosteroid use, renal transplant recipient, glycogen storage disease, alcohol abuse,[35] sickle cell anemia[36])

For evaluation of known or suspected autoimmune disease (e.g., rheumatoid arthritis) and MRI is contraindicated[37]

- Further evaluation of an abnormality or non-diagnostic findings on prior imaging
- Initial imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR)
- To determine change in treatment or when diagnosis is uncertain prior to start of treatment
- Follow-up to determine treatment efficacy of early rheumatoid arthritis
- Follow-up to determine treatment efficacy of advanced rheumatoid arthritis if x-ray and ultrasound are equivocal or noncontributory

Crystalline Arthropathy

- Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD[38]

Trauma

Bone Fracture

- Suspected stress or insufficiency fracture with a negative initial x-ray[39-41]:
    - If hips and MRI cannot be done
    - Non-hip extremities: if x-rays, taken 10-14 days after the injury or clinical assessment, are negative or nondiagnostic[42]
    - If at high risk for a complete fracture with conservative therapy (e.g., navicular bone) and MRI cannot be performed[43]
- Suspected acute hip fracture with initial x-rays negative or non-diagnostic[11, 44]
- Intra articular fractures that may require surgery (i.e., depressed tibial plateau fracture)[45]

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- Nonunion or delayed union as demonstrated by no healing between two sets of x-rays. If a fracture has not healed by 4-6 months, there is delayed union. Incomplete healing by 6-8 months is nonunion[46, 47]

Tendon or Muscle Rupture after X-Ray and MRI is contraindicated or cannot be performed[48-50]
- Clinical suspicion based on mechanism of injury and physical findings

Suspected ACL Rupture - Acute knee injury with physical exam limited by pain and swelling with x-ray completed (Wheeless, 2018) if MRI is contraindicated[6]
- Inability to perform because of pain and swelling should be considered a red flag
- Suspicion should be based on mechanism of injury, i.e., twisting, blunt force
- Normal x-ray:
    - Extreme pain, inability to stand, audible pop at time of injury, very swollen joint, leg numbness
- Abnormal x-ray:
    - Large joint effusion on x-ray knee effusion[51]

Osteochondral Lesions (defects, fractures, osteochondritis dissecans) and x-ray done (if MRI contraindicated or cannot be done)[6, 14, 52-54]
- Clinical suspicion based on mechanism of injury and physical findings

Foreign Body[55]
- Indeterminate x-ray and ultrasound

Loose bodies or synovial chondromatosis seen on x-ray or ultrasound
- In the setting of joint pain[56]

Peripheral Nerve Entrapment (e.g., tarsal tunnel, Morton's neuroma) and MRI is contraindicated, including any of the following[57-60]
- Abnormal Electromyogram or Nerve conduction study
- Abnormal x-ray or ultrasound
- Clinical suspicion and failed 4 weeks conservative treatment including at least 2 of the following (active treatment with physical therapy is not required):
    - Activity modification
    - Rest, ice, or heat
    - Splinting or orthotics
    - Medication

Pediatrics
Note: Leg length discrepancy – the literature indicates that standing plain film x-rays are preferred, but there are some advantages to using a CT scanogram instead and may be preferred[61, 62]
- Osteoid Osteoma after an x-ray is done[63]

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- Painful flatfoot (Pes planus) deformity with suspected tarsal coalition, not responsive to active conservative care[64]
    - When MRI cannot be performed; **OR**
    - Extra-articular coalition is suspected (bony bridges around the joints); **OR**
    - When needed for surgical planning[65]
- Slipped Capital Femoral Epiphysis and Chronic Recurrent Multifocal Osteomyelitis – MRI is the appropriate modality, rather than CT

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- When imaging, physical, or laboratory findings indicate joint infection, delayed or non-healing, or other surgical/procedural complications
- Joint prosthesis loosening or dysfunction, x-rays non-diagnostic[66, 67]
- Trendelenburg sign or other indication of muscle or nerve damage after recent hip surgery

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Table 1: Positive Orthopedic Joint Tests, Lower Extremity

ANKLE

Fibular translation
Squeeze
Cotton
Thompson
Thumb squeeze test
Mulder click

HIP

KNEE

Anterior draw
Pivot Shift Test
Lachman
Posterior tibial Sag
Posterior Draw
McMurray's Test
Valgus stress
Varus stress
Ege

BACKGROUND

Plain radiographs are typically used as the first-line modality for assessment of lower extremity conditions. Computed tomography (CT) is used for evaluation of tumors, metastatic lesions, infection, fractures, and other problems. Magnetic resonance imaging (MRI) is the first-line choice for imaging of many conditions, but CT may be used in these cases if MRI is contraindicated or unable to be performed.

OVERVIEW

***Conservative Therapy** – (musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components such as rest, ice, heat, modified activities, medical devices (such as crutches, immobilizer, metal braces, orthotics, rigid stabilizer, or splints, etc. and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized. Active modalities may consist of physical therapy, a physician-supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program (HEP)** – the following two elements are required to meet guidelines for completion of conservative therapy:

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- Information provided on exercise prescription/plan AND
- Follow up with member with information provided regarding completion of HEP (after suitable 4-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).

Joint Implants and Hardware – Dual-energy CT may be useful for metal artifact reduction if available but is also imperfect as the correction is based on a projected approximation of x-ray absorption, and it does not correct for scatter.[68] Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (calcium pyrophosphate deposition).[38]

CT and Ankle Fractures – One of the most frequently injured areas of the skeleton is the ankle. These injuries may include ligament sprains, as well as fractures. A suspected fracture is first imaged with conventional radiographs in anteroposterior, internal oblique and lateral projections. CT is used in patients with complex ankle and foot fractures after radiography.

CT and Hip Trauma – Computed tomography is primarily used to evaluate acute trauma, e.g., acetabular fracture or hip dislocation. It can detect intraarticular fragments and associated articular surface fractures, and it is useful in surgical planning.

CT and Knee Fractures – CT is used after plain films to evaluate fractures to the tibial plateau. These fractures occur just below the knee joint, involving the cartilage surface of the knee. Soft tissue injuries are usually associated with the fractures. The meniscus is a stabilizer of the knee, and it is very important to detect meniscal injury in patients with tibial plateau fractures. CT of the knee with two-dimensional reconstruction in the sagittal and coronal planes may be performed for evaluation of injuries with multiple fragments and comminuted fractures. Spiral CT has an advantage of rapid acquisition and reconstruction times and may improve the quality of images of bone. Soft tissue injuries are better demonstrated with MRI.

CT and Knee Infections – CT is used to depict early infection which may be evidenced by increased intraosseous density or the appearance of fragments of necrotic bone separated from living bone by soft tissue or fluid density. Contrast-enhanced CT may help in the visualization of abscesses and necrotic tissue.

CT and Knee Tumors – CT complements arthrography in diagnosing necrotic malignant soft-tissue tumors and other cysts and masses in the knee. Meniscal and ganglion cysts are palpable masses around the knee. CT is useful in evaluations of the vascular nature of lesions.

CT and Legg-Calve-Perthes Disease (LPD) – This childhood condition is associated with an insufficient blood supply to the femoral head which is then at risk for osteonecrosis. Clinical signs of LPD include a limp with groin, thigh, or knee pain. Flexion and adduction contractures may develop as the disease progresses and eventually movement may only occur in the flexion-extension plane. This condition is staged based on plain radiographic findings. CT scans are used in the evaluation of LPD and can demonstrate changes in the bone trabecular pattern. They also

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allow diagnosis of bone collapse and sclerosis early in the disease where plain radiography is not as sensitive.

CT and Osteolysis – Since computed tomography scans show both the extent and the location of lytic lesions, they are useful to guide treatment decisions, as well as to assist in planning for surgical intervention when needed, in patients with suspected osteolysis after Total Hip Arthroplasty (THA).

CT and Tarsal Coalition – This is a congenital condition in which two or more bones in the mid-foot or hind-foot are joined. It usually presents during late childhood or late adolescence and is associated with repetitive ankle sprains. Mild pain, deep in the subtalar joint and limited range of motion are clinical symptoms. Tarsal coalition is detectable on oblique radiographs, but these are not routinely obtained at many institutions. Clinical diagnosis is not simple; it requires the expertise of skilled examiners. CT is valuable in diagnosing tarsal coalition because it allows differentiation of osseous from non-osseous coalitions and depicts the extent of joint involvement as well as degenerative changes. It may also detect the overgrowth of the medial aspect of the talus that may be associated with talocalcaneal coalitions.

American Academy of Pediatrics "Choosing Wisely" Guidelines advise against ordering advanced imaging studies (MRI or CT) for most musculoskeletal conditions in a child until all appropriate clinical, laboratory and plain radiographic examinations have been completed. **"**History, physical examination, and appropriate radiographs remain the primary diagnostic modalities in pediatric orthopedics, as they are both diagnostic and prognostic for the great majority of pediatric musculoskeletal conditions. Examples of such conditions would include, but not be limited to, the work up of injury or pain (spine, knees and ankles), possible infection, and deformity. MRI examinations and other advanced imaging studies frequently require sedation in the young child (5 years old or less) and may not result in appropriate interpretation if clinical correlations cannot be made. Many conditions require specific MRI sequences or protocols best ordered by the specialist who will be treating the patient…if you believe findings warrant additional advanced imaging, discuss with the consulting orthopedic surgeon to make sure the optimal studies are ordered."[69]

POLICY HISTORY

Date	Summary
March 2022	• Clarification of language for non-hip stress fractures • Deleted Thessaly sign based on updated literature
May 2021	• Added unstable syndesmotic injury • Removed ankle instability • Added the following: navicular bone to high risk stress fracture, information about suspected bone infection in the setting of ulcers and neuropathy and following treatment for rheumatoid arthritis

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	• Clarified that pre-operative imaging is for *a planned surgery or procedure* • Removed *CT or MRI requests are *not* approvable for the following total knee arthroplasty (TKA) procedures: o Procedures utilizing computer-navigated or patient-specific or gender-specific instrumentation (Johnson, 2011) o Bicompartmental arthroplasty (investigational at this time) (Dudhniwala, 2016) o **Note**: Robot-assisted TKA (Makoplasty) (Banerjee, 2015; Nair, 2014) These surgical procedures are not considered a covered service and are not reimbursable based on lack of current scientific evidence for clinically important improvement, safety or efficacy; or based on scientific evidence of increased risk of serious complications. • Included early complications of hip surgery to the post operative evaluation list
May 2020	• Expanded orthopedic signs listing and moved to the top • Added note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging. • Added labral tear/posterior impingement to approvable list • Added flatfoot deformity • Expanded section about initial work-up of a mass • Added the National Comprehensive Care Network as a reference for imaging guidance • Expanded the section on osteomyelitis • Added section on crystalline arthropathy • Revised the section on non or delayed union • Added a section on loose bodies and synovial chondromatosis • Added a pediatric section • Removed Makoplasty from not approvable list • Added a section about joint implants and hardware to the background section • Updated references
May 2019	• Reformatting in parallel with the new LE MRI. Updated references • Added indication: peripheral nerve entrapment • Criteria for approval of existing indications specified within the parameters of the current evidence base

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	• Added initial statement about approvals: 'Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time'. • Added Extremity mass indications including peripheral lymphadenopathy; and mass with increased risk for malignancy • Modified Known Cancer indication to be more broad – 'cancer staging, cancer restaging, signs or symptoms of recurrence' • Expanded section for infection of bone or joint to include list of signs or symptoms and laboratory findings (elevated ESR or CRP, elevated white blood cell count, positive joint aspiration)

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LOWER EXTREMITY CTA/CTV**	**Original Date: July 01, 2008**
CPT Codes: 73706	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_061-1	**Implementation Date: January 2023**

INDICATIONS FOR LOWER EXTREMITY CTA/CTV (COMPUTED TOMOGRAPHY ANGIOGRAM / COMPUTED TOMOGRAPHY VENOGRAM)

Abdominal Arteries CTA (CT Angiography) (CPT Code 75635) includes run-off so this is never approved when that procedure has been.

Peripheral Vascular Disease and Abdominal Arteries CTA (CT Angiography) (CPT Code 75635) has not been recently approved

- Critical Limb ischemia **ANY** of the below with clinical signs of peripheral artery disease. Ultrasound imaging is not needed. If done and negative, it should still be approved due to high false negative rate[1, 2]
    - Ischemic rest pain
    - Tissue loss
    - Gangrene
- Claudication with abnormal (ankle/brachial index, arterial Doppler)[3-5]
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (ankle/brachial index, arterial Doppler)[6]
- After stenting or surgery with signs of recurrent symptoms OR abnormal ankle/brachial index; abnormal or indeterminate arterial Doppler, OR pulse volume recording)[5]

Popliteal Artery Entrapment Syndrome with abnormal arterial ultrasound[7]

Deep Venous Thrombosis with clinical suspicion of lower extremity DVT after abnormal or non-diagnostic ultrasound where a positive study would change management[8-10]

Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound or other imaging

- Tumor invasion[11]
- Trauma[12]
- Vasculitis[13]

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- Aneurysm[14]
- Stenosis/occlusions[15]

Hemodialysis Graft Dysfunction after Doppler ultrasound not adequate for treatment decisions[16]

Vascular Malformation[17, 18] - If MRA is contraindicated
- Non diagnostic doppler ultrasound

Note: CTA useful in delineating high flow lesions such as an arteriovenous malformation.

Traumatic injuries with clinical findings suggestive of arterial injury[12]

Assessment/evaluation of known vascular disease/condition

Pre-operative/procedural evaluation
- Pre-operative evaluation for a planned surgery or procedure[3]

Post- operative/procedural evaluation
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested[19, 20]

Special Circumstances[2]
- High suspicion of an acute arterial obstruction - Arteriography preferred (the gold standard).
- Renal impairment
    - Not on dialysis
        - Mild to moderate, GFR 30-89 ml/min MRA can be done
        - Severe, GFR < 30 ml/min MRA without contrast
    - On dialysis
        - CTA with contrast can be done
- Doppler ultrasound can be useful in evaluating bypass grafts

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BACKGROUND

Lower extremity computed tomography angiography (CTA) is an effective, noninvasive and robust imaging modality that is used in the assessment of symptomatic lower extremity vascular disease. It has excellent spatial resolution and shows accurate details of peripheral vasculature. CTA is an effective alternative to catheter-based angiography and allows accurate planning of open surgical and endovascular interventions.

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OVERVIEW

Abdominal Arteries CTA – For imaging of the abdomen, pelvis **AND** both legs (CTA aorto-iliofemoral runoff; abdominal aorta and bilateral iliofemoral lower extremity runoff) use CPT code 75635.

Peripheral Arterial Disease – CTA is used in the evaluation of patients with peripheral arterial disease. It can be used to evaluate the patency after revascularization procedures. It is the modality of choice in patients with intermittent claudication. A drawback is its hampered vessel assessment caused by the depiction of arterial wall calcifications, resulting in a decreased accuracy in severely calcified arteries.

Chronic Limb Threatening Ischemia – Assessment and promotion of blood flow through the calf arteries is very important in patients with chronic limb threatening ischemia. CT Angiography allows for visualization of pedal vessels.

Surgical or Percutaneous Revascularization – CTA is accurate in the detection of graft-related complications, including stenosis and aneurysmal changes. It can reveal both vascular and extravascular complications.

CTA and screening for peripheral vascular disease: The USPSTF (U.S. Preventive Services Task Force) does not recommend routine screening for peripheral vascular disease in asymptomatic patients.[21] High risk patients (e.g., diabetics) may be screened with ABI (ankle brachial index) and duplex ultrasound.

POLICY HISTORY

Date	Summary
March 2022	No changes
May 2021	No changes
May 2020	• Clarified that CTA does not include a baseline CT exam • Expanded section about vascular malformation to include initial testing. • Added information about renal function and contrast agents • Added acute arterial obstruction and renal impairment • Simplified language • Updated references
May 2019	• Added indication for deep venous thrombosis • Reformatting and new references.

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LOWER EXTREMITY MRI** **(Foot, Ankle, Knee, Leg or Hip MRI)**	**Original Date: September 1997**
CPT Codes: 73718, 73719, 73720, 73721, 73722, 73723, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_057-4	**Implementation Date: January 2023**

INDICATIONS FOR LOWER EXTREMITY MRI (FOOT, ANKLE, KNEE, LEG or HIP)
(Plain radiographs must precede MRI evaluation)

Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time.

If an MR Arthrogram fits approvable criteria below, approve as MRI

Joint specific provocative orthopedic examination[1]
Note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging (see Table 1).

- Ankle
  - Unstable syndesmotic injury (high ankle injury)
    - With inconclusive stress x-rays and a standing CT cannot be done
    - Can have positive fibular translation, squeeze or cotton test, but imaging may be needed to confirm diagnosis
- Knee[2-7]
  - Joint instability or meniscal injury on exam, demonstrated with a positive
    - McMurray's
    - Apley's
    - Lachman's
    - Anterior or Posterior Drawer sign
    - Varus or valgus stress
    - Acute mechanical locking of the knee not due to guarding[8]
- Hip
  - Anterior Impingement sign (labral tear)[9-11]
  - Posterior Impingement sign (labral tear)[12]

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Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed[4, 13, 14] (does not apply to young children).

- Persistent joint or musculotendinous pain unresponsive to conservative treatment*, within the last 6 months which includes active medical therapy (physical therapy, chiropractic treatments, and/or physician supervised exercise**) of at least four (4) weeks, **OR**
- With progression or worsening of symptoms during the course of conservative treatment
- Persistent hip mechanical symptoms including clicking, locking, catching, giving way or hip instability with a clinical suspicion of labral tear, with or without clinical findings suggestive of impingement[12, 15]

Ankle instability and suspected anterior talofibular ligament rupture (anterior and posterior drawer tests) as a result of a sprain requires initial active conservative therapy (above) and x-ray

Painful acquired or congenital flatfoot deformity in an adult, after x-ray completed

- After failure of active conservative therapy listed above[16, 17]

Extremity Mass

- Mass or lesion after non-diagnostic x-ray or ultrasound[18]
    - Baker's cyst should be initially evaluated with ultrasound
    - If superficial mass, then ultrasound is the initial study
    - If deep mass, then x-ray is the initial study

Known Cancer of the Extremity[19-23]

- Cancer staging
- Cancer Restaging
- Signs or symptoms of recurrence

Infection of Bone or Joint[24-26]

- Abnormal x-ray or ultrasound
- Negative x-ray but with a clinical suspicion of infection
    - Signs and symptoms of joint or bone infection include:
        - Pain and swelling
        - Decreased range of motion
        - Fevers
    - Laboratory findings of infection include:
        - Elevated ESR or CRP
        - Elevated white blood cell count
        - Positive joint aspiration
        - Ulcer (diabetic, pressure, ischemic, traumatic) with signs of infection (redness, warm, swelling, pain, discharge which may range from white to

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serosanguineous) that is not improving despite treatment and bone or deep infection is suspected
    - Increased suspicion if size or temperature increases, bone is exposed/positive probe-to-bone test, new areas of breakdown, new smell[27]
- Neuropathic foot with friable or discolored granulation tissue, foul odor, non-purulent discharge, and delayed wound healing[28]

Osteonecrosis (e.g., Avascular Necrosis (AVN), Legg-Calve-Perthes Disease)[29-31]

- Abnormal x-ray
- Normal or Indeterminate X-rays, but symptomatic and high risk
    - Glucocorticosteroid use
    - Renal Transplant recipient
    - Alcohol abuse[32]
    - Sickle Cell Anemia[33]

For evaluation of known or suspected autoimmune disease (e.g., rheumatoid arthritis)[34]

- Further evaluation of an abnormality or non-diagnostic findings on prior imaging
- Initial imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR)
- To determine change in treatment or when diagnosis is uncertain prior to start of treatment
- Follow-up to determine treatment efficacy of the following:
    - Early rheumatoid arthritis
    - Advanced rheumatoid arthritis if x-ray and ultrasound are equivocal or noncontributory

Trauma

Bone Fracture

- Suspected stress or insufficiency fracture with a negative initial x-ray[35, 36]:
    - If hips, then approve an immediate MRI
    - Suspicion of a hip fracture in a pregnant patient does not require an initial x-ray
    - Non-hip extremities: if x-rays, taken 10-14 days after the injury or clinical assessment, are negative or nondiagnostic[37]
    - If at high risk for a complete fracture with conservative therapy (e.g., navicular bone), then immediate MRI is warranted[38]
- Suspected acute hip fracture with initial x-rays negative or non-diagnostic[11, 39]
- Pathologic fracture on x-ray[40]
- Intra-articular fractures that may require surgery (e.g., depressed tibial plateau fracture)[41]
- Nonunion or delayed union as demonstrated by no healing between two sets of x-rays. If a fracture has not healed by 4-6 months, there is delayed union. Incomplete healing by 6-8 months is nonunion, CT is the preferred study[42]

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Tendon or Muscle Rupture after X-Ray[43-46]

- Clinical suspicion based on mechanism of injury and physical findings

Suspected ACL Rupture - Acute knee injury with physical exam limited by pain and swelling with x-ray completed[47, 48]

- Based on mechanism of injury, i.e., twisting, blunt force
- Normal x-ray:
    - Extreme pain, inability to stand, audible pop at time of injury, very swollen joint, leg numbness
- Abnormal x-ray:
    - Large joint effusion on x-ray knee effusion

Osteochondral lesions (defects, fractures, osteochondritis dissecans) and x-ray completed[2, 15, 49, 50]

- Clinical suspicion based on mechanism of injury and physical findings

Foreign Body[51]

- Indeterminate x-ray and ultrasound

Loose bodies or synovial chondromatosis seen on x-ray or ultrasound

- In the setting of joint pain[52]

Hip Impingement (Femoroacetabular Impingement)

- With negative, equivocal, or non-diagnostic x-rays[15] (and imaging would change treatment – active conservative care or surgery are the two mainstays of treatment)[53]
- To determine candidacy for hip preservation surgery[54]

Known or suspected inflammatory myopathies: (Includes polymyositis, dermatomyositis, immune-mediated necrotizing myopathy, inclusion body myositis)[55, 56]

- For diagnosis
- For biopsy planning

Peripheral Nerve Entrapment (e.g., tarsal tunnel, Morton's neuroma)[57-60]

- Abnormal Electromyogram or Nerve conduction study
- Abnormal x-ray or ultrasound
- Clinical suspicion and failed 4 weeks conservative treatment including at least two of the following (active treatment with physical therapy is not required):
    - Activity modification
    - Rest, ice, or heat
    - Splinting or orthotics
    - Medication

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Pediatrics

- Painful flatfoot deformity with suspected tarsal coalition, not responsive to active conservative care[61]
- Slipped Capital Femoral Epiphysis with negative frog leg and AP x-rays of the hips but clinically suspected[62-64]
    - Drehman sign
    - Limited internal rotation of the hip
    - Consider imaging the asymptomatic contralateral hip with a normal x-ray to detect early SCFE if prophylactic surgery is planned[65]
- Chronic Recurrent Multifocal Osteomyelitis after initial work-up (labs and x-ray)[66]
- Acute limp in a child 5 or less years old, concern for infection (initial x-rays not needed)[67]
- There is no relevant literature regarding the use of MRI pelvis to the feet in the initial evaluation of acute limp with nonlocalized symptoms and no concern for infection.
- Osteoid Osteoma – MRI not usually done because x-ray and CT more accurate for diagnosis[68]

Pre-operative/procedural evaluation

Pre-operative evaluation for a planned surgery or procedure

Post-operative/procedural evaluation

- When imaging, physical or laboratory findings indicate joint infection, delayed or non-healing or other surgical/procedural complications
- Joint prosthesis loosening or dysfunction, x-rays non-diagnostic[69, 70]
- Trendelenburg sign[71] or other indication of muscle or nerve damage after recent hip surgery

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Table 1: Positive Orthopedic Joint Tests, Lower Extremity

ANKLE

Fibular translation
Squeeze
Cotton
Thompson
Thumb squeeze test
Mulder click

HIP

KNEE

Anterior draw
Pivot Shift Test
Lachman
Posterior tibial Sag
Posterior Draw
McMurray's Test
Valgus stress
Varus stress
Ege

BACKGROUND

Magnetic resonance imaging shows the soft tissues and bones. With its multiplanar capabilities, high contrast, and high spatial resolution, it is an accurate diagnostic tool for conditions affecting the joint and adjacent structures. MRI can positively influence clinicians' diagnoses and management plans for patients with conditions such as primary bone cancer, fractures, abnormalities in ligaments/tendons/cartilage, septic arthritis, and infection/inflammation.

OVERVIEW

***Conservative Therapy** – (Musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components such as rest, ice, heat, modified activities, medical devices, (including crutches, immobilizer, metal braces, orthotics, rigid stabilizer, or splints, etc. and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.

****Home Exercise Program (HEP)** – the following two elements are required to meet guidelines for completion of conservative therapy:

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- Information provided on exercise prescription/plan AND
- Follow-up with member with information provided regarding completion of HEP (after suitable 4-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).

Joint Implants and Hardware – The presence of a metallic implant or metallic fixation device does not represent a contraindication to MRI. More recently, the advent of implants made with less ferromagnetic alloys and technical advancements of MR sequences (metal artifact reduction sequences [MARS], slice encoding for metal artifact correction [SEMAC], and multi-acquisition with variable-resonance image combination [MAVRIC]) made MRI fully feasible in patients with joint implants, with artifacts mostly limited to the area of the implant itself.[26]

Stress Fractures – "Certain stress fractures are considered high risk based on a tendency for nonunion or delayed union. High-risk stress fractures include the anterior tibial diaphysis, lateral femoral neck and femoral head…patella, medial malleolus, navicular, fifth metatarsal base, proximal second metatarsal, tibial hallux sesamoid, and talus. The second-line test to diagnose a stress fracture should be guided by the location of the patient's pain and likelihood of high-risk injury. A follow-up radiographic examination has increased sensitivity compared to initial radiographs but is less sensitive than MRI."[35]

MRI and Knee Trauma – MRI is an effective means of evaluating internal derangements of the knee with a very high accuracy for detection of meniscal injury. On MRI of the knee, meniscal injury may appear "free-floating", corresponding to a meniscal avulsion or detachment from the tibial plateau. The floating meniscus seen on MRI is a result of significant trauma. It may also be associated with significant ligamentous injury. The results of the MRI are valuable to the surgeon as they plan to reattach the meniscus to the tibial plateau.

MRI and Osteonecrosis – Osteonecrosis is a complication of knee surgery which may be accompanied by new or persistent pain after meniscal surgery. It can be detected by MRI with subcortical low signal intensity of T1-weighted images with or without central high signal intensity on T2-weighted images. Osteonecrosis can result in collapse of the articular surface.

MRI and Legg-Calve-Perthes Disease (LPD) – This childhood condition is associated with an insufficient blood supply to the femoral head which is then at risk for osteonecrosis. Clinical signs of LPD include a limp with groin, thigh, or knee pain. Flexion and adduction contractures may develop as the disease progresses and eventually movement may only occur in the flexion-extension plane. This condition is staged based on plain radiographic findings. MRI is used in identifying the early stage of LPD when plain films are normal. It is also used in preoperative planning to diagnose "hinge abduction" (lateral side of the femoral head contacts the acetabular margin and femoral head does not slide as it should). However, MRI is not used as a standard diagnostic tool.

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MRI and Septic Arthritis – Young children and older adults are the most likely to develop septic arthritis in the hip joint. Early symptoms include pain in the hip, groin, or thigh along with a limping gait and fever. It is sometimes hard to differentiate this condition from transient synovitis, a less serious condition with no known long-term sequelae. MRI may help in the differential diagnosis of these two conditions. Coronal T1-weighted MRI, performed immediately after contrast administration, can evaluate blood perfusion at the femoral epiphysis.

MRI and Slipped Capital Femoral Epiphysis – This condition, where the femoral head is displaced in relation to the femoral neck, is the most common hip disorder in adolescents, and it is more common in obese children. Its symptoms include a limping gait, groin pain, thigh pain and knee pain. Most cases are stable, and the prognosis is good with early diagnosis and treatment. Unstable slipped capital femoral epiphysis may lead to avascular necrosis. MRI is used for diagnosis of slipped capital femoral epiphysis. Its image can be oriented to a plane orthogonal to the plane of the physis to detect edema in the area of the physis.

MRI and Tarsal Coalition – This is a congenital condition in which two or more bones in the midfoot or hindfoot are joined. It usually presents during late childhood or late adolescence and is associated with repetitive ankle sprains. Mild pain, deep in the subtalar joint and limited range of motion are clinical symptoms. Tarsal coalition is detectable on oblique radiographs, but these are not routinely obtained at many institutions. Clinical diagnosis is not simple; it requires the expertise of skilled examiners. MRI is valuable in diagnosing tarsal coalition because it allows differentiation of osseous from non-osseous coalitions and depicts the extent of joint involvement as well as degenerative changes. It may also detect overgrowth of the medial aspect of the talus that may be associated with talocalcaneal coalitions.

MRI and Tarsal Tunnel – Tarsal Tunnel Syndrome is due to compression of the posterior tibial nerve as it passes through the tarsal tunnel into the foot. Compression can cause a sensation of burning or numbness to the bottom of the foot. Common causes include flat foot, over-protonation, and arthritis. Nerve conduction studies can reveal damage to the posterior tibial nerve. MRI may be valuable in demonstrating other structures causing extrinsic compression on the nerve.[72]

MRI and Chronic Recurrent Multifocal Osteomyelitis – This noninfectious inflammation of the bone in children can have non-elevated inflammatory markers and a normal CBC. This condition presents as bone pain of insidious onset with or without localized swelling but can be multifocal and have silent areas of involvement (vertebral silent lesions can lead to compression). MRI can be approved after initial labs and x-ray. CT is not sensitive, so the next option is a bone scan.

The American Medical Society for Sports Medicine "Choosing Wisely" Guidelines advise against ordering a knee MRI for a patient with anterior knee pain without mechanical symptoms or effusion unless the patient has not improved following completion of an appropriate functional rehabilitation program. "The most common cause of anterior knee pain is patellofemoral pain syndrome. Magnetic resonance imaging (MRI) is rarely helpful in

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managing this syndrome. Treatment should focus on a guided exercise program to correct lumbopelvic and lower limb strength and flexibility imbalances. If pain persists, if there is recurrent swelling or if mechanical symptoms such as locking and painful clicking are present, and radiographs are non-diagnostic, an MRI may be useful."[73]

The American Academy of Pediatrics "Choosing Wisely" Guidelines advise against ordering advanced imaging studies (MRI or CT) for most musculoskeletal conditions in a child until all appropriate clinical, laboratory and plain radiographic examinations have been completed. **"**History, physical examination, and appropriate radiographs remain the primary diagnostic modalities in pediatric orthopaedics, as they are both diagnostic and prognostic for the great majority of pediatric musculoskeletal conditions. Examples of such conditions would include, but not be limited to, the work up of injury or pain (spine, knees, and ankles), possible infection, and deformity. MRI examinations and other advanced imaging studies frequently require sedation in the young child (5 years old or less) and may not result in appropriate interpretation if clinical correlations cannot be made. Many conditions require specific MRI sequences or protocols best ordered by the specialist who will be treating the patient… if you believe findings warrant additional advanced imaging, discuss with the consulting orthopaedic surgeon to make sure the optimal studies are ordered."[74]

POLICY HISTORY

Date	Summary
March 2022	• Clarification of language for non-hip stress fractures • Deleted Thessaly sign based on updated literature
November 2021	• Added +0698T
May 2021	• Added unstable syndesmotic injury • Removed ankle instability • Added the following: navicular bone to high risk stress fracture; information about suspected bone infection in the setting of ulcers and neuropathy, following treatment for rheumatoid arthritis • Clarified that pre-operative imaging is for a planned surgery or procedure • Included early complications of hip surgery to the post operative evaluation list
May 2020	• Expanded orthopedic signs listing and moved to the top • Added note: With a positive orthopedic sign, an initial x-ray is always preferred. However, it is not required to approve advanced imaging. • Added labral tear/posterior impingement to approvable list • Added flatfoot deformity • Expanded section about initial work-up of a mass

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	• Added the National Comprehensive Care Network as a reference for imaging guidance • Expanded the section on stress fractures • Revised the section on non or delayed union • Added a section on loose bodies and synovial chondromatosis • Added a pediatric section • Removed Makoplasty from not approvable list • Added a section about joint implants and hardware to the background section • Added a section about chronic recurrent multifocal osteomyelitis to the background section • Updated references
January 2020	• Added 'infection of bone or joint section' previously omitted in error
May 2019	• Added initial statement about approvals: 'Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time'. • Added joint or muscle pain when x-ray completed • Expanded Extremity mass indications including peripheral lymphadenopathy; and mass with increased risk for malignancy • Added indications for foreign body and peripheral nerve entrapment • Modified Known Cancer indication to be more broad – 'cancer staging, cancer restaging, signs or symptoms of recurrence' • Expanded sections for bone fracture and infection of bone or joint to include list of signs or symptoms and laboratory findings (elevated ESR or CRP, elevated white blood cell count, positive joint aspiration)

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LOWER EXTREMITY MRA/MRV**	**Original Date: September 1997**
CPT Code: 73725	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_058-1	**Implementation Date: January 2023**

When a separate MRA and MRI exam is requested, documentation requires a medical reason that clearly indicates why additional MRI imaging of the lower extremity is needed.

Lower Extremity MRA & Abdomen/Pelvis Magnetic Resonance Angiography (MRA) Runoff Requests: **Two authorization requests are required, one Abdomen MRA, CPT code 74185 and one for Lower Extremity MRA, CPT code 73725.** This will provide imaging of the abdomen, pelvis, and both legs.

INDICATIONS FOR LOWER EXTREMITY MRA/MRV

Peripheral Vascular Disease

- Critical Limb ischemia **ANY** of the below with clinical signs of peripheral artery disease. Ultrasound imaging is not needed. If done and negative, it should still be approved due to high false negative rate[1, 2]
    - Ischemic rest pain
    - Tissue loss
    - Gangrene
- Claudication with abnormal (ankle/brachial index, pulse volume recording or arterial Doppler[3-5]
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (ankle/brachial index, arterial Doppler)[6]
- After stenting or surgery with signs of recurrent symptoms OR abnormal ankle/brachial index; abnormal or indeterminate arterial Doppler, OR pulse volume recording)[4]

Popliteal Artery Entrapment Syndrome with abnormal arterial ultrasound[7]

Deep Venous Thrombosis with clinical suspicion of lower extremity DVT after abnormal or non-diagnostic ultrasound where a positive study would change management[8-10]

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Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound or other imaging

- Tumor invasion[11, 12]
- Trauma[13]
- Vasculitis[14]
- Aneurysm[15]
- Stenosis/occlusions[16]

Vascular Malformation[17, 18]

- Non diagnostic doppler ultrasound

Traumatic injuries with clinical findings suggestive of arterial injury – CTA preferred emergently[13]

Assessment/evaluation of suspected or known vascular disease/condition

Pre-operative/procedural evaluation

- Pre-operative evaluation for a planned surgery or procedure[3]

Post-operative/procedural evaluation

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.[19, 20]

Special Circumstances[2]

- High suspicion of an acute arterial obstruction - Arteriography preferred (the gold standard).
- Renal impairment
    - Not on dialysis
        - Mild to moderate, GFR 30-45 ml/min MRA with contrast can be performed
        - Severe, GFR < 30 ml/min MRA without contrast
    - On dialysis
        - CTA with contrast can be done
- Doppler ultrasound can be useful in evaluating bypass grafts

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BACKGROUND

Magnetic resonance angiography (MRA) is a noninvasive alternative to catheter angiography for evaluation of vascular structures in the lower extremity. Magnetic resonance venography (MRV) is used to image veins instead of arteries. MRA and MRV are less invasive than conventional x-ray digital subtraction angiography.

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OVERVIEW

Noninvasive testing - **Noninvasive hemodynamic testing** – "Noninvasive testing (NIVT), both before and after intervention, has been used for decades as a first-line investigatory tool in the diagnosis and categorization of PAD. It is widely available and provides a large amount of information at low cost without the use of ionizing radiation. NIVT can consist of one or more of the following components: the ABI, segmental pressure measurements (SPMs), pulse-volume recordings (PVRs), photoplethysmography (PPG), and transcutaneous oxygen pressure measurement (TcPO2)."[20]

MRA of Foot – Fast contrast-enhanced time-resolved 3D MR angiography is used in evaluating the arterial supply of the foot. It does not require the use of ionizing radiation and iodinated contrast medium and it is minimally invasive, safe, fast, and accurate. Dorsalis pedis bypass surgery is an option for preserving a foot in a patient with arterial occlusive disease and MRA may be used in the preoperative evaluation. It can discriminate arteries from veins and can provide other key information, e.g., patency of the pedal arch, presence of collateral pathways, and depiction of target vessel suitable for surgical bypass. Time-resolved gadolinium-enhanced MRA can identify injured fat pads in the foot before they have become ulcerated.

MRA and arterial obstructive disease – Catheter angiography is the standard of reference for assessing arterial disease but MRA with contrast-enhanced media has gained acceptance and can image the entire vascular system. Contrast agents such as high dose gadolinium have been associated with the development of nephrogenic systemic fibrosis in patients with chronic renal insufficiency, but newer agents are safer in this regard. Gadolinium dosage may be decreased without compromising image quality in high-spatial-resolution contrast-enhanced MRA of the lower extremity.

POLICY HISTORY

Date	Summary
March 2022	Clarified renal impairment, not on dialysis, mild to moderate, GFR 30-45 ml/min MRA with contrast can be performed
May 2021	No changes
May 2020	• Clarified that CTA does not include a baseline CT exam • Expanded section about vascular malformation to include initial testing. • Added information about renal function and contrast agents • Added acute arterial obstruction and renal impairment • Simplified language • Updated references
May 2019	• Added initial statement about approvals: 'Some indications are for MRI, CT, or MR or CT Arthrogram. More than one should not be approved at the same time'. • Added background information and updated references

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc. *	
Clinical guidelines **ABDOMEN CT**	**Original Date: September 1997**
CPT Codes: 74150, 74160, 74170	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_030	**Implementation Date: January 2023**

Note: For syndromes for which imaging starts in the pediatric age group, MRI preferred

NOTE: ABDOMEN CT **ALONE** SHOULD ONLY BE APPROVED WHEN DISEASE PROCESS IS SUSPECTED TO BE LIMITED TO THE ABDOMEN. CT Abdomen/Pelvis Combo (CPT Codes: 74176, 74177, 74178) is the correct study when the indication(s) include both the abdomen AND pelvis, such as CTU (CT Urography), CTE (CT Enterography), acute abdominal pain, widespread inflammatory disease or neoplasm. Otherwise, the exam should be limited to the appropriate area (i.e., Abdomen OR Pelvis) which includes the specific organ, area of known disease/abnormality, or the area of concern.

INDICATIONS FOR ABDOMEN CT

Abdominal Pain for Unknown Etiology

- CT allowed after initial workup is inconclusive and must include results of the following:
    - Initial imaging, such as ultrasound (although ultrasound does have limitations, it is a common misconception that ultrasound is not a good tool in ALL obese patients, such that it is often useful even in obese patients and quite reasonable to attempt as a first-line imaging modality particularly given the benefit of no radiation), scope study, or x-ray AND
    - Appropriate laboratory testing (chemistry profile, complete blood count, and urinalysis)
        - Amylase/ lipase if suspected pancreatitis
        - Liver function tests if suspicion of hepatic disease
- For acute abdominal pain in a patient over the age of 65[1, 2]

Evaluation of suspicious known mass/tumors (unconfirmed diagnosis of cancer) for further evaluation of indeterminate or questionable findings

- Initial evaluation of suspicious masses/tumors found by physical exam or imaging study, such as ultrasound (US), and only the abdomen is affected[3, 4]

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- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the abdomen and pelvis. No further surveillance CT unless tumor(s) are specified as highly suspicious or a change was found on the last follow-up CT, new/changing sign/symptoms, or abnormal lab values
- For abnormal incidental abdominal lymph nodes when follow-up is recommended based on prior imaging (initial 3-month follow-up)[5]

Follow-up of known cancer[6, 7]

- In patient undergoing active treatment within the past year or per surveillance imaging tip sheet that summarizes NCCN recommendations
- Known cancer with suspected abdominal metastasis based on a sign, symptom (e.g., anorexia, early satiety, intestinal obstruction, night sweats, pelvic pain, weight loss, vaginal bleeding) or an abnormal lab value (alpha-fetoprotein, CEA, CA 19-9, p53 mutation)

For evaluation of suspected infection or inflammatory disease based on exam or discovered on previous imaging[8-10]

- Right upper quadrant pain for suspected biliary disease with negative or equivocal ultrasound
- For epigastric or left upper quadrant pain if labs or other imaging are inconclusive[11]

For evaluation of suspected infection or for follow-up known infection limited to the abdomen

- Any known infection that is clinically suspected to have created an abscess limited to the abdomen. (If location unclear or unknown, CT Abdomen/Pelvis)
- Any history of fistula limited to the abdomen that requires re-evaluation or is suspected to have recurred
- Abnormal fluid collection limited to the abdomen seen on prior imaging that needs follow-up evaluation

For evaluation of inflammatory disease or follow-up limited to the abdomen

- For suspected inflammatory bowel disease (Crohn's disease or ulcerative colitis) with abdominal pain **AND** one of the following[12-14]:
    - Chronic diarrhea
    - Bloody diarrhea

  Note: For patients under 35 years old, consider MRE
- High clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy[12-15]
- Known inflammatory bowel disease, (Crohn's or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation

For evaluation of an organ or abnormality seen on previous imaging

ADRENAL

- To locate a pheochromocytoma once there is clear biochemical evidence (may require abdomen and pelvis imaging)
- Suspected adrenal secreting tumor after full clinical and biochemical work-up[16, 17]

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- Suspected adrenal mass ≥ 1 cm incidentally discovered with no history of malignancy (one follow-up in 6-12 months to document stability)
- If adrenal mass ≥ 4 cm and no diagnosis of cancer, can approve for preoperative planning (surgery to rule out adrenal cortical carcinoma)
- For adrenal mass < 4 cm with history of malignancy (if ≥ 4 cm consider biopsy or PET/CT unless pheochromocytoma is suspected)
- Yearly surveillance for patients with Multiple Endocrine Neoplasia type 1 (MEN1) beginning at age 10[18]
- For patients with Von Hippel Lindau, surveillance at least every other year starting at age 16 if MRI contraindicated (Abdominal US starting at age 8)[19]

LIVER

- Indeterminate liver lesion > 1 cm seen on ultrasound[20] **
- Indeterminate liver lesion < 1cm on initial imaging with known chronic liver disease or a history of extrahepatic malignancy
- Hepatitis/hepatoma screening after ultrasound is abnormal, equivocal, or non-diagnostic (may be limited in patients who are obese, those with underlying hepatic steatosis, as well as nodular livers).[21-24] (No literature supports the use of AFP alone in the screening of HCC).
- For jaundice or abnormal liver function tests after equivocal or abnormal ultrasound[25]
- For surveillance of HCC in patients who have received liver-directed therapy, surgical resection, medical treatment or transplant (MRI or CT) at one-month post treatment and then every 3 months for up to two years[25, 26]**
- For follow-up of suspected adenoma every 6-12 months
- To confirm diagnosis of focal nodular hyperplasia seen on other imaging
- For follow-up of focal nodular hyperplasia (FNH) annually if US is inconclusive[27]
- Pre-procedure for transjugular intrahepatic portosystemic shunt (TIPS)[28, 29]
- In patients with Beckwith-Wiedemann syndrome and abnormal ultrasound or rising AFP and MRI is contraindicated[30]

PANCREAS

- Pancreatic cystic lesion found on initial imaging
- Intraductal papillary mucinous neoplasm (IPMN) and mucinous cystic neoplasm (MCN) require surveillance imaging as follows (if MRI/MRCP is contraindicated) if indeterminate on initial imaging (if there are no high-risk characteristics, see Background section)[31]:
    - For incidental and asymptomatic cysts <5 mm, one follow-up at three years[32]
    - For cysts 5 mm-1 cm image every 2 years for 4 years, and if stable can lengthen intervals
    - For cysts 1-2 cm image every year for 2 years and if stable every 2 years for 4 years, and if stable can lengthen intervals
    - Cysts that are 2-3 cm every 6-12 months for 3 years and if stable then yearly for 4 years and if stable can lengthen intervals (can also use EUS)
    - For lesions > 3 cm MRI/CT or EUS every 6 months for 3 years, then imaging alternating with EUS every year for 4 years and if stable can lengthen intervals

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- Annual surveillance for individuals determined to have an increased lifetime risk of developing pancreatic cancer (if MRI/MRCP and EUS contraindicated), based on genetic predisposition or family history
    - Starting at age 50 or 10 years younger than the earliest age of cancer affected first-degree relative (except with Peutz-Jeghers start at age 30-35)
    - Von Hippel Lindau starting at age 16 at least every other year (abdominal US starting at age 8)
    - Hereditary Pancreatitis starting at age 40 or 20 years after first attack)[7, 33, 34] ***
- For patients with MEN 1, yearly surveillance for primary neuroectodermal tumors (pNET) starting at age 10 (EUS also considered)
- For suspected acute pancreatitis with pain and abnormal amylase and lipase and <48-72 hours if ultrasound is inconclusive[25, 35]
- Suspected acute pancreatitis with atypical signs and symptoms including equivocal amylase and lipase[36]
- Severe acute pancreatitis, 72-96 hours after onset of symptoms[37]
- Pancreatitis by history, (including pancreatic pseudocyst) with abdominal pain suspicious for worsening, or re-exacerbation
- Known necrotizing pancreatitis requiring follow-up
- For localization of an insulinoma once diagnosis is confirmed[38]

RENAL

- For an indeterminate renal mass on other imaging[39]
- Active surveillance for indeterminate cystic renal mass, not a simple renal cyst[40] (see Bosniak criteria in the Overview section)
- Active surveillance for patients with tuberous sclerosis and known angiomyolipoma (AML) if MRI is contraindicated[41]
- For surveillance of patients with Von Hippel Lindau at least every other year to assess for clear cell renal cell carcinoma to begin at age 16 (screening with ultrasound starting at around age 8)[19]
- Follow-up for solid renal masses under 1 cm at 6 and 12 months, then annually[42]
- Active surveillance for renal cell carcinoma in patients with Birt-Hogg syndrome every 36 months[43]
- For evaluation of total kidney volume in polycystic kidney disease when MRI is contraindicated[44]

SPLEEN

- Incidental findings of the spleen that are indeterminate on other imaging

For evaluation of a suspected or known hernia

- Abdominal/pelvic pain suspected to be due to an occult, umbilical, Spigelian, or incisional hernia when physical exam and/or prior imaging (such as ultrasound) is non-diagnostic or equivocal or if requested as a preoperative study and limited to the abdomen
- Hernia with suspected complications (e.g., bowel obstruction or strangulation, or non-reducible) based on symptoms (e.g., diarrhea, hematochezia, vomiting, severe pain, or guarding), physical exam (guarding, rebound) or prior imaging[45]

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- For confirming the diagnosis of a recurrent hernia when ultrasound is negative or non-diagnostic
- Complex ventral hernia that is ≥ 10 cm for pre-operative planning[45]

For evaluation of known or suspected vascular disease (e.g., aneurysms, hematomas)[46, 47]
NOTE: CT/MRI should not be approvable without a contraindication to CTAngiography/MRAngiography (such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI (rather than CTA/MRA) is preferred.
- Evidence of vascular abnormality identified on imaging studies and limited to the abdomen.

Pre-operative evaluation
- For abdominal surgery or procedure

Post-operative/procedural evaluation
- Follow-up of known or suspected post-operative complication involving only the abdomen
- A follow-up study to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed

Indication for combination studies for the initial pre-therapy staging of cancer, evaluation before starting treatment OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases
- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine, and MUGA

BACKGROUND
CT provides direct visualization of anatomic structures in the abdomen and pelvis and is a fast-imaging tool used to detect and characterize diseases. Abdominal imaging begins at the diaphragm and extends to the umbilicus or iliac crests. CT uses x-rays and multiple detectors to create cross-sectional images of the normal anatomy, as well as demonstrate abnormal soft tissue densities, calcifications or fluid/gas patterns in the viscera or peritoneal space.

In general, ionizing radiation from CT should be avoided during pregnancy. Ultrasound is clearly a safer imaging option and is the first imaging test of choice; although, CT or MRI after equivocal ultrasound has been validated for diagnosis. Clinicians should exercise increased caution with CT imaging in children, pregnant women, and young adults due to the risks of exposure to ionizing radiation. Screening for pregnancy as part of a work-up is suggested to minimize the number of unexpected radiation exposures for women of childbearing age.

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Cross-sectional imaging (liver ultrasound with Doppler, CT or MRI) should be completed no more than a month prior to the Transjugular Intrahepatic Portosystemic Shunt (TIPS) to assess for vascular patency and look for hepatic masses or other problems that could complicate the procedure. Post procedure, an ultrasound of the liver is performed a day after to assess shunt patency. Hepatic encephalopathy (HE) is the most common complication and usually occurs 2-3 weeks after insertion of TIPS. Unique complications may include intravascular hemolysis and infection of the shunt. Other complications can include capsule puncture, intraperitoneal bleed, hepatic infarction, fistula, hematobilia, thrombosis of stent, occlusion or stent migration and may require cross-sectional imaging.

Follow up and maintenance imaging if complications suspected include Doppler ultrasound to assess shunt velocity. If asymptomatic sonogram performed at 4 weeks post placement, then every 6 months to a year. The gold standard for shunt patency is portal venography, usually reserved if concern for shunt occlusion.

OVERVIEW

Ultrasound should be considered prior to a request for Abdomen CT for the following evaluations:

- Possible gallstones or abnormal liver function tests
- Evaluation of cholecystitis
- Follow up for aortic aneurysm
  Note: For known or suspected abdominal aneurysm, CT/MRI should not be approvable without a contraindication to CTAngiography /MRAngiography, such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI (rather than CTA/MRA) is preferred.

Screening for Hepatocellular carcinoma (HCC) - AASLD (American Association for the Study of Liver Diseases) recommends screening for HCC with ultrasound every 6 months for patients with hepatitis C and B.[21] The literature differs on the role of AFP (alpha fetoprotein) in the screening of HCC. Some authors argue against its use altogether due to its lack of sensitivity and specificity in detecting HCC[21, 23] and instead recommend ultrasound alone for screening. According to Marquardt, the AASLD and EASLD (European Association for the Study of the Liver) “do not endorse its [AFP] use in clinical routine, neither alone nor in combination with ultrasound”. This approach is supported by reports of patients with chronic viral hepatitis and elevated AFP but normal livers on imaging. AFP elevation in these cases is due to hepatic inflammation and viral replication,[48] not neoplasm. Others advocate for combined ultrasound and AFP for screening,[49, 50] citing increased sensitivity compared to ultrasound alone in detecting early-stage HCC particularly in cirrhotic patients. In a meta-analysis by Tzartzeva, et al of thirty-two studies (13,367 patients with cirrhosis), ultrasound with AFP had a 63% sensitivity of detecting early-stage HCC, compared to 45% for ultrasound alone. In the final analysis, no literature supports the use of AFP alone in the screening of HCC.[50]

Although most international groups recommend US screening and surveillance for HCC, the evidence to support this practice is weak. The recommendation for screening with US every 6 months by the AASLD is based on a prospective Chinese study of hepatitis B patients that showed that patients who had an US survived longer. However, there is no good evidence to show that these results apply to the

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population in the United States, which has a much higher percentage of obese patients, fewer patients with chronic hepatitis B, and many more patients with alcoholic cirrhosis, often with hepatitis C and NAFLD (and the role of surveillance in NAFLD without cirrhosis is unclear). US is insensitive for detection of HCC in patients with hepatic steatosis, as well as nodular cirrhotic livers who are undergoing surveillance. The regenerative nodules in cirrhotic livers alter the background hepatic echotexture, making HCC difficult to detect. Another inherent limitation of US is its operator dependence.[51]

- Incidental liver lesions – "Incidental hepatic lesions that are ≥1 cm and have distinctly benign imaging features do not require follow-up. Such features include sharp margin, homogeneous low attenuation (≤20 HU) on noncontrast or portal venous–phase imaging, or characteristic features of hemangiomas, FNH, or perfusional changes (including focal fatty sparing or deposition)… Incidental hepatic lesions that are ≥1 cm and have suspicious imaging features require further workup with prompt MRI or biopsy, depending on the lesion's size and features and the patient's risk level. Suspicious imaging features include ill-defined margins, heterogeneous density, mural thickening or nodularity, thick septa, and intermediate to high attenuation on portal venous–phase imaging (>20 HU, in the absence of pseudoenhancement)."[51]

A diagnosis of HCC can be made with CT or MRI if the typical characteristics are present: a solid FLL with enhancement in the arterial phase with washout in the delayed venous phase should be considered to have HCC until otherwise proven (strong recommendation, moderate quality of evidence. If the characteristic features are not seen on imaging, a biopsy may be indicated.
"A study by Serst et al, performed CT, MRI, and biopsy for a series of 74 patients with nodules identified by surveillance ultrasound. The authors concluded that sensitivity and specificity of the combination of the two diagnostic tests was 98% and 81%, respectively, and that biopsy could be reserved for those without definitive findings on either CT or MRI."[52]

A CT or MRI should be performed in cirrhotics with an ultrasound showing a lesion of > 1 cm, an elevated or rising α -fetoprotein in the absence of a liver lesion on US, or when there is a clinical suspicion for the presence of HCC. The choice of MRI versus CT is controversial at this time.

**Surveillance for HCC is required for patients who have received liver-directed therapy, surgical resection, medical treatment, or a transplant for HCC. However, because of the higher risk of tumor recurrence, US is not typically used for surveillance for HCC in the first 2 years after treatment. The European Association for the Study of the Liver recommends multiphase CT or MRI to assess response 1 month after resection or locoregional or systemic therapies, followed by one imaging technique every 3 months to complete at least 2 years, and then regular US every 6 months. This schedule is more frequent than some of the other society recommendations and the most common practice among interventional radiologists (every 3 months).

"The AASLD (American Association for the Study of Liver Diseases) recommends screening for the following high-risk groups: Asian male hepatitis B carriers over age 40, Asian female hepatitis B carriers over age 50, hepatitis B carriers with a family history of HCC, Africans and African Americans with

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hepatitis B, cirrhotic hepatitis B carriers, individuals with hepatitis C cirrhosis, individuals with stage 4 primary biliary cholangitis, individuals with genetic hemochromatosis and cirrhosis, individuals with alpha 1-antitypsin deficiency and cirrhosis, individuals with cirrhosis from other etiologies. We scan patients with cirrhosis from any etiology every 6 months with ultrasound. Ultrasonography remains the primary imaging modality of choice for HCC surveillance. It is more cost-effective than CT and MRI, and more widely available. A meta-analysis reported a sensitivity of 94% in detecting lesions and a specificity of >90%, although the figures were less favourable for lesions measuring less than 2 cm. The sensitivity for early HCC is 63%. Although our liver clinic routinely uses alpha-fetoprotein as an adjunct to imaging screening, it is acknowledged that it is neither sensitive nor specific for early diagnosis of HCC."[53]

CT for incidental adrenal mass - In general, masses found < 1 cm do not need to be pursued. If an adrenal mass has diagnostic features of a benign mass, such as a myelolipoma (presence of macroscopic fat), cyst, or hemorrhage (masses without enhancement, defined as change in pre- and postcontrast imaging of <10 HU), no additional workup or follow-up imaging is needed. If the mass has a density of 10 HU on unenhanced CT or signal loss compared with the spleen between in- and opposed-phase images of a chemical-shift MRI (CS-MRI) examination, these features are almost always diagnostic of a lipid-rich adenoma, regardless of size. If no benign imaging features but stable for a year or longer, it is very likely benign and needs no further imaging. The role of adrenal mass biopsy is reserved predominantly to confirm a suspected adrenal metastasis; this procedure has been shown to be safe with a low morbidity. If there are signs or symptoms of pheochromocytoma, plasma-fractionated metanephrine and normetanephrine levels should be obtained prior to biopsy. Otherwise, endocrine workup of an incidental adrenal mass is controversial. Current guidelines from the American Association of Clinical Endocrinologists and the American Association of Endocrine Surgeons recommend an initial biochemical evaluation of all adrenal incidentalomas to exclude pheochromocytoma, subclinical Cushing's syndrome, and hyperaldosteronism.

Genetic syndromes and adrenal tumors - Adrenal cortical carcinoma (ACC) diagnosed during childhood is known to be commonly associated with hereditary syndromes including Beckwith-Wiedemann (BWS) and Li-Fraumeni syndrome (LFS). In adults, ACC may be associated with Multiple Endocrine Neoplasia 1 (MEN1), familial adenomatous polyposis coli and neurofibromatosis type 1 (NF1); however, there are currently no surveillance imaging recommendations.[54]

CT of the kidney - Recommendations for follow up of a complex cystic renal mass are made using Bosniak criteria[55]:

- Bosniak I (water density 0-20 HU); no further follow-up
- Bosniak II (one or a few thin septations, small or fine calcifications, hyperdense cysts up to 3 cm); no further follow-up
- Bosniak IIF felt to be benign but too complex to be diagnosed with certainty; image at 6 and 12 months, then annually for 5 years if no progression
- Bosniak III thick-walled cystic lesions with wall or septal enhancement; resection favored vs conservative management and RFA in select cases[40]
- Bosniak IV malignant cystic renal mass with enhancing soft tissue components; resection favored, malignant until proven otherwise

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Screening for pancreatic cancer

*** Pancreatic cancer is thought to have a familial or hereditary component in approximately 10% of cases. Surveillance of individuals with genetic predisposition for pancreatic adenocarcinoma should include known mutation carriers from hereditary syndromes such as Peutz-Jeghers (10-30% lifetime risk), hereditary pancreatitis (which is associated with genes *PRSS1* and *SPINK1*), familial atypical multiple melanoma and mole syndrome (10-30% risk) or for members of familial pancreatic cancer with a first-degree family member with pancreatic cancer. In patients who are mutation carriers in *BRCA2* (5-10% lifetime risk), *PALB2* (5-10% lifetime risk), and Lynch syndrome (5-10%) families. Surveillance for patients with *BRCA1* (2% lifetime risk) and *ATM* serine/threonine kinase (1-5% lifetime risk) is limited to those with first- or second-degree relatives with pancreatic cancer. NCCN also recommends screening for individuals with a known pathogenic/likely pathogenic germline variant in a pancreatic susceptibility gene, including *CDKN2A, MLH1, MLH2, MSH6, PMS2, EPCAM* (mismatch repair genes associated with Lynch syndrome), *ATM, PALB2, STK11, TP-53* and a family history (first- or second-degree relative) from the same side of the family; or a family history of exocrine pancreatic cancer in ≥2 first-degree relatives from the same side of the family or ≥3 first- and second-degree relatives from the same side of the family (and at least one is a first-degree relative)[7, 56, 57]. Patients with a family history of pancreatic cancer affecting two first-degree relatives meet criteria for familial pancreatic cancer and are candidates for genetic testing. It should be noted that 90% of families meeting criteria for familial pancreatic cancer will not have a pathogenic mutation.[58]

Insulinomas are rare pancreatic tumors. Localization of the tumor by ultrasound and CT are the preferred initial options once a diagnosis has been made, followed by endoscopic ultrasound or arterial stimulation with hepatic venous sampling. Whipples triad includes symptoms of hypoglycemia, low blood glucose relieved by ingestion of glucose, and benign 90%. Work-up prior to imaging should include: a 72-hour fast with serial glucose and insulin levels over this period until the patient becomes symptomatic. An insulin/glucose ration of greater than 0.3 has been found in virtually all patients with insulinoma or other islet cell disease.[38]

Surveillance of Pancreatic Cysts - Some pancreatic cysts have the potential for malignant transformation to invasive ductal adenocarcinoma; hence the need for intervention vs surveillance. The data, however, is unclear as to the risk of cancer. Cyst surveillance can be offered to patients with asymptomatic cysts presumed to be IPMNs or MCNs. Pancreatic cystic Neoplasms (PCN) make up about 2-45% of the general population.

High risk characteristics for mucinous pancreatic cysts include all of the following: Symptoms, Jaundice secondary to the cyst, acute pancreatitis secondary to the cyst, elevated serum CA 19-9 and no benign cause present, an enhancing mural nodule or solid component within the cyst or pancreas, main pancreatic duct of > 5mm, change in duct caliber with upstream atrophy, size over 3 cm, high grade dysplasia or cancer on cytology. These patients should undergo EUS + -FNA or be referred to a multidisciplinary group for further recommendations.[31]

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CT and elevated Liver Function Tests - For elevated bilirubin, or serum transaminases with or without bilirubin elevation, US is the initial recommended test to assess for duct dilatation which might lead to ERCP or MRCP, vs other causes which might necessitate further lab testing or liver biopsy.[59]

Combination request of Abdomen CT/Chest CT - A chest CT will produce images to the level of L3. Documentation for combo is required.

Imaging of hernias - Most hernias are diagnosed clinically with imaging recommended for the diagnosis of occult hernias or in the evaluation of hernia complications, such as bowel obstruction or strangulation. To detect occult hernias, ultrasound is a first-line study with a sensitivity of 86% and specificity of 77%, compared to 80% sensitivity and 65% specificity for CT.[60] According to Miller, et al "Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias…."[61] Based on this analysis, MRI is recommended only when ultrasound and CT have been performed and fail to make a diagnosis.

POLICY HISTORY

Date	Summary
March 2022	• In Follow-up of known cancer, added per surveillance imaging of NCCN recommendations • Clarified IPMN and MCN surveillance imaging • Added total kidney volume in polycystic kidney disease when MRI is contraindicated to Renal section • Clarified "and/or" prior imaging (such as US) in abdominal/pelvic pain due to suspected hernia
April 2021	Added Notes: • For syndromes for which imaging starts in the pediatric age group, MRI preferred • ABDOMEN or Pelvis CT ALONE SHOULD ONLY BE APPROVED WHEN DISEASE PROCESS IS SUSPECTED TO BE LIMITED TO THE ABDOMEN or Pelvis. CT Abdomen/Pelvis Combo (CPT Codes: 74176, 74177, 74178) is the correct study when the indication(s) include both the abdomen AND pelvis, such as CTU (CT Urography), CTE (CT Enterography), acute abdominal pain, widespread inflammatory disease or neoplasm. Otherwise, the exam should be limited to the appropriate area. (i.e., Abdomen OR Pelvis) which includes the specific organ, area of known disease/abnormality or the area of concern.
May 2020	• Added at top of guideline- For syndromes with imaging started in pediatric age group, MRI preferred • Removed Surveillance of cancer. Deleted active monitoring for recurrence as clinically indicated. • Removed suspected cholecystitis or retained gallstones as an indication for CT. Would require an MRCP or ERCP. • Added indication for suspected adrenal secreting tumor

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	• Added surveillance for MEN 1 and Von Hippel Lindau; also Beckwith-Wiedemann syndrome (if abnormal US or rising AFP); Added multiple indications for surveillance for patients with increased lifetime risk of pancreatic cancer; also for surveillance for renal cell cancer in Birt-Hogg syndrome • Added pre procedural imaging prior to transjugular intrahepatic portosystemic shunt (TIPS) • Added imaging for indeterminate liver lesion < 1 cm with known chronic liver disease or a history of extrahepatic malignancy (ACR, 2020) • Added follow up for pancreatic cystic masses under 5mm (possible IPMN) • Added for localization of an insulinoma • Expanded section on hernia imaging • Removed diverticulitis and appendicitis since need CT of the abdomen and pelvis • Expanded background section to include: Genetic syndromes associated with adrenal tumors, improved on Bosniak criteria; Improved indications for screening for pancreatic cancer; Added section on work up for insulinoma; Added section on CT and elevated liver function tests; Removed reduction radiation exposure, consider barium studies for inflammatory bowel disease; work up for distant mets in melanoma, and pre-operative evaluation of primary rectal cancer.
May 2019	• For evaluation of suspected infection or inflammatory disease, Added: o Right upper quadrant pain for suspected biliary disease with negative or equivocal US or HIDA scan o For epigastric or left upper quadrant pain if labs or other imaging are inconclusive • For evaluation of an organ or abnormality seen on previous imaging o Removed: For the evaluation of an organ enlargement such as splenomegaly or hepatomegaly as evidenced by physical exam or confirmed on any previous imaging study” o Added: To locate a pheochromocytoma once there is clear biochemical evidence o Changed adrenal indications from mass >4 cm to ≥1 cm with no hx of malignancy; AND adrenal mass ≥4 cm and no diagnosis of cancer, can approve for preoperative planning; AND adrenal mass <4 cm with history of malignancy • Added indications for: liver lesions, adenoma, hyperplasia; modified hepatitis/hepatoma screening; pancreatic cystic lesions, pancreatitis, pancreatic cancer risk; renal mass; spleen

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	• Modified hernia indications from suspected spigelian hernia or hernia with suspected complications to occult hernia when physical exam or prior imaging is non diagnostic or equivocal • Removed follow-up for peritonitis; evaluation of trauma; unexplained weight loss; removed age restrictions for abdominal pain • Added Background information and updated references

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guideline **ABDOMEN/PELVIS CTA (Angiography)**	**Original Date: September 1997**
CPT Codes: 74174	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_069	**Implementation Date: January 2023**

IMPORTANT NOTE: When encounter requests for Abd/Pelvis CTA & Lower Extremity CTA (Runoff) requests, these should be Abdominal Arteries CTA. Only one authorization request is required, using CPT Code 75635. This study provides for imaging of the abdomen, pelvis, and both legs and is the noninvasive equivalent to an "aortogram and run-off".

INDICATIONS FOR ABDOMEN/PELVIS CT ANGIOGRAPHY/CT VENOGRAPHY (MRA/MRV)

For evaluation of known or suspected abdominal/pelvis vascular disease

Arterial Disease

- Evaluation of known or suspected aortic aneurysm‡ [1-3]
    - For screening, ultrasound is initial study
    - Known or suspected abdominal aortic aneurysm >2.5 cm **AND** equivocal or indeterminate ultrasound results
    - Suspected complications of known aneurysm as evidenced by signs/symptoms such as new onset of abdominal or pelvic pain
    - Known or suspected **iliac artery aneurysm** with indeterminate or equivocal Doppler ultrasound results
      Surveillance imaging every three years for diameter 2.0-2.9 cm and annually for 3.0-3.4 cm if Doppler ultrasound is inconclusive. If >3.5 cm, <6 month follow-up (and consider intervention)[4]

‡**NOTE: For known or suspected abdominal aneurysm, CT/MRI should not be approvable without a contraindication to CTA/MRA** (such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI is preferred).

- Evidence of vascular abnormality seen on prior imaging studies
- For known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, arteriovenous malformations (AVMs), and fistulas, intramural hematoma, and vasculitis[5-7]
- For suspected aortic dissection[8]

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- Suspected retroperitoneal hematoma or hemorrhage to determine **vascular source** of hemorrhage, in setting of trauma, tumor invasion, fistula or vasculitis, otherwise CT/MR abdomen and pelvis (rather than CTA/MRA) may be sufficient and the modality of choice for diagnosing hemorrhage[9]
- Lower gastrointestinal hemorrhage: Active bleeding in a hemodynamically stable patient or non-localized intermittent bleeding as an alternative to Tc-99m RBC scan when colonoscopy did not localize the bleeding, or is contraindicated or unavailable[10-12]
- For evaluation of suspected mesenteric ischemia[5, 13-15]
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (CTA or MRA)[16]
- For patients with vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time study of the abdomen and pelvis (CTA/MRA)
- For Loeys-Dietz imaging at least every two years[17]
- For assessment in patients with spontaneous coronary artery dissection (SCAD) can be done at time of coronary angiography (also approve CTA pelvis)[18]
- Vascular invasion or displacement by tumor (if involves both the abdomen and pelvis (otherwise limit to either abdomen or pelvis as appropriate)

Venous disease

- Venous thrombosis if previous studies have not resulted in a clear diagnosis
- For suspected/known May-Thurner syndrome[19, 20]
- For evaluation of venous thrombosis in the inferior vena cava (IVC)[14]
- Vascular invasion or displacement by tumor (if involves both the abdomen and pelvis (otherwise limit to either abdomen or pelvis as appropriate)
- For diffuse unexplained lower extremity edema with negative or inconclusive ultrasound[21]

Pre-operative evaluation

- Evaluation of interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Prior to repair of abdominal aortic aneurysm (AAA)
- For imaging of the deep inferior epigastric arteries for surgical planning (breast reconstructive surgery)[22]

Post-operative or post-procedural evaluation

- Evaluation of endovascular/interventional abdominal vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism and intimal hyperplasia
- Evaluation of post-operative complications, e.g., pseudoaneurysms, related to surgical bypass grafts, vascular stents, and stent-grafts in the peritoneal cavity
- Suspected complications of inferior vena cava (IVC) filters
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA) or abdominal extent of iliac artery aneurysms.
    - Routine, baseline study (post-op/intervention) is warranted within 1-3 months[1, 23, 24] (abdomen and pelvis MRA when CTA is inconclusive or cannot be performed)

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- If asymptomatic at 6-month intervals for one year, then annually
- If symptomatic/complications related to stent graft – more frequent imaging may be needed
- Follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other vascular indications

- For hemodynamically unstable patients[25, 26]
- Suspected retroperitoneal hematoma or hemorrhage to determine vascular source of hemorrhage, in setting of trauma, tumor invasion, fistula or vasculitis; otherwise, CT/MR abdomen and pelvis (rather than CTA/MRA) may be sufficient and the modality of choice for diagnosing hemorrhage[9]
- Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate)[27]
- For diffuse unexplained lower extremity edema with negative or inconclusive ultrasound[21]

Chest CTA/Abdomen/Pelvis CTA combo

- For evaluation of extensive vascular disease involving the chest and abdominal cavities
- For pre-op or preprocedural evaluation for Transcatheter Aortic Valve Replacement (TAVR)[23, 28]
- Acute aortic dissection[29]
- Takayasu's arteritis[30]
- Marfan syndrome
- Loeys-Dietz syndrome
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post-operative complications[31, 32]
- Significant post-traumatic or post-procedural vascular complications

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BACKGROUND

Body CTA is a method used to characterize vascular anatomy, diagnose vascular diseases, and plan treatment. Following contrast thin section CT acquisition is utilized and timed to coincide with peak arterial and venous enhancement. Both multiplanar and 3D reconstructions can be reformatted**.**

Bruits - blowing vascular sounds heard over partially occluded blood vessels. Abdominal bruits may indicate partial obstruction of the aorta or other major arteries such as the renal, iliac, or femoral arteries. Associated risks include but are not limited to; renal artery stenosis, aortic aneurysm, atherosclerosis, AVM, or coarctation of aorta.

Peripheral Artery Disease (PAD) – Before the availability of computed tomography angiography (CTA), peripheral arterial disease was evaluated using CT and only a portion of the peripheral arterial tree could be imaged. Multi-detector row CT (MDCT) overcomes this limitation and provides an accurate

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alternative to CT and is a cost-effective diagnostic strategy in evaluating PAD. Abdominal Arteries CTA (including runoff to the lower extremities) is the preferred study when evaluation of arterial sufficiency to the legs is part of the evaluation.

Lower GI bleeding- Colonoscopy should be the initial diagnostic procedure for nearly all patients presenting with acute LGIB (strong recommendation, low-quality evidence). Hematochezia associated with hemodynamic instability should lead to consideration of a brisk UGIB source, especially in at-risk patients, such as those with a history of peptic ulcer disease or liver disease with portal hypertension and those using antiplatelet or anticoagulant medications, and an upper endoscopy should be performed. CTA is a reasonable first-line screening test if needed before angiography or emergent surgery.[11]

CTA and Abdominal Aortic Aneurysm – Endovascular repair is an alternative to open surgical repair of an abdominal aortic aneurysm. It has lower morbidity and mortality rates and is minimally invasive. In order to be successful, it depends on precise measurement of the aneurysm and involved vessels. CTA with 3D reconstruction is useful in obtaining exact morphologic information on abdominal aortic aneurysms. CTA is also used for the detection of postoperative complications of endovascular repair.

CTA and Abdominal Aortic Aneurysm – The normal diameter of the suprarenal abdominal aorta is 3.0 cm and that of the infrarenal is 2.0 cm. Aneurysmal dilatation of the infrarenal aorta is defined as diameter ≥ 3.0 cm or dilatation of the aorta ≥ 1.5x the normal diameter.

Evaluation of AAA can be accurately made by ultrasound. Ultrasound can detect and size AAA, with the advantage of being relatively inexpensive, noninvasive, and not requiring iodinate contrast. The limitations are that overlying bowel gas can obscure findings and the technique is operator-dependent. CTA/MRA are needed only when ultrasound is insufficient or when surgery is planned.

Recommended intervals for initial follow-up imaging of ectatic aortas and abdominal aortas (follow-up intervals may vary depending on comorbidities and the growth rate of the aneurysm) from the white paper of the ACR Incidental Findings Committee II on vascular findings using ultrasound[1]):
2.5-2.9 cm: …….5 yr
3.0-3.4 cm:…….. 3 yr
3.5-3.9 cm:……2 yr
4.0-4.4 cm:……1 yr
4.5-4.9 cm……6 mo
5.0-5.5 cm:……3-6 mo

The Society of Vascular Surgery has different follow-up intervals for AAA[1]:
>2.5 cm - <3 cm……..10 yr
3.0 - 3.9 cm……3 yr
4.0 - 4.9 cm……12 mo
5.0 - 5.4 cm……..6 mo

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The Society of Vascular Surgery recommends elective repair of AAA ≥ 5.5 cm in patients at low or acceptable surgical risk.[1]

Iliac Artery Aneurysms – Follow-up asymptomatic incidentally detected iliac artery aneurysms: The definition of an iliac artery aneurysm is dilatation to more than 1.5 times its normal diameter, in general ≥ 18 mm in men and ≥ 15 mm in women, an internal iliac artery > 8mm. Surveillance is extrapolated from AAA surveillance and can be done by Doppler ultrasound or CTA if hard to visualize by ultrasound.[4]

CTA and Thoracic Aorta Endovascular Stent-Grafts – CTA is an effective alternative to conventional angiography for postoperative follow-up of aortic stent grafts. It is used to review complications after thoracic endovascular aortic repair. CTA can detect luminal and extraluminal changes to the thoracic aortic after stent-grafting and can be performed efficiently with fast scanning speed and high spatial and temporal resolution.

MRI/CT and acute hemorrhage – MRI is not indicated and MRA/MRV (MR Angiography/Venography) is rarely indicated for evaluation of intraperitoneal or retroperitoneal hemorrhage, particularly in the acute setting. **CT is the study of choice** due to its availability, speed of the study and less susceptibility to artifact from patient motion. Advances in technology have allowed conventional CT to not just detect hematomas but also the source of acute vascular extravasation. In special cases finer vascular detail to assess the specific source vessel responsible for hemorrhage may require the use of CTA. CTA in diagnosis of lower gastrointestinal bleeding is such an example.[10] In this case, colonoscopy should be the initial diagnostic procedure.

MRA/MRV is often utilized in non-acute situations to assess vascular structure involved in atherosclerotic disease and its complications, such as vasculitis, venous thrombosis, vascular congestion or tumor invasion. Although some of these conditions may be associated with hemorrhage, it is usually not the primary reason why MRI/MRA/MRV is selected for the evaluation. A special condition where MRI may be superior to CT for evaluating hemorrhage is to detect an underlying neoplasm as the cause of bleeding.[33]

POLICY HISTORY

Date	Summary
April 2022	• Added "(abdomen and pelvis MRA when CTA is inconclusive or cannot be performed)" to follow-up for EVAR and AAA
April 2021	• No substantive changes
May 2020	• Added FMD, SCAD, Marfans, etc. • Added May-Thurner • Removed CTA for renal artery stenosis • Added combo study section
May 2019	• Added indications for vascular disease for iliac artery aneurysm; complications of known aneurysm; surveillance imaging timeline; hemodynamically unstable patients; evaluation of venous thrombosis in

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	the inferior vena cava; suspected complications of inferior vena cava (IVC) filters; and for post op complications • For pre-op evaluation, added indications for prior to repair of AAA; and for imaging of the deep inferior epigastric arteries for surgical planning • Added/modified Background information and updated references

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **ABDOMEN CTA (Angiography)**	**Original Date: September 1997**
CPT Codes: 74175	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_034-1	**Implementation Date: January 2023**

IMPORTANT NOTE
When vascular imaging of the aorta and both legs, i.e., CTA aortogram and runoff is desired (sometimes incorrectly requested as Abd/Pelvis CTA & Lower Extremity CTA Runoff), only one authorization request is required, using CPT Code 75635 Abdominal Arteries CTA. This study provides for imaging of the abdomen, pelvis, and both legs. The CPT code description is CTA aorto-iliofemoral runoff; abdominal aorta and bilateral ilio-femoral lower extremity runoff.

INDICATIONS FOR ABDOMEN CT ANGIOGRAPHY/CT VENOGRAPHY (CTA/CTV)

For evaluation of known or suspected abdominal vascular disease

Arterial Disease

- Evaluation of known or suspected aortic aneurysm‡ (or can approve CTA abdomen and pelvis if concern extends into pelvis)[1-3]
    - For screening, US is initial study
    - Known or suspected aneurysm > 2.5 cm AND equivocal or indeterminate ultrasound results
    -
    - Suspected complications of known aneurysm as evidenced by signs/symptoms such as new onset of abdominal or pelvic pain
    - Surveillance imaging every three years for diameter 2.0-2.9 cm and annually for 3.0-3.4 cm if doppler ultrasound is inconclusive. If > 3.5 cm, < 6 month follow-up (and consider intervention)[4]

‡NOTE: For known or suspected abdominal aneurysm, CT/MRI should not be approvable without a contraindication to CTA/MRA (such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI is preferred).

- Evidence of vascular abnormality seen on prior imaging studies and limited to the abdomen
- For known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, compression syndromes,

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arteriovenous malformations (AVMs), fistulas, intramural hematoma, and vasculitis limited to the abdomen

- For suspected aortic dissection (approve CTA/MRA abdomen and pelvis)
- For diagnosis or follow-up of visceral artery aneurysm[5, 6]
- Suspected retroperitoneal hematoma or hemorrhage to determine vascular source of hemorrhage, in setting of trauma, tumor invasion, fistula or vasculitis, otherwise CT/MR abdomen and pelvis (rather than CTA/MRA) may be sufficient and the modality of choice for diagnosing hemorrhage[7]
- For evaluation of suspected mesenteric ischemia/ischemic colitis (can approve CTA/MRA abdomen and pelvis)[8]
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (CTA or MRA)[9]
- For patients with vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time study of the abdomen and pelvis (CTA/MRA)
- For Loeys-Dietz imaging at least every two years[10]
- For assessment in patients with spontaneous coronary artery dissection (SCAD) can be done at time of coronary angiography (also approve CTA pelvis)[11]
- Vascular invasion or displacement by tumor
- For evaluation of hepatic blood vessel abnormalities (aneurysm, hepatic vein thrombosis, stenosis post-transplant) after doppler ultrasound has been performed; to clarify or further evaluate ultrasound findings
- **For evaluation of known or suspected renal artery stenosis or resistant hypertension** in the setting of normal renal function (with impaired renal function, eGFR <30, use US with Doppler) unrelated to recent medication demonstrated by any of the following[12-19]:
    - Unsuccessful control after treatment with 3 or more (>2) anti-hypertensive medication at optimal dosing and one should be a diuretic
    - Acute elevation of creatinine after initiation of an angiotensin converting enzyme inhibitor (ACE inhibitor) or angiotensin receptor blocker (ARB)
    - Asymmetric kidney size noted on ultrasound
    - Onset of hypertension in a person younger than age 30 without any other risk factors or family history of hypertension**
    - Significant hypertension (diastolic blood pressure > 110 mm Hg) in a young adult (i.e., younger than 35 years) suggestive of fibromuscular dysplasia[20]
    - Diagnosis of a syndrome with a higher risk of vascular disease, such as neurofibromatosis, tuberous sclerosis, and Williams' syndrome
    - New onset of hypertension after age 50
    - Acute rise in blood pressure in a person with previously stable blood pressures
    - Flash pulmonary edema without identifiable causes
    - Malignant or accelerated hypertension
    - Bruit heard over renal artery and hypertension
    - Abnormal/inconclusive renal doppler ultrasound

Venous Disease

- Suspected renal vein thrombosis in patient with known renal mass or from other causes[21]

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- Venous thrombosis if previous studies have not resulted in a clear diagnosis (add pelvis CTA/CTV when appropriate)
- For known/suspected May-Thurner syndrome (include pelvic CTV)[22, 23]
- Vascular invasion or displacement by tumor in the abdomen
- For evaluation of portal venous system (hepatic portal system) after doppler ultrasound has been performed
- For diffuse unexplained lower extremity edema with negative or inconclusive ultrasound[24]

Pre-operative evaluation

- For evaluation of transjugular intrahepatic portosystemic shunt (TIPS) when Doppler ultrasound indicates suspected complications[25-28]
- Evaluation prior to interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- For pre-transplant evaluation of either liver or kidney
- Imaging of the deep inferior epigastric arteries for surgical planning (breast reconstruction surgery), include pelvic CTA/MRA[29]
- For surgical planning for UPJ (ureteropelvic junction) obstruction to look for a lower pole crossing vessel
- Planning prior Y90 radiation treatment for liver cancer in order to evaluate anatomic variation/shunts/determine best catheter placement/see if coil(s) needed[30]

Post-operative or post-procedural evaluation

- Evaluation of endovascular/interventional abdominal vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Evaluation of post-operative complications, e.g., pseudoaneurysms related to surgical bypass grafts, vascular stents, and stent-grafts in the peritoneal cavity
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA) or abdominal extent of iliac artery aneurysms typically needs to include pelvic imaging, therefore Abdomen Pelvis CTA would usually be the appropriate study.

Other Vascular indications

- Suspected retroperitoneal hematoma or hemorrhage to determine vascular source of hemorrhage, in setting of trauma, tumor invasion, fistula or vasculitis; otherwise, CT/MR abdomen and pelvis (rather than CTA/MRA) may be sufficient and the modality of choice for diagnosing hemorrhage[7]
- For evaluation of hepatic blood vessel abnormalities (aneurysm, hepatic vein thrombosis, stenosis post-transplant) after doppler ultrasound has been performed; to clarify or further evaluate ultrasound findings
- Lower gastrointestinal hemorrhage: Active bleeding in a hemodynamically stable patient or non-localized intermittent bleeding as an alternative to Tc-99m RBC scan when colonoscopy did not localize the bleeding, is contraindicated, or unavailable[31, 32]

Chest CTA/Abdomen/Pelvis CTA combo

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- For evaluation of extensive vascular disease involving the chest and abdominal cavities
- For pre-op or preprocedural evaluation for Transcatheter Aortic Valve Replacement (TAVR)[33, 34]
- Acute aortic dissection[35]
- Takayasu's arteritis[36]
- Marfans syndrome
- Loeys-Dietz
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post-op complications[37, 38]
- Significant post-traumatic or post-procedural vascular complications

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BACKGROUND

Computed tomography angiography (CTA) generates images of the arteries that can be evaluated for evidence of stenosis, occlusion, or aneurysms. It is used to evaluate the arteries of the abdominal aorta and the renal arteries. CTA uses ionizing radiation and requires the administration of iodinated contrast agent, which is a potential hazard in patients with impaired renal function. Abdominal CTA is not used as a screening tool, e.g., evaluation of asymptomatic patients without a previous diagnosis.

Cross-sectional imaging (liver ultrasound with Doppler, CT or MRI) should be completed no more than a month prior to the transjugular intrahepatic portosystemic shunt (TIPS) to assess for vascular patency and look for hepatic masses or other problems that could complicate the procedure.

Post-procedure, an ultrasound of the liver is conducted a day after to assess shunt patency. Hepatic encephalopathy (HE) is the most common complication and usually occurs 2-3 weeks after insertion of TIPS. Unique complications may include intravascular hemolysis and infection of the shunt. Other complications can include capsule puncture, intraperitoneal bleed, hepatic infarction, fistula, hematobilia, thrombosis of stent, occlusion, or stent migration and may require cross-sectional imaging.

Follow-up and maintenance imaging if complications suspected include Doppler ultrasound to assess shunt velocity. If asymptomatic sonogram performed at 4 weeks post placement, then every 6 months to a year. The gold standard for shunt patency is portal venography, usually reserved if concern for shunt occlusion.

OVERVIEW

CTA and Renal Artery Stenosis: Renal artery stenosis is the major cause of secondary hypertension. It may also cause renal insufficiency and end-stage renal disease. Atherosclerosis is one of the common causes of this condition, especially in older patients with multiple cardiovascular risk factors and worsening hypertension or deterioration of renal function. CTA is used to evaluate the renal arteries and detect renal artery stenosis.

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**NF1 may present with hypertension due to renal artery stenosis in children. All young patients (<30 year) with hypertension should be clinically screened for secondary causes of hypertension, including NF1, so that renal revascularization can be offered before permanent end organ damage has occurred.[39]

Abdominal Aneurysms and general guidelines for follow-up: The normal diameter of the suprarenal abdominal aorta is 3.0 cm and that of the infrarenal is 2.0 cm. Aneurysmal dilatation of the infrarenal aorta is defined as diameter ≥ 3.0 cm or dilatation of the aorta ≥ 1.5x the normal diameter.[2] Evaluation of AAA can be accurately made by **ultrasound.** Ultrasound can detect and size AAA, with the advantage of being relatively inexpensive, noninvasive, and not requiring iodinate contrast. The limitations are that overlying bowel gas can obscure findings and the technique is operator-dependent. CTA/MRA needed only when ultrasound is inconclusive/insufficient or when surgery is planned.

The Society of Vascular Surgery recommends elective repair of AAA ≥ 5.5 cm in patients at low or acceptable surgical risk.[1]

MRI/CT and acute hemorrhage: MRI is not indicated and MRA/MRV (MR Angiography/Venography) is rarely indicated for evaluation of intraperitoneal or retroperitoneal hemorrhage, particularly in the acute setting. **CT is usually the study of choice** due to its availability, speed of the study, and less susceptibility to artifact from patient motion. Advances in technology have allowed conventional CT to not just detect hematomas but also the source of acute vascular extravasation. In special cases finer vascular detail to assess the specific source vessel responsible for hemorrhage may require the use of CTA. CTA in diagnosis of lower gastrointestinal bleeding is such an example.[32]

MRA/MRV is often utilized in non-acute situations to assess vascular structure involved in atherosclerotic disease and its complications, vasculitis, venous thrombosis, vascular congestion, or tumor invasion. Although some of these conditions may be associated with hemorrhage, it is usually not the primary reason why MRI/MRA/MRV is selected for the evaluation. A special condition where MRI may be superior to CT for evaluating hemorrhage is to detect an underlying neoplasm as the cause of bleeding.[40]

POLICY HISTORY

Date	Summary
April 2022	• Added indication for UPJ surgery • Clarified note regarding vascular imaging of the aorta and both legs (i.e., CTA aortogram and runoff) • Clarified evaluation of known or suspected aortic aneurysm • Removed follow-up intervals for EVAR and AAA since Abdomen Pelvis CTA is usually appropriate study • Added Y90 indication
April 2021	Added Notes:

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	• For syndromes for which imaging starts in the pediatric age group, MRI preferred • ABDOMEN or Pelvis CT ALONE SHOULD ONLY BE APPROVED WHEN DISEASE PROCESS IS SUSPECTED TO BE LIMITED TO THE ABDOMEN or Pelvis. CT Abdomen/Pelvis Combo (CPT Codes: 74176, 74177, 74178) is the correct study when the indication(s) include both the abdomen AND pelvis, such as CTU (CT Urography), CTE (CT Enterography), acute abdominal pain, widespread inflammatory disease or neoplasm. Otherwise, the exam should be limited to the appropriate area. (i.e., Abdomen OR Pelvis) which includes the specific organ, area of known disease/abnormality or the area of concern.
May 2020	• Added compression syndromes for evaluation of vascular disease • Added evaluation of FMD, Vascular Ehlers-Danlos syndrome, Loetz-Dietz • Added May-Thurner Added to assess DVT in pregnant women vs serial compression ultrasound, to include pelvis • Added indications for combo studies for chest CTA/abdomen and pelvis CTA
May 2019	• Added indications for transjugular intrahepatic portosystemic shunt when Doppler ultrasound indicates suspected complications; accelerated hypertension; pre-transplant evaluation of either liver or kidney; imaging of deep inferior epigastric arteries for surgical planning (breast reconstruction surgery • For chest CTA/Abdomen CTA combo: added Transcatheter Aortic Valve Replacement; Acute Aortic dissection; Takayasu's arteritis; post op complications; significant post-traumatic or post-procedural vascular complications • Added and modified Background information and updated references

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guideline **ABDOMEN/PELVIS CT COMBO**	**Original Date: September 1997**
CPT Codes: 74176, 74177, 74178	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_068	**Implementation Date: January 2023**

Note: For syndromes for which imaging starts in the pediatric age group, MRI preferred

Note: CT Abdomen/Pelvis Combo (CPT Codes: 74176, 74177, 74178) is the better study when the indication(s) include both the abdomen AND pelvis, such as CTU (CT Urography), CTE (CT Enterography), acute abdominal pain, widespread inflammatory disease, or neoplasm. Otherwise, the exam should be limited to the appropriate area (i.e., Abdomen OR Pelvis) that includes the specific organ, area of known disease/abnormality or the area of concern.

INDICATIONS FOR ABDOMEN/PELVIS COMPUTED TOMOGRAPHY (CT)

Evaluation of Abdominal and Pelvis Pain for Unknown Etiology

- CT allowed after initial workup is inconclusive and must include results of the following:
    - Initial imaging such as ultrasound (although ultrasound does have limitations, it is a common misconception is that ultrasound is not a good tool in ALL obese patients, such that it is often useful even in obese patients and quite reasonable to attempt as a first line imaging modality particularly given the benefit of no radiation), scope study, or x-ray AND
    - Appropriate laboratory testing (chemistry profile, complete blood count, and urinalysis)
        - Amylase/lipase if suspected pancreatitis
        - Liver function tests if suspicion of hepatic disease
- For acute abdominal pain in a patient over the age of 65[1, 2]

Evaluation of suspicious or known mass/tumors (unconfirmed diagnosis of cancer) for further evaluation of indeterminate or questionable findings

- Initial evaluation of suspicious masses/tumors found by physical exam or imaging study, such as ultrasound (US), and both the abdomen and pelvis are likely affected[3, 4]
- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the abdomen and pelvis. No further surveillance CT unless tumor(s) are specified as highly suspicious or a change was found on the last follow-up CT, new/changing sign/symptoms, or abnormal lab values
- For abnormal incidental abdominopelvic lymph nodes when follow-up is recommended based on prior imaging (initial 3-month FU)[5]

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- For follow-up of mesenteric panniculitis[6-8] or lymphadenitis[9] when another diagnosis is suspected after initial imaging or there is a failure of symptom resolution

Evaluation of known cancer[10, 11] (see exception for prostate cancer*)

- **Initial staging of known cancer**
    - **Follow-up of known cancer of patient undergoing active treatment within the past year or as per surveillance imaging guidance (Surveillance Imaging for Cancer Patients from NCCN)[11]**
    - **New evidence of an unknown primary[12]**
    - **Known cancer with suspected abdominal/pelvic metastasis** based on a sign, symptom, (e.g., anorexia, early satiety, intestinal obstruction, night sweats, pelvic pain, weight loss, vaginal bleeding) or an abnormal lab value (alpha-fetoprotein, CEA, CA 19-9, p53 mutation)

***Prostate Cancer** imaging is indicated for the following scenarios (Pelvis CT +/- Abdomen)

- **Initial Staging**
    - High Risk and above (T3a or higher, PSA >20‡, Gleason 8-10)
    - Intermediate Risk (T2b-T2c or PSA 10-20‡ or Gleason 7) when Nomogram predicts >10% probability of lymph node involvement (MSKCC/Kattan is the nomogram recommended by NCCN 2021)[11, 13]

‡In patients who have been on a 5-alpha reductase inhibitor (such as Proscar) in the past 12 months, an "adjusted PSA" should be used. To adjust, multiply PSA by a factor of 2 (e.g., PSA 6 on finasteride adjusts to a PSA of 12) (initial imaging with CT is not needed for low risk or very low risk prostate cancer (NCCN 2021))[11, 13]

- **Workup of recurrence and/or response to treatment**
    - Initial treatment by radical prostatectomy with failure of PSA to fall to undetectable levels or PSA detectable and rising on at least 2 subsequent determinations
    - Initial treatment radiation therapy with post-RT rising PSA or positive digital exam and is candidate for local therapy

For evaluation of suspected infection or inflammatory disease[14, 15]

- Suspected diverticulitis or acute appendicitis* for initial imaging with at least **ONE** of the following[16]:
    - WBC Elevated
    - Fever
    - Anorexia
    - Nausea and vomiting

  *Use ultrasound or MRI in pregnant women with suspected appendicitis[17]
- Suspected diverticulitis[18] when
    - Pain is present in the LLQ (<3 months duration), medical records note suspicion for diverticulitis, the patient has no prior history of diverticulitis, AND LLQ tenderness is present on exam; OR
    - Patient is immunocompromised; OR

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    - Patient has a history of diverticulitis, symptoms are similar to prior episodes, AND patient has failed treatment currently (treatment could be liquid diet/anti-inflammatories or antibiotic)
- Suspected appendicitis in a child (< age 18)[19-23] when ultrasound is inconclusive or cannot be completed due to body habitus or inability to cooperate OR when peritoneal signs are present (guarding, rebound) or other red flags
- For acute non-localized abdominal pain and fever, no recent surgery[24]
- For suspected retroperitoneal fibrosis after labs and inconclusive ultrasound[25]

For follow-up evaluation of known infection or inflammatory disease involving the abdomen and pelvis[14, 26]

- Complications of diverticulitis with severe abdominal/pelvic pain or severe tenderness or mass not responding to antibiotic treatment (prior imaging study is not required for diverticulitis diagnosis)[14, 15]
- Pancreatitis by history (including pancreatic pseudocyst) with continued abdominal pain, early satiety, nausea, vomiting, or signs of infection greater than 4 weeks from initial presentation[26] when there is reason to suspect extensive disease extending into the pelvis (otherwise CT abdomen)
- Known inflammatory bowel disease, (Crohn's or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation or for monitoring therapy[26]
- Any known infection that is clinically suspected to have created an abscess in the abdomen and pelvis
- Any history of fistula that requires re-evaluation or is suspected to have recurred in the abdomen and pelvis
- Abnormal fluid collection seen on prior imaging that needs follow-up evaluation
- Follow-up for known peritonitis (from any cause) if abdominal/pelvic pain and tenderness to palpation is present, and **at LEAST ONE** of the following:
    - Rebound, guarding, or rigid abdomen; **OR**
    - Severe tenderness to palpation present over entire abdomen
- For known retroperitoneal fibrosis to determine extent of disease

Suspected peritonitis (from any cause) if abdominal pain and tenderness to palpation is present, and at LEAST ONE of the following:

- Rebound, guarding (not voluntary) or rigid abdomen, OR
- Severe tenderness to palpation present over entire abdomen

Suspected or known acute pancreatitis[26] when have reason to suspect extension beyond abdomen, into pelvis

- For suspected acute pancreatitis with pain and abnormal amylase and lipase and < 48-72 hours, when ultrasound is inconclusive[26, 27]
- Suspected acute pancreatitis with atypical signs and symptoms, and when a diagnosis other than pancreatitis may be possible
- Severe acute pancreatitis, 72-96 hours after onset of symptoms[28]

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- Known necrotizing pancreatitis requiring follow-up
- Pancreatitis by history, (including pancreatic pseudocyst) with abdominal pain suspicious for worsening, or re-exacerbation
- Known necrotizing pancreatitis requiring follow-up

Suspected inflammatory bowel disease (includes CT enterography)

- For suspected inflammatory bowel disease (Crohn's disease or ulcerative colitis) with abdominal pain **AND** one of the following[29-31]:
    - Chronic diarrhea
    - Bloody diarrhea

  Note: For patients under 35 years old, consider MRE due to concern for likelihood of the need for repeat imaging in order to reduce potential radiation dose[32]
- High clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy[29-31, 33]

For evaluation of hematuria when stone is NOT suspected (includes CT urography (CTU))[34-36]

- Documented by greater than 3 red blood cells (RBC) per high-power field on urinalysis and not based on a dipstick test[34] AND ONE or more of the following:
    - Age > 60;
    - 30+ pack year smoking history; or
    - > 25 RBC/hpf (i.e., high risk)
- If not high risk (as above), need equivocal or abnormal renal ultrasound prior to CT
- Gross hematuria
    - UA must be negative for infection
    - UA can be negative for blood if hematuria is witnessed by patient or provider

NOTE: If a previous "routine" CT abdomen/pelvis has been done (with or with/without contrast), and a CTU is later requested, the previous CT must show a clear reason that additional delayed post-contrast images of the collecting system are needed.

For evaluation of known or suspected kidney or ureteral stone in a patient with acute flank pain

- **CT is indicated if one or more of the following is present:**
    - Atypical presentation (i.e., fever or WBC >15,000)
    - Inadequate analgesia
    - Abnormal or indeterminate ultrasound (with findings needing further evaluation with CT)
- **Ultrasound should be performed PRIOR to CT in the following situations (CT is needed only if US is inconclusive or has findings that need further imaging):**
    - Pediatric and pregnant patients (MRU preferred if further imaging indicated)
    - Typical presentation without signs/symptoms of infection in a patient < 65
- **CT is allowed for acute abdominal pain, in general, for patients >65**

Preoperative planning

- CT is indicated when no imaging has been done in the last 30 days, or if passage or movement of stones will change management[37]

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Postoperative stone follow-up CT

- Symptomatic patients following:
    - Ureteroscopic extraction of an intact stone[38]
    - Ureteroscopy with lithotripsy/fragmentation of a radiolucent stone[38]
- Further evaluation of hydronephrosis seen on post-operative ultrasound (following ureteroscopy or ESWL)[38]

For evaluation of pyelonephritis in the following situations

- When other imaging such as ultrasound is abnormal
- For a patient who remains febrile after 72 hours of treatment[39] or symptoms resolve and then recur within 2 weeks[40]
- For a complicated patient with history of diabetes, stone disease, prior urinary tract surgery, or who is immunocompromised and is not responding to treatment[41]

For evaluation of Complicated Urinary tract Infection: (see above section for pyelonephritis)

- **Women:** UTI is considered complicated (and therefore imaging (ultrasound and/or CT) is warranted) in any of the following situations,
    - Immunocompromised host
    - Persistence of bacteria or symptoms after culture specific treatment,
    - Rapid recurrence with same bacteria after treatment,
    - Multidrug resistant bacteria
    - When there is suspicion of renal calculi or obstruction[39, 42]
- **Men:** Any UTI is considered complicated due to high likelihood of anatomic abnormalities,[43] therefore imaging (ultrasound and/or CT) is warranted

Suspected small bowel obstruction when there is a strong clinical suspicion

- Crampy pain, vomiting, distention, high pitched or absent bowel sounds, prior history of abdominal surgery, or based on initial radiograph[44, 45]

Suspected colonic or mesenteric ischemia[46] CTA also appropriate[47]

For suspected small bowel bleeding when endoscopy and capsule endoscopy are inconclusive or negative[48]

For known or suspected abdominal aneurysm

NOTE: CT/MRI should not be approvable without a contraindication to CTAngiography/MRAngiography, such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI (rather than CTA/MRA) is preferred.

- Known or suspected aneurysm > 2.5 cm **AND** equivocal or indeterminate ultrasound results
- Suspected complications of known aneurysm as evidenced by signs/symptoms such as new onset of abdominal or pelvic pain
- Scheduled follow-up evaluation of aorto/iliac endograft or stent (Abd/Pelvic CTA preferred)

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- Evaluation of endovascular/interventional abdominal vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Evaluation of post-operative complications, e.g., pseudoaneurysms, related to surgical bypass grafts, vascular stents, and stent-grafts in the peritoneal cavity
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA) or abdominal extent of iliac artery aneurysms. Routine, baseline study (post-op/intervention) is warranted within 1-3 months.[49, 50]
    - Asymptomatic at six (6)-month intervals, for one (1) year, then annually
    - Symptomatic/complications related to stent graft – more frequent imaging may be needed
- Follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

For evaluation of trauma[51]

- Suspected retroperitoneal hematoma or hemorrhage based on lab or physical findings
- Blunt injury with suspicion of multisystem trauma and hematuria
- Penetrating abdominal injury with suspicion of multisystem trauma with or without hematuria[51]

For evaluation of a suspected or known hernia

- Abdominal/pelvic pain suspected to be due to an occult, umbilical, Spigelian, or incisional hernia when physical exam and prior imaging is non-diagnostic or equivocal or if requested as a preoperative study
- Hernia with suspected complications (e.g., bowel obstruction or strangulation, or non-reducible) based on symptoms (e.g., diarrhea, hematochezia, vomiting, severe pain, or guarding), physical exam (guarding, rebound) or prior imaging[52]
- For confirming the diagnosis of a recurrent hernia when ultrasound is negative or non-diagnostic
- Complex ventral hernia that is ≥ 10 cm for pre-operative planning[52]

Other Indications for Abdomen/Pelvic CT Combo

- To locate a pheochromocytoma once there is clear biochemical evidence
- Concern for lymphoma/malignancy with B symptoms of fevers to more than 101° F, drenching night sweats, and/or unexplained weight loss of more than 10% of body weight over 6 months (can also approve chest CT)[53]
- Unexplained weight loss of 10% of body weight in two months (patient history is acceptable); with a second MD visit documenting some further decline in weight[54]
- Unexplained weight loss of 5% of body weight in six months confirmed by documentation to include the following[55, 56]:
    - Related history and abdominal exam
    - Chest x-ray
    - Abdominal ultrasound
    - Lab tests, must include TSH
    - Colonoscopy if patient fifty plus (50+) years old

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- In the workup of a paraneoplastic syndrome after ultrasound, mammography, and appropriate lab tests are completed
- To screen all adult patients with dermatomyositis to rule out occult malignancy[57-59]
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound[60]
- For elevation of carcinoembryonic antigen (CEA) in a patient with no cancer history after complete clinical workup (including organ-specific investigations, such as colonoscopy, gastroscopy, mammography, cystoscopy, ultrasound) that fails to demonstrate a reason and CEA is >10 ng/ml, or fails to drop below 5 ng/ml after 3-6 months intervals (see Background section)
- For fever of unknown origin (temperature of ≥101 degrees for a minimum of 3 weeks) after standard diagnostic tests are negative (see Background section)[61]
- For evaluation of suspected May-Thurner syndrome (CTV/MRV preferred)[62, 63]
- For further evaluation of an isolated right varicocele with additional signs and symptoms that suggest malignancy or suspicious prior imaging[64]

Pre-operative evaluation
- For abdominal/pelvic surgery or procedure

Post-operative/procedural evaluation
- Follow-up of known or suspected post-operative complication
- A follow-up study to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed.

Indication for combination studies for the initial pre-therapy staging of cancer, evaluation before starting treatment OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases
- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine, or Lumbar Spine, and MUGA

BACKGROUND

CT provides direct visualization of anatomic structures in the abdomen and pelvis and is a fast-imaging tool used to detect and characterize disease. Abdomen/pelvis imaging begins at the diaphragmatic dome through pubic symphysis. CT uses x-rays and multiple detectors to create cross-sectional images of the normal anatomy as well as demonstrate abnormal soft tissue densities, calcifications or fluid/gas patterns in the viscera or peritoneal space.

In general, ionizing radiation from CT should be avoided during pregnancy. Ultrasound is clearly a safer imaging option and is the first imaging test of choice; although, CT or MRI after equivocal ultrasound has been validated for diagnosis. Clinicians should exercise increased caution with CT imaging in children, pregnant women, and young adults due to the risks of exposure to ionizing radiation.

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Screening for pregnancy as part of a work-up is suggested to minimize the number of unexpected radiation exposures for women of childbearing age.

OVERVIEW

CT Imaging for renal colic and hematuria

More than 2 million emergency visits in the US are for suspected renal colic, and CT is performed in over 90% of patients diagnosed with kidney stones.[65] Evidence now supports ultrasound or no further imaging in specific clinical scenarios as renal colic is often self-limited. CT can guide therapy in a subset of patients who require intervention or who have other conditions that mimic renal colic (i.e., appendicitis). CT protocols include: "stone protocol" for detecting urinary tract calculi, "renal mass protocol" for characterizing known renal masses, and CT urography for evaluating hematuria. Non-contrast CT can be used for detecting most ureteral and renal stones but sometimes an intravenous contrast agent is needed to determine the relationship of the calculus to the opacified ureter.

CT imaging for recurrent urinary tract infections

Imaging in patients without risk factors and less than two infections a year on average and who respond promptly to therapy, is of low yield. Risk factors include but are not limited to: Infection with urea-splitting organism, previous pyelonephritis, history of calculi or obstruction, obstructive symptoms, elevated creatinine, severe diabetes, childhood UTI, neurogenic bladder dysfunction, history of GU surgery, suspected bladder diverticula or urethral, urinary incontinence, pelvic floor dysfunction, post void residual.[66]

CT Imaging for abdominal aortic aneurysms

NOTE: For known or suspected abdominal aneurysm, CT/MRI should not be approvable without a contraindication to CTAngiography /MRAngiography, such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI (rather than CTA/MRA) is preferred.

If a pulsatile abdominal mass is found in an asymptomatic patient, **abdominal ultrasonography** is an inexpensive and noninvasive technique for **initial evaluation**. For further examination, CT may be performed to better define the shape and extent of the aneurysm and the local anatomic relationships of the visceral and renal vessels. CT has high level of accuracy in sizing aneurysms; however, CTA and MRA are the gold standards for imaging. The majority of evidence regarding AAA surveillance using CT is based on CTA data and is primarily related to contrast bolus timing. Contrast-enhanced CT is well established in the literature and is capable of identifying aortic aneurysms, with many papers discussing incidental AAA identification.[67, 68] Risk of rupture in 6 years for an AAA < 4 cm is 1%. For a 4-5 cm AAA, the risk of rupture increases to 1-3% per year and becomes 6-11% per year for AAA 5-7 cm in cross sectional diameter. For any AAA >7 cm, the risk of rupture goes to 7% per year.

Initial evaluation of abdominal aortic aneurysm (AAA)

Initial evaluation of AAA is accurately made by ultrasound.

****Abdominal aneurysms and general guidelines for follow-up**

The normal diameter of the suprarenal abdominal aorta is 3.0 cm and that of the infrarenal is 2.0 cm. Aneurysmal dilatation of the infrarenal aorta is defined as diameter ≥ 3.0 cm or dilatation of the aorta

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≥ 1.5x the normal diameter. Ultrasound can detect and size AAA, with the advantage of being relatively inexpensive, noninvasive, and not require iodinate contrast. The limitations are that overlying bowel gas can obscure findings and the technique is operator-dependent.

Recommended intervals for initial follow-up imaging (any modality) of ectatic aortas and abdominal aortas (follow-up intervals may vary depending on comorbidities and the growth rate of the aneurysm)
2.5-2.9 cm: ……5 yr
3.0-3.4 cm: ……. 3 yr
3.5-3.9 cm: ……2 yr
4.0-4.4 cm: ……1 yr
4.5-4.9 cm: ……..6 mo
5.0-5.5 cm: .....3-6 mo

The Society of Vascular Surgery has different follow-up intervals for AAA[49]:
>2.5 cm - <3 cm……..10 yr
3.0 - 3.9 cm……..3 yr
4.0 - 4.9 cm……12 mo
5.0 - 5.4 cm……..6 mo

The Society of Vascular Surgery recommends elective repair of AAA ≥ 5.5 cm in patients at low or acceptable surgical risk.[49]

CT for Mesenteric Ischemia
CT of the abdomen and pelvis with intravenous (IV) contrast performed during the venous phase has been less well-studied compared with CTA in diagnosing mesenteric ischemia. CT with IV contrast can assess nonvascular findings, major arterial lesions, and mesenteric veins; however, the lack of arterial phase may lead to suboptimal evaluation of the mesenteric arteries compared to CTA.[47]

CT for elevation of CEA with no history of a previous CEA-producing tumor
CEA is not normally elevated after birth, but elevated CEA levels increases the chance of finding colon cancer from 1.3% to 4.6%. It is also a predictor of other diseases, including other cancers (e.g., mucinous adenocarcinomas of the endocervix and ovary, as well as keratinising squamous cell carcinoma of the cervix), diabetes, chronic lung, and liver disease.

Evaluation should begin with a thorough history, including smoking history, and clinical exam. Investigation would include repeat CEA, full blood count, iron, liver function and renal function tests, CA 125 levels, and calcitoinin. If CEA <10ng/ml and clinical review is negative, repeat the clinical evaluation in 3 months and CEA for changes. If level falls, repeat at 6-month intervals until normal or 2 consecutive decreases. If CEA level remains above 5 ng/ml after 3-6-month intervals or exceeds 10ng/ml at any stage, consider CT imaging.[69]

CT and Fever of Unknown Origin

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Initial work up prior to CT would include a comprehensive history, repeated physical exam, complete blood count with differential, three sets of blood cultures, chest x-ray, complete metabolic panel, urinalysis, ESR, ANA, RA, CMV IgM antibodies, virus detection in blood, heterophile antibody test, tuberculin test, and HIV antibody test.[61]

CT and screening for occult malignancy

In patients with a dermatomyositis, an initial screen with CT chest and abdomen is recommended because large population-based cohort studies report a frequency of 20-25% of malignancy. For the first incidence of unprovoked DVT, there is no indication for screening for occult malignancy (history, blood testing including blood count, calcium, UA, liver function tests, CXR, and age- and gender-specific screening indicated).[70] In the case of recurrent DVT, recently a risk score including age >70, chronic lung disease, anemia, elevated platelet count, prior venous thrombosis and recent surgery was designed but still needs external validation before clinical use.[71, 72] Paraneoplastic neurologic syndromes fall into this category. They are rare, often sub-acutely manifesting conditions associated with malignant neoplasms, and they are hypothesized to be immune-mediated. When classic clinical symptoms are present and a high concentration of characteristic anti-neuronal antibodies, there is associated a high probability of malignancy. Small cell lung cancer, thymoma, breast cancer, ovarian cancer and teratoma, and testicular tumors are most common. In paraneoplastic syndrome, screen first for breast cancer with mammography then MRI breast, ovarian teratoma and ovarian cancer with pelvic ultrasound (also CA-125), and for a testicular tumor with ultrasound (also B-HCG and AFP), and if inconclusive follow by CT. Note that tumors may manifest as late as 5 years after the onset of PNS symptoms and further follow-up imaging may be warranted.[73]

Combination request of Abdomen CT/Chest CT

A Chest CT will produce images to the level of L3. Documentation for combo is required.

Evaluation for appendicitis following clinical and laboratory evaluation

Sonography of the right upper quadrant and pelvis followed by graded compression and color Doppler sonography of the right lower quadrant was used by Gaitini and colleagues as the initial imaging study in 420 consecutive patients referred for emergency evaluation of acute appendicitis. This method correctly diagnosed acute appendicitis in 66 of 75 patients (88%) and excluded it correctly in 312 of 326 patients (96%). It was inconclusive in 19 patients (<5%). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 74.2%, 97%, 88%, 93%, and 92%, respectively and comparable to CT.[74]

Appropriate and timely diagnosis of acute appendicitis is needed. Negative laparotomy rates can range from 16% to 47% when based on clinical and laboratory data alone, while perforation rate can reach 35% when surgery is delayed. Appropriate initial imaging can lower the negative laparotomy rate to 6-10%. Ultrasound has a higher non-diagnostic rate (4%) vs. 0.8% for MDCT. In a prospective study operator experience and patient BMI did not affect diagnostic accuracy.[74, 75]

Consider alternatives to CT imaging in patients with Crohn disease

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In facilities where the technical and clinical expertise exists, MR enterography is emerging as the study of choice (replacing CT) for patients requiring frequent follow-up examinations to determine disease extent or progression. The technique also allows evaluation of extramucosal and extraluminal disease.

Consider the role of capsule endoscopy

Small bowel capsule endoscopy allows for direct visualization of the mucosa of the small intestine and has been found to be superior to barium studies, CTE and ileocolonscopy. However, the specificity has been questioned. There is a high negative predictive value of 96%. Also, it may identify a site for selected biopsy to establish a diagnosis.

Lab tests used in diagnosing IBD

Anti-glycan antibodies are more prevalent in CD than UC, but this test has a low sensitivity. Fecal calprotectin is a helpful test that can help differentiate IBD from irritable bowel syndrome as well as in assessment of disease activity, including response to therapy. Data supports the use of fecal calprotectin to predict relapse in CD. Those who relapsed in one year had significantly higher levels at baseline. Fecal lactoferrin and fecal PMN-elastase are also used for monitoring disease activity in Crohn's.[76]

Imaging of hernias

Most hernias are diagnosed clinically with imaging recommended for the diagnosis of occult hernias or in the evaluation of hernia complications, such as bowel obstruction or strangulation. To detect occult hernias, ultrasound is a first-line study with a sensitivity of 86% and specificity of 77%, compared to 80% sensitivity and 65% specificity for CT.[77] According to Miller, et al "Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias…."[78] Based on this analysis, MRI is recommended only when ultrasound and CT have been performed and fail to make a diagnosis.

POLICY HISTORY

Date	Summary
March 2022	• Moved "New evidence of an unknown primary" from Evaluation of suspicious or known mass section to Initial staging of known cancer. • Clarified suspected diverticulitis • Added immunocompromised patients to suspected diverticulitis • Added "OR when peritoneal signs are present (guarding, rebound) or other red flags" to suspected appendicitis in a child • Clarified note regarding MRE for patients under 35 years of age • Removed "For CT Enterography (CTE) if a CT scan is inconclusive" from section on Suspected IBD • Clarified evaluation of hematuria

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	• Clarified concern for lymphoma/malignancy with B symptoms and removed if CXR, labs, and Abd/Pelvis US have been completed
April 2021	• Updated prostate cancer imaging section to reflect current NCCN 2021 changes and adjusted PSA • Revised and clarified hematuria when stone is not suspected • Updated known or suspected stone with acute flank pain section to more clearly reflect criteria for when CT imaging is needed • Renamed “recurrent UTI” as “Complicated UTI” and specified definitions and criteria for when imaging is needed for women and when for men
May 2020	• Added indication for imaging of new evidence of an unknown primary • FU for abnormal lymph nodes at 3 months • FU mesenteric panniculitis if symptoms fail to improve • Renal colic added no imaging if under 35 and adequate pain relief; if <55 and inadequate relief or abnormal US can image, >55 if no hx of stones or abnormal ultrasound • Pre op for renal surgery or procedure • Post op for symptomatic patients or asymptomatic and abnormal ultrasound • Added imaging for pyelonephritis with complex med hx such as diabetes or prior urinary tract surgery or immunocompromised • Added GL for men with UTI based on age <or>60 • Improved criteria for WU of IBD, added CTE information and imaging for monitoring therapy • Other indications added—for diffuse LE edema with neg or inconclusinve US; elevated CEA with no cancer hx, FUO; May-Thurner; isolated right varicocele; Paraneoplastic syndrome; dermatomyositis; acute pain in patient over 65 • Added to comment section on renal colic, recurrent UTI, CEA; Occult malignancy
May 2019	• For hematuria, clarified that testing should not be done by dipstick; for infectious hematuria, removed restriction of 6 week completion of antibiotic therapy • Modified indication for prostate cancer imaging when PSA levels ≥10 ng/mL per NCCN update • Removed indication for evaluation of organ enlargement; suspected cholecystitis or retained gallstones; hepatitis screening; adrenal mass; ischemic bowel; suspected partial small bowel obstruction • Added indications for known necrotizing pancreatitis; acute flank pain with or without hematuria; pregnant women with suspected appendicitis

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	consider US or MRI; blunt injury or penetrating abdominal injury; evaluation of endovascular/interventional abdominal vascular procedures; follow up for post endovascular repair or open repair of abdominal aortic aneurysm; symptoms of fevers, night sweats, unexplained weight loss over 6 months if CXR, labs, and US have been performed • Added time frame to Pancreatitis history to include >4 weeks of symptoms

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **ABDOMEN MRI** **MRCP (Magnetic Resonance Cholangiopancreatography)** **MRE (Magnetic Resonance Enterography)** **MRU (Magnetic Resonance Urography)**	**Original Date: September 1997**
CPT Codes: 74181, 74182, 74183, S8037, +0698T	**Last Revised Date: March 2022**
Guideline Number: NIA_CG_031	**Implementation Date: January 2023**

IMPORTANT NOTE: A single authorization for CPT codes 74181, 74182, 74183, S8037 covers imaging of the biliary tree and its attached organs, i.e., the liver, gallbladder (GB), and pancreas. These same codes also cover MRI abdomen, MRE (Enterography), and MRU (Urography). Multiple authorizations are not typically required. When both MRCP and MRI abdomen are requested, documentation requires a medical reason clearly indicating why both are needed, i.e., that meets guidelines for imaging of bowel, kidneys, or areas other than liver, pancreas, GB, and biliary tree as well.

Note: There is **no** MRI Abdomen/Pelvis combo (comparable to a CT Abdomen/Pelvis) such that if imaging of both the abdomen and pelvis are indicated, two separate exams (and authorization) are required (i.e., MRI Abdomen and MRI Pelvis)

INDICATIONS FOR ABDOMEN MRI

Evaluation of suspicious known mass/tumors for further evaluation of indeterminate or questionable findings

- Initial evaluation of suspicious abdomen masses/tumors found only in the abdomen by physical exam or imaging study, such as ultrasound (US), or CT.[1]
- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the pelvis. No further surveillance MR unless tumor(s) is/are specified as highly suspicious or change was found on exam or last follow-up imaging.

Initial staging of known cancer

Follow-up of known cancer[2, 3]:

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- In patient undergoing active treatment within the past year or per surveillance imaging tip sheet that summarizes NCCN recommendations[3]
- With suspected pelvic metastasis based on a sign, symptom, (e.g., anorexia, early satiety, intestinal obstruction, night sweats, pelvic pain, weight loss, vaginal bleeding) or an abnormal lab value (alpha-fetoprotein, CEA, CA 19-9, p53 mutation)
- For abnormal incidental abdominal lymph nodes when follow-up is recommended based on prior imaging (initial 3-month follow-up)[4]
- For known prostate cancer abdomen MRI can be approved when requested in combination with pelvis MRI when meets GL for pelvis MRI

For evaluation of an organ or abnormality seen on previous imaging

ADRENAL

- To locate a pheochromocytoma once there is clear biochemical evidence (See Background)[5]
- Suspected adrenal secreting tumor after full clinical and biochemical work-up[6, 7]
- Suspected adrenal mass ≥ 1 cm incidentally discovered with no history of malignancy (one follow-up in 6 – 12 months to document stability)
- If adrenal mass ≥ 4 cm and no diagnosis of cancer, can approve for preoperative planning (surgery to rule out adrenal cortical carcinoma)
- For adrenal mass < 4 cm with history of malignancy (if ≥ 4 cm consider biopsy or FDG-PET/CT unless pheochromocytoma is suspected)
- Yearly surveillance for patients with Multiple Endocrine Neoplasia type 1 (MEN1) beginning at age 10[8]
- For patients with Von Hippel Lindau (VHL) surveillance at least every other year starting at age 16 (abdominal ultrasound starting at age 8)[9]
- Surveillance MRI (include pelvis) every 2-3 years for patients with Hereditary Paraganglioma syndromes types 1-5[10]

LIVER

- Indeterminate liver lesion ≥ 1cm seen on prior imaging[11]
- Indeterminate liver lesion < 1cm on initial imaging, with known history of extrahepatic malignancy, or known chronic liver disease
- Hepatitis/hepatoma screening after ultrasound is abnormal, equivocal, or non-diagnostic (may be limited in patients who are obese, those with underlying hepatic steatosis, as well as nodular livers).[12-15] (No literature supports the use of AFP alone in the screening of HCC).
- For jaundice or abnormal liver function tests after equivocal or abnormal ultrasound[16]
- For surveillance of HCC in patients who have received liver-directed therapy, surgical resection, medical treatment, or transplant (MRI or CT) at one-month post treatment and then every 3 months for up to two years (See Background)[16, 17]
- For follow-up of suspected adenoma every 6-12 months
- For surveillance of patients with primary sclerosing cholangitis (also CA 19-9), every 6-12 months after the age of 20 (MRI and MRCP preferred over CT)[18]
- For follow up of focal nodular hyperplasia (FNH) annually if US is inconclusive[19]

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- For elastography in chronic liver disease to stage hepatic fibrosis[15] when transient elastography with ultrasound is insufficient
- In patients with Beckwith-Wiedemann syndrome and abnormal ultrasound or rising AFP[20]
- In Gaucher Disease when ultrasound (including Doppler assessment of portal blood flow) is insufficient[21]
    - For initial evaluation
    - To evaluate gross scarring and/or portal hypertension
    - To monitor hepatic volume/hepatomegaly annually

Evaluation of iron overload in the following settings

- Initial evaluation of liver iron in Hemochromatosis diagnosed in lieu of liver biopsy[22]
- Annual evaluation for high-risk patients: transfusion-dependent thalassemia major, sickle cell disease, Gaucher Disease, and other congenital anemias[23] when ultrasound is insufficient

PANCREAS

- Pancreatic cystic lesion found on initial imaging
- For follow-up of known intraductal papillary mucinous neoplasm (IPMN) and mucinous cystic neoplasm (MCN) (if there are no high-risk characteristics, see Background section)[24]:
    - For incidental and asymptomatic cysts <5 mm, one follow-up at three years[25]
    - For cysts 5mm-1cm image every 2 years for 4 years, and if stable may lengthen intervals
    - For cysts 1-2cm image every year for 3 years and if stable every 2 years for 4 years, and if stable may lengthen intervals
    - Cysts that are 2-3 cm followed every 6-12 months for 3 years and if stable then yearly for 4 years and if stable may lengthen intervals (can also use EUS-Endoscopic ultrasound)
    - For lesions ≥ 30 mm MRI/CT or EUS every 6 months for 3 years, then imaging alternating with EUS every year for 4 years and consider lengthening interval if stable
- Annual surveillance for individuals determined to have an increased lifetime risk of developing pancreatic cancer, based on genetic predisposition or family history
    - Starting at age 50 or 10 years younger than the earliest age of cancer affected first-degree relative (except with Peutz-Jeghers start at age 30-35)
    - Von Hippel Lindau starting at age 16 at least every other year (abdominal ultrasound starting at age 8)
    - Hereditary Pancreatitis starting at age 40 or 20 years before first attack[3, 26, 27] **
    - For other approvable genetic syndromes that increase lifetime risks, see Background section
- Annual surveillance for patients with MEN1 for primary neuroectodermal tumors (pNET) starting at age 10 (EUS also considered)
  For localization of an insulinoma, once diagnosis is confirmed (CT preferred)[28]

RENAL

- For an indeterminate renal mass on other imaging[29]
- Active surveillance for indeterminate cystic renal mass, not a simple renal cyst[30] (See Bosniak criteria in Background section).
- Follow-up for solid renal masses under 1 cm at 6 and 12 months, then annually[31]

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- Annual surveillance for patient with tuberous sclerosis and known angiomyolipomas[32]
- For surveillance of patients with Von Hippel Lindau at least every other year to assess for clear cell renal cell carcinoma to begin at age 16 (screening with ultrasound starting at around age 8)[9]
- Active surveillance for renal cell carcinoma in patients with Birt-Hogg syndrome every 36 months[33]
- MRU (may also approve MR pelvis for MR urography) when ultrasound is inconclusive and CT (CTU) cannot be done or is inconclusive and MRI is recommended
- Polycysytic Kidney Disease
    - Total kidney volume (TKV) is an important measure for assessing disease progression as it can determine prognosis through its ability to predict decline in renal function
        - Abdomen MRI is approvable prior to treatment (an ultrasound is not required prior to MR)
        - If MR is contraindicated or cannot be performed, Abdomen CT is approvable

SPLEEN
- Incidental findings of the spleen on ultrasound or CT that are indeterminate[34]
- In Gaucher Disease when ultrasound is insufficient[21]
    - For initial evaluation
    - To evaluate splenic fibrosis or the presence of focal splenic lesions
    - To monitor splenic volume/splenomegaly annually

Suspected Hernia
- Occult, spigelian, incisional or epigastric hernia when physical exam and prior imaging (ultrasound AND CT) is non-diagnostic or equivocal[35-38] and limited to the abdomen
- Suspected incarceration or strangulation based on physical exam (guarding, rebound) or prior imaging (CT preferred)[39]

For evaluation of suspected infection or for follow-up known infection (may approve in conjunction with Pelvis MRI when indicated)
- Persistent abdominal pain not explained by previous imaging/procedure
- Any known infection that is clinically suspected to have created an abscess in the abdomen
- Any history of fistula limited to the abdomen that requires re-evaluation or is suspected to have recurred
- Abnormal fluid collection limited to the abdomen seen on prior imaging that needs follow-up evaluation
- Suspected peritonitis (would typically need to include MRI Pelvis) when abdominal pain and tenderness to palpation are present, and **at LEAST one** of the following:
    - Rebound, guarding or rigid abdomen, **OR**
    - Severe tenderness to palpation over the entire abdomen
- Complications of diverticulitis with severe abdominal pain or severe tenderness or mass, not responding to antibiotic treatment (prior imaging study is not required for diverticulitis diagnosis)[40]

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For evaluation of suspected inflammatory bowel disease or follow-up known disease (includes MR enterography and can also approve Pelvis MRI/MRE)

- For suspected inflammatory bowel disease (Crohn's disease or ulcerative colitis) with abdominal pain **AND** one of the following[17, 41, 42]:
    - Chronic diarrhea
    - Bloody diarrhea
- High clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy[17, 41-43]
- Known inflammatory bowel disease (Crohn's or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation or for monitoring therapy[42]

Other indications for abdominal MRI (and pelvis where appropriate) when CT is inconclusive or cannot be completed

- Persistent abdominal/pelvic pain not explained by previous imaging
- To locate a pheochromocytoma once there is clear biochemical evidence (See Background)
- For B symptoms of fevers more than 101 F, drenching night sweats, or unexplained weight loss of more than 10% of body weight over 6 months
- Unexplained weight loss of 10% of body weight in two months (patient history is acceptable); with second MD visit documenting further decline in weight[44]
- Unexplained weight loss of 5% of body weight in six months confirmed by documentation to include the following[45, 46]:
    - Related history and abdominal exam
    - CXR
    - Abdominal ultrasound
    - Lab tests, including TSH
    - Colonoscopy if 50-85 years old
- For fever of unknown origin (temperature of ≥ 101 degrees for a minimum of 3 weeks) after standard diagnostic tests are negative[47]
- For suspected or known retroperitoneal fibrosis after complete workup and ultrasound to determine extent of disease[48]
- To screen patients with dermatomyositis for occult malignancy[49]
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound[50]
- For suspected May-Thurner syndrome (CTV/MRV preferred)[51, 52]
- For further evaluation of an isolated right varicocele with additional signs and symptoms that suggest malignancy or suspicious prior imaging findings[53]

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine

INDICATIONS FOR MRCP[54-56]

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- To confirm choledocholithiasis in patients in the acute setting after ultrasound has been completed[56-58]
- Suspected acute pancreatitis with atypical signs and symptoms, including equivocal amylase and lipase and diagnosis other than pancreatitis may be possible. (MRCP and CT may be ordered simultaneously in this setting and may be approved)[56, 59]
- Pancreatitis by history (greater than 4 weeks), (including pancreatic pseudocyst) with continued abdominal pain suspicious for worsening, or re-exacerbation. (MRCP and CT may be ordered simultaneously in this setting and may be approved)[56, 59]
- Evaluation of suspected congenital anomaly of the pancreaticobiliary tract, e.g., aberrant ducts, pancreas divisum or related complications[60]
- For confirmation of choledochal cyst after ultrasound has been done[61]
- For long-term postoperative surveillance for patients with history of choledochal cyst
- For post-surgical biliary anatomy and complications when ERCP is not possible or contraindicated
- For the assessment of benign or malignant biliary strictures
- Evaluation of persistent symptoms when abnormalities are identified on other imaging (e.g., ultrasound, CT, or MRI)
- Evaluation of abnormality related to the pancreatic or biliary tree based on symptoms or laboratory findings and initial imaging has been performed or is contraindicated (e.g., renal failure prevents contrast CT or body habitus limits US)
- Evaluation of pancreatobiliary disease in pregnant patients after ultrasound has been done

INDICATIONS RELEVANT TO ABDOMEN MRI OR MRCP

Pre-operative evaluation
- For abdominal surgery or procedure

Post-operative/procedural evaluation
- Follow-up of known or suspected post-operative complication involving only the abdomen
- A follow-up study to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed

If both Abdomen and Pelvis MRI are indicated and the Pelvis MRI has already been approved, then the Abdomen MRI may be approved.

BACKGROUND

***Abdominal Magnetic Resonance Imaging (MRI)** is a proven and useful tool for the diagnosis, evaluation, assessment of severity, and follow-up of diseases of the abdomen and avoids exposing the patient to ionizing radiation. MRI may be the best imaging procedure for patients with allergy to radiographic contrast material or renal failure. It may also be the procedure of choice for suspected lesions that require a technique to detect subtle soft-tissue contrast and provide a three-dimensional

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depiction of a lesion. Abdominal MRI studies are usually targeted for further evaluation of indeterminate or questionable findings, identified on more standard imaging exams such as ultrasound (US) and CT.

Magnetic Resonance Enterography is an excellent study for assessing submucosal pathology in inflammatory bowel disease. It generates highly reproducible images of the large and small bowel with excellent sensitivity and specificity. It can determine the presence and extent of transmural inflammation, fibrotic disease, and other intra-abdominal complications. It is also useful in assessment of bowel obstruction, abscess formation, tethering and fistula and is less dependent on bowel distention than CT enterography.[17] MRE is similar overall to CTE and useful (reduce radiation burden) when multiple studies are likely.[62]

Magnetic Resonance Cholangiopancreatography (MRCP) is a non-invasive radiologic technique for imaging the biliary and pancreatic ducts in the clinical setting of cholestatic liver function tests, right upper quadrant pain, recurrent pancreatitis, and assessing postoperative complications. MRCP is reliable for the diagnosis of pancreatic ductal abnormalities, e.g., pancreas divisum. It is also used to diagnose bile duct stones and assess the level of biliary obstruction. MRCP is especially useful as an alternative to ERCP (Endoscopic retrograde cholangiopancreatography), when a noninvasive exam is desired or when there is a very small likelihood that the patient will need therapeutic intervention afforded by ERCP. MRCP is unwarranted in patients with known pathology requiring ERCP-mediated intervention. Due to the variable accuracy of ultrasound in detecting choledocholithiasis, preoperative MRCP prior to cholecystectomy has been advocated particularly in the setting of acute cholecystitis, near normal common bile duct diameter (where ultrasound is less accurate) and elevated liver functions, especially alanine amino transaminase (ALT).[63] Secretin-enhanced MR Cholangiopancreatography has been recently developed to improve the diagnostic quality of MRCP images.[64]

In diagnosing acute pancreatitis, MRI and MRCP are not as practical as CT. The latter can be performed more quickly and provide better images due to less motion artifact (if patient cannot cooperate with instructions for MRI) in acutely ill patients.[56] In selected patients, however, such as those who cannot receive iodinated contrast for CT, MRI/MRCP may be considered or used in a complementary fashion to CT. Complications of chronic pancreatitis using MRCP are well-imaged in cooperative patients.

Cross-sectional imaging (liver ultrasound with Doppler, CT, or MRI) should be completed no more than a month prior to the transjugular intrahepatic portosystemic shunt (TIPS) to assess for vascular patency and look for hepatic masses or other problems that could complicate the procedure.

Post procedure, an ultrasound of the liver is performed a day after to assess shunt patency. Hepatic encephalopathy (HE) is the most common complication and usually occurs 2-3 weeks after insertion of TIPS. Unique complications may include intravascular hemolysis and infection of the shunt. Other complications, which may require cross-sectional imaging, can include capsule puncture, intraperitoneal bleed, hepatic infarction, fistula, hematobilia, thrombosis of stent, occlusion, or stent migration.

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Follow-up and maintenance imaging, if complications are suspected, include Doppler ultrasound to assess shunt velocity. If asymptomatic, a sonogram is performed at 4 weeks post placement, then every 6 months to a year. The gold standard for shunt patency is portal venography, usually reserved if concern for shunt occlusion.

OVERVIEW

MRI of the liver – The liver is a common site of metastatic spread. Patients with a history of known or suspected malignancy, especially tumors from the colon, lung, pancreas, and stomach, are at risk for developing hepatocellular carcinoma. Patients with chronic liver disease are also at risk for developing liver cancer and undergo periodic liver screening for focal liver lesion detection, usually with ultrasonography (US). Extra-cellular gadolinium chelate contrast-enhanced MRI is used for evaluating patients with an abnormal US. Patients with hepatic metastases being considered for metastasectomy undergo contrast-enhanced MRI using tissue-specific contrast agents.

Screening for Hepatocellular carcinoma (HCC) – AASLD (American Association for the Study of Liver Diseases) recommends screening for HCC with ultrasound every 6 months for patients with hepatitis C and B.[12] The literature differs on the role of AFP (alpha fetoprotein) in the screening of HCC. Some authors argue against its use altogether due to its lack of sensitivity and specificity in detecting HCC[12, 14] and instead recommend ultrasound alone for screening. According to Marquardt, the AASLD and EASLD (European Association for the Study of the Liver) "do not endorse its [AFP] use in clinical routine, neither alone nor in combination with ultrasound". This approach is supported by reports of patients with chronic viral hepatitis and elevated AFP but normal livers on imaging. AFP elevation in these cases is due to hepatic inflammation and viral replication,[65] not neoplasm. Others advocate for combined ultrasound and AFP for screening[66, 67] citing increased sensitivity compared to ultrasound alone in detecting early-stage HCC particularly in cirrhotic patients. In a meta-analysis by Tzartzeva, et al of thirty-two studies (13,367 patients with cirrhosis) ultrasound with AFP had a 63% sensitivity of detecting early-stage HCC compared to 45% for ultrasound alone. In the final analysis, no literature supports the use of AFP alone in the screening of HCC.[67]

MRI or MRCP for surveillance of cholangiocarcinoma in patients with PSC, other risk factors – Cholangiocarcinoma, a cancer with an increase in incidence globally, is very aggressive with 95% of patients dying within 5 years. Because of the superior sensitivity of MRI compared with ultrasound to detect cholangiocarcinoma, it is preferred for imaging surveillance. In a large study of PSC patients, regular surveillance was associated with a higher 5-year survival.[18]

The strongest risk factors for both intrahepatic (iCCA) and extrahepatic (eCCA) cholangiocarcinoma are choledochal cysts; cirrhosis is a stronger risk factor for iCCA (i.e., iCCA>eCCA); and choledocholithiasis is a stronger risk factor for eCCA (i.e., eCCA>iCCA).[68]

MRI of the adrenal glands – The adrenal glands are susceptible for metastases from various tumors, especially of lung or breast. Adrenal lesions may also represent primary tumors of the adrenal cortex of medulla, both benign and malignant. MRI may be done to distinguish between benign and malignant lesions. Metastases are predominantly hypointense on T1-weighted images and hyperintense on T2-

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weighted images. Benign lesions, which have high lipid content, exhibit a drop in signal intensity on opposed phase chemical shift imaging.

In general, masses found < 1 cm do not need to be pursued. If an adrenal mass has diagnostic features of a benign mass, such as a myelolipoma (presence of macroscopic fat), cyst, or hemorrhage (masses without enhancement, defined as change in pre- and postcontrast imaging of <10 HU), no additional workup or follow-up imaging is needed. If the mass has a density of 10 HU on unenhanced CT or signal loss compared with the spleen between in- and opposed-phase images of a chemical-shift MRI (CS-MRI) examination, these features are almost always diagnostic of a lipid-rich adenoma, regardless of size. If no benign imaging features but stable for a year or longer, it is very likely benign and needs no further imaging. The role of adrenal mass biopsy is reserved predominantly to confirm a suspected adrenal metastasis; this procedure has been shown to be safe with a low morbidity.

If there are signs or symptoms of pheochromocytoma, plasma-free metanephrine and normetanephrine levels or urinary fractionated metanephrines should be obtained prior to biopsy. Imaging is recommended with CT (MRI as second option) once biochemical evidence confirmed. Otherwise, endocrine workup of an incidental adrenal mass is controversial. Current guidelines from the American Association of Clinical Endocrinologists and the American Association of Endocrine Surgeons recommend an initial biochemical evaluation of all adrenal incidentalomas to exclude pheochromocytoma, subclinical Cushing's syndrome, and hyperaldosteronism.

Genetic syndromes and adrenal tumors – Adrenal cortical carcinoma (ACC) diagnosed during childhood is known to be commonly associated with hereditary syndromes, including Beckwith-Wiedemann (BWS) and Li-Fraumeni syndrome (LFS). In adults, ACC may be associated with Multiple Endocrine Neoplasia 1 (MEN1), familial adenomatous polyposis coli and neurofibromatosis type 1 (NF1); however, there are currently no surveillance imaging recommendations.[69]

MRI of the pancreas – Pancreatic cancer is thought to have a familial or hereditary component in approximately 10% of cases. Surveillance of individuals with genetic predisposition for pancreatic adenocarcinoma should include known mutation carriers from hereditary syndromes, such as Peutz-Jeghers (10-30% lifetime risk), hereditary pancreatitis (which is associated with genes *PRSS1* and *SPINK1*), familial atypical multiple melanoma and mole syndrome (10-30% risk) or for members of familial pancreatic cancer with a first-degree family member with pancreatic cancer. In patients who are mutation carriers in *BRCA2* (5-10% lifetime risk), *PALB2* (5-10% lifetime risk), and Lynch syndrome (5-10%) families. Surveillance for patients with *BRCA1* (2% lifetime risk) and *ATM* serine/threonine kinase (1-5% lifetime risk) is limited to those with first- or second-degree relatives with pancreatic cancer. NCCN also recommends screening for individuals with a known pathogenic/likely pathogenic germline variant in a pancreatic susceptibility gene, including *CDKN2A, MLH1, MLH2, MSH6, PMS2, EPCAM* (mismatch repair genes associated with Lynch syndrome), *ATM, PALB2, STK11, TP-53* and a family history (first- or second-degree relative) from the same side of the family; or a family history of exocrine pancreatic cancer in ≥2 first-degree relatives from the same side of the family or ≥3 first- and second-degree relatives from the same side of the family (and at least one is a first-degree relative).[3, 70, 71]

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Patients with a family history of pancreatic cancer affecting two first-degree relatives meet criteria for familial pancreatic cancer and are candidates for genetic testing. It should be noted that 90% of families meeting criteria for familial pancreatic cancer will not have a pathogenic mutation.[72]

Surveillance of Pancreatic Cysts – Some pancreatic cysts have the potential for malignant transformation to invasive ductal adenocarcinoma; hence the need for intervention vs surveillance. The data, however, is unclear as to the risk of cancer. Cyst surveillance can be offered to patients with asymptomatic cysts presumed to be IPMNs or MCNs. Pancreatic cystic Neoplasms (PCN) make up about 2-45% of the general population.

High risk characteristics for mucinous pancreatic cysts include all of the following: Symptoms, Jaundice secondary to the cyst, acute pancreatitis secondary to the cyst, elevated serum CA 19-9 and no benign cause present, an enhancing mural nodule or solid component within the cyst or pancreas, main pancreatic duct of > 5mm, change in duct caliber with upstream atrophy, size over 3 cm, high grade dysplasia or cancer on cytology. These patients should undergo EUS + -FNA or be referred to a multidisciplinary group for further recommendations.[24]

MRI and insulinoma – Insulinomas are rare pancreatic tumors. Localization of the tumor by ultrasound or CT are the preferred initial options once a diagnosis has been made, followed by endoscopic ultrasound or arterial stimulation with hepatic venous sampling. Whipples triad includes symptoms of hypoglycemia, low blood glucose relieved by ingestion of glucose, and benign 90%. Work-up prior to imaging should include a 72-hour fast with serial glucose and insulin levels over this period until the patient becomes symptomatic. An insulin/glucose ratio of greater than 0.3 has been found in virtually all patients with insulinoma or other islet cell tumors.[28]

MRI and elevated Liver Function Tests – For elevated bilirubin or serum transaminases with or without bilirubin elevation, US is the initial recommended test to assess for duct dilatation which might lead to ERCP or MRCP, vs other causes which might necessitate further lab testing or liver biopsy.[73]

MRI of the kidney – MRI in renal imaging has been used to differentiate benign lesions versus malignant lesions in patients unable to undergo CT scanning with contrast media or in cases where the CT findings were questionable. Initial evaluation of renal lesions is often undertaken with ultrasound. MRI can have additional diagnostic value in the evaluation of lesions with minimal amounts of fat or with intracellular fat. MRI may have a higher accuracy than CT in the evaluation of early lymph node spread. Although MRI of the kidney has not yet found broad clinical application, it may have an increasing role in the management of patients with renal disease.

Recommendations for follow up of a complex cystic renal mass are made using Bosniak criteria[74]:

- Bosniak I (water density 0-20 HU); no further follow-up
- Bosniak II (one or a few thin septations, small or fine calcifications, hyperdense cysts up to 3 cm); no further follow-up
- Bosniak IIF felt to be benign but too complex to be diagnosed with certainty; image at 6 and 12 months, then annually for 5 years if no progression

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- Bosniak III thick-walled cystic lesions with wall or septal enhancement; resection favored vs conservative management and RFA in select cases[30]
- Bosniak IV malignant cystic renal mass with enhancing soft tissue components; resection favored; malignant until proven otherwise

MRI of the spleen – Among some radiologists, the spleen is considered a 'forgotten organ' although it is included and demonstrated on every abdominal CT and MRI. Malignant tumors of the spleen are rare; malignant lymphomas are the most common and are usually a manifestation of generalized lymphoma. Splenic metastases are predominantly hypointense on T1-weighted images and hyperintense on T2-weighted images, and MRI is used for the detection of necrotic or hemorrhagic metastases.

MRI for the evaluation of vascular abnormalities such as renal artery stenosis and celiac/superior mesenteric artery stenosis (in chronic mesenteric ischemia) – Doppler Ultrasound, MRA, or CTA should be considered as the preferred imaging modalities.

Imaging of hernias – Most hernias are diagnosed clinically with imaging recommended for the diagnosis of occult hernias or in the evaluation of hernia complications, such as bowel obstruction or strangulation. To detect occult hernias, ultrasound is a first-line study with a sensitivity of 86% and specificity of 77%, compared to 80% sensitivity and 65% specificity for CT.[38] According to Miller, et al "Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias…."[37] Based on this analysis, MRI is recommended only when ultrasound and CT have been performed and fail to make a diagnosis.

Ultrasound – Ultrasound is the initial imaging technique used for screening suspected biliary or pancreatic disease, but it has limited ability to characterize abnormalities in the biliary and pancreatic ducts.

Endoscopic retrograde cholangiopancreatography (ERCP) – ERCP can combine diagnosis with therapeutic intervention, e.g., removal of stones, but it is an invasive procedure that carries significant risk of complications, e.g., pancreatitis. ERCP is also technically challenging in patients with post-surgical biliary and/or surgical anastomoses.

POLICY HISTORY

Date	Summary
March 2022	• Clarified coding note regarding MRE, MRU, MRCP, and MRI MRI: • Added Initial staging of known cancer • Under evaluation of suspicious known mass/tumor, added one follow-up surveillance MR to ensure to suspicious change occurring in tumor in pelvis with no further surveillance MR unless tumor(s) is/are

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	highly suspicious or change was found on last exam or last follow-up imaging • Follow-up of known cancer o Clarified surveillance imaging per NCCN recommendations o Added For abnormal incidental abdominal lymph nodes with follow-up is recommended based on prior imaging (initial 3-month follow-up) • Clarified elastography in chronic liver disease to stage hepatic fibrosis • Added Gaucher disease to Liver and Spleen sections • Added Polycystic Kidney Disease to Renal section • Clarified suspected incarceration or strangulation based on physical exam in Suspected Hernia section • In Other indications for abdominal MRI, changed wording (replaced 'and' with 'or' and deleted "if CXR labs and an ultrasound of the abdomen and pelvis have been completed") to state "For B symptoms of fevers more than 101 F, drenching night sweats, or unexplained weight loss of more than 10% of body weight over 6 months"
November 2021	Added +0698T
April 2021	Updated for concordance w/CTA abdomen/pelvis
May 2020	MRCP: • Added to confirm choledocholithiasis in the acute setting after ultrasound completed • Suspected acute pancreatitis with atypical presentation and other diagnosis possible • To confirm choledochal cyst or long-term post op surveillance • For assessment of suspected biliary strictures • For post op anatomy when ERCP cannot be done MRI: • Adrenal-added suspected adrenal secreting tumor after full work up • Surveillance for paraganglioma syndromes • Surveillance primary sclerosing cholangitis • Elastography to stage hepatic fibrosis • Beckwidth Wiedemann after abnormal ultrasound • Revised guidelines for follow up of pancreatic cystic lesions/intraductal papillary mucinous neoplasm • Revised based on NCCN 2019 guidelines for increased lifetime risk of developing pancreatic cancer • Added surveillance for MEN 1 • Added for localization of an insulinoma once dx confirmed • Added surveillance for VHL, renal and Birt-Hogg syndrome • Added MRU for recurrent UTI's in females

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	• Added a separate section on hernias • Improved info on inflammatory bowel disease, MRE • Added imaging for monitoring therapy in IBD • Under other indications added: to locate a pheochromocytoma when clear biochemical evidence; FUO: retroperitoneal fibrosis; added dermatomyositis; added May Thurner; added isolated right varicocele (only with additional signs and symptoms) • Comments with new section on surveillance of cholangiocarcinoma, genetic syndromes and adrenal tumors, Pancreatic cancer risk factors, surveillance of panc cysts, Insulioma work up, and CT and elevated LFT's.
May 2019	• Created combo guideline by absorbing MRCP guideline within the Abdomen MRI • Added Note: "A single authorization for CPT code 74181, 74182, 74183, S8037 includes imaging of the biliary tree and liver. Multiple authorizations are not required. When a separate MRCP and MRI abdomen exam is requested, documentation requires a medical reason that clearly indicates why additional MRI imaging of the abdomen is needed". • Added indications for evaluation of an organ or abnormality seen on previous imaging; liver lesions; jaundice or abnormal liver function; follow up of suspected adenoma and focal nodular hyperplasia; surveillance of HCC in patients who have received liver-directed therapy/surgical resection/medical treatment or transplant; pancreatic cystic lesion; intraductal papillary mucinous neoplasm and mucinous cystic neoplasm; pancreatic cancer risk; known necrotizing pancreatitis; renal mass; and spleen • Changed size parameters for adrenal mass: o Old: Suspected adrenal mass > 4 cm and there is a history of primary malignancy o Revised: Suspected adrenal mass ≥ 1 cm with no history of malignancy; if mass ≥ 4 cm and no diagnosis of cancer, can approve for preoperative planning; for mass < 4 cm with history of malignancy • Added/modified Background information and updated references

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **ABDOMEN MRA/MRV (Angiography)**	**Original Date: September 1997**
CPT Codes: 74185	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_034-2	**Implementation Date: January 2023**

IMPORTANT NOTE:

Abdomen/Pelvis Magnetic Resonance Angiography (MRA) & Lower Extremity MRA Runoff Requests: Two authorization requests are required, one Abdomen MRA, CPT code 74185 and one for Lower Extremity MRA, CPT code 73725 (a separate Pelvic MRA request is not required). This will provide imaging of the abdomen, pelvis, and both legs.

INDICATIONS FOR ABDOMEN MR ANGIOGRAPHY/MR VENOGRAPHY (MRA/MRV)

Arterial Disease
For evaluation of known or suspected abdominal vascular disease

- Evaluation of known or suspected aortic aneurysm‡ (also approve MRA pelvis)[1-3]:
    - For screening, US is initial study
        - Known or suspected aneurysm > 2.5 cm AND equivocal or indeterminate ultrasound results
        - Prior imaging (e.g., ultrasound) demonstrating aneurysm >2.5 cm in diameter
        - Suspected complications of known aneurysm as evidenced by signs/symptoms, such as new onset of abdominal or pelvic pain
        - Surveillance imaging every three years for diameter 2.0-2.9 cm and annually for 3.0-3.4 cm if doppler ultrasound is inconclusive. If > 3.5 cm, < 6 month follow-up (and consider intervention)[4]

‡NOTE: For known or suspected abdominal aneurysm, CT/MRI should not be approvable without a contraindication to CTA/MRA (such as severe renal dysfunction, contrast allergy, or another specific reason CT/MRI is preferred).

- Evidence of vascular abnormality seen on prior imaging studies and limited to the abdomen
- For known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, compression syndromes, arteriovenous malformations (AVMs), fistulas, intramural hematoma, and vasculitis limited to the abdomen

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- For suspected aortic dissection (approve CTA/MRA abdomen and pelvis)
- For diagnosis or follow-up of visceral artery aneurysm[5, 6]
- To determine the vascular source of retroperitoneal hematoma or hemorrhage in the setting of trauma, tumor invasion, fistula or vasculitis when CTA is contraindicated (CT rather than MRA/CTA is the modality of choice for diagnosing hemorrhage)[7]
- For evaluation of known or suspected mesenteric ischemia/ischemic colitis when CTA is contraindicated (can approve MRA abdomen and pelvis)[8]
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (CTA or MRA)[9]
- For patients with vascular Ehlers-Danlos syndrome or Marfan syndrome, recommend a one-time study of the abdomen and pelvis (CTA/MRA)
- For Loeys-Dietz, imaging at least every two years[10]
- For assessment in patients with spontaneous coronary artery dissection (SCAD), can be done at time of coronary angiography (also approve CTA pelvis)[11]
- Vascular invasion or displacement by tumor (conventional CT or MRI also appropriate)[12]
- For evaluation of hepatic blood vessel abnormalities (aneurysm, hepatic vein thrombosis, stenosis post-transplant) after doppler ultrasound has been performed; to clarify or further evaluate ultrasound findings

For evaluation of known or suspected renal artery stenosis or resistant hypertension in the setting of normal renal function (with impaired renal function, eGFR <30, use US with Doppler) unrelated to recent medication[13] demonstrated by any of the following[14, 15]:

- Unsuccessful control after treatment with 3 or more (>2) anti-hypertensive medication at optimal dosing
- Acute elevation of creatinine after initiation of an angiotensin converting enzyme inhibitor (ACE inhibitor) or angiotensin receptor blocker (ARB)
- Asymmetric kidney size noted on ultrasound
- Onset of hypertension in a person younger than age 30 without any other risk factors or family history of hypertension
- Significant hypertension (diastolic blood pressure > 110 mm Hg) in a young adult (i.e., younger than 35 years) suggestive of fibromuscular dysplasia
- Diagnosis of a syndrome with a higher risk of vascular disease, such as neurofibromatosis, tuberous sclerosis, and Williams' syndrome
- New onset of hypertension after age 50
- Acute rise in blood pressure in a person with previously stable blood pressures
- Flash pulmonary edema without identifiable causes
- Malignant hypertension
- Bruit heard over renal artery and hypertension
- Abnormal/inconclusive renal doppler ultrasound

Venous Disease

- Suspected renal vein thrombosis in patient with known renal mass or from other causes[16]

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- Venous thrombosis if previous studies have not resulted in a clear diagnosis (add pelvis MRA/MRV when appropriate)
- For known/suspected May-Thurner syndrome (iliac vein compression syndrome include pelvic CTV)[17, 18]
- Vascular invasion or displacement by tumor (conventional CT or MRI also appropriate)[12]
- For evaluation of portal venous system (hepatic portal system) after doppler ultrasound has been performed
- For diffuse unexplained lower extremity edema with negative or inconclusive ultrasound[19]
- In pregnant women with suspected deep venous thrombosis (DVT) (vs serial compression ultrasound) (include pelvis MRV for iliac veins)[20]

Pre-operative evaluation

- For evaluation of transjugular intrahepatic portosystemic shunt (TIPS) when Doppler ultrasound indicates suspected complications
- Evaluation prior to interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Evaluation prior to endovascular aneurysm repair (EVAR)
- Imaging of the deep inferior epigastric arteries for surgical planning (breast reconstruction surgery), include pelvic MRA[21]
- For pre-transplant evaluation of either liver or kidney
- For surgical planning for UPJ (ureteropelvic junction) obstruction to look for a lower pole crossing vessel
- Planning prior Y90 radiation treatment for liver cancer in order to evaluate anatomic variation/shunts/determine best catheter placement/see if coil(s) needed[22]

Post-operative or post-procedural evaluation

- Evaluation of endovascular/interventional abdominal vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia
- Evaluation of post-operative complications, e.g., pseudoaneurysms, related to surgical bypass grafts, vascular stents, and stent-grafts in the peritoneal cavity
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA) or abdominal extent of iliac artery aneurysms
    - Routine, baseline study (post-op/intervention) is warranted within 1-3 months (abdomen and pelvis MRA when CTA is inconclusive or cannot be performed)[1, 23]
    - If asymptomatic at six (6) month-intervals for one (1) year, then annually
    - If symptomatic/complications related to stent graft – more frequent imaging may be needed
- Follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other Vascular indications

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- For evaluation of hepatic blood vessel abnormalities (aneurysm, hepatic vein thrombosis, stenosis post-transplant) after doppler ultrasound has been performed; to clarify or further evaluate ultrasound findings
- Kidney failure or renal insufficiency if initial evaluation performed with ultrasound is inconclusive

Chest MRA/Abdomen MRA/Pelvic MRA combo

- For evaluation of extensive vascular disease involving the chest and abdominal cavities
- For pre-op or preprocedural evaluation for Transcatheter Aortic Valve Replacement (TAVR)[24, 25]
- Acute aortic dissection (CTA or CT preferred)[26]
- Takayasi's arteritits[27]
- Marfan syndrome
- Loeys-Dietz
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post-operative complications
- Significant post-traumatic or post-procedural vascular complications reasonably expected to involve the chest and/or abdomen and/or pelvis

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BACKGROUND

Magnetic resonance angiography (MRA) generates images of the arteries that can be evaluated for evidence of stenosis, occlusion, or aneurysms. It is used to evaluate the arteries of the abdominal aorta and the renal arteries. Contrast-enhanced MRA requires the injection of a contrast agent, resulting in very high quality images. MRA does not use ionizing radiation, allowing MRA to be used for follow-up evaluations. Abdominal MRA is not used as a screening tool, e.g., evaluation of asymptomatic patients without a previous diagnosis.

OVERVIEW

MRI Follow-up for post-endovascular repair (EVAR) – Although studies have shown that MRA is as sensitive as CT in detecting endoleaks, CTA is generally the study of choice in this evaluation due to convenience, improved spatial resolution, and less artifact from components of the stent graft. MRA is most helpful in the postoperative evaluation of patients with impaired renal function, but not severe enough to have contraindication to gadolinium administration or when CTA is inconclusive.

MRA and Abdominal Aortic Aneurysm – Endovascular repair is an alternative to open surgical repair of an abdominal aortic aneurysm. It has lower morbidity and mortality rates and is minimally invasive. In order to be successful, it depends on precise measurement of the aneurysm and involved vessels. MRA with gadolinium allows visualization of the aorta and major branches and is effective and reliable for use in planning the placement of the endovascular aortic stent graft. MRA is also used for the detection of postoperative complications of endovascular repair.

Abdominal Aneurysms and general guidelines for follow-up – The normal diameter of the suprarenal abdominal aorta is 3.0 cm and that of the infrarenal is 2.0 cm. Aneurysmal dilatation of the infrarenal

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aorta is defined as diameter ≥ 3.0 cm or dilatation of the aorta ≥ 1.5x the normal diameter.[2] Evaluation of AAA can be accurately made by ultrasound. Ultrasound can detect and size AAA, with the advantage of being relatively inexpensive, noninvasive, and not requiring iodinate contrast. The limitations are that overlying bowel gas can obscure findings and the technique is operator-dependent. CTA/MRA are needed only when ultrasound is insufficient or when surgery is planned.

Recommended intervals for initial follow-up imaging of ectatic aortas and abdominal aortas (follow-up intervals may vary depending on comorbidities and the growth rate of the aneurysm) from the white paper of the ACR Incidental Findings Committee II on vascular findings[2]:
2.5-2.9 cm:……5 yr
3.0-3.4 cm:……3 yr
3.5-3.9 cm:……2 yr
4.0-4.4 cm:……1 yr
4.5-4.9 cm:……6 mo
5.0-5.5 cm:……3-6 mo

The Society of Vascular Surgery has different follow-up intervals for AAA[1]:
>2.5 cm - <3 cm……..10 yr
3.0 - 3.9 cm……3 yr
4.0 - 4.9 cm……12 mo
5.0 - 5.4 cm……..6 mo.

The Society of Vascular Surgery recommends elective repair of AAA ≥ 5.5 cm in patients at low or acceptable surgical risk.[1]

MRA and Chronic Mesenteric Ischemia -"MRA has become increasingly accurate in depicting and grading stenosis of the mesenteric vessels, particularly for the celiac artery and SMA, with reported sensitivity and specificity in suspected chronic mesenteric ischemia up to 95% to 100%" and may be used for measuring flow in the SMA and superior mesenteric veins.[8]

MRA and Renal Artery Stenosis – Renal artery stenosis is the major cause of secondary hypertension. It may also cause renal insufficiency and end-stage renal disease. Atherosclerosis is one of the common causes of this condition, especially in older patients with multiple cardiovascular risk factors and worsening hypertension or deterioration of renal function. Navigator-gated MR angiography is used to evaluate the renal arteries and detect renal artery stenosis.

MRA and Renal Vein Thrombosis – Renal vein thrombosis is a common complication of nephrotic syndrome and often occurs with membranous glomerulonephritis. Gadolinium-enhanced MRA can demonstrate both the venous and arterial anatomy and find filling defects within renal veins. The test can be used for follow-up purposes as it does not use ionizing radiation.

MRI/CT and acute hemorrhage – MRI is not indicated and MRA/MRV (MR Angiography/Venography) is rarely indicated for evaluation of intraperitoneal or retroperitoneal hemorrhage, particularly in the acute setting. **CT is usually the study of choice** due to its availability, speed of the study, and less

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susceptibility to artifact from patient motion. Advances in technology have allowed conventional CT to not just detect hematomas but also the source of acute vascular extravasation. In special cases, finer vascular detail to assess the specific source vessel responsible for hemorrhage may require the use of CTA. CTA in diagnosis of lower gastrointestinal bleeding is such an example.[28]

MRA/MRV is often utilized in non-acute situations to assess vascular structure involved in atherosclerotic disease and its complications, vasculitis, venous thrombosis, vascular congestion, or tumor invasion. Although some of these conditions may be associated with hemorrhage, it is usually not the primary reason why MRI/MRA/MRV is selected for the evaluation. A special condition where MRI may be superior to CT for evaluating hemorrhage is to detect an underlying neoplasm as the cause of bleeding.[7]

POLICY HISTORY

Date	Summary
April 2022	• Added indication for UPJ surgery • Added "(abdomen and pelvis MRA when CTA is inconclusive or cannot be performed)" to follow-up for EVAR and AAA • Added Y90 indication
April 2021	• No substantive changes
May 2020	• Added compression syndromes for evaluation of vascular disease • Added evaluation of FMD, Vascular Ehlers-Danlos syndrome, Loetz-Dietz • Added May-Thurner • Added to assess DVT in pregnant women vs serial compression ultrasound, to include pelvis • Added indications for combo studies for chest MRA/abdomen and pelvis MRA
May 2019	• Added indications for visceral artery aneurysm; suspected chronic mesenteric ischemia; transjugular intrahepatic portosystemic shunt when US indicates suspected complications; imaging of deep inferior epigastric arteries for surgical planning (breast reconstruction surgery) • Added Background information and updated references

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National Imaging Associates, Inc.*	
Clinical guidelines **CT (VIRTUAL) COLONOSCOPY**	**Original Date: July 2007**
CPT Codes: 74261, 74262	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_033-1	**Implementation Date: January 2023**

INDICATIONS FOR CT COLONOGRAPHY (VIRTUAL COLONOSCOPY)

For diagnostic (symptomatic patient) evaluation when conventional colonoscopy is contraindicated or could not be completed[1-3]
(Rex, 2017)

- Patient had failed or incomplete colonoscopy
- Patient has an obstructive colorectal cancer
- When colonoscopy is medically contraindicated or not possible (e.g., patient is unable to undergo sedation or has medical conditions such as a recent myocardial infarction, recent colonic surgery, a bleeding disorder, or severe lung and/or heart disease)
- For a 3-year follow-up when at least one polyp of 6 mm in diameter detected at CTC if patient does not undergo polypectomy (or is unwilling or unable to undergo colonoscopy)

BACKGROUND

Computed tomographic (CT) colonography, also referred to as virtual colonoscopy, is used to examine the colon and rectum to detect abnormalities such as polyps and cancer. Polyps may be adenomatous (which have the potential to become malignant) or completely benign.

Colorectal cancer (CRC) is the third most common cancer and the second most common cause of cancer death in the United States. Symptoms include blood in the stool, change in bowel habit, abdominal pain, and unexplained weight loss.

Relative contraindications to CTC include symptomatic acute colitis, acute diarrhea, recent acute diverticulitis, recent colorectal surgery, symptomatic colon-containing abdominal wall hernia, and small bowel obstruction. It is not indicated in routine follow-up of inflammatory bowel disease, hereditary polyposis or non-polyposis cancer syndromes, evaluation of anal disease, or the pregnant or potentially pregnant patient. For all high-risk individuals, colonoscopy is preferred.

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In addition to its use as a diagnostic test in symptomatic patients, CT colonography may be used in asymptomatic patients with a high risk of developing colorectal cancer. Conventional colonoscopy is the main method currently used for examining the colon.

OVERVIEW

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

POLICY HISTORY

Date	Summary
April 2022	• Updated references
April 2021	• Updated background information and references only
May 2020	• Updated indications for diagnostic study
April 2019	• Corrected terminology to "CT Colonography" and "Virtual Colonoscopy" • Updated references

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MAGELLAN HAWAI'I

Specific policy administered by National Imaging Associates, Inc. (NIA)

Clinical guidelines Heart MRI	
CPT Codes: 75557, 75559, 75561, 75563 +75565, +0698T	**Original Date:** March 26, 2008
Guideline Number: NIA_CG_028	**Last Revised Date:** February 2023
	Last Reviewed Date (by NIA Committee): February 2022
	Implementation Date: April 2023

GENERAL INFORMATION

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INDICATIONS FOR CARDIAC MAGNETIC RESONANCE (CMR)

Cardiomyopathy & Heart Failure[1-3]

- To assess systolic and diastolic function in the evaluation of a newly diagnosed cardiomyopathy
- Suspected infiltrative disease such as amyloidosis, sarcoidosis[4], hemochromatosis, or endomyocardial fibrosis if PET has not been performed
- Suspected inherited or acquired cardiomyopathy
- Diagnosis of acute myocarditis, with suspicion based upon new, unexplained findings such as:
  - Rise in troponin not clearly due to acute myocardial infarction
  - Change in ECG suggesting acute myocardial injury or pericarditis, without evident myocardial infarction
- Assessment of hypertrophic cardiomyopathy[5]
  - When TTE is inadequate for diagnosis, management or operative planning, or when tissue characterization (degree of fibrosis) will impact indications for ICD

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    - For patients with LVH when there is a suspicion of alternative diagnoses, including infiltrative or storage disease as well as athlete's heart
    - For patients who are not otherwise as high risk for SCD, in whom the decision to proceed with an ICD is uncertain after assessment (which includes personal/family history, echocardiography), and CMR imaging is beneficial to assess for maximum LV wall thickness, ejection fraction (EF), LV apical aneurysm, and extent of myocardial fibrosis with LGE
    - For patients with obstructive HCM in whom the autonomic mechanism of obstruction is inconclusive on echocardiography, CMR is indicated for selection and planning of SRT (septal reduction therapy)
    - For patients with HCM, repeat imaging on a periodic basis (every 3-5 years) for the purpose of SCD risk stratification to evaluate changes in LGE, EF, development of apical aneurysm or LV wall thickness
- Arrhythmogenic right ventricular cardiomyopathy to aid in identification and diagnosis (assessment of myocardial fat, fibrosis, and RV tissue characteristics), based upon reason for suspicion, such as:
    - Nonsustained ventricular tachycardia (VT)
    - Unexplained syncope
    - ECG abnormalities
    - First-degree relatives with positive genotype for ARVD
- Noncompaction cardiomyopathy to aid in the diagnosis (measurement of compacted to noncompacted myocardium) when TTE is suggestive
- Clinical symptoms and signs consistent with a cardiac diagnosis known to cause presyncope/syncope (including, but not limited to, hypertrophic cardiomyopathy)
- Pulmonary hypertension in the absence of severe valvular disease

Valvular Heart Disease

- Evaluation of valvular stenosis, regurgitation, or valvular masses when transthoracic echocardiography (TTE) is inadequate[6]
- Pre-TAVR assessment if the patient has not undergone cardiac CT[7]
- Prior to transcatheter mitral valve intervention, when TTE and TEE result in uncertain assessment of the severity of mitral regurgitation[8, 9]
- Suspected clinically significant bioprosthetic valvular dysfunction and inadequate images from TTE and TEE[6]

Evaluation of Intra- and Extra-Cardiac Structures

- Initial evaluation of cardiac mass, suspected tumor or thrombus, or potential cardiac source of emboli
- Re-evaluation of intracardiac mass when findings would change therapy
- Evaluation of pericardial disease to provide structural and functional assessment and differentiate constrictive vs restrictive physiology
- Assessment of left ventricular pseudoaneurysm, when TTE was inadequate
- Identification and characteristics of coronary aneurysms or anomalous coronary arteries

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Pre-procedure Evaluation for Closure of ASD or PFO

- For assessment of atrial septal anatomy and atrial septal aneurysm
- For assessment of suitability for percutaneous device closure

Assessment Following LAA Occlusion

- For surveillance at 45 days or FDA guidance, if TEE or Heart CT was not done, to assess:
  - Device stability
  - Device leaks
  - To exclude device migration

Pre-Ablation Planning

- Evaluation of left atrium and pulmonary veins prior to radiofrequency ablation for atrial fibrillation

Aortic Pathology

- CT, MR, or echocardiogram can be used for screening and follow-up, with CT and MR preferred for imaging beyond the proximal ascending thoracic aorta
- Screening of first-degree relatives with a history of thoracic aortic aneurysm or dissection
- Six-month follow-up after initial diagnosis of thoracic aortic aneurysm to measure rate of change
- Annual follow-up for an enlarged thoracic aortic aneurysm (usually defined as > 4.4.cm)
- Biannual (2x/year) follow-up of enlarged aortic root or showing growth rate ≥ 0.5 cm/year
- Screening of first-degree relative with a bicuspid aortic valve
- Re-evaluation (<1 y) of the size and morphology of the aortic sinuses and ascending aorta in patients with a bicuspid AV and an ascending aortic diameter >4 cm with 1 of the following:
  - Aortic diameter >4.5 cm
  - Rapid rate of change in aortic diameter
  - Family history (first-degree relative) of aortic dissection
- Patients with Turner's syndrome annually if an abnormality exists; if initial study normal, can have imaging every 5 - 10 years
- Evaluation in patients with known or suspected connective tissue disease or genetic condition that predispose to aortic aneurysm or dissection, such as Marfan's, Ehler's Danlos or Loeys-Dietz syndrome (at the time of diagnosis and 6 months thereafter), followed by annual imaging (can be done more frequently if > 4.5 cm or rate of growth > 0.5 cm/year- up to twice per year)

Congenital Heart Disease (CHD)[10]

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- For all indications below, either CT or CMR can be done
- All lesions: evaluation prior to planned repair and evaluation for change in clinical status and/or new concerning signs or symptoms
- Patent Ductus Arteriosus: routine surveillance (1-2 years) in a patient with postprocedural aortic obstruction
- Eisenmenger Syndrome and Pulmonary Hypertension associated with CHD:
  - Evaluation due to change in pulmonary arterial hypertension-targeted therapy
  - Initial evaluation with suspicion of pulmonary hypertension following CHD surgery
- Aortic Stenosis or Regurgitation:
  - Routine surveillance (6-12 months) in a child with aortic sinus and/or ascending aortic dilation with increasing size
  - Routine surveillance (2–3 years) in a child with aortic sinus and/or ascending aortic dilation with stable size (CMR only)
- Aortic Coarctation and Interrupted Aortic Arch:
  - Routine surveillance (3–5 years) in a child or adult with mild aortic coarctation
  - Post procedure (surgical or catheter-based) routine surveillance (3–5 years) in an asymptomatic patient to evaluate for aortic arch aneurysms, in-stent stenosis, stent fracture, or endoleak
- Coronary anomalies
- Tetralogy of Fallot:
  - Postoperative routine surveillance (2–3 years) in a patient with pulmonary regurgitation and preserved ventricular function (CMR only)
  - Routine surveillance (2–3 years) in an asymptomatic patient with no or mild sequelae (CMR only)
  - Routine surveillance (2–3 years) in a patient with valvular or ventricular dysfunction, right ventricular outflow tract obstruction, branch pulmonary artery stenosis, arrhythmias, or presence of an RV-to-PA conduit
- Double Outlet Right Ventricle: Routine surveillance (3–5 years) in an asymptomatic patient with no or mild sequelae (CMR only)
- D-Loop Transposition of the Great Arteries (postoperative):
  - Routine surveillance (3–5 years) in an asymptomatic patient
  - Routine surveillance (1–2 years) in a patient with dilated aortic root with increasing size, or aortic regurgitation
  - Routine surveillance (3–12 months) in a patient with ≥moderate systemic AV valve regurgitation, systemic RV dysfunction, LVOT obstruction, or arrhythmias
- Congenitally Corrected Transposition of the Great Arteries:
  - Unrepaired: routine surveillance (3–5 years) in an asymptomatic patient
  - Postoperative: routine surveillance (3–5 years) in an asymptomatic patient
  - Postoperative anatomic repair: routine surveillance (6–12 months) in a patient with valvular or ventricular dysfunction, right or left ventricular outflow tract obstruction, or presence of an RV-to-PA conduit

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    - Postoperative physiological repair with VSD closure and/or LV-to-PA conduit: routine surveillance (3–12 months) in a patient with ≥moderate systemic AV valve regurgitation, systemic RV dysfunction, and/or LV-to-PA conduit dysfunction
- Truncus Arteriosus: routine surveillance (1–2 years) in an asymptomatic child or adult with ≥ moderate truncal stenosis and/or regurgitation
- Single-Ventricle Heart Disease:
    - Postoperative routine surveillance (1–2 years) in an asymptomatic patient
    - Routine surveillance (1–2 years) in an asymptomatic adult postoperative Stage 2 palliation (CMR only)
- Ebstein's Anomaly and Tricuspid Valve dysplasia (only CMR indicated):
    - Evaluation prior to planned repair and evaluation for change in clinical status and/or new concerning signs or symptoms
- Pulmonary Stenosis (only CMR indicated)
    - Unrepaired: routine surveillance (3–5 years) in an asymptomatic adult with PS and pulmonary artery dilation
    - Postprocedural (surgical or catheter-based): routine surveillance (1–3 years) in an asymptomatic adult with moderate or severe sequelae
- Pulmonary Atresia (postprocedural complete repair): routine surveillance (1–3 years) in an asymptomatic adult with ≥ moderate sequelae

Coronary Artery Disease Evaluation (CMR as an alternative to pharmacologic MPI)

CMR, which is done pharmacologically, is used for the assessment of coronary artery disease, and can be performed if the patient would otherwise be a candidate for a pharmacologic MPI.

- If the patient can walk and is having an MPI for another reason (LBBB, CABG, etc.), MPI is chosen over CMR
- Assessment of LV wall motion to identify patients with akinetic segments that would benefit from coronary revascularization
- To identify the extent and location of myocardial necrosis in patients with chronic or acute ischemic heart disease

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BACKGROUND[11]

- CMR is an imaging modality used to assess cardiac or vascular anatomy, function, perfusion, and tissue characteristics in a single examination. In lesions affecting the right heart, CMR provides excellent visualization and volume determination regardless of RV shape. This is particularly useful in patients with congenital heart disease

- **CMR Safety[12-15]**
  Since many cardiac patients have cardiac implanted electrical devices, the risk of CMR to the patient and the device must be weighed against the benefit to the patient in terms of clinical value in optimal management.

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Cardiac magnetic imaging (CMR) is often required when transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) provide inadequate imaging data.

Stress CMR for assessment of coronary artery disease (CAD) is performed pharmacologically either as:

- Vasodilator perfusion imaging with gadolinium contrast; **OR**
- Dobutamine inotropic wall motion (ventriculography)

With respect to CAD evaluation, since CMR is only pharmacologic (non-exercise stress), and stress echocardiography (SE) or myocardial perfusion imaging (MPI) provide similar information about CAD:

- Requests for stress CMR require **diversion** to exercise SE first, and to exercise MPI second.
- **Exemptions** for the diversion to SE or exercise MPI:
  - If body habitus or marked obesity (e.g., BMI ≥ 40) would interfere significantly with imaging with SE and MPI[16]
  - Evaluation of young (< 55 years old) patients with documented complex CAD, who are likely to need frequent non-invasive coronary ischemia evaluation and/or frequent radiation exposure from other testing[17]

OVERVIEW

CMR in CORONARY ARTERY DISEASE (CAD)[18-20]

Stable patients without known CAD fall into 2 categories[18-20]:

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant (≥ 50%) CAD (below):

The 3 Types of Chest Pain or Discomfort

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, The Pretest Probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability[20]:

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Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very low:** < 5% pretest probability of CAD, usually not requiring stress evaluation[18]
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CA

For additional information on stress imaging, please refer to NIA guideline CG 024 Myocardial Perfusion Imaging (aka Nuclear Cardiac Imaging Study).

Abbreviations

ARVD/C	Arrhythmogenic right ventricular dysplasia/cardiomyopathy
ASD	Atrial septal defect
CABG	Coronary artery bypass grafting surgery
CAD	Coronary artery disease
CMR	Cardiac magnetic resonance (imaging)
CT	Computed tomography
ECG	Electrocardiogram
EF	Ejection fraction
HCM	Hypertrophic cardiomyopathy
ICD	Implantable cardioverter-defibrillator
LAA	Left atrial appendage
LBBB	Left bundle-branch block
LGE	Late gadolinium enhancement
LV	Left ventricle
LVH	Left ventricular hypertrophy
LVOT	Left ventricular outflow
MPI	Myocardial perfusion imaging
MR	Mitral regurgitation
MR(I)	Magnetic resonance (imaging)

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PA	Pulmonary artery
PET	Positron emission tomography
PFO	Patent foramen ovale
PS	Pulmonary stenosis
RV	Right ventricle
SCD	Sudden cardiac death
SE	Stress echocardiography
SRT	Septal reduction therapy
TAVR	Transcatheter Aortic Valve Replacement
TTE	Transthoracic Echo
TEE	Transesophageal Echo
VT	Ventricular tachycardia

POLICY HISTORY

Date	Summary
February 2022	• Deleted the statement of deferral toward a stress echo, leaving the equivalency statement toward MPI • Clarified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain." • Changed postoperative routine surveillance for single-ventricle heart disease to 1 – 2 years in an asymptomatic patient
March 2021	• Added expanded guidelines for HCM with new reference
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review. • Added the following to the section Cardiomyopathy & Heart Failure: o Edited indication to assess systolic and diastolic function in the evaluation of a newly diagnosed cardiomyopathy o Added the following to suspected infiltrative disease such as amyloidosis, sarcoidosis, hemochromatosis, or endomyocardial fibrosis: if PET has not been performed o Added suspected inherited or acquired cardiomyopathy o Added evaluation after appropriate time interval following revascularization and/or optimal medical therapy to determine candidacy for ICD/CRT and/or to determine optimal choice of device o Added clinical symptoms and signs consistent with a cardiac diagnosis known to cause presyncope/syncope

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	(including but not limited to hypertrophic cardiomyopathy) • Added pulmonary hypertension in the absence of severe valvular disease Added the following indications to the section Evaluation of Intra- and Extra-Cardiac Structures o Initial evaluation of cardiac mass, suspected tumor or thrombus or potential cardiac source of emboli o Re-evaluation of intracardiac mass when findings would change therapy o Added the following to identification and characteristics of coronary aneurysm: or anomalous coronary arteries • Added section on Pre-Procedure Evaluation for Closure of ASD or PFO including the following indications: o For assessment of atrial septal anatomy and atrial septal aneurysm o For assessment of suitability for percutaneous device closure • Added section on Assessment Following LAA Occlusion including the following indications: o For surveillance at 45 days or FDA guidance, if TEE or Heart CT not done, to assess for: ▪ Device stability ▪ To exclude device migration ▪ To assess for device leaks • Added the following to evaluation of left atrium and pulmonary veins prior to radiofrequency ablation for atrial fibrillation: if cardiac CT has not been done • Added the following to the section Aortic Pathology o Re-evaluation (<1 y) of the size and morphology of the aortic sinuses and ascending aorta in patients with a bicuspid AV and an ascending aortic diameter >4 cm with 1 of the following: ▪ Aortic diameter >4.5 cm ▪ Rapid rate of change in aortic diameter ▪ Family history (first-degree relative) of aortic dissection o Added the following to the indication of evaluation in patients with known or suspected connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (can be done more frequently if >4.5 cm or rate of growth > 0.5 cm/year: up to twice per year)

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	• Extensive update to the indications for Congenital Heart Disease to include the following: o For all indications noted, either CT or CMR can be done o All lesions: evaluation prior to planned repair and evaluation for change in clinical status and/or new concerning signs or symptoms o Specific indications based on lesion were added with interval and criteria for repeat imaging included o Added indication for coronary anomalies • Updated and added new references
July 2019	• Removed table of comparison to Cardiac CT • Removed global risk calculator for asymptomatic patients • Removed scenarios for which approval of CMR is not approvable as well as follow-up indications • Removed section on MRI compatibility with Pacemakers • Format change: moved CAD section – clarification of indication of use of MRI in CAD and removed detailed indications • Expanded aortic screening section with removal of chart for "normal" sizes of aortic aneurysm • Expanded indication for prosthetic heart valves • Removed indication of screening with a strong family history of cardiomyopathy •

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Reviewed / Approved by NIA Clinical Guideline Committee

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MAGELLAN HAWAI'I

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Clinical Guideline Cardiac Calcium Score CT	
CPT Codes: 75571, S8092	**Original Date: January 2008**
Guideline Number: HMSA_CG_029	**Last Revised Date (by HMSA):** April 2023
	Last Reviewed Date (by NIA): April 2023
	Implementation Date: April 2023

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR CORONARY ARTERY CALCIUM (CAC) TESTING[1-10]

CAC testing is for cardiovascular risk assessment in individuals aged 40-75 years who have an intermediate (5-19.9%) 10-year ASCVD risk based upon the ACC/AHA pooled cohort risk calculator. Documentation is required that the results of the study will affect decision making for preventative actions (i.e., statin therapy).

Patients > 40 yo:

- Patients with estimated 10-year risk of less than 5% and are suspected to be at elevated atherosclerotic cardiovascular disease (ASCVD) risk because of a major risk factor not accounted for in the global risk equations below and consider CAC score as an adjudicator to upgrade risk: [4, 5, 11, 12]
    - Family history of premature ASCVD
    - Persistently elevated LDL-C > 160mg/dl or non-HDL-C >190mg/dl
    - Chronic kidney disease

- Metabolic syndrome Conditions specific to women (e.g., pre-eclampsia, premature menopause)
- Inflammatory diseases (HIV, psoriasis, RA)
- Ethnicity (e.g., South Asian ancestry)
- Persistently elevated triglycerides (>175mg/dl) hsCRP >2mg/L Lp(a) levels > 50mg/dl apoB>130mg/dl ABI < 0.9

All patients:

- CAC scoring should be performed in asymptomatic patients. It should not be used as a diagnostic test in patients with symptoms suggestive of ischemia.
- Patients with known CAD should not be considered for calcium scoring as the results are unlikely to affect treatment.[5, 13-15]
- CAC testing may be repeated for risk re-assessment after a minimum of 5 years, if documentation indicates it will alter management.[4, 5, 13]
    - it should not be repeated if the patient already has two CAC scores of zero 5 years apart or has a score >400 .
- Patients in whom statin therapy is indicated, but have intolerable adverse effects from, or are reluctant to take statin medication, in order to guide the need for alternative lipid-lowering strategies[2, 8, 13]

BACKGROUND[2, 4, 5]

Coronary artery calcium (CAC) testing is a cardiovascular risk assessment tool, applicable only to the patient without known cardiovascular disease, for the purpose of primary prevention. It is not for the patient with suspected or known cardiovascular disease, coronary or otherwise, who already requires aggressive risk factor modification.

CAC testing, by either EBCT or non-contrast CCT, provides a quantitative assessment of coronary artery calcium content in Agatston units, as an adjunct to the estimation of global risk for coronary or cardiovascular events over the next 10 years.[7] A CAC Score > 0 is a highly specific feature of coronary atherosclerosis.

CAC score > 100 can also provide support for aspirin therapy[5, 11] and statin therapy.[13]

Patients who have already manifested cardiovascular **disease** are already at high global risk and the Global Cardiovascular Risk Calculators are not applicable.

Links to Global Cardiovascular Risk Calculators[1, 3, 7, 14, 15]

Risk Calculator	Website for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk

Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/

Abbreviations

ASCVD	Atherosclerotic cardiovascular disease
CAC	Coronary artery calcium
CAD	Coronary artery disease
CCT	Cardiac computed tomography
EBCT	Electron beam computed tomography

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POLICY HISTORY

Date	Summary
April 2023	• **Age qualification changed** • **Legislative requirements removed for HPS**
June 2022	• Updated state legislative requirements
February 2022	• Modified indication statements to include additional examples of CAD risk factors • EBCT not to be used as test for symptoms of ischemia • EBCT not to be used in patients with known CAD
March 2021	No changes
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Updated and added new references
July 2019	• Repeat CAC testing indication revised as follows: It should not be repeated if the patient has already had two CAC Scores of zero 5 years apart added clause 'or has a score ≥ 400.' • For patients with estimated 10-year risk of less than 5% but are suspected to be at elevated atherosclerotic cardiovascular disease (ASCVD) risk because of a major risk factor not accounted for in the global risk equations, only family history of premature CAD was included as an example.

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7— HMSA health plan specific policy administered by NIA

Cardiac Calcium Score CT

National Imaging Associates, Inc.*	
Clinical guideline **CT HEART** **CT HEART Congenital** **(Not including coronary arteries)**	**Original Date: September 1997**
CPT Codes: 75572, 75573	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_025	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR HEART COMPUTED TOMOGRAPHY (CT)[1, 2]

Congenital Heart Disease[3]

For all indications below, either CT or CMR can be performed:

- All congenital lesions: prior to planned repair and for change in clinical status and/or new concerning signs or symptoms
- Patent Ductus Arteriosus: routine surveillance (1-2 years) in a patient with postprocedural aortic obstruction
- Aortic Stenosis or Regurgitation: routine surveillance (6-12 months) in a child with aortic sinus and/or ascending aortic dilation with increasing size
- Aortic Coarctation and Interrupted Aortic Arch:
    - Routine surveillance (3–5 years) in a child or adult with mild aortic coarctation
    - Post procedure (surgical or catheter-based) routine surveillance (3–5 years) in an asymptomatic patient to evaluate for aortic arch aneurysms, in-stent stenosis, stent fracture, or endoleak
- Tetralogy of Fallot:
    - Routine surveillance (2–3 years) in a patient with valvular or ventricular dysfunction, right ventricular outflow tract obstruction, branch pulmonary artery stenosis, arrhythmias, or presence of an RV-to-PA conduit

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- D-Loop Transposition of the Great Arteries (postoperative):
    - Routine surveillance (3–5 years) in an asymptomatic patient
    - Routine surveillance (1–2 years) in a patient with dilated aortic root with increasing size, or aortic regurgitation
    - Routine surveillance (3–12 months) in a patient with ≥moderate systemic AV valve regurgitation, systemic RV dysfunction, LVOT obstruction, or arrhythmias
- Congenitally Corrected Transposition of the Great Arteries:
    - Unrepaired: routine surveillance (3–5 years) in an asymptomatic patient
    - Postoperative: routine surveillance (3–5 years) in an asymptomatic patient
    - Postoperative anatomic repair: routine surveillance (6–12 months) in a patient with valvular or ventricular dysfunction, right or left ventricular outflow tract obstruction, or presence of an RV-to-PA conduit
    - Postoperative physiological repair with VSD closure and/or LV-to-PA conduit: routine surveillance (3–12 months) in a patient with ≥moderate systemic AV valve regurgitation, systemic RV dysfunction, and/or LV-to-PA conduit dysfunction
- Truncus Arteriosus: routine surveillance (1–2 years) in an asymptomatic child or adult with ≥ moderate truncal stenosis and/or regurgitation
- Single-Ventricle Heart Disease (includes hypoplastic left heart syndrome, double-inlet LV, double-inlet RV, mitral atresia, tricuspid atresia, unbalanced A-V septal defect): postoperative routine surveillance (3-5 years) in an asymptomatic patient

Cardiomyopathy

- Quantification of myocardial (muscle) mass (CMR or CT)
- Assessment of right ventricular morphology in suspected arrhythmogenic right ventricular cardiomyopathy, based upon other findings such as:
    - Nonsustained VT
    - Unexplained syncope
    - ECG abnormalities
    - First-degree relative with positive genotype of ARVC (either, but CMR is superior to CT)[4, 5]

Valvular Heart Disease

- Characterization of native or prosthetic valves with clinical signs or symptoms suggesting valve dysfunction, when TTE, TEE, and/or fluoroscopy have been inadequate[6]
- Evaluation of RV function in severe TR, including systolic and diastolic volumes, when TTE images are inadequate and CMR is not readily available
- Pulmonary hypertension in the absence of severe valvular disease
- Evaluation of suspected infective endocarditis with moderate to high pretest probability (i.e., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device), when TTE and TEE have been inadequate
- Evaluation of suspected paravalvular infections when the anatomy cannot be clearly delineated by TTE and TEE[7]

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Evaluation of Intra- and Extra-cardiac Structures

- Evaluation of cardiac mass, suspected tumor or thrombus, or cardiac source of emboli, when imaging with TTE and TEE have been inadequate
- Re-evaluation of prior findings for interval change (i.e., reduction or resolution of atrial thrombus after anticoagulation), when a change in therapy is anticipated[6-8]
- Evaluation of pericardial anatomy, when TTE and/or TEE are inadequate or for better tissue characterization of a mass and detection of metastasis [CMR superior for physiologic assessment (constrictive versus restrictive) and tissue characterization, CT superior for calcium assessment][9, 10]

Electrophysiologic Procedure Planning[2]

- Evaluation of pulmonary venous anatomy prior to radiofrequency ablation of atrial fibrillation and for follow-up when needed for evaluation of pulmonary vein stenosis
- Non-invasive coronary vein mapping prior to placement of biventricular pacing leads

Transcatheter Structural Intervention Planning

- Evaluation for transcatheter aortic valve replacement (TAVR)[6, 11, 12]
- When TTE and TEE cannot provide adequate imaging, CT imaging can be used for planning: robotic mitral valve repair, atrial septal defect closure, left atrial appendage closure, ventricular septal defect closure, endovascular grafts, and percutaneous pulmonic valve implantation[12, 13]
- Evaluation for suitability of transcatheter mitral valve procedures, alone or in addition to TEE[14]

Aortic Pathology[6-8, 15-20]

- CT, MR, or echo can be used for screening and follow-up, with CT and MR preferred for imaging beyond the proximal ascending thoracic aorta in the following scenarios:
    - Evaluation of dilated aortic sinuses or ascending aorta identified by TTE
    - Suspected acute aortic pathology, such as dissection
    - Re-evaluation of known aortic dilation or aortic dissection with a change in clinical status or cardiac examination or when findings would alter management
    - Screening first-degree relatives of individuals with a history of thoracic aortic aneurysm or dissection, or an associated high-risk mutation for thoracic aneurysm in common
    - Screening second-degree relative of a patient with thoracic aortic aneurysm, when the first-degree relative has aortic dilation, aneurysm, or dissection
    - Six-month follow-up after initial finding of a dilated thoracic aorta, for assessment of rate of change
    - Annual follow-up of enlarged thoracic aorta with size up to 4.4 cm
    - Biannual (twice/yr) follow-up of enlarged aortic root ≥ 4.5 cm or showing growth rate ≥ 0.5 cm/year

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- Patients with Marfan's syndrome may undergo annual imaging with CT, MRI or TTE, with increase to biannual (twice-yearly) when diameter ≥ 4.5 cm or when expansions is > 0.5 cm/yr
- Patient with Turner's syndrome should undergo initial imaging with CT, MRI, or TTE for evidence of dilatation of the ascending thoracic aorta. If imaging is normal and there are no risk factors for aortic dissection, repeat imaging should be performed every 5 - 10 years, or if otherwise indicated. If the aorta is enlarged, appropriate follow-up imaging should be done according to size, as above
- Evaluation of the aorta in the setting of a known or suspected connective tissue disease or genetic condition that predisposes to aortic aneurysm or dissection (i.e., Loeys-Dietz, Ehlers-Danlos), with re-evaluation at 6 months for rate of expansion. Complete evaluation with CMR from the cerebrovascular circulation to the pelvis is recommended with Loeys-Dietz syndrome.

BACKGROUND

- Cardiac computed tomography (Heart CT) images the cardiac chambers, great vessels, valves, myocardium, and pericardium to assess cardiac structure and function, particularly when echocardiography (transthoracic echocardiography and transesophageal echocardiography) cannot provide adequate information
- CT imaging can be used for assessment of:
    - Structures of the heart (e.g., chambers, valves, great vessels, masses), as in this guideline
    - Quantitative level of calcium in the walls of the coronary arteries, in the separate coronary artery calcium (CAC) scoring guideline

OVERVIEW[2]

Imaging in Congenital Heart Disease

Echocardiography is often utilized for initial assessment of congenital heart disease. However, if findings are unclear or need confirmation, CMR or CT can be useful.[3]

CT and Cardiac Masses

CT and CMR are used to evaluate cardiac masses, describing their size, density, tissue characteristics, and spatial relationship to adjacent structures.

CT and Pericardial Disease

While echocardiography is most often used in the initial examination of pericardial disease, CT and CMR can evaluate pericardial thickening and masses which are often detected initially with echocardiography. CT and CMR can accurately define the site and extent of masses, e.g., cysts, hematomas, and neoplasms.[9]

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Abbreviations

ARVD/C	Arrhythmogenic right ventricular dysplasia/cardiomyopathy
CABG	Coronary artery bypass grafting surgery
CAD	Coronary artery disease
CCS	Coronary calcium score
CCT	Cardiac (heart) CT
CHD	Coronary heart disease
CMR	Cardiac magnetic resonance (imaging)
CT	Computed tomography
CTA	Computed tomography angiography
ECG	Electrocardiogram
EF	Ejection fraction
HF	Heart failure
LVOT	Left ventricular outflow tract
MI	Myocardial infarction
MPI	Myocardial perfusion Imaging or cardiac nuclear imaging
MR(I)	Magnetic resonance (imaging)
PA	Pulmonary artery
PCI	Percutaneous coronary intervention
PVML	Paravalvular mitral leak
RV	Right ventricle
SE	Stress echocardiogram
TAVR	Transcatheter aortic valve replacement
TMVR	Transcatheter mitral valve replacement
TR	Tricuspid regurgitation
TEE	Transesophageal echocardiography
TTE	Transthoracic echocardiography
VT	Ventricular tachycardia

POLICY HISTORY

Date	Summary
February 2022	Listed clinical spectrum comprising single-ventricle heart disease to include: hypoplastic left heart syndrome, double-inlet LV, double-inlet RV, mitral atresia, tricuspid atresia, unbalanced A-V septal defect
March 2021	No changes
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review

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	• Extensive update to the indications for Congenital Heart Disease to include the following: o For all indications noted, either CT or CMR can be done o All lesions: evaluation prior to planned repair and evaluation for change in clinical status and/or new concerning signs or symptoms o Specific indications based on lesion were added with interval and criteria for repeat imaging included • Added separate section for infective endocarditis • Removed tables of aortic diameter norms and suggested follow-up imaging • Edits to background with removal of table outlining radiation exposure and comment • Edits to overview included, with removal of the following: o CT and CMR provide 3D anatomic relationship of the blood vessels and cardiac anatomic structures o Discussion of cardiac myxoma • Updated and added new references
July 2019	• Added the following indication: Evaluation of anomalous thoracic arteriovenous vessels, such as transposition of the great arteries, when magnetic resonance imaging (MRI) cannot be performed • For valvular heart disease added indication for pulmonary hypertension in the absence of severe valvular disease • Removed indication: to assess degree of calcification in calcific aortic stenosis • For evaluation of intra- and extra-cardiac structures, the following indication was added: Re-evaluation of prior findings for interval change (i.e. reduction or resolution of atrial thrombus after anticoagulation), when a change in therapy is anticipated • Removed section: scenarios in which heart CT is not indicated • Removed statement: CT imaging is competitive with MRI, but left in table in comparing two modalities (removed cost comparison)

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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National Imaging Associates, Inc.*	
Clinical guideline: **CT CORONARY ANGIOGRAPHY (CCTA)**	**Original Date: October 2009**
CPT Codes: 75574	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_062	**Implementation Date: April 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR CORONARY COMPUTED TOMOGRAPHIC ANGIOGRAPHY (CCTA)[1-4]

Evaluation in Suspected Coronary Artery Disease (CAD)[5-8]

- Intermediate and high pretest probability patients[9]
- Exercise ECG stress test with intermediate Duke Treadmill Score (- 10 to + 4)
- Equivocal, borderline, or discordant stress imaging evaluation with continued symptoms concerning for CAD
- Repeat testing in patient with new or worsening symptoms since prior normal stress imaging[3, 4]
- Asymptomatic patients without known CAD
  - Previously unevaluated ECG evidence of possible myocardial ischemia including ischemic ST segment or T wave abnormalities
  - Previously unevaluated pathologic Q waves
  - Previously unevaluated left bundle branch block
- Newly diagnosed clinical systolic heart failure (ejection fraction [EF] < 50%) or diastolic heart failure without recent CAD evaluation, in the presence of angina or an anginal equivalent symptoms, as an alternative to invasive coronary arteriography. [3, 4, 10-12]
- Before valve surgery or transcatheter intervention as an alternative to coronary angiography[13-15]
- To establish the etiology of mitral regurgitation[15]
- Evaluation of coronary anomaly or aneurysm [16-19]
  - Evaluation prior to planned repair

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- Evaluation due to change in clinical status and/or new concerning signs or symptoms
- Evaluation of coronary artery bypass grafts, to assess[3, 20]:
  - Patency and location when invasive coronary arteriography was either nondiagnostic or not performed
  - Location prior to cardiac or another chest surgery

Low probability patients will be directed to exercise stress test over CCTA unless other criteria for imaging studies are met

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BACKGROUND

Coronary computed tomographic angiography (CCTA) is a noninvasive imaging study that uses intravenously administered contrast material and high-resolution, rapid imaging computed tomography (CT) .[21, 22]

Stable patients without known CAD fall into 2 categories[1, 2, 4]:

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see Risk Calculators in the Overview section).
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant CAD.

The Three Types of Chest Pain or Discomfort:

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by rest and/or nitroglycerin
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics
- Once the type of chest pain has been established from the medical record, the Pretest Probability of significant CAD is estimated from the **Diamond Forrester Table** below, recognizing that additional coronary risk factors could increase pretest probability[4]:

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate

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	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very Low:** < 5% pretest probability of CAD
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

OVERVIEW

The *2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain* ***has given*** a Class 1 recommendation with level of evidence of A for patients with stable and acute chest pain, who have no known coronary artery disease (CAD).[9]

Patient selection and contraindications to CCTA must be considered and may be inappropriate for the following:

- Known history of severe and/or anaphylactic contrast reaction
- Inability to cooperate with scan acquisition and/or breath-hold instructions
- Pregnancy
- Clinical instability (e.g., acute myocardial infarction, decompensated heart failure, severe hypotension)
- Renal impairment as defined by local protocols
- Image quality depends on keeping HR optimally < 60 bpm, a regular rhythm, limited coronary calcification, stents > 3.0 mm in diameter, ≥ 5 second breath hold, and vessels requiring imaging ≥ 1.5 mm diameter.[23]

Scenarios that can additionally support a CCTA over a regular exercise treadmill test in the low probability scenario[24]

Inability to Exercise

- Physical limitations precluding ability to exercise for at least 3 full minutes of Bruce protocol
- The patient has limited functional capacity (< 4 METS) **such as one** of the following:
  - Unable to take care of their activities of daily living (ADLs) or ambulate
  - Unable to walk 2 blocks on level ground
  - Unable to climb 1 flight of stairs
  - Unable to vacuum, dust, do dishes, sweep, or carry a small grocery bag

Other Comorbidities

- Prior cardiac surgery (coronary artery bypass graft or valvular)
- Left ventricular ejection fraction ≤ 50%

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- Severe chronic obstructive pulmonary disease (COPD) with pulmonary function test (PFT) documentation, severe shortness of breath on minimal exertion, or requirement of home oxygen during the day
- Poorly controlled hypertension, with systolic blood pressure (BP) > 180 or Diastolic BP > 120

ECG and Echo-Related Baseline Findings

- Pacemaker or implantable cardioverter defibrillator (ICD)
- Resting wall motion abnormalities on echocardiography
- Complete LBBB

Risk-Related

- Intermediate or high global risk in patients requiring type IC antiarrhythmic drugs
- Arrhythmia risk with exercise

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) require that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate AND has an interpretable ECG for ischemia during exercise[4]:

- The (symptomatic) low pretest probability patient who can exercise and has an interpretable ECG[4]
- The patient who is under evaluation for exercise-induced arrhythmia
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription
- For the evaluation of syncope or presyncope during exertion[25]

Duke Exercise ECG Treadmill Score[26]

Calculates risk from ECG treadmill alone**:**

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤
  - 11) categories

An uninterpretable baseline ECG includes[1]:

- ST segment depression of 1 mm or more (not for non-specific ST - T wave changes)
- Ischemic looking T wave inversions of at least 2.5 mm
- LVH with repolarization abnormalities, WPW, a ventricular paced rhythm, or left bundle branch block

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- Digitalis use with associated ST - T abnormalities
- Resting HR under 50 bpm on a beta blocker and an anticipated suboptimal workload
- Note: RBBB with less than 1 mm ST depression at rest may be suitable for ECG treadmill testing

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years.

High global risk by itself generally lacks scientific support as an indication for stress imaging.[5]

There are rare exemptions, such as patients requiring IC antiarrhythmic drugs, who might require coronary risk stratification prior to initiation of the drug, when global risk is moderate or high.

- **CAD Risk—Low**
  10 - year absolute coronary or cardiovascular risk less than 10%
- **CAD Risk—Moderate**
  10 - year absolute coronary or cardiovascular risk between 10% and 20%
- **CAD Risk—High**
  10 - year absolute coronary or cardiovascular risk of greater than 20%

Websites for Global Cardiovascular Risk Calculators*
*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.[27-31]

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

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With addition of Coronary Artery Calcium Score, for CAD-only risk	

Definitions of Coronary Artery Disease[1, 2, 32-34]

- Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).
- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. It is not a diagnostic tool so much as it is a **risk stratification** tool. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Stenoses ≥ 70% are considered obstructive coronary artery disease (also referred to as clinically significant), while stenoses ≤ 70% are considered non-obstructive coronary artery disease.[32]
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
  - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[35]
  - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum luminal cross-sectional area on IVUS ≤ 6 square mm[1, 33, 34]
  - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[33, 34]
  - iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel[34, 36-38]
  - Demonstrable ischemic findings on stress testing (ECG or stress imaging), that are at least mild in degree
- A major vessel would be a coronary vessel that would be amenable to revascularization, if indicated. This assessment is made based on the diameter of the vessel and/or the extent of myocardial territory served by the vessel.
- FFR is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow.
- Newer technology that estimates FFR from CCTA images is covered under the separate NIA Guideline for FFR-CT.

Anginal Equivalent[1, 25, 39]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia), by presentation of clinical data such as

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respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope per se is not an anginal equivalent.

Abbreviations

ACS	Acute coronary syndrome
ADLs	Activities of daily living
CABG	Coronary artery bypass grafting surgery
CAD	Coronary artery disease
CCS	Coronary calcium score
CCTA	Coronary computed tomography angiography
CT(A)	Computed tomography (angiography)
COPD	Chronic obstructive pulmonary disease
DTS	Duke Treadmill Score
ECG	Electrocardiogram
EF	Ejection fraction
FFR	Fractional flow reserve
ICD	Implantable cardioverter-defibrillator
iFR	Instantaneous wave-free ratio or instant flow reserve
IVUS	Intravascular ultrasound
LBBB	Left bundle branch block
LVH	Left ventricular hypertrophy
MESA	Multi-Ethnic Study of Atherosclerosis
METS	Metabolic equivalents
MI	Myocardial infarction
MPI	Myocardial perfusion imaging
PCI	Percutaneous coronary intervention
PFT	Pulmonary function test
RBBB	Right bundle branch block
SE	Stress echocardiography
TTE	Transthoracic echocardiography
WPW	Wolff-Parkinson-White syndrome

POLICY HISTORY

Date	Summary
January 2023	Added the following statement, “low probability patients will be directed to exercise stress test over CCTA unless other criteria for imaging studies are met”.
February 2022	• Clarified “intermediate lesions are 50-69%” for ischemia-producing disease

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January 2022	[Off-cycle review] • Deleted the requirement for stress echocardiography. • Changed to Intermediate and High probability chest pain patients now allowable as first line testing • Intermediate DTS patients now allowable for CCTA • Removed EF < 40%, keeping the existing EF< 50% systolic dysfunction, and adding symptomatic diastolic heart failure with no prior workup • Added a paragraph explaining the changes, new guidelines of November 2021 with contraindications within the overview section • Added section on when CCTA is preferred over ETT in low-risk patients • Deleted the phrasing 'scenarios that support MPI over SE' as it would no longer apply here. Replaced with 'Scenarios that can additionally support a CCTA over a regular exercise treadmill test in the low probability scenario'. • Deleted statement that MPI may be supported over CCTA in Poorly controlled atrial fibrillation/ectopy • Took out the word 'intermediate' in the phrase "The (symptomatic) low pretest probability patient who is able to exercise and has an interpretable ECG" • Removed section on Coronary Artery calcium scoring
March 2021	• Deleted: Appropriate exercise ECG stress test with low Duke Treadmill Score (≥ 5) and continued symptoms concerning for CAD • Added: High pretest probability as an alternative to coronary angiography (can also do MPI) • Removed statement about low Duke treadmill score and continuing symptoms
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added further details for imaging of coronary anomaly or aneurysm to include the following: o Evaluation prior to planned repair o Evaluation due to change in clinical status and/or new concerning signs or symptoms • Added edits to the coronary artery disease definition section • Updated and added references

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July 2019	• CCTA can be used as an alternative to coronary angiography in appropriate patients prior to valve surgery or transcatheter intervention • Noted CMR is favored over CCTA in young patients for evaluation of coronary anomaly or aneurysm • Global Risk of Cardiovascular Disease information expanded in background section for additional clarification

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National Imaging Associates, Inc.*	
Clinical guidelines: **ABDOMINAL ARTERIES CTA (Angiography)**	**Original Date: July 2008**
CPT Codes: 75635	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_035	**Implementation Date: January 2023**

IMPORTANT NOTE

Only one authorization request is required, using CPT Code 75635 Abdominal Arteries CTA with run-off. This study provides for imaging of the abdomen, pelvis, and both legs and is the noninvasive equivalent to an "aortogram and run-off".

INDICATIONS FOR ABDOMINAL ARTERIES CTA with run-off

For evaluation of a vascular abnormality in the abdominal aorta and lower extremities

For evaluation of known or suspected abdominal, pelvic, or peripheral vascular disease[1-4]

- For known or suspected peripheral arterial disease (such as claudication, or clinical concern for vascular causes of ulcers) when non-invasive studies (pulse volume recording, ankle-brachial index, toe brachial index, segmental pressures, or doppler ultrasound) are abnormal or equivocal
- For critical limb ischemia with **ANY** of the below clinical signs of peripheral artery disease. Ultrasound imaging is **not** needed. If done and negative, it should still be approved due to a high false negative rate[5, 6]
    - Ischemic rest pain
    - Tissue loss
    - Gangrene

Pre-operative evaluation

- Evaluation of interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia

Post-operative or post-procedural evaluation

- Evaluation of post-operative complications, e.g., pseudoaneurysms related to surgical bypass grafts, vascular stents, and stent-grafts

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- Follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.
- After stenting or surgery with signs of recurrent symptoms OR abnormal ankle/brachial index; abnormal or indeterminate arterial doppler; OR pulse volume recording[7]

BACKGROUND

High resolution computed tomography angiography (CTA) provides a cost-effective and accurate imaging assessment in the diagnosis and follow-up of patients with aortic dissections or peripheral arterial disease (PAD).

OVERVIEW

Suspected Peripheral Arterial Disease – CTA (or MRA) is an excellent tool to diagnose lower extremity peripheral arterial disease (PAD). Benefits include the fast scanning time and accurate detection of occlusions and stenosis. According to the Society for Vascular Surgery guidelines, "Measurement of the ankle-brachial index (ABI) is the primary method for establishing the diagnosis of PAD. An ABI of ≤0.90 has been demonstrated to have high sensitivity and specificity for the identification of PAD compared with the gold standard of invasive arteriography."[2] The presence of a normal ABI at rest and following exercise almost excludes atherosclerotic disease as a cause for leg claudication.[1, 8]

When an ABI is >1.40 (suggesting noncompressible calcified vessels) and clinical suspicion is high, other tests such as toe-brachial index <8, a resting toe pressure <40 mm Hg, a systolic peak posterior tibial artery flow velocity < 10cm/s may be used. "In symptomatic patients in whom revascularization treatment is being considered, we recommend anatomic imaging studies, such as arterial duplex ultrasound, CTA, MRA, and contrast arteriography."[2] This later statement is accompanied by a "B" (moderate) rating for the accompanying evidence ("A" = high, "C" = low) "In patients with limited renal function or planned surgical intervention, noninvasive imaging tests (particularly MRA and CTA) may obviate the need for diagnostic catheter angiography to visualize the location and severity of peripheral vascular disease."[1]

Follow-up imaging post vascular surgery procedures have not been well researched without clear surveillance protocols in place. Clinical exam, ABI and EUS within the first month of endovascular therapy are generally recommended to assess for residual stenosis, and again at 6 and 12 months, then annually. More sophisticated imaging with CTA, MRA, or invasive catheter angiography is reserved for complex cases.[9]

POLICY HISTORY

Date	Summary
April 2022	No substantive changes
April 2021	No substantive changes

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May 2020	• Improved by making more similar to LE CTA guidelines • Added info regarding critical limb ischemia and clinical concern for vascular cause of ulcers after prior abnormal testing
May 2019	• Added indication for evaluation of an organ or abnormality seen on previous imaging • Removed indication for ischemia related to presence of ulcer, gangrene, or claudication • Added/modified Background information and updated references

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National Imaging Associates, Inc.*	
Clinical guidelines **BRAIN (HEAD) MRS**	**Original Date: April 2007**
CPT Codes: 76390, +0698T	**Last Revised Date: May 2022**
Guideline Number: NIA_CG_003	**Implementation Date: January 2023**

INDICATIONS FOR BRAIN MRS[1]

- For the evaluation of a recurrent or residual brain tumor from post-treatment changes, e.g., radiation necrosis[2]
- For further evaluation of a brain lesion to distinguish a brain tumor from other non-tumor diagnoses (e.g., abscess or other infectious or inflammatory process)[3,4]

BACKGROUND[3,5]

Magnetic resonance spectroscopy (MRS) is a noninvasive imaging technique that determines the concentration of brain metabolites, such as N-acetylaspartate, choline, creatine, and lactate, within the body tissue examined. Radiofrequency waves are translated into biochemical composition of the scanned tissue; the resulting metabolic profile is useful in identifying brain tumors, e.g., differentiating neoplastic and non-neoplastic brain lesions. In selected cases, MRS may be a valuable supplement to MRI. It is sensitive, but nonspecific. This modality should be considered as an adjunct to conventional imaging rather than replacement for histopathological evaluation.

In terms of brain tumor evaluation and classification, carefully designed multi-center trials complying with criteria of evidence-based medicine have not yet been completed.[6]

Tumor Recurrence vs. Radiation Necrosis – Differentiation between recurrent brain tumors and treatment related injury, e.g., radiation necrosis, is difficult using conventional MRI. The typical appearance of radiation necrosis is similar to that of recurrent brain tumors. MRS is a quantitative approach, measuring various brain metabolic markers, to help in the differentiation of recurrent tumors and radiation necrosis. This differentiation is important as additional radiation can benefit recurrent disease but can be detrimental to radiation necrosis. MRS may help in determining treatment options and in preventing unnecessary surgery. In addition, a tumor recurrence diagnosed by MRS allows the surgeon to begin treatment early instead of having to wait for symptoms of recurrence or biopsy confirmation.[2,7,8] However, no consensus exists regarding the value of this in clinical decision making, and no approach has yet been validated to be sufficiently accurate.[2,9,10]

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Glioma – MRS has been proposed for pre-operative grading of gliomas and differentiating high-grade gliomas (HGGs) from low-grade gliomas. It has been found to have moderate diagnostic value and should be combined with other advanced imaging techniques to improve accuracy. Currently, the data is limited; more research is needed for a definite conclusion for the utility of MRS for this indication. Therefore, it remains experimental/investigational.[11,12]

MRS in other diseases – A role for MRS has been suggested in the management of neurodegenerative disease, epilepsy, and stroke. MRS can also be applied in conjunction with MRI in the evaluation of pediatric neurodegenerative disease, traumatic brain injury and neonatal hypoxia-ischemia.[13-15] However, to better define these roles, it will be necessary to standardize the MRS methodology, as well as the collection, analysis, and interpretation of data so it can be consistently translated to the applicable clinical settings. Currently, these potential applications remain experimental/investigational.[14]

POLICY HISTORY

Date	Summary
May 2022	Updated references and background section
November 2021	Added +0698T
February 2021	Updated background information and references
May 2020	Updated references
July 2019	Deleted: • therapeutic f/u indication Added: • tumor versus non tumor indication Updated: • background info and refs

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National Imaging Associates, Inc.*	
Clinical guidelines: **UNLISTED STUDY**	**Original Date: September 2013**
76497 - Unlisted CT **76498 – Unlisted MRI**	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_063	**Implementation Date: January 2023**

IMPORTANT NOTE
The CPT code that has been selected is considered to be an "unlisted code".

UNLISTED MRI
CPT Code 76498, Unlisted MRI, can be used in the context of:

- Radiation treatment planning
- Whole Body MRI requests related to Rare Genetic Disease Screening as determined by professional society recommendations (not an all-inclusive list):
    - Li-Fraumeni Syndrome (LFS)
    - Constitutional Mismatch Repair Deficiency (CMMRD) syndrome
    - Hereditary retinoblastoma
    - Neurofibromatosis Type 1
    - Hereditary Paraganglioma-Pheochromocytoma (PGL/PCC) Syndrome
    - Rhabdoid Tumor Predisposition Syndrome (RTPS)
    - Increased genetic risk related to other cancer-predisposing syndromes

For all other MRI studies, another CPT code should be selected that describes the specific service being requested; otherwise, this procedure cannot be approved.

***NOTE: If there is concern for bone marrow pathologies** (for example, diffuse or multifocal marrow disorders; marrow involvement in storage diseases or progression of smoldering multiple myeloma (SMM) to multiple myeloma (MM) or high risk SMM patients) **a Bone Marrow MRI study may be more appropriate, please see NIA GL 059*.**

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UNLISTED CT

CPT Code 76497, Unlisted CT, can be used in the context of:

- Low Dose Whole Body CT
    - Initial workup of plasma cell dyscrasia (to differentiate MGUS, smoldering, and active myeloma/plasmacytoma)
    - Initial staging of known or suspected of active or smoldering multiple myeloma/plasmacytoma
    - Restaging of known active or smoldering myeloma/plasmacytoma- annually if no change in patient status, or at shorter interval clinically indicated by signs/symptoms, laboratory, or radiographic concern for disease relapse or progression

For all other CT studies, another CPT code should be selected that describes the specific service being requested, otherwise this procedure cannot be approved.

BACKGROUND

Multiple myeloma is a clonal plasma cell proliferative disorder hallmark by primary infiltration of bone marrow and the production of abnormal immunoglobulins. Myeloma is the second most common hematologic malignancy after lymphoma. Osseous disease is the most prominent finding in patients with suspected multiple myeloma (including smoldering myeloma).

Given the increased sensitivity of cross-sectional imaging and low dose that the studies can be performed at this method is now preferred over skeletal radiographs. Whole body low dose CT (WBLD CT) or PET/CT the initial study of choice to evaluate patients with known or suspected multiple myeloma and smoldering myeloma.[1] Whole body imaging with MRI is the initial study of choice for initial evaluation of solitary plasmacytoma,[1] which is ordered as Bone Marrow MRI. Whole body imaging with PET/CT is the first choice for initial imaging of solitary plasmacytoma.[1]

POLICY HISTORY

Date	Summary
April 2022	No changes
August 2021	• Added section for whole body MRI for rare genetic disease screening • Added: ***NOTE: If there is concern for bone marrow pathologies** (for example, diffuse or multifocal marrow disorders; marrow involvement in storage diseases or progression of smoldering multiple myeloma (SMM) to multiple myeloma (MM) or high risk

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	SMM patients) **a Bone Marrow MRI study may be more appropriate, please see NIA GL 059*.** • Added**: UNLISTED CT** **CPT Code 76497, Unlisted CT**, can be used in the context of: • Low Dose Whole Body CT o Initial workup of plasma cell dyscrasia (to differentiate MGUS, smoldering, and active myeloma/plasmacytoma) o Initial staging of known or suspected of active or smoldering multiple myeloma/plasmacytoma o Restaging of known active or smoldering myeloma/plasmacytoma- annually if no change in patient status, or at shorter interval clinically indicated by signs/symptoms, laboratory, or radiographic concern for disease relapse or progression **For all other CT studies, another CPT code should be selected that describes the specific service being requested, otherwise this procedure cannot be approved.** • Added background information
May 2020	• No changes
August 2019	• No changes

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **BREAST MRI**	**Original Date: September 1997**
CPT Codes: **Unilateral without contrast 77046** **Bilateral without contrast 77047** **Unilateral without and with contrast 77048** **Bilateral without and with contrast 77049** **+0698T**	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_023	**Implementation Date: January 2023**

INDICATIONS FOR BREAST MRI

See Legislative Requirements for specific mandates in: Commonwealth of Pennsylvania; State of Connecticut; State of Illinois; State of North Carolina

NO HISTORY OF KNOWN BREAST CANCER

For screening examination to detect breast cancer in any of the following situations

- A Breast Cancer Risk Assessment (including the Breast Cancer Consortium Risk Model (BCSC) which incorporates breast density, the International Breast Cancer Intervention Study (IBIS)/ Tyrer-Cuzick model, the Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm model (BOADICEA), the modified Gail (also known as the Breast Cancer Risk assessment tool (BCRAT)) or other validated risk assessment models) that identifies the patient as having a lifetime risk of 20% or greater of developing breast cancer[1]
    - Approve annually beginning 10 years prior to youngest family member's age at diagnosis or at age 40, whichever comes first, but not before age 25[2-6]
- Patients with lifetime risk of 20% or greater of developing breast cancer based on history of lobular neoplasia (LCIS/ALH (Lobular Carcinoma in Situ /Atypical Lobular Hyperplasia)) or ADH (atypical ductal hyperplasia)
    - Approve annually beginning at age of diagnosis of LCIS/ALH or ADH but not prior to age 25[2]
- Patients with intermediate lifetime risk (15%-20%) of developing breast cancer based on a history lobular neoplasia (LCIS/ALH (Lobular Carcinoma in Situ /Atypical Lobular Hyperplasia)) or ADH (atypical ductal hyperplasia)) AND have dense breast tissue on mammography
    - Approve annually beginning at age of diagnosis of LCIS/ALH or ADH but not prior to age 25[2,7,8]

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- Patients with history of extensive chest irradiation (usually as treatment for Hodgkin's or other lymphoma between ages ten and thirty)
    - Begin eight years after radiation, but not prior to age 25[2]
- Patients with known *BRCA 1/2* mutation
    - Approve annually starting at age 25[2,3]
- Patients not yet tested for *BRCA* gene, but with known *BRCA* mutation in first-degree relative
    - Approve annually starting at age 25[2,3]
- Personal history of germline mutations known to predispose to a high risk of breast cancer[1]:
    - Li-Fraumeni syndrome (*TP53* mutation)
        - Begin age 20-29 or age at earliest diagnosed breast cancer in family, if younger than age 20
    - Cowden syndrome (*PTEN*) or Bannayan-Riley-Ruvalcaba syndrome (BRRS)
        - Begin age 35 or 10 years before earliest breast cancer diagnosis in family (NCCN 2022)
    - *ATM*
        - Begin age 40
    - *BARD1*
        - Begin age 40
    - *CDH1*
        - Begin age 30
    - *CHEK2*
        - Begin age 40
    - *NF1*
        - Begin age 30, end age 50[2]
    - *PALB2*
        - Begin age 30
    - Peutz-Jeghers Syndrome (*STK11*)
        - Begin age 25

For evaluation of identified lesion, mass, or abnormality in breast in any of the following situations

- Evaluation of suspected breast cancer when other imaging examinations, such as ultrasound and mammography, and physical examination are inconclusive for the presence of breast cancer, and biopsy could not be performed (e.g., seen only in single view mammogram without ultrasound correlation)
    - Includes skin changes of suspected inflammatory breast cancer if conventional imaging and skin biopsies are first performed and negative[3,9,10]
- Inconclusive or conflicting findings on a diagnostic mammogram or ultrasound when the finding is not a palpable or a discrete mass
- For evaluation of suspicious mass, lesion, distortion, or abnormality of the breast in patient with history of breast cancer when other imaging is inconclusive
- For cases of new nipple inversion when mammographic and sonographic findings are inconclusive and a biopsy cannot be performed[11-13]
- Patients diagnosed with biopsy-proven lobular neoplasia, i.e., LCIS/ALH (Lobular Carcinoma in Situ /Atypical Lobular Hyperplasia) or ADH (atypical ductal hyperplasia)[2,3,14,15]

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- Spontaneous unilateral serous or bloody nipple discharge when conventional imaging is normal and there is no palpable mass[2,3,16]
- Paget's disease of the nipple: to detect underlying ductal carcinoma when conventional imaging is normal and there is no palpable mass[3]
- For a phyllodes tumor diagnosed by biopsy, breast MRI may help determine extent of disease and resectability in selected cases. However routine use for surgical planning is controversial[17-19]
- Follow-up of a probably benign (BI-RADS 3) lesion seen only on prior MRI (when prior mammogram and ultrasound did not show the abnormality)[20-22]

HISTORY OF KNOWN BREAST CANCER

- Yearly surveillance for history of breast cancer and dense breast tissue on mammography[4]
- Yearly surveillance for individuals with personal history of breast cancer diagnosed before age 50[4]
- Yearly surveillance in patients with genetic or other risk factors placing them at high risk for a new cancer or recurrence[3,23]

Staging, treatment, and surveillance of patients with a known history of Breast Cancer

- Approve for initial staging when conventional imaging is indeterminate in defining the extent of cancer, or presence of multifocal, multicentric, or contralateral cancer, or if there is a discrepancy in estimated tumor size between physical exam and imaging[2,3,14]
- For invasive lobular carcinoma that is poorly or inadequately defined by mammography, ultrasound, or physical exam[2,14]
- To identify primary cancer in a patient with axillary nodal adenocarcinoma and unidentified primary tumor[2]
- Prior to treatment: To serve as a baseline for comparison prior to a patient starting planned neoadjuvant chemotherapy[24]
  During or after treatment: To identify candidates for breast conserving therapy or evaluate response to treatment, including preoperative neoadjuvant therapy [within three (3) months][3]

Silicone Implants

MRI is not indicated for evaluation of saline implant complications or for asymptomatic silicone implants.[4,25]

- Confirmation of suspected silicone gel-filled breast implant ruptures in a*symptomatic* patients, after an abnormal or indeterminate finding on mammography or breast ultrasound
- MRI is considered the gold standard for evaluation of symptomatic silicone implant rupture.[3,4] Prior imaging is not required in patients with silicone implants and symptoms of possible rupture.
- For postoperative evaluation of silicone breast implant complications when other imaging is inconclusive

Pre-operative

- For preoperative evaluation for known breast cancer when surgery planned within thirty (30) days to be determined on a case-by-case basis[3,14,26,27]

Post-operative/procedural evaluation

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- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested[4]

LEGISLATIVE REQUIREMENTS

- Connecticut
  - **CT ST § 38a-530. Effective: October 1, 2020**
    - Coverage for breast MRI is mandated within the State of Connecticut without coinsurance, copay of more than $20 deductible, or other out of pocket expenses for women with dense breast tissue if the woman is believed to be at increased risk of breast cancer because of family or personal history of breast cancer, positive genetic testing. Coverage is also mandated for other indications determined by a woman's physician, or when screening is recommended by a physician and the woman is over age 40, has a family or prior history of breast cancer or has breast disease diagnosed through biopsy as benign. This applies to high deductible plans unless plans are used to establish an HRA or HSA to the extent permitted by federal law. Though not designated in the original intent of the bill, language includes the above provisions and criteria for breast MRI.
  - **Source:** Connecticut General Assembly[28]

- North Carolina
  - **Medicaid and NCHC cover magnetic resonance imaging (MRI) for the detection of:**
    - Breast cancer in beneficiaries who are at a high genetic risk for breast cancer:
      - known BRCA 1 or 2 mutation in beneficiary;
      - known BRCA 1 or 2 mutation in relatives; or
      - pattern of breast cancer history in multiple first-degree relatives, often at a young age and bilaterally.
    - Breast cancer in beneficiaries who have breast characteristics limiting the sensitivity of mammography (such as dense breasts, implants, scarring after treatment for breast cancer).
    - A suspected occult breast primary tumor in beneficiaries with axillary nodal adenocarcinoma with negative mammography and clinical breast exam.
    - Breast cancer in beneficiaries with a new diagnosis of breast cancer. It can be used to determine the extent of the known cancer and/or to detect disease in the contralateral breast.
    - To evaluate implant integrity in beneficiaries with breast implants.
  - **Source**: NC Medicaid[29]; amended September 15, 2020

- Illinois

  Commercial, Exchange, and Medicaid

  - MRI of the entire breast or breasts is approvable for individuals 35 years or older

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- if a mammogram demonstrates heterogenous or dense breast tissue **OR**
- when determined medically necessary by a physician licensed to practice medicine in all of its branches

- Screening breast MRI approvable when determined medically necessary by a physician licensed to practice medicine in all of its branches

Source: Illinois General Assembly
Illinois General Assembly - Full Text of SB0162 (ilga.gov)[30]

- Pennsylvania
  - **40 P.S. § 764c. Act of Jul. 1, 2020, P.L. 572, No. 52 (SB 595)**
    - Plans that provide hospital or medical/surgical coverage shall also provide coverage for breast imaging.
    - The minimum coverage required shall include:
      - **Supplemental magnetic resonance imaging** or, if such imaging is not possible, **ultrasound**
      - **If recommended by the treating physician** because the woman is believed to be at an increased risk of breast cancer due to:
        - personal history of atypical breast histologies;
        - personal history or family history of breast cancer;
        - genetic predisposition for breast cancer;
        - prior therapeutic thoracic radiation therapy;
        - heterogeneously dense breast tissue based on breast composition categories of the Breast Imaging and Reporting Data System established by the American College of Radiology with any one of the following risk factors:
          - lifetime risk of breast cancer of greater than 20%, according to risk assessment tools based on family history;
          - personal history of BRCA1 or BRCA2 gene mutations;
          - first-degree relative with a BRCA1 or BRCA2 gene mutation but not having had genetic testing herself;
          - prior therapeutic thoracic radiation therapy between 10 and 30 years of age; or
          - personal history of Li-Fraumeni syndrome, Cowden syndrome or Bannayan-Riley-Ruvalcaba syndrome or a first-degree relative with one of these syndromes;
          - extremely dense breast tissue based on breast composition categories of the Breast Imaging and Reporting Data System established by the American College of Radiology.
  - Nothing in this subsection shall be construed to require an insurer to cover the surgical procedure known as mastectomy or to prevent the application of deductible, copayment or coinsurance provisions contained in the policy or plan.
  - **Source:** Senate Bill 595[31]

BACKGROUND

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Magnetic resonance imaging (MRI) of the breast is a useful tool for the detection and characterization of breast disease, assessment of local extent of disease, evaluation of treatment response, and guidance for biopsy and localization.[32] Breast MRI should always be bilateral to allow for assessment of symmetry between the breasts. MRI findings should be correlated with clinical history, physical examination, and the results of mammography and any other prior breast imaging.

OVERVIEW

Staging of newly diagnosed breast cancer[2] – The decision to use breast MRI as an adjunct to clinical exam, mammography, and ultrasound should be made by the physician on a case-by-case basis, taking into account frequent false positives, increased time to treatment, and increased mastectomy rates. "There is no convincing evidence that MRI reduces re-excision lumpectomy rates, local recurrence, or overall survival in patients with invasive breast cancer or ductal carcinoma in situ."[3]

MRI and risk evaluation – The age of a family member's diagnosis is **only** relevant for patients under the age of 40. Anyone 40 or over should be getting annual mammograms and breast MRIs if their lifetime risk is 20% or greater.

MRI and dense breasts – Women with extremely dense breasts are 4-6x more likely to develop breast cancer than women with fatty tissue. Between 40 - 50% of US women aged 40-74 years have dense breast tissue. Breast density decreases the sensitivity of mammography and is associated with aggressive tumors and worse outcomes. There are four categories for breast density- almost entirely fatty, scattered areas of fibroglandular tissue, heterogeneously dense, and extremely dense. The last two are considered dense. Women with dense breasts and a BCSC risk of ≥ 2.5% (about 21%) are at greatest risk for interval stage IIb or higher cancers. Thus, knowing a women's risk along with density identifies subgroups who will benefit most from supplemental testing, such as ultrasound or MRI. Without considering overall breast cancer risk, MRI could result in more harm than good in terms of anxiety, overdiagnosis, and increased benign breast biopsies.[33] For women whose only risk is increased breast density, ultrasound can be considered for adjunctive screening.[15]

A movement to notify women of their breast density is now expanded, as of April 2019, to 38 states and the District of Columbia. Although there has been an increase in notification and awareness of breast density, no clear guidelines have been established for supplemental screening in this subset of women. A recent study showed that the majority of practices are utilizing supplemental screening, but the modalities used and referral patterns vary depending on several factors including location, type of practice (i.e., private or academic), and whether the practice has breast specialists. Also, the exact notification requirements as well as insurance coverage vary from state to state. Screening ultrasound was most utilized (53%) and most available in the Northeast (80%). Connecticut, for example, requires insurance to cover supplemental ultrasound exams. In this study 19.5% had MRI for supplemental screening and 87% of these were private practice settings.[34] At the present time, except in states that require it, more research is needed before approval of MRI for supplemental screening based on breast density alone, without other risk factors.[33,35,36]

MRI and breast cancer risk associated with certain syndromes

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- Lynch Syndrome- Women with Lynch syndrome and mismatch repair genes *MLH1* and *MSH2* may be at increased risk for breast cancer; however, breast screening is not recommended beyond what is recommended for an average risk patient.[1]
- NF-1- Mammography starting at age 30; breast MRI may be considered.

Management of patients with pathogenic variants of *RAD51C* and *RAD51D* genes should be based on family history (NCCN 2022). Currently, there is insufficient evidence for *FANCC*, *MRE11A*, *MUTYH* heterozygotes, *RECQL4, RAD50, RINT1, SLX4, SMARCA4*, or *XRCC2*.

Surgical excision vs MRI – Select patients may be suitable for monitoring in lieu of excision (although MRI is not indicated); e.g., Flat epithelial hyperplasia, papillomas without atypia, fibroepithelial lesions favoring fibroadenoma, radial scars adequately sampled or incidental. Other pathologies that may require excision include mucin-producing lesions, potential phyllodes tumor, papillary lesions, radial scar, or other histologies of concern to the pathologist.[2]

MRI during or after neoadjuvant chemotherapy – Dynamic contrast-enhanced MRI may be used to monitor response of a tumor to neoadjuvant chemotherapy used to shrink the tumor before surgery. This is very important in clinical decision making as alternative therapies may be selected based upon the MRI results. It may also be used to depict residual disease after neoadjuvant chemotherapy. MRI-compatible localization tissue markers should be placed prior to neoadjuvant chemotherapy to evaluate the location of the tumor in the event of complete response.[4]

MRI and breast implants – For asymptomatic women with silicone implants, no imaging is recommended for evaluation. However, MRI may be used in asymptomatic patients with silicone breast implants to evaluate breast implant integrity when a mammogram and/or ultrasound is suspicious for implant rupture.

For evaluation of unexplained axillary adenopathy in a patient under age 30, ultrasound (US) of the axilla is the recommended initial test. For age over 30, a mammogram and/or US of the axilla are recommended.

MRI after mastectomy – Most breast tissue is removed after mastectomy; however, recurrence may occur in residual tissue. The majority occur in the skin, subcutaneous tissues or deep to the pectoralis muscle and are reported to be about 1-2% annually. Clinical evaluation is the mainstay of the post-mastectomy breast. For a palpable lump or pain on the side of mastectomy with or without reconstruction or a high-risk patient post-bilateral prophylactic mastectomy with reconstructions, MRI is not indicated. There is no relevant literature to support MRI to screen the post-mastectomy breast (although may be indicated for contralateral native breast based on breast cancer risk). MRI may be useful for a palpable lump to help characterize malignancy once identified by ultrasound. Note that tissue expanders may be a contraindication to MRI.[37]

Breast pain – Breast pain is a common complaint with the incidence of breast cancer with breast pain as the only symptom, 0-3%. Clinically insignificant breast pain is cyclical, non-focal, or diffuse. There is no relevant literature regarding the use of MRI for focal or non-cyclical breast pain at any age.[4]

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MRI for a mass – "Any highly suspicious breast mass detected by imaging should be biopsied, irrespective of palpable findings; and any suspicious breast mass detected by palpation should be biopsied, irrespective of imaging findings".[38]

MRI and known breast cancer – "The ASBrS does not recommend routine diagnostic MRI in newly diagnosed breast cancer patients except as part of a scientific study… Routine annual MRI is not indicated for screening of women with a prior history of breast cancer unless they have a known genetic or other significant risk factor placing them at high-risk for a new breast cancer …."[3] Clinical indications and applications per NCCN state that Breast MRI may be used for staging evaluation to define extent of cancer or presence of multifocal or multicentric disease in the ipsilateral breast, or as screening of the contralateral breast at time of initial diagnosis (Category 2B); however, there are no high level data to demonstrate that the use of MRI to facilitate local therapy decision-making improves local recurrence or survival. False positive findings are common and surgical decisions should not be based solely on MRI, tissue sampling of areas of concern recommended.[14]

MRI and breast cancer in men – Breast MRI is generally not indicated for palpable masses or axillary adenopathy prior to biopsy. Studies are limited as to the diagnostic accuracy or clinical usefulness of MRI in male patients.[4]

Nipple discharge – Nipple discharge is a common complaint with at least 80% of women having at least 1 episode. Discharge that is considered pathologic is unilateral, spontaneous, from one duct orifice and serous or bloody. Physiologic discharge will be bilateral, from multiple ducts, and white, green, or yellow in color. "In general, MRI should be considered in cases in which other approaches have failed to identify an underlying cause of pathologic nipple discharge. The sensitivities of breast MRI for detection of underlying cause of pathologic nipple discharge are 86% to 100% for invasive cancer and 40% to 100% for noninvasive disease".[39] Ductography (galactography) has the ability to demonstrate very small lesions in the specific duct that is secreting the pathologic nipple discharge. However, it is invasive and may cause discomfort and pain. It can be time-consuming and technically challenging and the rate of incomplete ductography is as high as 15%. The discharge must be present on the day of the study so that a cannula can be placed in the appropriate duct. Failure to cannulate the discharging duct may occur and cannulation of the wrong duct may cause a false-negative ductogram.[39]

BI-RADS 3 (Probably Benign) MRI and Follow-up – A follow-up MRI study may be indicated to confirm stability of a probably benign mass seen only on prior MRI. In a review of sixteen studies of high-risk patients, the frequency of MRI examinations reported as BI-RADS 3 was between 6 and 12%.[20] In an average risk screening population of 2120 women and 3,861 MRI exams, 4.9% of MRI exams were BI-RADS 3.[40] Specific features of what constitutes a BI-RADS 3 lesion were not described in these studies, is at the discretion of the reporting radiologist, and still had an evolving definition during the study periods. At this writing the appropriate use of BI-RADS 3 for breast MRI has not been fully defined.[21] "The most appropriate and common use of BI-RADS 3 assessment is for a round- or oval-shaped mass with circumscribed margins and hyperintense T2 signal, which has either homogeneous enhancement or dark internal septations on a baseline examination. A mass meeting these criteria is most likely an

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intramammary lymph node or fibroadenoma".[20] The reported malignancy rate is ≤ 2% for lesions classified as BI-RADS 3 (Spick, 2018).[20,22]

POLICY HISTORY

Date	Summary
September 2022	Added mandate language for State of Illinois
June 2022	• Added criteria for an intermediate lifetime risk of breast cancer • Reformatted mandates
April 2022	• Revised high-risk screening section for germline mutations • Updated background section on genetic syndromes • Updated citations
November 2021	Added +0698T
July 2021	• Improved section on when to begin high risk screening for patients with lifetime risk of 20% or greater. • Added section on high risk screening in patients with lifetime risk of 20% or greater based on history of LCIS/ALH/ADH. • Changed high risk screening start date to 8 years after chest irradiation per NCCN • Added BARD1 germline mutation • Improved section on when MRI may be indicated for a new diagnosis of breast cancer • Added indication of baseline MRI prior to starting neoadjuvant chemotherapy • Improvement background section on MRI of the breast • Updated background section on genetic syndromes • Removed background section on abbreviated breast MRI
February 2021	• Added state specific language box for State of Pennsylvania • Added citations to state specific boxes
May 2020	• Added not indicated for saline implants, or asymptomatic silicone without prior imaging • Added gold standard for symptomatic silicone implant rupture • Removed section on increased breast density • Improved section on breast assessment tools • Improved section on germline mutations from NCCN 2019 • Added indication of new nipple inversion • Added phylloides • Added ACR for known breast cancer surveillance with dense tissue or dx < age 50 • Added comment section on MR for dense breast, syndromes, implants, after mastectomy, breast pain, cancer in male

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September 2019	• Added state specific language boxes for State of Connecticut and State of North Carolina
April 2019	• For silicone implants indication, added qualifying terms to assure patient is symptomatic and other imaging is inconclusive • For 'No history of breast cancer, screening examinations' added specifics about when the screening should be done • Removed indication "Two or more first degree relatives (parents, siblings, and children) have history of breast cancer" • Provided specifics on chest radiation including when to start screening: "Patients with histories of extensive chest irradiation (usually as treatment for Hodgkin's or other lymphoma between ages ten and thirty. Begin ten years after radiation, but not prior to age 25" • For indication: "Personal history of germline mutations", removed 'or first degree relative with' and added some of the different mutations and when screening should begin • For indication: "For evaluation of identified lesion, mass, or abnormality in breast in any of the following situations", removed "Two or more first degree relatives with history of breast cancer" • For "Evaluation of breast cancer when other imaging exams are inconclusive" added "includes skin changes of suspected inflammatory breast cancer" • Expanded the suspicious precursor lesions to include "atypical lobular hyperplasia and lobular carcinoma in situ" • Added indications: "Spontaneous unilateral serous or bloody nipple discharge when conventional imaging is normal and there is no palpable mass" AND "Paget's disease of the nipple: to detect underlying ductal carcinoma when conventional imaging is normal and there is no palpable mass" • Added indication: "Follow-up of a BI-RAD 3 lesion seen only on prior MRI when prior mammogram and US did not show the abnormality" • History of Known Breast Cancer: Changed subheading from "Screening exam to detect breast cancer" to "Staging, treatment, and surveillance of patients with a known history of breast cancer" AND added specific indications including: o Approve initial staging when conventional imaging is indeterminate in defining multifocal, multicentric, contralateral cancer or there is a discrepancy in estimated tumor size between physical exam and imaging

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	o During or after treatment to identify candidates for breast conserving therapy or evaluate response to treatment, including preoperative neoadjuvant therapy [within three (3) months] o Yearly surveillance in patients with genetic or other risk factors placing them at high risk for a new cancer or recurrence" • For evaluation of suspicious mass, lesion, distortion, or abnormality of breast in patient with history of breast cancer: added - 'when other imaging is inconclusive' • Added Background information on Nipple Discharge and specifics on screening for newly diagnosed or patients with breast cancer history • Updated references

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **CT BONE DENSITY STUDY**	**Original Date: April 1999**
CPT Codes: 77078	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_060-2	**Implementation Date: January 2023**

INDICATIONS FOR CT BONE DENSITY STUDY

For first time baseline study[1-5]

Patient with <u>suspected</u> osteoporosis or osteopenia meeting any of the following criteria when DXA scanning is not available or for patients with advanced degenerative changes of the spine or who are severely obese (BMI >35 kg/m) that may limit the efficacy of DXA scans

- Asymptomatic women 65 years of age or older
- For post-menopausal women age < 65 or during the menopause transition, and men < 70 having at least one of the following risk factors for low bone mass or fractures:
  - Low body weight (<127 lb. or 57.6 kg or BMI < 20 kg per m)
  - A history of fracture
  - History of maternal hip fracture that occurred after the age of 50 years
  - High risk medications (e.g., steroids or glucocorticosteroids, medroxyprogesterone acetate, anticonvulsants, heparin, lithium, estrogen receptor modulators, calcitonin, or bisphosphonates)
  - History of estrogen deficiency
  - Conditions that cause or contribute to osteoporosis and fractures (e.g., malabsorption syndromes, inflammatory bowel disease and other gastrointestinal conditions, metabolic bone disease, hyperparathyroidism, hypogonadism, thyroid hormone therapy or hyperthyroidism, chemotherapy, long-term heparin therapy, rheumatologic and autoimmune diseases, renal failure, hematologic disorders, multiple myeloma, chronic alcoholism, cerebral palsy, etc.)
- Men aged 70 or older
- Individuals with fragility fractures, including vertebral abnormalities that are indicative of osteoporosis, osteopenia, low bone mineral content, or vertebral fractures seen on other imaging studies/x-ray
- Individuals aged 50 years and older who develop a wrist, hip, spine, or proximal humerus fracture with minimal or no trauma, excluding pathologic fractures
- Loss of body height (>4 cm (>1.5 inches))[1]
- Amenorrhea for greater than 1 year before the age of 42

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- Eating disorders, including anorexia nervosa and bulimia
- Individuals who have had gastric bypass for obesity (accuracy of DXA may be affected by obesity)

Follow-up of individuals with <u>known</u> osteoporosis or osteopenia[6, 7]

- In women with low to moderate risk reassess fracture risk in 2-4 years
- In post-menopausal women with a low bone mineral density at high risk for fractures on treatment, monitor the spine and hip every 1-3 years
- For patients on bisphosphonates, reassess fracture risk every 3-5 years
- No previous bone density within past 23 months **AND** meets any one of the above risk factor criteria. (More frequent BMD testing may be warranted in certain clinical situations and should be determined on a case-by-case basis.)

Indications for QCT/pQCT in pediatric and adolescent include[8]:

- Individuals receiving (or expected to receive) glucocorticoid therapy for more than 3 months
- Individuals receiving radiation or chemotherapy for malignancies
- Individuals with an endocrine disorder known to adversely affect BMD (e.g., hyperparathyroidism, hyperthyroidism, growth hormone deficiency or Cushing's syndrome)
- Individuals with bone dysplasias known to have excessive fracture risk (osteogenesis imperfecta, osteopetrosis) or high BMD, such as prolonged exposure to fluoride
- Individuals with medical conditions that could alter bone marrow density, such as: (chronic renal failure, inflammatory arthritides, eating disorders, organ transplantation, prolonged immobilization, sprue, inflammatory bowel disease, malnutrition, cystic fibrosis, osteomalacia, acromegaly, cirrhosis, HIV infection, prolonged exposure to fluorides, and hematologic disorders (thalassemia, sickle cell disease))

BACKGROUND

Bone mineral density (BMD) measurement identifies patients with low bone density and increased fracture risk. Methods for measuring BMD are non-invasive, painless, and available on an outpatient basis. Dual energy x-ray absorptiometry (DXA), previously referred to as DEXA, is the most commonly used method of evaluating BMD and is the only BMD technology for which World Health Organization (WHO) criteria for the diagnosis of osteoporosis can be used. Patients who have a BMD that is 2.5 standard deviations below that of a "young normal" adult (T-score at or below -2.5) are deemed to have osteoporosis. Quantitative computed tomography (QCT) has not been validated for WHO criteria but can identify patients with low BMD compared to the QCT reference database, and it can be used to identify patients who are at risk of fracture.

OVERVIEW:

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DXA – Dual energy x-ray absorptiometry (DXA) is most often used to measure bone mineral density due to its low radiation exposure, low precision error, and capacity to measure multiple skeletal sites (spine, hip, or total body).

Axial DXA – This provides the "gold standard". Axial DXA predicts fracture risk at the site being measured.

Peripheral DXA – This device measures BMD at peripheral sites, generally at the heel or wrist. It is relatively cheap and portable and is an option when there is limited access to axial DXA.

Quantitative computed tomography (QCT) – QCT measures volumetric integral, trabecular, and cortical bone density at the spine and hip and can be used to determine bone strength. Radiation dose is increased when compared with DXA. Indications are the same for QCT as DXA; however, DXA is recommended as the first-line test in most cases.[1, 2]

Fracture Risk Assessment - The fracture risk assessment (FRAX) tool developed by the WHO estimates the 10-year risk of having a fracture based on factors such as age, sex, body mass index (BMI), previous fractures, parental fracture history, glucocorticoid use, rheumatoid arthritis, and conditions predisposing to secondary osteoporosis (insulin-dependent diabetes, osteogenesis imperfecta in adults, untreated long-standing hyperthyroidism, hypogonadism or premature menopause (<45 years), chronic malnutrition, or malabsorption and chronic liver disease) and tobacco and alcohol use. Based on FRAX, a 65-year-old woman, without any additional conditions increasing fracture risk, has a 9.3% 10-year risk of developing a fracture. This value is therefore used as the risk level cut-off recommending screening in patients younger than 65.[9]

Ethnicity and Screening - Due to the potential negative consequences of fractures and the lack of an optimal age at which to screen populations of different ethnicity, the US Preventive Services Task Force (USPSTF) now recommends screening all women aged 65 and older regardless of race and ethnicity.

Follow-up Imaging – Follow-up imaging is performed on patients at risk of developing osteoporosis or to evaluate the outcome of osteoporosis treatment. Follow-up imaging is generally performed at 1-2 years after initiation of therapy for osteoporosis and subsequently every 2 years unless clinical circumstances prompt earlier imaging. In patients at increased risk for developing osteoporosis, imaging may be performed more frequently, particularly with patients with certain medical conditions and taking medications predisposing to fracture. The later population includes those undergoing long-term therapy with common medications such as heparin or glucocorticoids.

Pediatric and Adolescent patients - As QCT can assess both volume and density of bone in the axial and appendicular skeleton, it may be more useful than DXA scans in children. Bone mineral density measurement in children and adolescents is indicated whenever clinical management is likely to be impacted by the test results.

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POLICY HISTORY

Date	Summary
April 2022	• Added new section regarding pediatric and adolescent patients
June 2021	• Added vertebral abnormalities indicative of osteoporosis, osteopenia, low bone mineral content, or vertebral fracture • Added - Individuals age 50 years and older who develop a wrist, hip, spine, or proximal humerus fracture with minimal or no trauma, excluding pathologic fractures • Added- History of maternal hip fracture that occurred after the age of 50 years • Added- History of estrogen deficiency
May 2020	• Changed indications for asymptomatic women and men • Added imaging for men age >70 • Updated timing for follow up studies
April 2019	• Changed language by removing "screening" in the following: "For first time baseline ~~screening~~ study" AND "For ~~screening~~ follow-up of individuals with known osteoporosis or osteopenia" • Removed erroneous chart information that was not intended for inclusion in guideline • Updated references

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Clinical guidelines **BONE MARROW MRI**	**Original Date: July 2008**
CPT Codes: 77084	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_059	**Implementation Date: January 2023**

INDICATIONS FOR BONE MARROW MRI (images entire body)

- For the diagnosis, staging and follow-up of patients with multiple myeloma (MM), as well as leukemia and other related hematological malignancies[1-3]
- Suspected progression of smoldering multiple myeloma (SMM) to multiple myeloma (MM) or high risk SMM patients[3-5]
- Diagnosis and assessment of treatment response in diffuse or multifocal marrow disorders (e.g., chronic recurrent multifocal osteomyelitis; marrow involvement in storage diseases, such as Gaucher's, or hematologic malignancies/ processes (e.g., Waldenström macroglobulinemia) when the diagnosis is in doubt)[6-8]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

NOTE: If the request is for whole body MRI screening for a rare genetic predisposition syndrome (such as Li-Fraumeni syndrome (LFS) constitutional mismatch repair deficiency (CMMRD) syndrome, neurofibromatosis type 1 etc.) an unlisted MRI study may be more appropriate, please see NIA GL 063*.

BACKGROUND

Magnetic Resonance Imaging (MRI) is currently used for the detection of metastatic disease to the bone marrow. Bone marrow MRI, using moving tables and special coils to survey the whole body, is used for screening to search for primary tumors and metastases. The unique soft tissue contrast of MRI enables precise assessment of bone marrow infiltration and adjacent soft tissues allowing detection of alterations within the bone marrow earlier than with other imaging modalities. MRI results in a high detection rate for both focal and diffuse disease, mainly due to its high sensitivity in directly assessing the bone marrow components: fat- and water-bound protons.

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When bone marrow MRI is indicated, it is a single CPT code study with large field of view images covering the osseous structures, usually in two planes. The study covers from the vertex to the heels. Individual CPT codes corresponding to multiple separate studies of portions of the axial and appendicular skeleton are not necessary for bone marrow MRI.

Some conditions with diffuse marrow infiltration are not confined to the musculoskeletal system. Additional dedicated organ MRI exams may also be required for these patients.

OVERVIEW

MRI allows bone marrow components to be visualized and is the most sensitive technique for the detection of bone marrow pathologies. The soft tissue contrast of MRI enables detection of alterations within the bone marrow before osseous destruction becomes apparent on CT. Whole body bone marrow MRI has been applied for bone marrow screening of metastasis, as well as for systemic primary bone malignancies, such as multiple myeloma (MM). Sensitive detection is mandatory to estimate prognosis and to determine adequate therapy.

Multiple myeloma and related conditions include: "1. Multiple myeloma- monoclonal proliferation of plasma cells with myeloma-defining CRAB (Calcium level elevation, Renal failure, Anemia, or Bone lesions) findings; 2. MGUS (monoclonal gammopathy of undetermined significance) - monoclonal proliferation of plasma cells without myeloma-defining CRAB; 3. Solitary plasmacytoma – monoclonal plasma cells manifesting as a single tumor; and 4. Smoldering myeloma - monoclonal proliferation of plasma cells in bone marrow and/or serum/urine with abnormal levels of monoclonal protein."[9]

MRI findings are included as one of the International Myeloma Working Group (IMWG) diagnostic criteria of active myeloma.[2] Although MRI is not the only imaging tool for diagnosis, when "more than one focal lesion on MRI that is at least 5 mm or greater in size" in addition to >10% clonal bone marrow plasma cells, the diagnosis of active myeloma can be made. For smoldering multiple myeloma (SMM), defined as asymptomatic patients with increased levels of M protein and increased bone marrow plasma cells, "The IMWG now recommends that one of following: PET-CT, Low dose whole body CT (LDWBCT), or MRI of the whole body or spine (Bone marrow MRI) be done in all patients with suspected smoldering myeloma, with the exact imaging modality determined by availability and resources".[4, 10] The importance of imaging in the diagnosis of active myeloma is highlighted as "The IMWG consensus statement now recommends that SMM patients with more than one unequivocal focal lesion (diameter > 5 mm) should be considered to have symptomatic myeloma that requires treatment".[2] Recent advances have allowed the identification of a subset of SMM patients with a greater than 80% risk of progression to MM in 2 years based on biomarkers.[5]

POLICY HISTORY

Date	Summary

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April 2022	• Added statement for whole body MRI related to genetic predisposition syndromes
June 2021	• Clarified hematologic malignancies/ processes (e.g., Waldenström macroglobulinaemia) • Updated references
May 2020	• Added description of whole body bone marrow MRI in background section • Added Low dose CT in evaluation of myeloma, in background section • Updated references
April 2019	• Removed indication "vertebral fractures with suspected bone metastasis' • Added indication: "Diagnosis and assessment of treatment response in diffuse or multifocal marrow disorders (e.g., chronic recurrent multifocal osteomyelitis; marrow involvement in storage diseases such as Gaucher's; or hematologic malignancies when the diagnosis is in doubt)" • Added Background info to clarify when this study is indicated • Added Overview section to explain multiple myeloma and related conditions • Updated references

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **HEART (Cardiac) PET with CT for Attenuation**	**Original Date: July 1999**
CPT Codes: 78459, 78491, 78492, +78434, 78429, 78430, 78431, 78432, 78433	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_079	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

This guideline is for stress imaging, specifically Heart (Cardiac) PET imaging, with appropriate preference for suitable alternatives, such as stress echocardiography (SE) or myocardial perfusion imaging (MPI), when more suitable, unless otherwise stated (refer to Background section).

INDICATIONS FOR HEART PET WITH CT FOR ATTENUATION

SUSPECTED CAD (When neither SE nor MPI have provided or are expected to provide optimal imaging)

- **Symptomatic patients without known CAD (use Diamond Forrester Table)**
  - Low or intermediate pretest probability and unable to exercise *(SE diversion not required)*
  - High pretest probability *(SE diversion not required)*
  - Repeat testing in a patient with new or worsening symptoms and negative result at least one year ago **AND** meets one of the criteria above
- **Asymptomatic patients without known CAD** *(SE diversion not required)*
  - Previously unevaluated ECG evidence of possible myocardial ischemia including substantial ischemic ST segment or T wave abnormalities (see section in Overview)
  - Previously unevaluated pathologic Q waves (see section in Overview)

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- Unevaluated complete left bundle branch block

ABNORMAL CALCIUM SCORES (CAC)[1-5] (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- ASYMPTOMATIC patient with a calcium score >400, not previously evaluated
- SYMPTOMATIC patient with prior CAC ≥ 100

INCONCLUSIVE CAD EVALUATION WITHIN THE PAST 2 YEARS AND OBSTRUCTIVE CAD REMAINS A CONCERN (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- Exercise stress ECG with low-risk Duke treadmill score (≥5), (see section in Overview) but patient's current symptoms indicate an intermediate or high pretest probability *(SE diversion not required* for high pretest probability)
- Exercise stress ECG with an intermediate Duke treadmill score
- Inconclusive/borderline coronary computed tomography angiography (CCTA) (e.g., 40 - 70% lesions)
- Non-diagnostic exercise stress test with physical inability to achieve target heart rate (THR) *(SE diversion not required)*
- An intermediate evaluation by prior stress imaging (within the past 2 years) *(SE diversion not required)*

FOLLOW-UP OF PATIENT'S POST CORONARY REVASCULARIZATION (PCI or CABG) (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- **Asymptomatic, follow-up stress imaging** at a minimum of 2 years post coronary artery bypass grafting (CABG), or percutaneous coronary intervention (PCI), (whichever is later), is appropriate only for patients with a history of silent ischemia or a history of a prior left main stent
  OR
- For patients with high occupational risk (e.g., associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers, and firefighters)
- **New, recurrent, or worsening symptoms post coronary revascularization,** is an indication for stress imaging, if it will alter management

FOLLOW-UP OF KNOWN CAD (When neither SE nor MPI have provided or are expected to provide optimal imaging)

- **Follow-up of asymptomatic or stable symptoms** when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR ≤ 0.80 or stenosis greater than or equal to 70% of a major vessel), over

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two years ago, without intervening coronary revascularization is an appropriate indication for stress imaging in patients if it will alter management

SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- Prior acute coronary syndrome (as documented in MD notes), without subsequent invasive or non-invasive coronary evaluation
- Newly diagnosed systolic heart failure or diastolic heart failure, *with reasonable suspicion of cardiac ischemia (prior events, risk factors*), unless invasive coronary angiography is immediately planned[6-8]
- Reduced LVEF ≤ 50% requiring myocardial viability assessment to assist with decisions regarding coronary revascularization. (Diversion from PET not required when LVEF less than or equal to 40%)[7-9]
- Ventricular arrhythmias
    - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise-induced VT, when invasive coronary arteriography is not the immediately planned test[10]
    - Nonsustained VT, multiple episodes, each ≥ 3 beats at ≥ 100 bpm, frequent PVC's (defined as greater than or equal to 30/hour on remote monitoring) without known cause or associated cardiac pathology, when an exercise ECG cannot be performed
- Prior to Class IC antiarrhythmic drug initiation (Propafenone or Flecanide), as well as annually in intermediate and high global risk patients (SE diversion not required)[11]
- Assessment of hemodynamic significance of one of the following documented conditions[12]:
    - Anomalous coronary arteries[13]
    - Muscle bridging of coronary artery [3, 14]
- Coronary aneurysms in Kawasaki's disease[15] or due to atherosclerosis
- Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter[16]

- **Cardiac Sarcoidosis[17-19]**
    - Evaluation and therapy monitoring in patients with sarcoidosis, after documentation of suspected cardiac involvement by echo or ECG, when CMR has not been performed
    - Evaluation of suspected cardiac sarcoid, after CMR has shown equivocal or negative findings in the setting of a high clinical suspicion[19]
    - Evaluation of CMR findings showing highly probable cardiac sarcoidosis, when PET could serve to identify inflammation and the consequent potential role for immunosuppressive therapy[19]
    - Initial and follow-up PET in monitoring therapy for cardiac sarcoid with immunosuppressive therapy, typically about 4 times over 2 years

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- **Infective Endocarditis**
    - In suspected infective endocarditis with moderate to high probability (i.e., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device), when TTE and TEE have been inconclusive with respect to diagnosis of infective endocarditis or characterization of paravalvular invasive complications[20-22]

- **Aortitis**
    - For diagnosis and surveillance of Aortitis, PET/CT or PET/MRI‡ hybrid imaging[23]
      ‡**NOTE:** If PET/MR study is requested, there is no specific CPT Code for this imaging study and a Health Plan review will be required.

PRIOR TO ELECTIVE NON-CARDIAC SURGERY (When neither SE nor MPI have provided or are expected to provide optimal imaging)

- An intermediate or high risk surgery with of one or more risk factors (see below), AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year[24-26]*
    - **Risk factors:** history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dL.
    - **Surgical Risk:**
        - **High risk surgery:** Aortic and other major vascular surgery, peripheral vascular surgery, anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss
        - **Intermediate risk surgery:** Carotid endarterectomy, head and neck surgery, intraperitoneal and intrathoracic surgery, orthopedic surgery, prostate surgery
        - **Low risk surgery**: Endoscopic procedures, superficial procedure, cataract surgery, breast surgery

- Planning for any organ or stem cell transplantation is an indication for preoperative stress imaging, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, at the discretion of the transplant service[27]

POST CARDIAC TRANSPLANT (SE diversion not required)[28]

- Annually, for the first five years post cardiac transplantation, in a patient not undergoing invasive coronary arteriography
- After the first five years post cardiac transplantation, patients with documented transplant coronary vasculopathy can be screened annually if invasive coronary arteriography is not planned

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BACKGROUND[29, 30]

Cardiac PET scanning, when used in conjunction with CT attenuation, includes evaluation of perfusion, function, viability, inflammation, anatomy, and risk stratification for cardiac-related events such as myocardial infarction and death. Maximum diagnostic accuracy of cardiac PET/CT is achieved when images are interpreted in conjunction with other relevant imaging, clinical information, and laboratory data.

PET Scan

- Indicated when all the criteria for MPI are met **AND** there is likely to be equivocal imaging results because of BMI or large breasts or implants or prior thoracic surgery or results of a prior MPI
- Can identify regions of myocardial viability with hibernating myocardium (viable, with poor flow and contractility) by imaging with fluorine18 (F-18) fluorodeoxyglucose (FDG or 18-FDG) for this purpose
- Useful in the evaluation of inflammation: e.g., evaluation and therapy monitoring in patients with sarcoidosis, after documentation of cardiac involvement by echo or electrocardiography (ECG), in place of, or subsequent to CMR if needed to help with an uncertain diagnosis

Coronary application of PET includes evaluation of **stable patients without known CAD**, who fall into two categories[3, 6, 31]

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see websites for Global Cardiovascular Risk Calculators section).
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant (≧ 50%) CAD (below):

The 3 Types of Chest Pain or Discomfort

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
    - Substernal chest pain or discomfort with characteristic quality and duration
    - Provoked by exertion or emotional stress
    - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, The Pretest Probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability[3, 6]:

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Diamond Forrester Table

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very Low:** < 5% pretest probability, usually not requiring stress evaluation
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High: > 90% pretest probability of CAD**

OVERVIEW

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) require that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate AND has an interpretable ECG for ischemia during exercise[3]:

- The (symptomatic) low or intermediate pretest probability patient who can exercise and has an interpretable ECG[3]
- The patient who is under evaluation for exercise-induced arrhythmia
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription
- For the evaluation of syncope or presyncope during exertion[32]

Duke Exercise ECG Treadmill Score

Calculates risk from ECG treadmill alone[33]:

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting.
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤ - 11) categories.

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An uninterpretable baseline ECG includes[6]:

- ST segment depression 1 mm or more (not for non-specific ST- T wave changes)
- Ischemic looking T waves; at least 2.5 mm inversions (excluding V1 and V2)
- LVH with repolarization abnormalities, pre-excitation pattern such as WPW, ventricular paced rhythm, or left bundle branch block
- Digitalis use with associated ST segment abnormalities

Previously unevaluated pathologic Q waves (in two contiguous leads) defined as the following:

- > 40 ms (1 mm) wide
- > 2 mm deep
- > 25% of depth of QRS complex

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years. **High global risk by itself generally lacks scientific support as an indication for stress imaging.** There are rare exemptions, such as patients requiring I-C antiarrhythmic drugs who might require coronary risk stratification prior to initiation of the drug.

- **CAD Risk—Low**
  10-year absolute coronary or cardiovascular risk less than 10%
- **CAD Risk—Moderate**
  10-year absolute coronary or cardiovascular risk between 10% and 20%
- **CAD Risk—High**
  10-year absolute coronary or cardiovascular risk of greater than 20%

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Websites for Global Cardiovascular Risk Calculators*

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.[34-37]

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

Definitions of Coronary Artery Disease[2, 6, 31]

Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).

- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[38]
    - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum lumen cross-sectional area on IVUS ≤ 6 square mm[6, 39]
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[39]
    - Demonstrable ischemic findings on stress testing (ECG or stress imaging), that are at least mild in degree

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- A major vessel would be a coronary vessel that would be amenable to revascularization if indicated. This assessment is made based on the diameter of the vessel and/or the extent of myocardial territory served by the vessel.
- FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow.
- Newer technology that estimates FFR from CCTA image is covered under the separate NIA Guideline for FFR-CT.

Anginal Equivalent[6, 32]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia), by presentation of clinical data, such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Most syncope per se is not an anginal equivalent.

Abbreviations

ADLs	Activities of daily living
BMI	Body mass index
CABG	Coronary artery bypass grafting
CAC	Coronary artery calcium
CAD	Coronary artery disease
CCTA	Coronary computed tomography angiography
CMR	Cardiac magnetic resonance imaging
CT(A)	Computed tomography (angiography)
DTS	Duke Treadmill Score
ECG	Electrocardiogram
FFR	Fractional flow reserve
IVUS	Intravascular ultrasound
LBBB	Left bundle-branch block
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
MESA	Multi-Ethnic Study of Atherosclerosis
MET	Estimated metabolic equivalent of exercise
MI	Myocardial infarction
MPI	Myocardial perfusion imaging
MR(I)	Magnetic resonance (imaging)
PCI	Percutaneous coronary intervention
PET	Positron emission tomography

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PFT	Pulmonary function test
PVCs	Premature ventricular contractions
SE	Stress echocardiography
TEE	Transesophageal echocardiography
THR	Target heart rate
TTE	Transthoracic echocardiography
VF	Ventricular fibrillation
VT	Ventricular tachycardia
WPW	Wolff-Parkinson-White

Policy History

Date	Summary
February 2022	• Moved the sentence regarding utilization of suitable alternatives to the General Information section • Clarified evaluation of possible ischemia in newly diagnosed heart failure by stating *"with reasonable suspicion of cardiac ischemia (prior events, risk factors, or symptoms and signs)"* • Clarified "intermediate lesions are 50-69%" for ischemia-producing disease • Placed Link to Overview Section in General Information • Added stress imaging approval for calcium score > 100 with low to intermediate probability symptoms • Deleted the requirement for diabetes when calcium score > 400 for stress imaging • Added Calcium score section: o Added stress imaging approval for calcium score > 100 with symptoms consistent with low to intermediate pretest probability • Added reminder *(SE diversion not required for CABG)* • Changed preoperative guideline to include intermediate risk surgery with one or more risk factors AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year • Changed solid organ transplant guideline to include stem cell transplant and "any" organ transplant • Added definition of surgical risk to preop guidelines • In Background section clarified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain." • Added definition of Q waves • Deleted sentence regarding calcium scoring within the Global Risk Section

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	• Deleted sentence regarding using calcium score solely for risk stratification • Deleted redundant statement on viability • Deleted IFR references
March 2021	• Added annual indication for IC antiarrhythmics • Added History of diabetes mellitus, > 40 years old, with calcium score >400
March 2020	• The following statement was added to reflect an additional CPT code: Cardiac PET scanning, when used in conjunction with CT attenuation, includes evaluation of perfusion, function, viability, inflammation, anatomy, and risk stratification for cardiac-related events such as myocardial infarction and death. Maximum diagnostic accuracy of cardiac PET/CT is achieved when images are interpreted in conjunction with other relevant imaging, clinical information, and laboratory data. • Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added clarification of repeat testing in a patient with new or worsening symptoms and negative result at least one year prior to include the statement "AND meets one of the criteria above" • Added clarification of frequent PVCs under ventricular arrhythmias which states defined as greater than or equal to 30/hour to include "on remote monitoring" • Edited indication of planning for solid organ transplantation to remove the requirement of limited functional capacity but maintaining requirement of ≥ 3 listed risk factors • Edits to the Background section include the following: o Indication changed to read as follows: PET is indicated when all the criteria for MPI are met AND There is likely to be equivocal imaging results because of BMI or large breasts or implants or prior thoracic surgery or results of a prior MPI • Removed the statement regarding radiation burden • Added edits to the Coronary Artery disease definition section • Updated and added new references

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Reviewed / Approved by NIA Clinical Guideline Committee

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National Imaging Associates, Inc.*	
Clinical guidelines **MYOCARDIAL PERFUSION IMAGING** **(aka NUCLEAR CARDIAC IMAGING STUDY)**	**Original Date: October 2009**
CPT Codes: 78451, 78452, 78453, 78454, 78466, 78468, 78469, 78481, 78483, 78499, +0742T	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_024	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results, and the reason that alternative imaging cannot be performed, must be included in the documentation submitted.

This guideline is for stress imaging, specifically myocardial perfusion imaging (MPI), with appropriate preference for suitable alternatives, such as stress echocardiography (SE), when more suitable, unless otherwise stated (refer to Overview section).

INDICATIONS for MPI[1-4]

SUSPECTED CORONARY ARTERY DISEASE (CAD)

- **Symptomatic patients without known CAD (use Diamond Forrester Table)**
  - Low or intermediate pretest probability and unable to exercise *(SE diversion not required)*
  - High pretest probability *(SE diversion not required)*
  - Repeat testing in a patient with new or worsening symptoms and negative result at least one year prior AND meets one of the criteria above
- **Asymptomatic patients without known CAD** *(SE diversion not required)*
  - Previously unevaluated ECG evidence of possible myocardial ischemia including ischemic ST segment or T wave abnormalities (See Overview section)
  - Previously unevaluated pathologic Q waves (see Overview section)
  - Previously unevaluated complete left bundle branch block

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ABNORMAL CALCIUM SCORES (CAC)[4-8]

- ASYMPTOMATIC patient with a calcium score >400, not previously evaluated
- SYMPTOMATIC patient with prior CAC ≥ 100

INCONCLUSIVE CAD EVALUATION WITHIN THE PAST 2 YEARS AND OBSTRUCTIVE CAD REMAINS A CONCERN

- Exercise stress ECG with low-risk Duke treadmill score (≥5), (see section in Overview) but patient's current symptoms indicate an intermediate or high pretest probability *(SE diversion not required* for high pretest probability)
- Exercise stress ECG with an intermediate Duke treadmill score
- Intermediate coronary computed tomography angiography (CCTA) (e.g., 40 - 70% lesions)
- Non-diagnostic exercise stress test with inability to achieve target heart rate (THR) *(SE diversion not required)*
- An indeterminate (equivocal, borderline, or discordant) evaluation by prior stress imaging (SE or CMR) within the past 2 years *(SE diversion not required)*

FOLLOW-UP OF PATIENT'S POST CORONARY REVASCULARIZATION (PCI or CABG)[4]

- **Asymptomatic follow-up stress imaging** at a minimum of 2 years post coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI) (whichever is later) is appropriate for patients with a history of silent ischemia or a history of a prior left main stent.[4] *(SE diversion not required for CABG)*
  OR
  For patients with high occupational risk, associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers and firefighters *(SE diversion not required)*
- **New, recurrent, or worsening symptoms post coronary revascularization** is an indication for stress imaging), if it will alter management

FOLLOW-UP OF KNOWN CAD

- **Follow-up of asymptomatic or stable symptoms** when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR ≤ 0.80 or stenosis ≥ 70% of a major vessel), over two years ago, without intervening coronary revascularization is an appropriate indication for stress imaging in patients if it will alter management

SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION

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- Prior acute coronary syndrome (with documentation in MD notes), without invasive or non-invasive coronary evaluation *(SE diversion not required)*
- Newly diagnosed systolic heart failure or diastolic heart failure, *with reasonable suspicion of cardiac ischemia (prior events, risk factors*), unless invasive coronary angiography is immediately planned *(SE diversion not required)*[1, 9-11]
- LVEF requiring myocardial viability assessment to assist with decisions regarding coronary revascularization[9, 10]
- Ventricular arrhythmias
    - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise-induced VT, when invasive coronary arteriography is not immediately planned[12] *(SE diversion not required)*
    - Nonsustained VT, multiple episodes, each ≥ 3 beats at ≥ 100 bpm, or frequent PVCs (defined as greater than or equal to 30/hour on remote monitoring) without known cause or associated cardiac pathology, when an exercise ECG cannot be performed[13]
- Prior to initiation of Class IC antiarrhythmic drug initiation (Propafenone or Flecainide), as well as annually in intermediate and high global risk patients *(SE diversion not required)* [14]
- Assessment of hemodynamic significance of one of the following documented conditions:
    - Anomalous coronary arteries[15]
    - Myocardial bridging of coronary artery
- Coronary aneurysms in Kawasaki's disease[16] or due to atherosclerosis
- Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter[17]

PRIOR TO ELECTIVE NON-CARDIAC SURGERY IN ASYMPTOMATIC PATIENTS

- An intermediate or high risk surgery with of one or more risk factors (see below), AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year[18-20]
    - **Risk factors:** history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dL.
    - **Surgical Risk:**
        - **High risk surgery:** Aortic and other major vascular surgery, peripheral vascular surgery, anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss
        - **Intermediate risk surgery:** Carotid endarterectomy, head and neck surgery, intraperitoneal and intrathoracic surgery, orthopedic surgery, prostate surgery
        - **Low risk surgery**: Endoscopic procedures, superficial procedure, cataract surgery, breast surgery
- Planning for any organ or stem cell transplantation is an indication for preoperative MPI, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, at the discretion of the transplant service. [3, 21]

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POST CARDIAC TRANSPLANT *(SE diversion not required)*

- Annually, for the first five years post cardiac transplantation, in a patient not undergoing invasive coronary arteriography
- After the first five years post cardiac transplantation, patients with documented transplant coronary vasculopathy can be screened annually unless invasive coronary arteriography is planned

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BACKGROUND

This guideline is for stress imaging, specifically myocardial perfusion imaging (MPI), with appropriate preference for alternatives, such as stress echocardiography (SE) or stress ECG alone when more suitable (see section below).

Radionuclide myocardial perfusion imaging (MPI) allows for evaluation of cardiac perfusion at rest and at exercise, as well as using pharmacologic agents for the diagnosis and management of coronary artery disease. With radionuclide MPI, pharmacologic stress may be performed with an inotropic agent or vasodilator. These agents are indicated for patients who cannot reach an adequate endpoint with physical exercise stress testing.[22]

Stable patients without known CAD fall into 2 categories[1, 3, 4]:

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see Websites for Global Cardiovascular Risk Calculators section).
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant CAD (below):

The 3 Types of Chest Pain or Discomfort

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, The Pretest Probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability[1, 4]:

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Diamond Forrester Table

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40–49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50–59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very low:** < 5%pretest probability of CAD, usually not requiring stress evaluation
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

OVERVIEW

MPI may be performed without diversion to a SE in any of the following[4, 23]:

- Inability to Exercise
    - Physical limitations precluding ability to exercise for at least 3 full minutes of Bruce protocol
    - Limited functional capacity (< 4 METS) **such as one** of the following:
        - Unable to take care of their ADLs or ambulate
        - Unable to walk 2 blocks on level ground
        - Unable to climb 1 flight of stairs
- Other Comorbidities
    - Severe chronic obstructive pulmonary disease (COPD) with pulmonary function test (PFT) documentation, severe shortness of breath on minimal exertion, or requirement of home oxygen during the day
    - Poorly controlled hypertension, with systolic BP > 180 or diastolic BP > 120 (and clinical urgency not to delay MPI)
- ECG and Echo-Related Baseline Findings
    - Prior cardiac surgery (coronary artery bypass graft or valvular)
    - Documented poor acoustic imaging window
    - Left ventricular ejection fraction ≤ 40%
    - Pacemaker or ICD
    - Persistent atrial fibrillation
    - Resting wall motion abnormalities that would make SE interpretation difficult

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    - Complete left bundle branch block (LBBB)
- Risk-Related scenarios
    - High pretest probability in suspected CAD
    - Intermediate or high global risk in patients requiring type IC antiarrhythmic drugs (prior to initiation of therapy and annually)
    - Arrhythmia risk with exercise
- Previously unevaluated pathologic Q waves (in two contiguous leads) defined as the following:
    - > 40 ms (1 mm) wide
    - > 2 mm deep
    - > 25% of depth of QRS complex

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) require that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate **AND** has an interpretable ECG for ischemia during exercise[4]:

- The (symptomatic) low or intermediate pretest probability patient who can exercise and has an interpretable ECG[4]
- The patient who is under evaluation for exercise-induced arrhythmia
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription
- For the evaluation of syncope or presyncope during exertion[24]

Duke Exercise ECG Treadmill Score[25]

Calculates risk from ECG treadmill alone**:**

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤ - 11) categories

An uninterpretable baseline ECG includes[1]:

- ST segment depression 1 mm or more; (not for non-specific ST- T wave changes)
- Ischemic looking T waves; at least 2.5 mm inversions (excluding V1 and V2)
- LVH with repolarization abnormalities, pre-excitation pattern such as WPW, ventricular paced rhythm, or LBBB
- Digitalis use with associated ST segment abnormalities
- Resting HR under 50 bpm on a medication, such as beta-blockers or calcium channel blockers, that is required for patient's treatment and cannot be stopped, with an anticipated suboptimal workload

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Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years. **High global risk by itself generally lacks scientific support as an indication for stress imaging.** There are rare exceptions, such as patients requiring IC antiarrhythmic drugs who might require coronary risk stratification prior to initiation of the drug.

- **CAD Risk—Low**
  10-year absolute coronary or cardiovascular risk less than 10%.
- **CAD Risk—Moderate**
  10-year absolute coronary or cardiovascular risk between 10% and 20%.
- **CAD Risk—High**
  10-year absolute coronary or cardiovascular risk of greater than 20%.

Websites for Global Cardiovascular Risk Calculators*[26-30]

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

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Definitions of Coronary Artery Disease[1, 3, 6, 31]

Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).

- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[32]
    - For a left main artery, suggested by a percentage stenosis ≥ 50%[1, 31, 33]
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[31, 33]
    - Demonstrable ischemic findings on stress testing (ECG or stress imaging), that are at least mild in degree
- FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion. Less than or equal to 0.80 is considered a significant reduction in coronary flow.

Anginal Equivalent[1, 24]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia). This may include respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope per se is not an anginal equivalent.

Abbreviations

ADLs	Activities of daily living
BSA	Body surface area in square meters
CABG	Coronary artery bypass grafting
CAD	Coronary artery disease
CMR	Cardiac magnetic resonance imaging
CTA	Computed tomography angiography
ECG	Electrocardiogram
FFR	Fractional flow reserve
IVUS	Intravascular ultrasound
LBBB	Left bundle-branch block
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy

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MI	Myocardial infarction
MET	Estimated metabolic equivalent of exercise
MPI	Myocardial perfusion imaging
PCI	Percutaneous coronary intervention
PFT	Pulmonary function test
PVCs	Premature ventricular contractions
SE	Stress echocardiography
THR	Target heart rate
VT	Ventricular tachycardia
VF	Ventricular fibrillation
WPW	Wolf Parkinson White

POLICY HISTORY

Date	Summary
February 2022	• Moved the sentence regarding utilization of suitable alternatives such as Stress Echocardiography to the General Information section • Placed Link to Overview Section in General Information • Clarified evaluation of possible ischemia in newly diagnosed heart failure by stating "with reasonable suspicion of cardiac ischemia (prior events, risk factors, or symptoms and signs)" • Clarified "intermediate lesions are 50-69%" for ischemia-producing disease • Added stress imaging approval for calcium score > 100 with low to intermediate probability symptoms • Deleted the requirement for diabetes when calcium score > 400 for stress imaging • Deleted "≤50%" from "LVEF ≤50% requiring myocardial viability assessment to assist with decisions regarding coronary revascularization" • Added Calcium score section: o Added stress imaging approval for calcium score > 100 with symptoms consistent with low to intermediate pretest probability • Added reminder *(SE diversion not required for CABG)* • Changed preoperative guideline to include intermediate risk surgery with one or more risk factors AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year • Changed solid organ transplant guideline to include stem cell transplant and "any" organ transplant • Added definition of surgical risk to preop guidelines

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	• In Background section clarified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain." • Added definition of Q waves • Deleted sentence regarding calcium scoring within the Global Risk Section • Deleted sentence regarding using calcium score solely for risk stratification • Deleted IFR references
March 2021	• Wording changes for low and intermediate pretest probability patients • Added annual studies for patients on Flecainide • Added indication for Ca score in diabetic > 40 and calcium score > 400 with reference added • Removed BMI > 40 as indication for MPI
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added clarification of repeat testing in a patient with new or worsening symptoms and negative result at least one year prior to include the statement "AND meets one of the criteria above" • Added clarification of frequent PVCs under ventricular arrhythmias which states defined as greater than or equal to 30/hour to include "on remote monitoring" • Edited indication of planning for solid organ transplantation to remove the requirement of limited functional capacity but maintaining requirement of ≥ 3 listed risk factors • Removed explanation of three vasodilators approved for stress testing from the background • Added edits to the Coronary Artery disease coronary artery disease definition section • Updated and added new references •
July 2019	• For special diagnostic consideration, prior acute coronary syndrome (as documented in MD notes), the following clause was added: 'without subsequent invasive or non-invasive coronary evaluation (SE diversion not required)' • For section on prior to elective non-cardiac surgery the following was added: 'There has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year' • For section on prior to elective non-cardiac surgery indication 'Planning for solid organ transplantation is an indication for preoperative MPI, if

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	there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year' • Added indication for follow-up every 2 years for patients with known CAD in high-risk occupations • Added prior left main stent in asymptomatic patients as follow-up every two years • Clarification of diversion to stress echo in suitable patients' post-revascularization • Clarification of post cardiac transplant • Removed section on Global Risk Calculator • Added "with EKGECG changes," as indication for stress echo in patients on digoxin or with LVH • Removed indication for ETT in asymptomatic patients • Added presyncope and syncope with exercise as an indication for ETT •

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Reviewed / Approved by NIA Clinical Guideline Committee

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National Imaging Associates, Inc.*	
Clinical guidelines **HEART (Cardiac) PET**	**Original Date: July 1999**
CPT Codes: 78459, 78491, 78492, +78434	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_072	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

This guideline is for stress imaging, specifically Heart (Cardiac) PET imaging, with appropriate preference for suitable alternatives, such as stress echocardiography (SE) or myocardial perfusion imaging (MPI), when more suitable, unless otherwise stated (refer to Background section).

INDICATIONS FOR HEART PET

SUSPECTED CAD (When neither SE nor MPI have provided or are expected to provide optimal imaging)

- **Symptomatic patients without known CAD (use Diamond Forrester Table)**
  - Low or intermediate pretest probability and unable to exercise *(SE diversion not required)*
  - High pretest probability *(SE diversion not required)*
  - Repeat testing in a patient with new or worsening symptoms and negative result at least one year ago **AND** meets one of the criteria above
- **Asymptomatic patients without known CAD** *(SE diversion not required)*
  - Previously unevaluated ECG evidence of possible myocardial ischemia including substantial ischemic ST segment or T wave abnormalities (see section in Background)
  - Previously unevaluated pathologic Q waves (see section in Background)
  - Unevaluated complete left bundle branch block

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ABNORMAL CALCIUM SCORES (CAC)[1-5] (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- ASYMPTOMATIC patient with a calcium score >400, not previously evaluated
- SYMPTOMATIC patient with prior CAC ≥ 100

INCONCLUSIVE CAD EVALUATION WITHIN THE PAST 2 YEARS AND OBSTRUCTIVE CAD REMAINS A CONCERN (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- Exercise stress ECG with low-risk Duke treadmill score (≥5) (see section in Background) but patient's current symptoms indicate an intermediate or high pretest probability *(SE diversion not required* for high pretest probability)
- Exercise stress ECG with an intermediate Duke treadmill score
- Inconclusive/borderline coronary computed tomography angiography (CCTA) (e.g., 40 - 70% lesions)
- Non-diagnostic exercise stress test with physical inability to achieve target heart rate (THR) *(SE diversion not required)*
- An intermediate evaluation by prior stress imaging (within the past 2 years) *(SE diversion not required)*

FOLLOW-UP OF PATIENT'S POST CORONARY REVASCULARIZATION (PCI or CABG) (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- **Asymptomatic, follow-up stress imaging** at a minimum of 2 years post coronary artery bypass grafting (CABG), or percutaneous coronary intervention (PCI), (whichever is later), is appropriate only for patients with a history of silent ischemia or a history of a prior left main stent
  OR
- For patients with high occupational risk (e.g., associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers, and firefighters)
- **New, recurrent, or worsening symptoms post coronary revascularization** are an indication for stress imaging, if it will alter management

FOLLOW-UP OF KNOWN CAD (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- **Follow-up of asymptomatic or stable symptoms** when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR ≤ 0.80 or stenosis greater than or equal to 70% of a major vessel), over two years ago, without intervening coronary revascularization is an appropriate indication for stress imaging in patients if it will alter management

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SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION (When neither SE nor MPI have provided, or are expected to provide, optimal imaging)

- Prior acute coronary syndrome (as documented in MD notes), without subsequent invasive or non-invasive coronary evaluation
- Newly diagnosed systolic heart failure or diastolic heart failure, *with reasonable suspicion of cardiac ischemia (prior events, risk factors*), unless invasive coronary angiography is immediately planned[6-8]
- Reduced LVEF ≤ 50% requiring myocardial viability assessment to assist with decisions regarding coronary revascularization. (Diversion from PET not required when LVEF less than or equal to 40%)[6, 7, 9]
- Ventricular arrhythmias
    - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise-induced VT, when invasive coronary arteriography is not the immediately planned test[10]
    - Nonsustained VT, multiple episodes, each ≥ 3 beats at ≥ 100 bpm, frequent PVC's (defined as greater than or equal to 30/hour on remote monitoring) without known cause or associated cardiac pathology, when an exercise ECG cannot be performed
- Prior to Class IC antiarrhythmic drug initiation (Propafenone or Flecanide), as well as annually in intermediate and high global risk patients (SE diversion not required)[11]
- Assessment of hemodynamic significance of one of the following documented conditions[12]:
    - Anomalous coronary arteries[13]
    - Muscle bridging of coronary artery [3, 14]
- Coronary aneurysms in Kawasaki's disease[15] or due to atherosclerosis
- Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter[16]

- **Cardiac Sarcoidosis[17-19]**
    - Evaluation and therapy monitoring in patients with sarcoidosis, after documentation of suspected cardiac involvement by echo or ECG, when CMR has not been performed
    - Evaluation of suspected cardiac sarcoid, after CMR has shown equivocal or negative findings in the setting of a high clinical suspicion[19]
    - Evaluation of CMR findings showing highly probable cardiac sarcoidosis, when PET could serve to identify inflammation and the consequent potential role for immunosuppressive therapy[19]
    - Initial and follow-up PET in monitoring therapy for cardiac sarcoid with immunosuppressive therapy, typically about 4 times over 2 years

- **Infective Endocarditis**

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- In suspected infective endocarditis with moderate to high probability (i.e., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device), when TTE and TEE have been inconclusive with respect to diagnosis of infective endocarditis or characterization of paravalvular invasive complications[20, 21]

- **Aortitis**
  - For diagnosis and surveillance of Aortitis, PET/CT or PET/MRI‡ hybrid imaging[22]
    ‡**NOTE:** If PET/MR study is requested, there is no specific CPT Code for this imaging study and a Health Plan review will be required.

PRIOR TO ELECTIVE NON-CARDIAC SURGERY (When neither SE nor MPI have provided or are expected to provide optimal imaging)

- An intermediate or high risk surgery with of one or more risk factors (see below), AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year[23-25]
  - **Risk factors:** history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dL.
  - **Surgical Risk:**
    - **High risk surgery:** Aortic and other major vascular surgery, peripheral vascular surgery, anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss
    - **Intermediate risk surgery:** Carotid endarterectomy, head and neck surgery, intraperitoneal and intrathoracic surgery, orthopedic surgery, prostate surgery
    - **Low risk surgery**: Endoscopic procedures, superficial procedure, cataract surgery, breast surgery

- Planning for any organ or stem cell transplantation is an indication for preoperative stress imaging, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, at the discretion of the transplant service[26]

POST CARDIAC TRANSPLANT (SE diversion not required)[27]
- Annually, for the first five years post cardiac transplantation, in a patient not undergoing invasive coronary arteriography
- After the first five years post cardiac transplantation, patients with documented transplant coronary vasculopathy can be screened annually if invasive coronary arteriography is not planned

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BACKGROUND[28, 29]

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PET Scan

- Indicated when all the criteria for MPI are met **AND** there is likely to be equivocal imaging results because of BMI or large breasts or implants or prior thoracic surgery or results of a prior MPI
- Can identify regions of myocardial viability with hibernating myocardium (viable, with poor flow and contractility) by imaging with fluorine18 (F-18) fluorodeoxyglucose (FDG or 18-FDG) for this purpose.
- Useful in the evaluation of inflammation: e.g., evaluation and therapy monitoring in patients with sarcoidosis, after documentation of cardiac involvement by echo or electrocardiography (ECG), in place of, or subsequent to CMR if needed to help with an uncertain diagnosis

Coronary application of PET includes evaluation of **stable patients without known CAD**, who fall into two categories[3, 8, 30]

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see Websites for Global Cardiovascular Risk Calculators section).
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant (≧ 50%) CAD (below):

The 3 Types of Chest Pain or Discomfort

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
    - Substernal chest pain or discomfort with characteristic quality and duration
    - Provoked by exertion or emotional stress
    - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, The Pretest Probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability[3, 8]:

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Diamond Forrester Table

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very Low:** < 5% pretest probability, usually not requiring stress evaluation
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

OVERVIEW

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) require that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate AND has an interpretable ECG for ischemia during exercise[3]:

- The (symptomatic) low or intermediate pretest probability patient who is able to exercise and has an interpretable ECG[3]
- The patient who is under evaluation for exercise-induced arrhythmia
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription
- For the evaluation of syncope or presyncope during exertion[31]

Duke Exercise ECG Treadmill Score[32]

Calculates risk from ECG treadmill alone**:**

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting.
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤ - 11) categories.

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An uninterpretable baseline ECG includes[8]:

- ST segment depression 1 mm or more (not for non-specific ST- T wave changes)
- Ischemic looking T waves; at least 2.5 mm inversions (excluding V1 and V2)
- LVH with repolarization abnormalities, pre-excitation pattern such as WPW, ventricular paced rhythm, or left bundle branch block
- Digitalis use with associated ST segment abnormalities

Previously unevaluated pathologic Q waves (in two contiguous leads) defined as the following:

- > 40 ms (1 mm) wide
- > 2 mm deep
- > 25% of depth of QRS complex

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years. **High global risk by itself generally lacks scientific support as an indication for stress imaging.** There are rare exceptions, such as patients requiring IC antiarrhythmic drugs who might require coronary risk stratification prior to initiation of the drug.

- **CAD Risk—Low**
  10-year absolute coronary or cardiovascular risk less than 10%
- **CAD Risk—Moderate**
  10-year absolute coronary or cardiovascular risk between 10% and 20%
- **CAD Risk—High**
  10-year absolute coronary or cardiovascular risk of greater than 20%

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Websites for Global Cardiovascular Risk Calculators*[33-37]

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

Definitions of Coronary Artery Disease[2, 8, 30]

Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).

- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[38]
    - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum lumen cross-sectional area on IVUS ≤ 6 square mm[8, 39]
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[39]

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    - Demonstrable ischemic findings on stress testing (ECG or stress imaging), that are at least mild in degree
- A major vessel would be a coronary vessel that would be amenable to revascularization if indicated. This assessment is made based on the diameter of the vessel and/or the extent of myocardial territory served by the vessel.
- FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow.
- Newer technology that estimates FFR from CCTA image is covered under the separate NIA Guideline for FFR-CT.

Anginal Equivalent[8, 31]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia), by presentation of clinical data, such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Most syncope per se is not an anginal equivalent.

Abbreviations

ADLs	Activities of daily living
BMI	Body mass index
CABG	Coronary artery bypass grafting
CAC	Coronary artery calcium
CAD	Coronary artery disease
CCTA	Coronary computed tomography angiography
CMR	Cardiac magnetic resonance imaging
CT(A)	Computed tomography (angiography)
DTS	Duke Treadmill Score
ECG	Electrocardiogram
FFR	Fractional flow reserve
IVUS	Intravascular ultrasound
LBBB	Left bundle-branch block
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
MESA	Multi-Ethnic Study of Atherosclerosis
MET	Estimated metabolic equivalent of exercise
MI	Myocardial infarction
MPI	Myocardial perfusion imaging

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MR(I)	Magnetic resonance (imaging)
PCI	Percutaneous coronary intervention
PET	Positron emission tomography
PFT	Pulmonary function test
PVCs	Premature ventricular contractions
SE	Stress echocardiography
TEE	Transesophageal echocardiography
THR	Target heart rate
TTE	Transthoracic echocardiography
VF	Ventricular fibrillation
VT	Ventricular tachycardia
WPW	Wolff-Parkinson-White

Policy History

Date	Summary
February 2022	• Moved the sentence regarding utilization of suitable alternatives such as Stress Echocardiography to the General Information section • Clarified "intermediate lesions are 50-69%" for ischemia-producing disease • Clarified evaluation of possible ischemia in newly diagnosed heart failure by stating *"with reasonable suspicion of cardiac ischemia (prior events, risk factors, or symptoms and signs)"* • Placed Link to Overview Section in General Information • Added stress imaging approval for calcium score > 100 with low to intermediate probability symptoms • Deleted the requirement for diabetes when calcium score > 400 for stress imaging • Added Calcium score section: o Added stress imaging approval for calcium score > 100 with symptoms consistent with low to intermediate pretest probability • Added reminder *(SE diversion not required for CABG)* • Changed preoperative guideline to include intermediate risk surgery with one or more risk factors AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year • Changed solid organ transplant guideline to include stem cell transplant and "any" organ transplant • Added definition of surgical risk to preop guidelines • In Background section clarified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain. "

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	• Added definition of Q waves • Deleted sentence regarding calcium scoring within the Global Risk Section • Deleted sentence regarding using calcium score solely for risk stratification • Deleted redundant statement on viability • Deleted IFR references
March 2021	• Added annual indication for IC antiarrhythmics • Added History of diabetes mellitus, > 40 years old, with calcium score >400
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added clarification of repeat testing in a patient with new or worsening symptoms and negative result at least one year prior to include the statement "AND meets one of the criteria above" • Added clarification of frequent PVCs under ventricular arrhythmias which states defined as greater than or equal to 30/hour to include "on remote monitoring" • Edited indication of planning for solid organ transplantation to remove the requirement of limited functional capacity but maintaining requirement of ≥ 3 listed risk factors • Edits to the Background section include the following: o Indication changed to read as follows: PET is indicated when all the criteria for MPI are met AND There is likely to be equivocal imaging results because of BMI or large breasts or implants or prior thoracic surgery or results of a prior MPI • Removed the statement regarding radiation burden • Added edits to the Coronary Artery disease definition section • Updated and added new references
November 2019	• Removed CPT code +0482T and replaced with code +78434
August 2019	• Changes in CAD indications in line with MPI/SE • Added infective endocarditis and aortitis indications • Removed cardiac neoplasms and masses indication section • Added myocardial viability indications • Expanded indications for cardiac sarcoidosis as the initial and follow-up study

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National Imaging Associates, Inc.*	
Clinical guidelines **MUGA (Multiple Gated Acquisition) Scan**	**Original Date: September 1997**
CPT Codes: 78472, 78473, 78494, +78496	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_027	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results, and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

Indications for Multiple Gated Acquisition (MUGA) Scan[1]

- To evaluate left ventricular function in a patient with coronary artery disease, valvular heart disease, myocardial disease, or congenital heart disease, in any of the following scenarios:
    - When ventricular function is required for management, and transthoracic echocardiography (TTE) or other imaging has proven inadequate[2, 3]
    - When there are conflicting results between other testing (i.e., Myocardial Perfusion Imaging and TTE) in the measurement of ejection fraction (EF), and the results of the MUGA will help in the management of the patient
    - Prior TTE has demonstrated systolic dysfunction (EF < 50%) and management will change based on the results of the MUGA scan

- In the course of cardiotoxic chemotherapy when TTE images are inadequate to evaluate left ventricular systolic function[2-5]:
    - Previous low LV ejection fraction was < 50% and receiving potentially cardiotoxic chemotherapy
    - Prior to cardiotoxic chemotherapy, and subsequently for monitoring and follow up. The frequency of testing should be left to the discretion of the ordering physician, but generally no more often than at baseline and every 6 weeks thereafter

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BACKGROUND[2, 6-8]

1— MUGA

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Multiple-gated acquisition (MUGA) scanning uses radiolabeled red blood cells to scan right and left ventricular images in a cine loop format that is synchronized with the electrocardiogram.

A prior MUGA scan is not an indication for repeat MUGA (if another modality would be suitable, i.e., TTE).

Abbreviations

EF	Ejection Fraction
MUGA	Multiple Gated Acquisition (nuclear scan of ventricular function)
TTE	Transthoracic echocardiography

POLICY HISTORY

Date	Summary
February 2022	• No significant changes
March 2021	• Added the following statement: Previous low LV ejection fraction was < 50% and receiving potentially cardiotoxic chemotherapy
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added statement to Background that a prior MUGA scan is not an indication for repeat MUGA (if another modality would be suitable. i.e. TTE) • Removed statements from Background that CMR is recommended when TTE is inadequate and/or candidacy for cardiotoxic chemotherapy based upon LVEF is questionable and that MUGA can also be considered when CMR is not available.
July 23, 2019	• Removed chart on individual dosing for specific chemotherapeutic agents • Added indication for when there are conflicting results between other testing (i.e. MPI and TTE) in the measurement of ejection fraction, and the results of the MUGA will help in the management of the patient • Removed section on Radionuclide Angiography, Combination of Other Studies with MUGA, section on TTE and strain • Removed CAD indication • Added indication for cardiotoxicity as follows: o In the course of cardiotoxic chemotherapy when TTE images are inadequate to evaluate left ventricular

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	systolic function (Patel 2013, Plana 2014, Yancy 2013, Zamorano 2016): o Prior to cardiotoxic chemotherapy, and subsequently for monitoring and follow up. The frequency of testing should be left to the discretion of the ordering physician, but generally no more often than at baseline and every 6 weeks thereafter o In patients with EF < 50% on TTE receiving potentially cardiotoxic chemotherapy, more frequent monitoring (every 4 weeks) may be appropriate o Removed section on Radionuclide Angiography, Combination of Other Studies with MUGA, section on TTE and strain

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National Imaging Associates, Inc.*	
Clinical guidelines **BRAIN PET SCAN**	**Original Date: July 1999**
CPT Codes: 78608, 78609	**Last Revised Date: May 2022**
Guideline Number: NIA_CG_071	**Implementation Date: January 2023**

INDICATIONS FOR BRAIN PET SCAN

Known brain tumor or cancer

- To differentiate radiation necrosis or post-treatment change from residual/recurrent tumor when brain MRI‡ [1] is inconclusive
- To differentiate low from high grade glioma when brain MRI‡ is inconclusive[2, 3]
- For evaluation of primary brain lymphoma when brain MRI‡ is inconclusive[4]
- For evaluation of meningiomas when brain MRI‡ is inconclusive[4, 5]
- To guide intervention/biopsy

To determine operability of refractory seizures[6-8]

Post-treatment/procedural evaluation

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed.

Mild Cognitive Impairment or Dementia[9]

- For the detection of early Alzheimer's disease†;
- For the differentiation between Alzheimer's disease, dementia with Lewy body disease (DLB) and frontotemporal lobar degeneration (FTD)†; or
- To assess for the presence of beta amyloid plaque in Alzheimer's disease when being considered for Aduhelm treatment†

†Note: **AFTER** an initial insufficient evaluation with a Brain MRI‡ and the following 2 criteria have been met[10, 11]:

- Objective cognitive impairment[12, 13] has been demonstrated by:
  - Either by Mini Mental Status Evaluation (MMSE) or Montreal Cognitive Assessment (MoCA) less than 26[14]
  - **OR** by Neuropsychological testing showing at least mild cognitive impairment[15, 16]
- Potential treatable causes have been assessed and addressed,[12] such as:

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- Metabolic causes, such as thyroid or vitamin deficiency, anemia, or toxic metabolic encephalopathy
- Medication side effects[17]
- Medical causes, such as vascular or traumatic or inflammatory

‡**Note:** Brain CT is acceptable if brain MRI is contraindicated. However, Brain CT cannot be substituted for MRI when Brain PET is requested for evaluation of amyloid plaque because MRI is a prerequisite to Aduhelm treatment.

BACKGROUND

Positron Emission Tomography (PET) scanning can be used to assesses brain metabolism and perfusion. Uses include identifying epileptic foci prior to surgery, differentiation of residual tumor versus scar, helping differentiate inconclusive findings on Brain MRI and identifying causes of cognitive decline.[18]

POLICY HISTORY

Date	Summary
May 2022	• Updated references and backgroud • Removed FDG from Indications title • Added meningioma when MR is inconclusive
July 2021	• Added information on detection of amyloid for use with Aduhelm
May 2020	• Added CNS lymphoma and glioma after inconclusive imaging • For the detection of early Alzheimer's disease or the differentiation between Alzheimer's disease, Dementia with Lewy body disease (DLB) versus Frontotemporal lobar degeneration (FTD) after appropriate clinical work up and initial insufficient evaluation with a brain MRI • Changed post-surgery to post treatment • Removed longitudinal assessment of memory decline • Added references
June 2019	• Changed indications title to specify: 'using FDG (fluourodeoxyglucose)' • For indication: Mild Cognitive Impairment or Dementia, added '*Brain MRI to rule out structural causes or Brain CT if MRI is contraindicated*' • Added information to background section

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National Imaging Associates, Inc.*	
Clinical guidelines: **Single Photon Emission Computed Tomography (SPECT), including** • **Bone/Joint** • **Non-Bone Infection/Inflammation** • **Tumor** • **Cardiac** • **Neck** • **Lung** • **Brain** • **Radionuclide Cisternography (CSF)** • **Renal** • **Abdomen/Pelvis**	**Original Date: July 2008**
CPT Codes: 78803,78830, 78831, 78832, 78835	**Last Revised Date: April 2022**
Guideline Numbers: NIA_CG_078	**Implementation Date: January 2023**

This guideline refers to SPECT / SPECT CT imaging for the following (select 'ctrl' then 'left click' to jump to section):

- **Bone/Joint**
- **Non-Bone Infection/Inflammation**
- **Tumor**
- **Cardiac**
- **Neck**
- **Lung**
- **Brain**
- **Radionuclide Cisternography (CSF)**
- **Renal**
- **Abdomen/Pelvis**
- **Policy History**
- **References**

INDICATIONS FOR A BONE/JOINT SPECT/SPECT CT SCAN

When routine dynamic and planar imaging is, or is projected to be, insufficient for the following suspected conditions[1-6]:

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MALIGNANCY

Note: For known bone metastases, whole body planar bone scan for staging and restaging is typically sufficient

- Screening evaluation of patients with malignancy presenting with elevated alkaline phosphatase, bone pain, or new pathological fracture
- Staging or Restaging evaluation when recent overlapping whole body imaging (CT or PET/CT of the neck, chest, abdomen and pelvis) has not been performed, cannot be performed, or is inconclusive in evaluation of bone metastases
- Staging and restaging for radionuclide bone therapy for predominant bone metastases

INFECTION

- Osteomyelitis: a plain x-ray AND an MRI of the area have been performed, unless MRI is contraindicated, technically limited or inconclusive[5, 6]
- Discitis: MRI is contraindicated, technically limited or inconclusive

BONE VIABILITY

- Detection of early avascular necrosis, bone infarct, or bone graft viability when patient has had a plain x-ray; and MRI is contraindicated or inconclusive[7]

TRAUMA

- Extremities: Detection of stress fractures and other occult skeletal trauma when there is persistent pain in the suspected area after negative or inconclusive x-ray and MRI[8]
- Spine:
    - For indications such as spondylolysis or determination of age of fracture after CT/MRI is inconclusive[9]
    - Spondylolysis evaluation in a child, with persistent pain after MRI and conservative treatment, in determining further treatment plan[10, 11]

INCONCLUSIVE

- Inconclusive MRI/CT
- Identification of a primary etiology (via most reactive/ inflammatory changes) when multiple etiologies are identified by MRI/CT, AND intervention planning is needed (includes primary facet joint target localization)[9, 12-16]

POSTOPERATIVE

- Evaluation of persistent symptoms in postoperative spine/joints/bones, after X-ray and CT are negative/inconclusive[9, 17-22]

EXTREMITIES

- For evaluation of unexplained extremity pain when clinical criteria and other imaging (x-ray, AND MRI/ Ultrasound/ CT) evaluation is inconclusive (e.g., differentiating complex regional pain syndrome from other causes of pain)[23-26]

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FOLLOW-UP

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

NOTE: Inconclusive includes the scenario when imaging findings do not explain patient clinical symptoms or lack of treatment efficacy.

BACKGROUND

SPECT: Single-photon emission computed tomography (SPECT) is a nuclear medicine imaging technique used to localize data from gamma ray emitting injected radiopharmaceuticals to specific anatomical locations within the patient. The resulting 3D images can be reconstructed in multiple planes, much like a CT scan. The ability to manipulate the imaging data into distinct multiplanar slices improves the diagnostic capability and spatial resolution while using the same pharmaceutical as with traditional planar bone scan. Radiopharmaceuticals used vary based on the clinical indication. The technique is applied in brain, cardiac, pulmonary, abdominal, endocrine, and musculoskeletal imaging.

SPECTCT: SPECTCT (Single-photon emission computed tomography with Computed Tomography) is now available in many places. The CT portion helps to correct the attenuation (decrease) of photons from the target, as it gets absorbed/reflected through the soft tissues before it reaches the detector. It also helps with anatomic localization much like the CT of PETCT. The CT aspect of SPECTCT may or may not be of diagnostic quality depending on the vendor. However, SPECTCT is now more common among newer gamma imaging scanners. SPECTCT leads to increased specificity and accuracy.

BONE SPECT/SPECTCT: Due to advances in cross-sectional imaging, the technique currently has limited indications for detecting bone pathology. It is most commonly used in patients who have been found to have an unexpected single area abnormality on a planar (screening) bone scan. It is also used in those who cannot undergo MRI or CT imaging or to clarify the findings on MRI or CT. Although vast majority of bone scan indications have been replaced by MRI or CT over the decades, the recent advent of SPECT has shown comparable or complementary performance versus MRI for some indications as those listed above.[23, 24, 27, 28] For patients with impaired renal function who cannot receive iodinated or gadolinium-based contrast agents or undergo MRI for other reasons, SPECT/ SPECTCT imaging can improve the performance of conventional planar nuclear bone imaging.

TRACERS: Nuclear medicine bone imaging is commonly performed with Technetium-99m-MDP (methylene diphosphonate). For indications such as infection or inflammation, Indium-111/ Technetium-99m-HMPAO (hexamethylpropyleneamine oxime) labelled white blood cells, or Gallium-67 (for spine/sternum) can be used. Gallium is typically used for discitis evaluation, and

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imaging can be carried out to 2-3 days post tracer injection for better target-to-background ratio. Technetium-99m sulfur colloid scan is typically used concordantly for marrow mapping, to distinguish bone marrow from infection site.

Although 18F-labelled sodium fluoride (NaF) PET scanning is highly sensitive for detecting bone lesions, its routine use has not replaced conventional bone scanning due to the latter's "effectiveness, widespread availability, low cost and favorable dosimetry".[4] If a bone SPECT / SPECTCT is not sufficient, specific PET tracers that detect both soft tissue and bone metastases (e.g., F18- FDG, F18- Fluciclovine, Ga68-Dotatate) have replaced the need for a separate NaF PET.

CRPS: In the evaluation of complex regional pain syndrome (CRPS), formerly reflex sympathetic dystrophy, three phase bone scintigraphy (flow, blood pool, and delayed images) and MRI imaging sensitivities reported in the medical literature, ranges widely.[26] In general, scintigraphy is more specific than MRI. SPECT imaging, however, is not routinely used for this indication.

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INDICATIONS FOR NON-BONE INFECTION / INFLAMMATION SPECT/SPECT CT

When primary standard modality of CT / CTA / MRI / Ultrasound are inconclusive, limited, or cannot be done,[29] including:

- Fever of Unknown Origin when CT/MR are negative/inconclusive/limited
- Non-bone infection/inflammation when primary standard imaging is negative/ inconclusive, including infections related to
    - Transplant and vascular grafts when ultrasound / CTA are negative/inconclusive/limited[30, 31]
    - Prosthetic valves, when echocardiography AND Coronary CTA are inconclusive[32]
    - Cardiac implantable devices when echocardiography is inconclusive[32]

BACKGROUND

Infection-seeking tracers labelled with single-photon-emitting radionuclides include autologous leukocytes [white blood cells (WBC)] labelled with 99mTc-hexamethylpropyleneamine oxime (HMPAO) or 111In-diethylenetriaminepentaaceticacid (DTPA). Imaging is typically completed the same day (for Technetium-Tc labelled agents) or the 2nd day (for Indium-labelled agents). CT portion of SPECT CT localizes the infection agent accumulation to the anatomic site. The tracer activity is not affected by artifact from implants and devices. They are typically used when other modalities such as CT or MRI have not yielded conclusive results or have not explained clinical status.

For infections related to vascular grafts, nuclear medicine modalities are particularly useful to mapping the extent of the infection (focal uptake) for surgical planning. Primary imaging is first done with ultrasound for extracavitary graft and CTA for intracavitary graft.[30]

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INDICATIONS FOR TUMOR SPECT/SPECT CT

- Iodine imaging for subsequent post thyroidectomy staging of differentiated thyroid cancers, in the setting of[33]:
  - Post thyroidectomy neck CT/MR showing residual unresectable thyroid tissue/ disease in the neck
  - Distant metastases as seen on CT/MR
  - Post thyroidectomy unstimulated thyroglobulin > 5-10ng/ml
  - Radioactive iodine therapy is being considered for high risk or recurrent tumor
  - Post radioiodine treatment (post therapy scan)
  - During surveillance, with rising thyroglobulin or stable / rising antithyroglobulin antibodies or abnormal ultrasound neck

Note: Refer to neck SPECT/SPECTCT for thyroid nodules

- For initial or restaging of Neuroendocrine tumors (typically In111-octreotide and Iodine-123 MIBG), for any part of the body,[34]
  - When CT/MRI OR PET imaging is not available, cannot be done, has contraindications, or is inconclusive
  - I-131 MIBG: when I131 MIBG therapy is being considered
  - In111- octreotide: Somatostatin analog therapy is being considered and Ga68 Dotatate PET is not available

- Imaging during / post therapy with therapeutic agents such as 131 Iodine, 177Lu-Dotatate, 111In Zevalin, when it can change management

- Lymphoscintigraphy with sentinel node localizations, for preoperative planning in melanoma, breast, head and neck, and gynecological cancers

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BACKGROUND

Thyroid cancers are imaged by Iodine-123 or Iodine-131 tracers. Prior to treatment, sometimes a whole body I-123 imaging may be done if it is an aggressive cancer or if there is a suspicion of metastases. Whole body imaging with I-131 is acquired up to 10 days post therapeutic dosage with I-131 for thyroid cancers. Subsequent surveillance is done by monitoring thyroglobulin, thyroglobulin antibodies, and ultrasound neck. If there is concern for recurrence, typically whole body I-123 or I-131 imaging is done after either stimulation (thyroid hormone withdrawal or thyrogen stimulation). SPECT/ SPECTCT is frequently done of the neck and of any other areas that need clarification on planar imaging.

Indium octreotide and Iodine MIBG (meta-iodobenzylguanidine) imaging are used to assess neuroendocrine tumors for somatostatin (SSTR) receptors to enable treatment with somatostatin analogs, such as octreotide acetate (Sandostatin).

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177Lu-Dotatate is a treatment for neuroendocrine cancers that have SSTR expression as seen on Gallium-68 PET or Indium-111 pentetreotide/ Octreotide imaging. 90Y-ibritumomab tiuxetan (or Zevalin®) is used as treatment for refractory non-Hodgkin's lymphoma and may need initial biodistribution assessment with Indium-111 ibritumomab tiuxetan. Therapeutic agents have gamma or bremsstrahlung radiation that can be harnessed to image and evaluate the biodistribution of the therapeutic tracer.

Lymphoscintigraphy with sentinel node mapping is often used in early stage breast, melanoma, and gynecological cancers immediately prior to surgical resection of primary lesion. This evaluates initial lymph nodes draining the target region. These lymph nodes are resected during surgery to evaluate for possible involvement, in which case the cancer is upstaged. For exact anatomic correlation, SPECT/ SPECTCT is preferred, but may not be performed due to time constraints before surgery. It is limited to newer systems with faster SPECTCT acquisition times or if planar imaging is inconclusive.

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INDICATIONS FOR CARDIAC SPECT/SPECT CT

As addressed in MPI and MUGA guidelines.

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INDICATIONS FOR NECK SPECT/ SPECT CT (NON-CANCER)

- Parathyroid adenoma: Clinically or laboratory proven hyperparathyroidism AND ultrasound of the neck completed. If CT is already completed, it should be inconclusive.[35]
- Thyroid: Abnormal thyroid tests and planar imaging is inconclusive for the location of a focal thyroid lesion.

BACKGROUND

Parathyroid adenomas are evaluated typically initially by cervical ultrasound. Parathryoid SPECT/ SPECTCT with Tc99m sestamibi or Iodine and sestamibi tracer combo has similar diagnostic performance to 4D-CT with less radiation dose.

Thyroid disorders that are diffuse typically do not need SPECT/ SPECTCT imaging. However, it may be needed in cases of differentiation of a single cold nodule in the background of multinodular goiter to direct biopsy. Iodine-123 tracer is typically used for these.

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INDICATIONS FOR LUNG SPECT/ SPECTCT

- Quantification of lung function prior to lung resection/radiation
- Evaluation of congenital cardiac, thoracic, or pulmonary disease, or lung transplants or bronchopleural fistulae[36]
- Chronic thromboembolic pulmonary hypertension
- Suspected acute pulmonary embolism with comorbidities (such as COPD, left heart failure, pneumonia, tumor) AND chest x-ray has been performed, AND chest CTA cannot be performed or limited
- Calculation of lung shunt fraction prior to hepatic radioembolization

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BACKGROUND

Ventilation perfusion scans are typically done for pulmonary embolism (PE) assessment when chest CTA cannot be performed, for young patients, or in pregnancy when they have a normal chest x-ray (due to lower radiation exposure). SPECT/ SPECTCT of the ventilation images is markedly limited in the US as the two ventilation tracers used in the US (Tc99m DTPA, Xenon) are not highly amenable to SPECT imaging. This and the overdiagnosis of small insignificant PE on SPECT/SPECTCT, like CTA, have enabled planar images to be the preferred method of evaluation of acute PE. However, for the purposes of lung surgery evaluation, congenital heart disease, and chronic pulmonary hypertension, the lung perfusion images have more significance, and these are amenable to SPECT/ SPECTCT with further increases in sensitivity and specificity.

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INDICATIONS FOR BRAIN SPECT/ SPECT CT[37]

- For preoperative localization of epileptic foci after EEG, Brain MRI and PET are done and insufficient[38, 39]
- DAT scan[40-42]
    - To differentiate essential tremor and drug-induced parkinsonism from parkinsonian syndromes
    - For early/inconclusive parkinsonian features
    - For dementia: differentiating Dementia with Lewy Bodies (DLB) from other dementia types. If FDG PET was completed for this indication, it was inconclusive.
- To evaluate cerebrovascular reserve in planning appropriate endovascular/vascular intervention or neurovascular surgical approach[43, 44] - can include:
    - Evaluation for vascular diseases such as Moyamoya
    - Carotid balloon occlusion
    - Hyperperfusion syndromes
    - Shunting for idiopathic normal pressure hydrocephalus[45]
- Brain perfusion study for evaluation of brain death when CT or MRI already done and planar images are inconclusive[46]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Injected brain tracers used include 99mTc-bicisate (ECD; ethyl cysteinate dimer), 99mTc-exametazime (HMPAO; hexamethylpropylene amine oxime), and 99mTc-pentetate (DTPA; diethylenetriaminepentaacetic acid). I123 Ioflupane is used for DAT scan (Dopamine Transporter Scan). Brain studies are performed as a default with SPECT/ SPECTCT unless it is a brain death scintigraphy. These tracers cross the blood brain barrier where they emit gamma rays that are detected by the imaging system. A 3D image of the brain is created using computerized techniques with the degree of radionuclide activity corresponding to neuronal activity or cerebral blood flow.

Epilepsy: 15–30% of patients with refractory focal epilepsy do not have distinct lesions on MRI. The next investigation for a possible surgically resectable epileptogenic focus includes PET. If this is negative or inconclusive, ictal (during seizure) brain SPECT/ SPECTCT can be obtained, which can reveal increased uptake at the epileptogenic area.

Stroke/ Trauma/ Presurgical planning: These situations are usually evaluated with brain MRI (or brain CT if there is a contraindication to brain MRI). However, if these results are inconclusive or limited, could not be performed, do not explain the clinical picture, or if additional information is needed for surgeries, Brain SPECT images are obtained, often to evaluate vascular reserve. Brain images are obtained at rest and after vasodilatory acetazolamide

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injection challenge. These may clarify inconclusive clinical or imaging abnormalities or assess vascular reserve for surgeries. This can also be done with other challenges as well, such as carotid balloon occlusion. In the assessment of transient ischemic disease, reduced perfusion can be seen earlier than changes on conventional imaging and may help plan appropriate therapeutic intervention. In traumatic brain injury (including whiplash, post-concussion syndromes), SPECT studies have shown areas of hypoperfusion without corresponding MRI or CT findings.[47]

Brain Death: This is typically used in the ICU setting, when clinical assessment and electroencephalography are less reliable in diagnosing brain death because of conditions such as severe hypothermia, coma caused by barbiturates, electrolyte or acid–base imbalance, endocrine disturbances, drug intoxication, poisoning, and neuromuscular blockade. Brain death scintigraphy may also be helpful in patients who are being considered as possible organ donors or when family members require documentation of lack of blood flow.

Dementia: Brain SPECT imaging has been replaced by brain PET due to better resolution.

DAT scan (Dopamine transporter Imaging): I123 Ioflupane tracer demonstrates the location and concentration of dopamine transporters (DATs) in the synapses of striatal dopaminergic neurons. This is decreased in presynaptic parkinsonian syndromes (Parkinson's disease, multiple system atrophy, and progressive supranuclear palsy) but is not affected in mimicking conditions such as essential tremor, drug-induced parkinsonism or psychogenic parkinsonism. It is also useful in the differentiation of Alzheimer dementia from Dementia with Lewy Bodies. The latter is in the spectrum of parkinsonism but may or may not have clinical symptoms of parkinsonism, such as bradykinesia, rigidity, or tremor at rest.

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INDICATIONS FOR A RADIONUCLIDE CISTERNOGRAPHY (CSF) SPECT/SPECT CT SCAN

- CSF imaging (for evaluation of hydrocephalus, leak, shunt, normal pressure hydrocephalus, spontaneous intracranial hypotension) when[45]
  - Brain/spine or respective site imaging already performed with appropriate CT/ MRI / CT myelography, and deemed to be insufficient; AND
  - Planar images projected to be insufficient for localization of abnormality
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Cerebrospinal fluid (CSF) flow studies for the evaluation of obstructive or non-obstructive hydrocephalus of various etiologies or CSF leaks (CSF cisternography) are performed after the intrathecal administration of radionuclide. The radionuclides used for CSF flow studies are Indium-111 DTPA for cisternography and leaks.[48] Persistence of activity in the lateral ventricles after 24 hours of imaging is diagnostic of normal pressure hydrocephalus. Cine phase contrast MRI is the preferred technique for evaluating CSF flow dynamics and helps determines which patients with NPH will benefit from treatment.[49, 50]

To evaluate ventriculoperitoneal shunt patency, Tc-99m DTPA radionuclide is injected into the shunt reservoir. Normal shunt patency is confirmed by showing activity along the entire course of the shunt, ultimately spilling into the abdominal cavity.

CSF leaks are more commonly acquired either iatrogenic or post-traumatic[51] than congenital or spontaneous and can occur anywhere along the cranial spinal axis. Scintigraphy for detecting CSF leaks has been superseded by CT and MRI myelographic techniques or thin section skull base CT due to their better spatial resolution.[51, 52] Diagnosis using scintigraphy requires intrathecal administration of radionuclide followed by imaging typically at 3,6, 24, and 48 hours. Pledgets can be placed in the nasal cavity or auditory canal in the setting of CSF rhinorrhea and otorrhea, respectively. CSF leak path is traced. Initial diagnostic imaging is typically done with high resolution CT, CT/MR cisternography.[53-55]

Spontaneous idiopathic hypotension (SIH), also known as craniospinal hypotension, poses a diagnostic challenge due to its protean clinical symptoms, inconsistently demonstrated imaging findings on conventional MRI scanning, and lack of awareness of the diagnosis among clinicians. SIH often presents a variable mix of symptoms, including orthostatic headaches, visual defects or blurred vision, limb paresthesia, transient 3rd cranial nerve palsy, numbness in the face or limbs, cognitive deficits, behavioral changes, neck pain and stiffness, taste alteration, or parkinsonism. In this condition a CSF leak anywhere along the neuraxis is not detected in nearly one-third of patients thought to be due to the slow or intermittent nature of these leaks.[56] Radionuclide cisternography was found to be more sensitive than CT myelography in a few

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limited case series.[57-59] Imaging at multiple time points up to 48 hours, as well as direct and indirect signs, aid in the detection of intermittent or slow leaks, with lower radiation exposure than CT myelography.[60] SPECT-CT allows improved anatomical localization and characterization.[61, 62]

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INDICATIONS FOR RENAL SPECT/ SPECTCT[63, 64]

Complex clinical scenarios involving the following indications wherein cross-sectional imaging and routine dynamic planar imaging alone is, or projected to be, insufficient:

- Evaluation of renal collecting system for trauma, surgery, obstruction in ADULTS, or with signs, symptoms, and laboratory findings supporting the need for such an evaluation in adults; **AND**
  - CT has been performed and is inconclusive or contraindicated
- For evaluation of renal collecting system for obstruction or vesicoureteral reflux in children and young females:
  - After ultrasound and VCUG (voiding cystourethrography) / VUS (voiding urosonography) are inconclusive or discordant with clinical picture[63, 65]
- For diagnosis of reno-vascular hypertension with signs, symptoms, laboratory findings, or other imaging supporting the need for such a diagnosis when
  - Duplex ultrasound is inconclusive; **AND**
  - MRA or CTA cannot be performed or is contraindicated; **AND**
  - The patient has adequate renal function (GFR >30) mL/min/1.73 m^2) to undergo the study[63]
- Further evaluation of renal perfusion and split function after completion of ultrasound, including in the setting of surgery, trauma, infection, congenital and mass abnormalities[63]
- Diagnosis of renal transplant complications after ultrasound has been performed[31, 63]
- Evaluation of renal infections and discrimination of pyelonephritis from cortical scarring[63]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Renal scintigraphy remains an important technique for evaluation of the renal circulation, parenchyma, and collecting system. Through the acquisition of serial images over time and graphic depiction of radionuclide activity, information about renal blood flow and function not typically afforded by cross-sectional imaging can be achieved through qualitative and quantitative means. Tailored studies utilizing the administration of diuretic or angiotensin-converting enzyme inhibitors, in conjunction with the radionuclide imaging agent, allows for evaluation of suspected hydronephrosis or renovascular hypertension, respectively. The ability to create 3D multiplanar images with the SPECT/SPECTCT technique greatly improves the diagnostic capability over traditional planar imaging.

Tubular secretion agents, such as ^{99m}Tc-MAG3, are used for diuretic renography because tubular tracers are much more efficiently extracted by the kidney than ^{99m}Tc-DTPA (diethylene triamine pentaacetic acid), and washout is therefore easier to evaluate. 99mTc-DTPA is filtered

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purely by the glomerulus and thus can be used both to image the kidney and to measure glomerular filtration rate. T- 99m DMSA (Dimercaptosuccinic acid) is especially useful for pyelonephritis and scar evaluations.

OVERVIEW

Diuresis renography can evaluate severity of urinary tract obstruction and can differentiate an obstructed collecting system from a dilated, but non-obstructing, system. It can also provide the differential function in each kidney. Multiple follow-up exams may be needed to detect gradual improvement or worsening.

Captopril Renography is done by imaging before and after administration of acetylcholine esterase inhibitor in patients with high index of suspicion of renovascular hypertension. It is used to identify subgroup in whom hypertension caused by renal artery stenosis could potentially respond to revascularization.[63]

Renal scintigraphy can be used to screen for postoperative complications in renal allograft dysfunction. These can include infarcts, acute tubular necrosis (ATN), collecting system obstruction, urine leaks, drug-induced nephrotoxicity, and rejection. ATN is differentiated from acute rejection as it usually occurs within the first few days after transplantation whereas acute rejection occurs from one week to months after transplantation. Baseline study may be for future comparison.

Renal scintigraphy can also be used to assess differential function in each kidney and in each segment of the kidney for further treatment implications in cases of surgery, trauma, infection, and congenital and mass abnormalities.

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INDICATIONS FOR ABDOMEN / PELVIS SPECT/ SPECT CT SCAN

- Hepatic radioembolization[66]
  - For evaluation of pulmonary and gastrointestinal shunts or dosimetry calculations prior to procedure (typically utilizing Tc MAA)
  - Post-procedure imaging in lieu of PET to determine dose effect/dose toxicity (using the Y90 radiation itself)[67]
- For evaluation of the following:
  - Intermittent/occult gastrointestinal bleeding after initial workup is indeterminate/contraindicated (scopes, CTA)[68]
  - Indeterminate or vascular hepatic lesions or bleed, when CT/MRI are contraindicated/inconclusive[69, 70]
  - Indeterminate accessory splenic tissue/asplenia when CT/MRI are contraindicated/inconclusive[71]
- Liver transplant (and other hepatic surgery/radiation) preoperative and postoperative function and complications when ultrasound/CT/MR are indeterminate or contraindicated[69]
- Localization of:
  - Suspected ectopic/residual gastric tissue (e.g., Meckel's diverticulum)[68]
  - Abnormalities in hepatobiliary scintigraphy (e.g., biliary abnormalities/leaks) when ultrasound (in infants) or CT is inconclusive/contraindicated[69]
- Peritoneal imaging for evaluation of complications of shunts, dialysis, or peritoneal integrity, when CT is inconclusive/contraindicated[68]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Most indications utilize a series of standard planar images over time to determine the progression of the radionuclide through the respective system. However, SPECT / SPECTCT improves anatomic localization, increases diagnostic certainty and accuracy, and decreases the need for delayed imaging.

99mTc-labeled autologous red blood cells (99mTc-RBCs) are injected in intermittent gastrointestinal bleeds and imaged intermittently up to 24 hours to localize bleeds. It can detect bleeding rates as low as 0.1 cc/min to 0.5 cc/min (vs CTA-0.3-1ml/min and angiography 0.5-1ml/min). SPECT/SPECTCT increases the sensitivity and specificity of bleeding-site localization. It has lower radiation exposure than CTA, particularly relevant in children (e.g., Meckel diverticulum studies).[72]

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Tc99m sulfur colloid (and sometimes Tc99m RBC) ARE used to identify indeterminate vascular hepatic lesions, such as hemangiomas and hemangioendotheliomas. Denatured Tc99m RBC is useful for identifying indeterminate accessory splenic tissue.

Hepatic radioembolization is used for liver-dominant malignancy or metastases that are unresectable. It involves intraarterial injection of yttrium-90 (Y90)-labeled glass or resin microspheres. **A Tc99m MAA nuclear scan (typically requiring SPECT)** is performed before the actual treatment with Y90. MAA, which is similar in size to the Y90 microspheres, mimics the distribution of the Y90 particles and should embolize within the tumor's hepatic arterioles, thus outlining the expected localization of the radiation. The scan is compared to a CTA/MRA to evaluate for any possible shunting of the treatment agent to the lungs or the GI tract. Coils can be placed as needed to minimize any shunting of Y90 to areas other than the desired target.

Post-procedure imaging (within 24 hours) with either SPECT or PET (at the discretion of the treating physicians) is then performed to confirm the final distribution of the Y90 and to calculate the actual radiation dose delivered to the tumor. Utilizing the Bremsstrahlung radiation of the Y90 embolization agent, SPECT or SPECT/CT can be completed with routine nuclear medicine collimators. However, due to their higher energy level (as compared to routine nuclear medicine agents), the Y90 photons scatter and/or pass through the collimator septa and degrade the image quality. Alternatively, PET scanning can be done, again using the Y90 treatment agent itself; but for PET via a minor decay pattern that emits a positron (32 in every one million decays) that is detectable with PET scanners. FDG PET may be needed later (ideally performed >12 weeks after treatment) to access tumor response to this radiation, in accordance with the tumor-specific guidelines for FDG PET restaging so may still require inconclusive conventional imaging, if necessary for the type of cancer being treated.

Peritoneal imaging includes evaluation of patency of peritoneovenous shunts, diaphragmatic perforations, or peritoneal loculations, especially prior to intraperitoneal chemotherapy. This is accomplished by injection of Tc99m MAA into the peritoneal cavity.

SPECT / SPECTCT in **hepatobiliary imaging** can help localize abnormalities by distinguishing superimposed bowel activity and clarifying biliary abnormalities and bile leaks. It may obviate the need for delayed imaging and increase diagnostic certainty. Imaging is achieved utilizing the IV administration of Tc99m-labeled iminodiacetic acid, which is excreted by hepatocytes like bile.

Liver transplant complications are best evaluated by ultrasound, CT, and MR; however, limited applications in pediatric patients may exist when radiation doses or sedation considerations exist.

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POLICY HISTORY

BONE/JOINT SPECT/SPECT CT SCAN

Date	Summary
April 2022	• Reorganized indications for clarity • Within MALIGNANCY o Simplified staging or restaging evaluation by removing "for the following" and the sub-bullets for breast cancer, prostate cancer, primary bone cancers, and monitoring of cancers with predominantly bone metastases o Clarified staging or restaging evaluation to be performed if other imaging has not been performed, is contraindicated, or is inconclusive in evaluation of bone metastases
February 2021	• First line: "When routine dynamic planar imaging is insufficient", is elaborated to "When routine dynamic and planar imaging is, or is projected to be insufficient for the following suspected conditions"; ACR 2019, NCCN 2020, SNMMi 2020 references added. • New topic divisions were created under Malignancy, Infection, Bone viability, Trauma, Inconclusive, Postoperative, Extremities and Follow -up • First indication under Malignancy for screening evaluation: "recent/active" phrase was removed as a specifier for malignancy • "or before radionuclide bone therapy" was removed from the prostate cancer indication • "Primary bone cancers (such as Ewings, Osteosarcoma)" was added under staging/restaging for Malignancy • Under Infection, osteomyelitis and discitis indications were separated. Osteomyelitis indication has not changed, while requirement for x-ray was removed for discitis. ACR 2019, 2017 references added. • Under bone viability, removed CT indication, that was previously needed as an alternative to x-ray. Changed reference to ACR 2016 • Under trauma, subdivided indications for extremities and spine. Under extremities, changed requirement to needing both x-ray and MRI; changed reference to ACR 2017. Under spine, added the following indications: o "for indications such as spondylolysis or determination of age of fracture after CT/MRI is inconclusive (ACR 2015).

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	○ Spondylolysis evaluation in a child, with persistent pain after MRI and conservative treatment, in determining further treatment plan (Cheung 2018; Goetzinger 2020)" • Under inconclusive category, previous" Resolution of questionable/inconclusive abnormal skeletal radiographs when MRI or CT is inconclusive or cannot be performed" was replaced by "inconclusive MR/CT" • Under inconclusive category, added "Identification of a primary etiology (via most reactive/ inflammatory changes) when multiple etiologies are identified by MRI/CT, AND intervention planning is needed (includes primary facet joint target localization) (Cohen 2020; Tender, 2019, Russo 2017, ACR 2015)" • Under Postoperative indication, updated references and clarified prior "Painful knee and hip arthroplasties after x-ray has been done and when CT/MR are inconclusive/limited/inconclusive (Backer, 2020; Van Der Bruggen, 2018)" to "Evaluation of persistent symptoms in postoperative spine/joints/bones, after X-ray and CT are negative/inconclusive (Peters, 2019; Paycha, 2018; Backer, 2020; Van Der Bruggen, 2018, ACR 2015)" • Extremity pain: changed prior requirement of "xray, MRI, Ultrasound or CT" to "x-ray, AND MRI/, Ultrasound/ or CT" • Background: Under bone SPECT/SPECTCT, the following was removed:" Bone Single-Photon Emission Computed Tomography (SPECT or SPECTCT):" • Background: Under bone SPECT/SPECTCT, the following was added at the end where SPECT/SPECTCT performance was comparable to MRI: "as those listed above (Deidrichs, 2017; Ha, 2015; Huellner, 2013; Israel, 2019). For patients with impaired renal function who cannot receive iodinated or gadolinium-based contrast agents or undergo MRI for other reasons, SPECT/ SPECTCT imaging can improve the performance of conventional planar nuclear bone imaging." • Background: Under TRACERS, added that Tc sulfur colloid scan is used to distinguish bone marrow from infection site; and deleted the following: "For patients with impaired renal function who cannot receive iodinated or gadolinium-based contrast agents or undergo MRI for other reasons, SPECT/ SPECTCT imaging can improve the performance of conventional planar nuclear bone imaging." • Added updated references

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May 2020	• Background: Added info regarding SPECTCT including references; deleted duplicate info; added radiotracers for infection; clarified some of the explanation. • Updated references to include SPECTCT, and its comparison to MRI • Modified Cancer guidelines to reflect NCCN 2020 and Appropriate Use Criteria By Donohoe 2019 • Added clarification for "inconclusive" • For infection imaging, added if MRI" technically limited or inconclusive"
April 2019	• Emphasized the indication is for High Risk patients and not routine workup for all patients with cancer • Updated references

NON-BONE INFECTION/ INFLAMMATION SPECT/SPECT CT

Date	Summary
April 2022	• No significant changes
February 2021	• Added the specific preliminary imaging needed. • Added "when CT/MR are negative/inconclusive/limited" to Fever of Unknown Origin. • Added: "a. Transplant and vascular grafts, when ultrasound / CTA are negative/inconclusive/limited (Lauri, 2020; Volkan-Salanci, 2021). b. Prosthetic valves, when echocardiography AND Coronary CTA are inconclusive (Galea, 2020). c. Cardiac implantable devices when echocardiography is inconclusive (Galea, 2020)." • Added new references.
May 2020	Added indications: When CT / CTA / MRI are inconclusive, limited, or cannot be done (ACR 2018): • Fever of Unknown Origin • Non bone infection/ inflammation, including those associated with implant/grafts/devices

TUMOR SPECT/SPECT CT

Date	Summary

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April 2022	• Renamed GL as Single Photon Emission Computed Tomography (SPECT)
February 2021	• Updated references and added the following to Iodine imaging: o Iodine imaging for subsequent post thyroidectomy staging of differentiated thyroid cancers, in the setting of (NCCN 2020): o Post thyroidectomy neck CT/MR showing residual unresectable thyroid tissue/ disease in the neck o Distant metastases as seen on CT/MR o Post thyroidectomy unstimulated thyroglobulin >5-10ng/ml o Radioactive iodine therapy is being considered for high risk or recurrent tumor o Post radioiodine treatment (post therapy scan) o During surveillance, with rising thyroglobulin, or stable / rising antithyroglobulin antibodies, or abnormal ultrasound neck. Refer to neck SPECT/SPECTCT for thyroid nodules. • Updated references and added the following to neuroendocrine cancers: o when CT/MRI OR PET imaging is not available, cannot be done, has contraindications, or is inconclusive. o I-131 MIBG: when I131 MIBG therapy is being considered o In111- octreotide: Somatostatin analog therapy is being considered and Ga68 Dotatate PET is not available • Changed therapy imaging as follows: "Imaging during/ post therapy with therapeutic agents such as 131 Iodine, 177Lu-Dotatate, 111In Zevalin, when it can change management" • Added head and neck cancer to lymphoscintigraphy. Added references.
May 2020	Added: • Iodine imaging for initial and subsequent staging of Thyroid cancers, for any part of the body, when ultrasound of the neck has been done (ACR 2015). • Indium octreotide and Iodine MIBG Imaging for initial or restaging of Neuroendocrine tumors, for any part of the body, when CT/MRI and PET imaging is not available, cannot be done, has contraindications, or is inconclusive (ACR 2015). • Imaging during therapy with therapeutic dose agents such as 131 Iodine, 177Lu-Dotatate, 111In Zevalin, or for their dosimetry calculations.

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	• Lymphoscintigraphy with sentinel node localizations, for preoperative planning in melanoma, breast, and gynecological cancers

CARDIAC SPECT/SPECT CT – As addressed in MPI and MUGA guidelines

NECK SPECT/SPECT CT (NON-CANCER)

Date	Summary
April 2022	• No significant changes
February 2021	• Added to parathyroid adenoma: "If CT is already completed, it should be inconclusive (Itani 2020)." • Added new references
May 2020	Added indications: • Clinically or laboratory proven hyperparathyroidism AND ultrasound of the neck completed. • Abnormal Thyroid tests and planar imaging is inconclusive for a focal lesion.

LUNG SPECT/SPECT CT

Date	Summary
April 2022	• No significant changes
February 2021	• Added new references • Removed "AND planar images are inconclusive." for pulmonary embolism as it is not possible to view these planar images at the time of authorization. • Added new indication: Calculation of lung shunt fraction prior to hepatic radioembolization
May 2020	Added indications: • Quantification of lung function prior to lung resection/ radiation and evaluation of congenital cardiac, thoracic, or pulmonary disease, or lung transplants or bronchopleural fistulae (ACR 2018). • Chronic Thromboembolic pulmonary hypertension • Suspected acute pulmonary embolism with comorbidities (such as COPD, left heart failure, pneumonia, tumor) AND chest x-ray has been done, AND chest CTA cannot be done or limited, AND planar images are inconclusive.

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BRAIN SPECT/SPECT CT

Date	Summary
April 2022	• Removed For patient with history of stroke or trauma with recent Bract CT or MRI based on updated ACR Appropriateness Criteria
February 2021	• To the cerebrovascular reserve indication, added "- can include: o evaluation for vascular diseases such as Moya Moya o carotid balloon occlusion o hyperperfusion syndromes o shunting for idiopathic normal pressure hydrocephalus (ACR 2020)" • Broke up DAT scan indication into three sub indications and clarified further. Added that if FDG PET was completed, it had to be inconclusive for dementia imaging by DAT • Updated references
May 2020	• Eliminated dementia indication, as it has been replaced by PET • Combined stroke and trauma into one indication • Gave specific indications for parkinsonism per SNMMI guidelines • Added brain death indication • Added the requirement of PET for epilepsy imaging, as brain SPECT is typically done in the ictal phase which is very laborious (Duncan 2016). • Updated background to be more specific to the indications described and included tracers. • Updated references
April 2019	Updated references only

RADIONUCLIDE CISTERNOGRAPHY (CSF) SPECT/SPECT CT SCAN

Date	Summary
April 2022	• No significant changes
February 2021	• Planar imaging requirement changed to "projected to be, insufficient for localization of focal abnormality" • Updated references
May 2020	• Initial indications distilled into one for all CSF imaging • Abbreviated background, added references
April 2019	• Added content explaining this study is appropriate after other imaging has been completed or is contraindicated • Updated references

RENAL SPECT/SPECT CT

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Date	Summary
April 2022	• No significant changes
February 2021	• Changed 2nd line to “dynamic planar imaging alone is or projected to be insufficient” • Updated references
May 2020	• Added congenital vesicoureteral reflux and obstruction indications per ACR 2015/2017 • Added surgery, trauma, infection, congenital and mass abnormalities to indications of renal function and urinary tract evaluation • Clarified kidney injury evaluation indication to include specifically renal perfusion and split function • Updated and added references • Changed background to remove duplicated SPECT content, adding a short paragraph on most indications, and tracers and decreasing renal transplant background.
April 2019	• Changed the following indication: “Diagnosis of acute tubular necrosis intrinsic renal acute kidney injury when other causes of renal failure have been excluded and evaluated with US” • Added Background information to provide a summary of non-transplant related application • Updated references

ABDOMEN/PELVIS SPECT/ SPECTCT SCAN

Date	Summary
April 2022	• For Hepatic radioembolization o Clarified Tc MAA for evaluation of pulmonary and GI shunts or dosimetry calculations o Clarified Y90 for post-procedure imaging in lieu of PET for dose effect/dose toxicity • In Background, added further details on Y90 and imaging
February 2021	• For hepatic radioembolization 2nd sub bullet: changed post procedure imaging as ”Post procedure imaging in lieu of PET to determine dose effect/ dose toxicity” • In second indication, deleted needing planar images and changed to updated reference; also changed prerequisite imaging from CT/CTA to CTA, per ACR 2016. • To the liver transplantation indication, added “(and other hepatic surgery/radiation) preoperative and post operative” function assessment • For peritoneal imaging, added ”evaluation of complications of shunts, dialysis or peritoneal integrity”

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	• For peritoneal imaging, removed ”planar imaging is or is projected to be, insufficient AND“ • In background for hepatic radioembolization, added the following for post procedure imaging in the last line: “evaluation for suboptimal/excessive tumor radiation exposure, and establishing dose-effect and dose-toxicity via quantitative data when planning subsequent treatments. Quantitative assessments would be better with Y90 PET.” • Added new references
May 2020	• Added hepatobiliary, and gastrointestinal bleed indications • Added ectopic gastric mucosa and peritoneal shunt applications • Added hepatic radioembolization indications, and removed hepatic chemoembolization indications • Used wording of ACR for existing indications • Removed duplicate SPECT background info • Added short paragraph on most of the indications in background. • Added and updated references
April 2019	• Added ‘when ultrasound is inconclusive’ to the following indications: o Detection of space-occupying lesions….when US is inconclusive o Evaluation of hepatic primary or metastatic tumors….when US is inconclusive • Updated references

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ADDITIONAL RESOURCES

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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Clinical guidelines **PET SCANS** **includes** • **PET** • **PET with CT Attenuation** • **PET/CT**	**Original Date: September 1997**
	Last Revised Date: May 2022
Guideline Number: NIA_CG_070-1	**Implementation Date: January 2023**

GENERAL NOTES:

ADULT AND PEDIATRIC MALIGNANCIES[1]: ONCOLOGICAL PET IS INDICATED FOR BIOPSY-PROVEN CANCER OR STRONGLY SUSPECTED CANCER BASED ON OTHER DIAGNOSTIC TESTING. The appropriateness of an ordered PET/CT study is dependent on which radiopharmaceutical will be used for the PET/CT.

FDG-PET/CT (fluorodeoxyglucose-positron emission tomography)

LUNG NODULE seen on LDCT or CT+ contrast (without known malignancy)

- Solid Component of Dominant Nodule (either solitary or clearly dominant) ≥ 8mm and <3cm or Part solid/mixed nodules with the solid component 8 mm or larger
- Mixed nodule (i.e., ground glass and solid nodule) with solid component of the nodule ≥ 4mm on LDCT when there has been
    - Interval growth of the solid component of at least 1.5mm on subsequent LDCT scans

      OR
    - Interval development of a new mixed nodule on subsequent LDCT with the solid nodule component ≥ 4mm

NOTE: >3cm is considered a MASS; therefore, a tissue type is usually needed prior to PET (to determine if SCLC or NSCLC). However, if the chest CT imaging findings meet criteria for limited stage SCLC and no prior imaging shows metastatic disease elsewhere, PET can be approved prior to biopsy in order to guide biopsy of any FDG-avid adenopathy at the same time the primary is biopsied. If disease clearly is in both sides of the chest and/or outside the chest, then PET is not needed/approvable prior to tissue diagnosis.

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USEFUL DEFINITIONS (to aid in using the following table(s))

- **INITIAL STAGING** refers to imaging that is performed AFTER the diagnosis of cancer is made, and generally before any treatment**.**
- **RESTAGING** includes scans that are either needed **during active treatment*** (**subsequent treatment strategy****) to determine response to treatment, within 6 months after the **end of treatment**, or when there is clinical **concern for recurrence** (i.e., new imaging, new signs, rising labs/tumor markers or symptoms relative to type of cancer and entire clinical picture) (recurrence is not required to be biopsy proven)
- ***ACTIVE TREATMENT** includes traditional chemotherapy, immunotherapy, radiation, as well as patients on "maintenance therapy" who have known, or existing, metastatic disease being held in check by this treatment. Allogenic bone marrow transplant and CART T-cell therapy should be considered 'active' treatment for at least 6 months after infusion/transplant and as such can be approved at 30 days, 100 days, and 6 months after the most recent infusion.
- ****SUBSEQUENT TREATMENT STRATEGY**
    - For restaging or monitoring response during active treatment (including immunotherapy), and/or a single evaluation after completion/cessation of therapy. The interval should **ideally‡** be 6-12 weeks after surgery, and 12 weeks after radiation (to avoid false positive findings that can be caused by treatment changes or healing).
    - PET/CT can be performed 1 - 3 weeks after neoadjuvant chemotherapy or neoadjuvant chemoradiation if done for presurgical planning to evaluate for distant metastatic disease or to evaluate known metastatic disease located in areas separate from the site(s) being radiated.

      ‡NOTE: a valid clinical reason explaining why the interval needs to be shorter than ideal must be present

- **INCONCLUSIVE IMAGING see Background** section at end of guidelines
- **SURVEILLANCE PET** is generally **not approvable**. Surveillance means no active treatment, no current suspicion of recurrence and occurs 6 months or more after completion of treatment. **Possible exceptions† where PET "may be considered" for surveillance:**
    - Ewing's
    - Osteosarcoma
    - Breast (Stage 4)
    - Cervical (stage 2-4)
    - Diffuse Large B Cell Lymphoma when disease was only seen previously on PET

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- Histiocytic neoplasms every 3-6 months for the first 2 years post completion of treatment
- Melanoma (stage 2b-4)
- Myeloma/plasmacytoma (ideally use same type imaging as was used in initial dx, up to 5 yrs after the diagnosis of plasmacytoma)
- Seminoma (Stage 2b, 2c and 3)

†NOTE: These cases would need to include a clinical reason why PET is needed (i.e., being considered), rather than conventional imaging (CT, MRI, bone scan). Generally, this would be accepted only when ordered by the treating oncologist or clearly at their recommendation (not as routine follow-up ordered by PCP).

FDG PET

ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
ADRENAL (other than pheochromocytoma/ paraganglioma)	**Not Indicated**	**Not Indicated**
AIDS-related KAPOSI SARCOMA	with prior inconclusive imaging	**Not Indicated**
ACUTE LYMPHOBLASTIC LEUKEMIA (ALL)	lymphomatous extramedullary disease	lymphomatous extramedullary disease
ACUTE MYELOGENOUS LEUKEMIA (AML)	If suspected extramedullary involvement	If suspected/known extramedullary involvement
ANAL (Note that normal size pelvic adenopathy can be considered as inconclusive)	with prior inconclusive imaging (can be done with PET (PET/CT or PET/MR‡‡ if available)).	with prior inconclusive imaging
BASAL CELL (BCC of the skin)	**Not Indicated**	**Not Indicated**

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
BLADDER	Muscle invasive only, with prior inconclusive imaging	With inconclusive imaging and suspected metastatic disease or recurrence outside of the urinary tract
BREAST	Indicated for stage IIb and above (if only T and N are provided, this equates to T3 (tumor > 50mm); or T4 (tumor of any size with direct extension to chest wall and/or skin); or N2 (>3 axillary LN, ipsilateral internal mammary node); or the combination of T2 (tumor >20mm but <50mm) plus N1 (any positive lymph node involvement)	with prior inconclusive imaging, if initial staging was performed with PET OR if recurs with IIb or higher disease (based on pathology/imaging/exam) since no previous initial staging would have typically been performed for lower grade breast cancer
CERVICAL	Indicated (can consider PET/MR‡‡ if available)	Indicated
CHORDOMA	with prior inconclusive imaging	**with prior inconclusive imaging**
CHOLANGIOCARCINOMA	with prior inconclusive imaging	with prior inconclusive imaging
CHONDROSARCOMA (bone)	**Not Indicated**	**Not Indicated**
COLORECTAL	with prior inconclusive imaging OR potentially surgically curable M1 disease OR when considered for image-guided liver-directed therapies	with prior inconclusive imaging

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
ENDOMETRIAL	with prior inconclusive imaging	with prior inconclusive imaging
ESOPHOGEAL and EGJ (esophagogastric junction epicenter < 2cm into stomach)	Indicated	Indicated
EWING SARCOMA-**Osseous**	Indicated (all ages)	Patients <30 yrs old: Indicated Patients >30 yrs old: Indicated for known or suspected metastatic disease (based on PE/imaging)
FALLOPIAN TUBE CANCER	with prior inconclusive imaging	with prior inconclusive imaging
GALLBLADDER	with prior inconclusive imaging	with prior inconclusive imaging
GASTRIC (include EGJ tumors with epicenter >2cm into stomach)	with prior inconclusive imaging or if radiation is being considered **(Not indicated for T1N0M0 or M1)**	with prior inconclusive imaging, PET/CT is indicated or for post radiation imaging
GESTATIONAL TROPHOBLASTIC CANCER	with prior inconclusive imaging	with prior inconclusive imaging
HEAD and NECK (including mucosal melanoma of the head and neck)	Indicated • May be done in conjunction with a dedicated face/neck MRI (or CT) when surgery or radiation is planned	Indicated • Can concurrently approve a Neck MRI and PET 3-4 months after definitive treatment in patients with locoregionally advanced disease or with altered anatomy.

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
		• PET should not be done earlier than 12 weeks after definitive treatment unless signs or symptoms of recurrence • If final PET/CT is equivocal or borderline for residual disease, a repeat PET/CT at ≥ 6 weeks may help identify those that can be safely observed without additional surgery
HEPATOCELLULAR	with prior inconclusive imaging	with prior inconclusive imaging
LEUKEMIA (refer to specific types listed in table when possible)	If there is lymph node involvement (lymphomatous features), soft tissue and/or extramedullary involvement (myeloid sarcoma) and/or if forms "chloromas" (leukemia tumor balls)	If there is lymph node involvement (lymphomatous features), soft tissue and/or extramedullary involvement (myeloid sarcoma) and/or if forms "chloromas" (leukemia tumor balls)
LUNG		
• **Non-Small Cell**	Indicated	Indicated
• **Limited stage small cell** **Stage I-III** o And T3/T4 if disease is encompassed in tolerable radiation plan (potentially curable)	Indicated	Indicated
• **Extensive small cell** o Stage IV and T3 or T4 disease not able to be treated with curative intent	**Not indicated**	**Not indicated**

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
LYMPHOCYTIC LEUKEMIA • **Chronic (CLL) and Small (SLL)**	For suspected high-grade transformation or to guide biopsy with prior inconclusive imaging	with accelerated CLL or to guide biopsy with prior inconclusive imaging (includes negative CT with rising tumor markers or if conventional imaging documents mets, IF clearly considering resection)
LYMPHOMA (Non-Hodgkins and Hodgkins)	Indicated (can consider PET/MR‡‡)	Indicated (can consider PET/MR‡‡)
MELANOMA (See Uveal melanoma below for indications)	only stage III, IV indicated	only stage III, IV indicated
MERKEL CELL	Indicated	Indicated
MESOTHELIOMA (malignant)		
• **Pleural**	Indicated only prior to surgery for stage I-IIIA	Indicated only prior to surgery for stage I-IIIA
• **Peritoneal**	Indicated	Indicated
MULTIPLE MYELOMA		
• **Smoldering myeloma** (asymptomatic)	Indicated	Indicated annually or possibly more frequently as clinically indicated (labs and/or symptoms to suggest progression)
• **Active myeloma**	Indicated	Indicated
• **Plasmacytoma**	Indicated	Indicated

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
NEUROBLASTOMA	Indicated when MIBG is negative, inconclusive, or there are discordant findings between MIBG and pathology	Indicated when FDG PET was used for initial staging or if MIBG has become inconclusive or discordant
NEUROENDOCRINE TUMORS (NET) WHEN UNDIFFERENTIATED/DE-DIFFERENTIATED (including pheochromocytoma, paraganglioma, extrapulmonary large/small cell)	Indicated if used after prior negative or inconclusive Ga68 Dotatate scan	Indicated when FDG was used for initial staging, or when used after prior negative/inconclusive Ga68 Dotatate scan (or MIBG scan) OR after inconclusive conventional imaging
OVARIAN	with prior inconclusive imaging	with prior inconclusive imaging
OCCULT PRIMARY	with prior inconclusive imaging appropriate to pathology of the biopsy that identified the occult malignancy	with prior inconclusive imaging
OSTEOSARCOMA • **Osseous**	For patients >30 years old: Indicated when the prior bone scan is inconclusive or negative (i.e., the primary bone tumor is not seen on bone scan). PET can be approved in conjunction with MR of primary site For patients <30 years old: Indicated PET can be approved in conjunction with MR of primary site	For patients >30 yrs old: Indicated when disease is positive on prior FDG-PET or when there is inconclusive conventional imaging. PET can be approved in conjunction with MR of primary site For patients <30 years old: Indicated PET can be approved in conjunction with MR of primary site

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
PANCREATIC	With prior inconclusive imaging OR with any of the following high-risk features: • borderline resectable disease • markedly elevated CA19-9 >180 U/ml • large primary tumor/lymph nodes • very symptomatic (jaundice, symptomatic gastric outlet obstruction, venous thromboembolism, extreme pain and excessive weight loss	When PET was used for initial staging and need to assess response to treatment in order to determine if now a surgical candidate
PENILE	with prior inconclusive imaging	with prior inconclusive imaging
PERITONEAL CANCER (PRIMARY)	with prior inconclusive imaging	with prior inconclusive imaging
POST TRANSPLANT LYMPHOPROLIFERATIVE DISORDER (PTLD)	Indicated when the diagnosis is made OR if suspected based on abnormal PE, abnormal imaging or abnormal labs (i.e., significantly elevated or rising viral titers)	Indicated
PROSTATE (FDG PET only) *See other PET tracer section below for prostate cancer*	**Not Indicated**	**Not Indicated**
RENAL	ONLY when conventional imaging is equivocal for metastatic disease and if	ONLY when conventional imaging is clearly insufficient in these circumstances:

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
	present would alter initial treatment plan	• For suspected recurrence/metastatic disease outside of the urinary tract • To monitor treatment with a Tyrosine Kinase Inhibitor (such as sunitinib, sorafenib) for advanced RCC when disease was only seen previously on PET
SKIN SQUAMOUS CELL	with prior inconclusive imaging	**Not Indicated**
SMALL BOWEL CARCINOMA	**Not indicated**	with prior inconclusive imaging
SOFT TISSUE SARCOMA (including soft tissue/extraosseous Ewing sarcoma and soft tissue/extraosseous osteosarcoma)/ GIST/ Rhabdomyosarcoma	For patients >30 years old: with prior inconclusive imaging For patients <30 years old: Indicated (does not require inconclusive conventional imaging)	For patients >30yrs old with prior inconclusive imaging For patients <30 yrs old: Indicated (does not require inconclusive conventional imaging)
TESTICULAR • **Seminoma**	**Not Indicated**	with prior inconclusive imaging OR residual mass >3cm with normal AFP and beta-hcG and 6 weeks post chemotherapy (If this final PET/CT is equivocal or borderline for residual disease, an additional repeat PET/CT > 6 weeks later may help identify those that can be safely observed without additional surgery)
• **Non-Seminoma**	**Not Indicated**	**Not Indicated**

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
THYMOMA/THYMIC CANCER	Indicated	Indicated
THYROID		
• **Papillary, Follicular**	**Not Indicated**	Indicated with the following 3 criteria: • A thyroidectomy and radioiodine ablation were done initially; AND • Serum thyroglobulin (Tg) is >2 ng/ml (unstimulated or stimulated) OR there is a high anti- thyroglobulin antibody (anti-Tg Ab) >1 year after treatment AND • A Negative current I-131/I-123 scan OR a Negative prior stimulated whole body I-131/ I-123 scan done at Tg level similar to the current Tg level (a current scan is needed if on radioiodine sensitizing medications)
• **Hurthle**	**If Tg is high and/or pathology is high-risk**	IF Tg is high and/or pathology is high-risk
• **Anaplastic**	With prior inconclusive imaging	With prior inconclusive imaging
• **Medullary**	**Not Indicated** (see NET/Dotatate indications below)	With prior inconclusive imaging when calcitonin levels ≥ 150 pg/ml or CEA levels >5 ng/ml post-surgery with prior insufficient Dotatate scan
UTERINE	with prior inconclusive imaging	with prior inconclusive imaging

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ONCOLOGICAL INDICATIONS FOR FDG PET

(SEE SPECIAL TRACERS SECTIONS FOR INDICATIONS OTHER TRACERS)

CANCER TYPE	INITIAL STAGING	RESTAGING
UVEAL MELANOMA	**Not Indicated**	with prior inconclusive imaging
VAGINAL	Indicated	Indicated
VULVAR	≥T2 or after prior inconclusive imaging	Indicated

MISCELLANEOUS (NON-ONCOLOGIC) INDICATIONS FOR FDG PET

(excluding brain and cardiac PET which have separate Guidelines)

TYPE	INITIAL STAGING	RESTAGING
CASTLEMAN'S DISEASE	Indicated	Indicated
HISTIOCYTIC NEOPLASMS:		
• **Langerhan's**	Indicated	Indicated if on active treatment for multiple bone disease, high risk bone disease or multisystem involvement
• **Erdheim Chester**	Indicated	Indicated if on active treatment
• **Rosai-Dorfman**	Indicated	Indicated if on active treatment

***SARCOIDOSIS**

- ONLY if conventional testing (CXR, CT and inflammatory serology) remain inconclusive for known sarcoid to determine:
    - if treatment might be helpful
    - extent of disease, if it will potentially change management
    - response to treatment
- OR if strongly supected sarcoid to determine most suitable site to biopsy

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***VASCULITIS**

- In limited circumstances, with known vasculitis, AFTER conventional imaging (MRA/CTA/MR/CT) has clearly been shown to be insufficient to determine treatment

*****Adjudications should occur on a case-by-case basis

NON FDG PET TRACERS

GA68-DOTATATE, GA68-DOTATOC and CU64-DOTATATE FOR NET (Neuroendocrine Tumors)

CANCER TYPE	INITIAL STAGING	RESTAGING
CARCINOID **EXTRAPULMONARY LARGE AND SMALL CELL** **MEN-1/MEN-2 SYNDOMES** **NEUROENDOCRINE TUMORS (NET)** **PHEOCHROMOCYTOMA** **PARAGANGLIOMA**	• Indicated • PET/MR‡‡ can be considered	• Indicated • PET/MR‡‡ can be considered
MEDULLARY THYROID	Prior CT/ MRI insufficient to • Determine extent of treatment plan • Determine if candidate for invasive diagnostic/ therapeutic procedure • Determine optimal anatomic location for invasive procedure	When calcitonin levels ≥ 150 pg/ml or CEA levels >5 ng/ml post-surgery

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YTTRIUM-90 (Y90)

Y90 PET SCAN: Indicated when performed immediately after treatment of liver malignancy (primary or metastatic) with Y90 (usually within 24 hours while Y90 is still detectible). The Y90 treatment is the tracer for this PET (see Y90 background section).

PSMA TRACERS (such as F18 piflufolastat (Pylarify®), GA 68 PSMA-11, GA 68 gozetotide (Locametz®), and GA 68 gozetotide (Illuccix®)); F18 FLUCICLOVINE (AXUMIN®) and C11 CHOLINE

For PROSTATE CANCER

CANCER	INITIAL STAGING	RESTAGING
PROSTATE (PET/CT or PET/MRI‡‡) • After a negative Axumin® PET, a subsequent PSMA PET is not covered until a repeat PSA (done at least 3 months later) shows a progressive rise • 11-Choline should be approved only if PSMA and/or Axumin® are not available. Order of preference typically would be PSMA, then Axumin®, then 11-Choline	**Only PSMA** (not Axumin® or Choline) is indicated in initial staging for high risk; defined as 1 or more of the following: • Gleason 8, 9 or 10 (specimen contains pattern 4 or 5) • Gleason 7 IF primary pattern** is 4 (4+3=7) • Gleason 7 primary pattern 3 (3+4=7) must ALSO have a PSA >10 and/or cT2b-cT3c disease • Gleason 6 disease (3+3=6) must ALSO have a PSA > 20 and/or cT3a-cT4 disease • >50% cores positive for cancer in random biopsy **The Primary Pattern refers to the 1st number in the Gleason Pattern	For post-surgery/radiation in **suspected recurrence** with at least **two separate detectable PSA levels above the nadir** for that patient for: • **Axumin®** (or Choline) o Indicated if bone scan and CT/MRI are negative or inconclusive • **PSMA** (preferred tracer) o PSA < 10 Indicated o PSA > 10 Indicated if bone scan and CT/MRI are negative or inconclusive

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	Pelvic MRI can be approved concurrently if needed for surgical planning	For post surgery/radiation in **known recurrence, PSMA** is approvable if: • **Disease** was previously seen only on PSMA PET For **metastatic castrate resistant disease** that have failed both taxanes and ARDI, **PSMA** is approvable if: • Individual is a candidate for Lu-PSMA treatment (Pluvicto®) (must be clearly documented in note) • Restaging on Lu-PSMA treatment (Pluvicto®)

BACKGROUND

Inconclusive Imaging includes the following:

- Equivocal or ambiguous other prior standard imaging if results will change management
- Biopsy guidance (e.g., tumors with necrosis)
- High suspicion of metastases due to clinical or histopathological or laboratory considerations but with no evidence of metastases on standard initial staging
- Clinical or laboratory disease progression with negative standard imaging
- Contraindications to IV contrast, including allergy and chronic renal failure precluding MRI in a patient with a known or highly suspected malignancy
    - PET/CT may be indicated if CT cannot be performed due to significant iodinated contrast allergy or chronic renal failure **AND** MRI cannot be performed due to significant gadolinium contrast allergy or if renal failure with GFR < 30.[2]
- Evaluation for other distant metastases prior to surgical resection of limited metastases/local disease and otherwise negative prior standard imaging
- Response to neoadjuvant therapy when CT/MR insufficient
- Residual masses after completion of therapy
- Target definition for radiation planning
- If previous conventional imaging has been inconclusive, and it seems reasonable to expect that to still be the case, new conventional imaging is NOT required

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In situations where there is questionable disease in an area that requires significantly invasive procedures to obtain tissue (such as open surgical procedures), and malignancy is high on the radiographic differential diagnosis, it is reasonable and medically appropriate to attempt to gain as much information about diagnosis from imaging prior to subjecting the patient to tissue diagnosis that has real risk of morbidity/mortality.

Definition of Disease Progression:
For any signs of progression, as noted below, that could not be confirmed by other imaging, PET/CT is needed. Findings concerning for progression of disease include:

- Worsening of symptoms such as pain or dyspnea
- Evidence of worsening or new disease on physical examination
- Declining performance status
- Unexplained weight loss
- Increasing alkaline phosphatase, alanine aminotransferase (ALT), aspartate transaminase (AST), or bilirubin
- Hypercalcemia
- New radiographic abnormality or increase in the size of pre-existing radiographic abnormality
- New areas of abnormality on functional imaging (e.g., bone scan, PET/CT)
- Increasing tumor markers (e.g., carcinoembryonic antigen [CEA], CA 15-3, CA27.29)
- To help differentiate possible recurrent/active tumor from necrotic or inactive scar tissue, malignant from benign tissue, and nondescript benign changes.

PET and separate CT/MR: Positron emission tomography-Computed Tomography (PET/CT) is a rapidly developing and changing technology that is able to detect biochemical reactions, e.g., metabolism, or abnormal distribution of cell receptors within body tissues. A radioactive tracer is used during the procedure. Unlike other nuclear medicine examinations, PET/CT can measure metabolic activity of the cells of body tissues, providing information about the functionality and structure of the particular organ or tissue examined. PET/CT may also detect biochemical changes that help to evaluate malignant tumors and other lesions.

TYPICALLY, separate CT/MR scans being requested concurrently with a PET are not needed. There should be very few instances where separate studies are needed, and when this does happen, it is usually SITE-SPECIFIC. Most PET scanners now in use can “simultaneously” perform PET and CT (whether for CT Attenuation or a Diagnostic CT). Contrast can be given for the CT portion of the PET/CT. A separate request for diagnostic CTs in addition to PET is, therefore, not needed. The ordering MDO can specify to the imaging provider details about what type of CT scan is desired to be done with the PET portion. “Exceptions” generally occur when CT is needed in a plane other than standard axial imaging (for example: coronal CT for facial bone imaging that might be needed for surgical reconstruction). Separate MRIs are likewise rarely needed, but are perhaps somewhat more frequently needed than additional, separate CTs, since MRI does allow multiple imaging planes and may provide additional information. When

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evaluating for these “exceptions”, the reason additional separate imaging is needed should be clearly delineated before approval.

‡‡**PET/MR**: Patients with certain malignancies may benefit from PET/MRI since it detects brain and liver metastases better when compared with PET/CT. NCCN does suggest consideration of PET/MR in some malignancies, but not specifically for replacing PET/CT. PET/MRI should only be considered for those specific malignancies (see table for specific cancers) and in certain situations. Typically, PET/CT should suffice; however, under some circumstances, with clear explanation of why PET/MR is preferred rather than PET/CT, PET/MR may be an appropriate study.

Langerhans Cell Histiocytosis is the most common type of histiocytosis, with variable presentations and sites involvement. Some studies suggest PET/CT may be more effective in detecting bone lesions compared with MRI and bone scans in assessing disease response as healing/treatment changes of bone lesions on conventional imaging may be delayed. However, PET/CT is not the modality of choice in assessing disease response of lung or brain lesions.

Y90 PET Scans:
Hepatic radioembolization, involving intraarterial injection of yttrium-90 (Y90)-labeled glass or resin microspheres, is used for liver-dominant malignancy or metastases that are unresectable. A Tc99m MAA nuclear scan (typically requiring SPECT) is performed before the actual treatment with Y90. MAA, which is similar in size to the Y90 microspheres, mimics the distribution of the Y90 particles and should embolize within the tumor’s hepatic arterioles, thus outlining the expected localization of the radiation. The scan is compared to a CTA/MRA to evaluate for any possible shunting of the treatment agent to the lungs or the GI tract. Coils can be placed as needed to minimize any shunting of Y90 to areas other than the desired target.

Post-procedure imaging (within 24 hours) with either SPECT or **PET** (at the discretion of the treating physicians) is then performed to confirm the final distribution of the Y90 and to calculate the actual radiation dose delivered to the tumor. Utilizing the Bremsstrahlung radiation of the Y90 embolization agent, SPECT (or SPECT/CT) can be completed with routine nuclear medicine collimators. However, due to their higher energy level (as compared to routine nuclear medicine agents), the Y90 photons scatter and/or pass through the collimator septa and degrade the image quality. Alternatively, **PET scanning can be done, again using the Y90 treatment agent itself**, but for PET via a minor decay pattern that emits a positron (32 in every one million decays) that is detectable with PET scanners.

FDG PET may be needed later (ideally performed >12 weeks after treatment) to access tumor response to this radiation, in accordance with the tumor-specific gudielines for FDG PET restaging (in the table above) and may still require inconclusive conventional imaging, if necessary for the type of cancer being treated.

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POLICY HISTORY

Date	Summary
May 2022	• Updated changes based on NCCN including updates most notably for prostate cancer, Hurthle, NETs • Clarified when PET may be approved prior to biopsy for lung nodules and when PET is unnecessary (e.g., disease clearly present in both sides of chest and/or outside the chest) • Added indications for rare specific histiocytic syndromes and for sarcoid and vasculitis for non-oncological indications • Added restaging for RCC and pancreatic cancer in specific situations • Added indications for Y90 PET scan (liver malignancy) • Updated definitions of clinical guidelines (PET, PET/CT, and PET with CT Attenuation) • Minor wording clarifications, table adjustments
June 2021	Added: • Definitions • CART T info • PTLD information added • PET/MRI information • Updated/added details for Prostate cancer and PSMA, Axumin and Choline • Minor adjustments to the PET FDG table, such as added details from NCCN, clarifications, separation of non-malignant uses
May 2020	• Modified to table format • Added section of follow up of a new or interval growth of a mixed pulmonary lung nodule on subsequent LDCT (NCCN 2020) • Initial staging indicated o Changed AML to extramedullary disease (previously lymphomatous involvement) o Changed Breast cancer stage IIb and above (previously III and IV) o Added Castleman's disease o Added for Chronic Lymphocytic Leukemia to guide biopsy o Changed Mesothelioma to only prior to surgery for stage I-IIIA o Added "soft tissue" sarcoma in pediatric patient o Added Thymoma and thymic cancer

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	o Added Langerhans Cell Histiocytosis-predominantly osseous disease (previously not included) • Initial staging which is only indicated after prior inconclusive imaging (NCCN 2019/2020) o Added AIDS related Kaposi sarcoma o Changed Anal carcinoma (previously indicated) o Added Ewing sarcoma-osseous o Added Gestastional trophoblastic disease o Added Hepatocellular/Intrahepatic Cholangiocarcinoma (previously not included) o Added Fallopian tube and primary peritoneal cancer o Added Osteosarcoma-osseous o Changed Penile cancer (previously indicated with palpable nodes) • Initial staging NOT indicated (NCCN 2019/2020) o Changed testicular (previously indicated) o Added Uveal Melanoma o Added Langerhans Cell Histiocytosis-predominantly non-osseous disease (previously not included) • Restaging indicated (NCCN 2019/2020) o Added Castleman's disease o Added for accelerated Chronic Lymphocytic Leukemia and to guide biopsy o Added Gastric Cancer post radiation treatment o Changed Mesothelioma to only prior to surgery for stage I-IIIA o Added "soft tissue" to sarcoma in pediatric patient o Added Thymoma and thymic cancer o Added Langerhans Cell Histiocytosis-predominantly osseous disease (previously not included) • Restaging which are only indicated after prior inconclusive imaging (NCCN 2019/2020) o Removed for resectable disease in Colorectal cancer o Removed for if candidate for surgery/locoregional therapy for endometrial cancer o Specified Ewings sarcoma-osseous o Added Extrahepatic Cholangiocarcinoma (previously not indicated) o Added Gallbladder carcinoma (previously not indicated) o Changed Gastric Cancer to prior inconclusive imaging or if radiation planning considered (previously indicated if no metastasis or early disease) o Added Gestastional trophoblastic disease

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	o Added Hepatocellular/Intrahepatic Cholangiocarcinoma (previously not included) o Changed Ovarian cancer (previously indicated for greater than Stage I) o Added Fallopian tube and all stages of primary peritoneal cancer o Added Osteosarcoma- osseous o Added that for pheochromocytoma/ paraganglioma, extrapulmonary large/small cell, restaging FDG PET/CT can be done after inconclusive CT o Modified Seminoma with residual mass >3cm or 6 weeks post chemotherapy (previously indicated) o Added Uveal melanoma • Restaging NOT indicated (NCCN 2019/2020) o Added AIDS related Kaposi sarcoma o Changed Testicular non seminoma (previously indicated) o Added Langerhans Cell Histiocytosis-predominantly non-osseous disease (previously not included) • Added CT face/neck may be done in conjunction with PET when surgery or radiation is planned • Added to head and neck cancer that if a final PET is equivocal or borderline for residual disease PET, a repeat PET/CT a $\underline{\geq}$ 6 weeks may help identify those that can be safely observed without additional surgery • Medullary thyroid: added FDG restaging indicated when CEA >5ng/ml post-surgery and after prior insufficient Dotatate scan • Modified pancreatic cancer symptoms to excessive weight loss • Added to Seminoma: if final PET is equivocal or borderline for residual disease PET, a repeat PET/CT a $\underline{\geq}$ 6 weeks may help identify those that can be safely observed without additional surgery) • Thyroid FDG- changed serum thyroglobulin level to >2ng/ml (previously >5ng/ml) and added 'current OR two prior stimulated whole body I-131/ I-123 scans are negative (a current scan is needed if on radioiodine sensitizing medications)' • GA^{68} Dotatate- added restaging calcitonin levels ≥ 150 pg/ml or CEA levels >5 ng/ml post-surgery • F18 Fluciclovine (Axumin) o Initial staging changed to: With prior inconclusive bone scan with no CT/MRI correlate; or inconclusive bone SPECT/CT

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	○ Restaging changed to with rising/persistent PSA and after CT/MRI has been performed and is insufficient for detection of metastases • Added Inconclusive imaging features to background as noted in NCCN 2020 • Added Disease progression to Background as noted in NCCN 2020 • Added Section of Langerhans Cell Histiocytosis to background section
September 2019	• Removed Introduction section • Removed "Important Note" • Changed title "The following are noncovered for all other indications including (but not limited to):" to "The following are noncovered for F^{18} FDG, Ga^{68} Dotatate, F^{18} Fluciclovine (NCCN 2019):" • Under noncovered for F^{18} FDG, Ga^{68} Dotatate, F^{18} Fluciclovine section, added the following: ○ Breast cancer - Initial Staging for Stage I and II Breast Cancer ○ Melanoma - Initial and Restaging for Stage I and II Melanoma (NCCN 2016) ○ Bladder Cancer - non muscle invasive (by imaging or tissue sample) ○ Vulvar Cancer < T2 or no suspicion of metastatic disease ○ Prostate Cancer - Initial or Restaging ○ Small cell lung cancer - Staging (Initial or Restaging) for extensive disease ○ Ovarian Cancer - Restaging if stage I ○ Pancreatic Cancer - Restaging ○ Renal Cancer - Initial and Restaging ○ Skin Squamous Cell Carcinoma - Restaging ○ Gastric Cancer - Initial staging if there is evidence of metastases (M1), or very early disease (T1) ○ Malignant Pleural Mesothelioma - Initial staging except if stage I-IIIA and pre-surgical ○ Hepatocellular / Intrahepatic Cholangiocarcinoma - Initial and Restaging ○ Gallbladder/ Extrahepatic Cholangiocarcinoma - Restaging ○ Small bowel adenocarcinoma - Initial Staging ○ Chordoma – Restaging

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	o Adrenal (except pheochromocytoma/ paraganglioma) - Initial or Restaging o Smoldering Myeloma - except to discern smoldering from active myeloma with negative skeletal survey o ALL (Acute Lymphoblastic Leukemia)/ AML (Acute Myelogenous Leukemia) - Unless prior imaging suggests lymphomatous involvement o BCC (Basal Cell Carcinoma (of the skin)) o Infection and/or Inflammation: removed "- PET for chronic osteomyelitis, infection of hip arthroplasty, and fever of unknown origin." • Under indications for oncological PET heading, added: "Note: for radiation treatment planning, contact health plan directly" • Under Initial Treatment Strategy, the first sentence now specifies "active myeloma" instead of "myeloma" previously • Under Initial Treatment Strategy, the last sentence now replaces "after a" with "AND": "To determine the optimal anatomic location for an invasive procedure AND prior imaging insufficient" • "CLL – chronic lymphocytic leukemia (PET/CT is generally not useful in CLL/SLL but may be necessary to direct nodal tissue sampling when high-grade histologic transformation is suspected) (NCCN, 2018)." has been changed to "CLL (Chronic Lymphocytic Leukemia): only when high-grade histologic transformation is suspected (NCCN, 2018)" • Changed references for SPN to "(Bueno, 2018; MacMahon, 2017)" from previous "(Vansteenkiste, 2006)" • Removed the section: " Excluding • ALL- acute lymphoblastic leukemia o Unless prior CT imaging suggest lymphomatous involvement • AML – acute myelogenous leukemia o Unless clinical suspicion for extramedullary disease • BCC – basal cell carcinoma (of the skin) • Prostate cancer (NCCN, 2018)" • Added "EXCEPT for the following, which are only indicated after prior inconclusive imaging (NCCN 2019): o Colorectal o Ovarian/ fallopian o Sarcoma/ GIST/ Uterine/Rhabdomyosarcoma o Chordoma o Muscle invasive bladder cancer

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	o Endometrial Cancer o Penile (for palpable nodes only) o Occult Primary o Pancreatic Cancer (unless high risk features: borderline resectable, markedly elevated CA19-9 > 180 U/ml, large primary tumor/ lymph nodes) o Skin squamous Cell Carcinoma o Gallbladder/ Extrahepatic Cholangiocarcinoma o Poorly differentiated neuroendocrine tumors with prior negative Ga68 Dotatate/ MIBG/Octreotide scan (includes Pheochromocytoma/ paraganglioma, extrapulmonary large/small cell)" • Under subsequent Treatment Strategy, first line has been modified by adding parenthesis as follows: Restaging or monitoring response to active treatment (including immunotherapy)" • Under subsequent Treatment Strategy, changed "not to be performed within 4 weeks of completion of therapy (ideally F^{18} FDG, Ga^{68} Dotatate, F^{18} Fluciclovine PET is delayed 2 - 3months after surgical therapy, 2 - 3 months after radiation therapy if locoregional assessment is the imaging goal), and/or evaluation for suspicion of recurrence due to new or changing signs/symptoms. (Asymptomatic surveillance is not approvable) (NCCN, 2018)." to "The interval should ideally be 6 - 12 weeks after surgery, and 12 weeks after radiation. PET can be performed 1-3 weeks after neoadjuvant chemotherapy or neoadjuvant chemoradiation to assess stage for surgery. PET evaluation can also be done for suspicion of recurrence due to new or changing signs/symptoms or rising tumor markers, or inconclusive findings on CT. Asymptomatic surveillance is not approvable. (NCCN 2018, 2019)" • List of cancers under subsequent imaging (without needing prior inconclusive imaging) has been changed. The following were removed: Breast cancer (female and males), colorectal cancer (including colon, rectal, appendiceal or anal cancer), ovarian cancer. The following were changed as follows: • "Lung cancer - Non-small cell" to "Lung cancer - Non-small cell and limited stage small cell cancer" • "Esophageal cancer" to "Esophageal and esophagogastric cancer" • "Melanoma" to Melanoma- only stage III, IV (excludes uveal melanoma) • "Myeloma to "Active Myeloma/plasmacytoma"

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	• Added for Soft tissue sarcoma: “only stage II/III for response to neoadjuvant Rx” • Added Merkel cell carcinoma • Added “Mesothelioma, if also presurgical” • Individual References were removed for soft tissue sarcoma and vulvar/ vaginal cancer. • Statement regarding subsequent PET scans needing prior inconclusive imaging has been modified from “only” if other imaging (ie. US, CT, MRI, NM) is inconclusive in determining a treatment plan or unable to be performed “ to “ only if other imaging (ie. US, CT, MRI, NM) is inconclusive/ insufficient in determining a treatment plan or unable to be performed or with rising tumor markers and negative/ insufficient other imaging. PETCT is to be used only if the cancer is known to be generally F^{18} FDG, Ga^{68} Dotatate, F^{18} Fluciclovine avid. It may be indicated if iodinated and gadolinium contrast are both contraindicated due to significant allergy or chronic renal failure without dialysis (NCCN 2019). “ • Under subsequent PET scans needing prior inconclusive imaging, the following were changed: o Added: Breast cancer (female and males), Bladder cancer, only if metastatic, Colorectal Cancer – resectable metastatic disease only, Anal/ Vulvar/ Penile Carcinoma, Bone Sarcoma, Sarcoma/ GIST/ Uterine/Rhabdomyosarcoma, Ovarian/ malignant germ cell tumors/primary peritoneal cancer – Stage II-IV, Endometrial cancer if candidate for surgery/locoregional therapy; Poorly differentiated Cancers, or Dedifferentiated neuroendocrine tumors with prior negative Ga68 Dotatate/ MIBG/Octreotide scan • Removed: prostate cancer, pancreatic cancer, individual references for cancers • Changed: “Lung cancer -Small cell” to “Extensive small cell lung cancer”; “Tumor of unknown Origin” to “Occult primary”; “Neuroendocrine cancer (e.g. carcinoid, pheochromocytoma, etc)” to “Poorly differentiated or dedifferentiated neuroendocrine tumors with prior negative Ga68 Dotatate/ MIBG/Octreotide scan (includes Pheochromocytoma/ paraganglioma, extrapulmonary large/small cell)”. • Last sentence has been changed from “Other malignancies where the tumor has been shown to be F^{18} FDG, Ga^{68} Dotatate, F^{18} Fluciclovineavid on prior PET/CT imaging if done, and other imaging (ie: US, CT, MRI, NM) is inconclusive in determining a

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	treatment plan or unable to be performed " to "Other malignancies where other imaging (i.e., US, CT, MRI, NM) is inconclusive in determining a treatment plan or unable to be performed." • Under thyroid Cancer, o Added references "(NCCN 2019, ATA 2015)" to subsequent treatment strategy for papillary/follicular/ hurthle cancers ▪ Changed "Stimulated serum thyroglobulin > 2 ng/ml" to "Stimulated serum thyroglobulin > 5 ng/ml or high anti- thyroglobulin antibody (anti-Tg Ab) > 1 year after treatment (Na SJ 2012)" ▪ Changed "Current whole body I-131 scan is negative (Kloos, 2005)" to "Current stimulated whole body I-131/ I-123 scan is negative (Alzahranj 2012)" o Changed "Medullary thyroid cancer when calcitonin levels > 150 pg/ml post-operatively (Wells, 2015)" to "Medullary thyroid cancer when calcitonin levels ≥ 150 pg/ml post primary treatment (NCCN 2019, Souteiro 2019)" o Changed "Anaplastic 3-6 months after initial treatment, 3-6 month interval if persistent structural disease (Smallridge, 2012)" to "Anaplastic: Initial and Restaging after prior inconclusive/ insufficient CT/MRI (NCCN 2019)" • Added pediatric cancers section as follows: "PEDIATRIC CANCERS (for indications different from adult guidelines): o Sarcoma - Initial and Restaging (Quartuccio 2015) o Neuroblastoma/ other cancers under Ga68 imaging: only with prior negative/ inconclusive MIBG/ Octreotide/ Ga68 PETCT (Uslu 2015, Alexander 2018, Kong 2016, Li 2018, Elkhatib 2017) o Nasopharyngeal Cancer- Initial staging after inconclusive/ insufficient MRI; Restaging. (Cheuk 2012) • For Gallium 68 Dotatate PET: o Added references for initial or subsequent treatment strategy: (NCCN 2019, Deppen, 2016 a, b) o Added under neuroendocrine tumors: "Medullary Thyroid Cancer for Initial staging; and Restaging when calcitonin ≥ 150 pg/ml"

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	○ Modified last part of the last sentence as follows: "and rising biomarkers (asymptomatic surveillance is not approvable). " • Under 18F-Fluciclovine PET/CT SCAN: ○ Added "(Axumin)" after 18F-Fluciclovine ○ Removed reference "(Bach-Gansmo, 2017)" ○ Changed "18F-Fluciclovine PET/CT scans should be performed only if other imaging (CT, MRI, US, NM) is inconclusive/insufficient AND the patient has not already been evaluated with an F18 FDG, Ga68 Dotatate, F18 Fluciclovine PET/CT Scan" to "Known prostate cancer for workup of recurrence and response to treatment, only if other imaging (CT, MRI) AND Bone scan is inconclusive/ insufficient. (NCCN 2019, Andriole 2019, Bach-Gansmo 2017)" ○ Removed:" Known prostate cancer for workup of recurrence and response to treatment:" ○ "Initial treatment by radical prostatectomy with" was replaced by "Post radical prostatectomy with" ○ "Initial treatment radiation therapy with" was replaced by "Post radiation therapy with" ○ "Post-RT rising PSA or positive digital exam and is candidate for local therapy" was replaced by "rising/persistent PSA (increase should be >2ng/ml unless doubling time ≤ 8 months or pt is a candidate for local salvage therapy)" • Removed: "NOTE: Not all plans cover 18F-Fluciclovine (A9588), such as Magellan Complete Care of Florida and Magellan Complete Care of Arizona. If you are unsure, you should check with the Health Plan prior to requesting a PET with Fluciclovine from NIA." • Added Background section as follows: "BACKGROUND: Positron emission tomography (PET) is a rapidly developing and changing technology that is able to detect biochemical reactions, e.g., metabolism, or abnormal distribution of cell receptors within body tissues. A radioactive tracer is used during the procedure. Unlike other nuclear medicine examinations, PET can measure metabolic activity of the cells of body tissues, providing information about the functionality and structure of the particular organ or tissue examined. PET may also detect biochemical changes that help to evaluate malignant tumors and other lesions.

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	The degree of radioactive tracer uptake may indicate increased metabolism in the cells of body tissues or an abnormal distribution of cell receptors. Cancer cells may show increased radioactive tracer relative to tissue not involved with tumor. Radioactive tracer uptake is often higher in fast-growing tumors; PET is often not as beneficial for slow growing tumors. Radioactive tracer uptake may occur in various types of active inflammation and is not specific for cancer."

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Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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MAGELLAN HAWAI'I

Specific policy administered by National Imaging Associates, Inc. (NIA)

Clinical guidelines STRESS ECHOCARDIOGRAPHY	
CPT Codes: 93350, 93351, +93320, +93321, +93325, +93352, +93356	**Original Date:** February 2023
Guideline Number: NIA_CG_026	**Last Revised Date:** February 2023
	Last Reviewed Date (by NIA): February 2023
	Implementation Date: April 2023

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

This guideline is for stress imaging, specifically Stress Echocardiography (SE) with appropriate preference for suitable alternatives, such as an exercise treadmill exam without imaging, when more suitable, unless otherwise stated (refer to Overview section).

INDICATIONS for STRESS ECHO

SUSPECTED CORONARY ARTERY DISEASE (CAD)

Symptomatic patients without known CAD (use Diamond Forrester table)

- Low pretest probability and interpretable ECG: ECG treadmill stress test first is appropriate
- Intermediate/High pretest probability and interpretable ECG: stress echo is appropriate
- Repeat testing in patient with new or worsening symptoms and negative result at least one year ago AND meets one of the criteria above

Asymptomatic patients without known CAD

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- Previously unevaluated ECG evidence of possible myocardial ischemia including ischemic ST segment or T wave abnormalities (See Overview section)
- Previously unevaluated pathologic Q waves (See Overview Section)
- Previously unevaluated complete left bundle branch block

ABNORMAL CALCIUM SCORES (CAC)[1-5]

- ASYMPTOMATIC patient with a calcium score > 400, not previously evaluated

INCONCLUSIVE CAD EVALUATION WITHIN THE PAST 2 YEARS AND OBSTRUCTIVE CAD REMAINS A CONCERN

- Exercise stress ECG with low risk Duke treadmill score ≥5, but patient's current symptoms indicate an intermediate or high pretest probability
- Exercise stress ECG with an intermediate Duke treadmill score
- Intermediate coronary computed tomography angiography (CCTA) defined as:
    - 40 -70% lesion

FOLLOW-UP OF PATIENTS POST CORONARY REVASCULARIZATION (PCI or CABG)[6]

- **Asymptomatic, follow-up stress imaging** (MPI or SE), at a minimum of 2 years post coronary artery bypass grafting (CABG), or percutaneous coronary intervention (PCI), whichever is later, is appropriate for patients with a history of silent ischemia or a history of a prior left main stent[3] OR
- For patients with high occupational risk including any of the following:
    - Associated with public safety
    - Airline and boat pilots
    - Bus and train drivers
    - Bridge and tunnel workers/toll collectors
    - Police officers and firefighters
- **New, recurrent, or worsening symptoms post coronary revascularization** is an indication for stress imaging

FOLLOW-UP OF KNOWN CAD

- **Routine follow-up of asymptomatic or stable symptoms** when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR ≤ 0.80 or stenosis greater than or equal to 70% of a major vessel), over two years ago without intervening coronary revascularization, is an appropriate indication for stress imaging (MPI or SE)

SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION

- Prior acute coronary syndrome (with documentation in MD notes), within last three months, without a prior stress test or coronary angiography performed since that time
- Newly diagnosed systolic heart failure or diastolic heart failure, ***with reasonable suspicion of cardiac ischemia (prior events, risk factors*)**, unless invasive coronary angiography is immediately planned[1, 7]
- Ventricular arrhythmias:

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    - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise-induced VT, when invasive coronary arteriography has not been performed[8]
    - Nonsustained VT, multiple episodes, each ≥ 3 beats at ≥ 100 bpm, frequent PVCs (defined as greater than or equal to 30/hour on remote monitoring), when an exercise ECG cannot be performed[9]
- For intermediate and high risk global patients who require initiation of Class IC antiarrhythmic drugs. It can be performed annually thereafter until discontinuation of drug use[10]
- Hemodynamic assessment of ischemia in one of the following documented conditions:
    - Anomalous coronary arteries in an asymptomatic individual without prior stress echocardiography[11];
    - Myocardial bridging of a coronary artery[12]
- Coronary aneurysms in Kawasaki's disease[13]
- Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter[14]

CHRONIC VALVULAR DISEASE

Evaluation with Inclusion of Doppler[15-18]

- Dobutamine SE for the evaluation of aortic stenosis and flow (contractile) reserve in symptomatic patients with severe aortic stenosis by calculated valve area, low flow / low gradient, and ejection fraction < 50%
- Exercise echo Doppler evaluation for mitral stenosis (MS) if there is:
    - Exertional shortness of breath which suggests the amount of MS is worse than is seen on the resting echocardiogram
- Exercise echo Doppler evaluation for mitral regurgitation (MR) if there is:
    - Exertional shortness of breath which suggests the amount of MR is worse than is seen on the resting echocardiogram; **OR**
    - The echocardiogram is not able to distinguish whether the MR is moderate or severe in a patient that is asymptomatic
- For symptomatic patients with HCM, who do not have resting or provocable outflow tract gradient ≥50 mm Hg on TTE, for detection and quantification of dynamic LVOT obstruction[19]
- For asymptomatic patients with HCM who do not have a resting or provocable outflow tract gradient ≥ 50 mm Hg on TTE (Class 2A)

PRIOR TO ELECTIVE NON-CARDIAC SURGERY[20-23]

- An intermediate or high risk surgery with of one or more risk factors (see below), AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year[22, 24, 25]

    - **Risk factors:** history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dL.
    - **Surgical Risks:**

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- **High risk surgery:** Aortic and other major vascular surgery, peripheral vascular surgery, anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss
- **Intermediate risk surgery:** Carotid endarterectomy, head and neck surgery, intraperitoneal and intrathoracic surgery, orthopedic surgery, prostate surgery
- **Low risk surgery**: Endoscopic procedures, superficial procedure, cataract surgery, breast surgery

- Planning for any organ or stem cell transplantation is an indication for preoperative stress imaging, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, at the discretion of the transplant service. [23, 26]

POST CARDIAC TRANSPLANTATION

- Annually, for the first five years post cardiac transplantation, in a patient not undergoing invasive coronary arteriography
- After the first five years post cardiac transplantation, patients with documented transplant coronary vasculopathy can be screened annually unless invasive coronary arteriography is planned

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BACKGROUND

Stress echocardiography (SE) refers to ultrasound imaging of the heart during exercise electrocardiography (ECG) testing, during which visualized wall motion abnormalities can provide evidence of potential significant coronary artery disease (CAD).

While drug-induced stress with dobutamine can be an alternative to exercise stress testing in patients who are unable to exercise, this guideline does not require use of this modality. Hence, reference in this document to SE predominantly refers to exercise stress echocardiography.

Although SE provides comparable accuracy without radiation risk, relative to myocardial perfusion imaging (MPI), scenarios which do not permit effective use of SE might be better suited for stress imaging with MPI, cardiovascular magnetic resonance imaging (CMR) or positron emission tomography (PET), or coronary computed tomography angiography (CCTA).

Stable patients without known CAD fall into 2 categories[3, 23, 27]:

- **Asymptomatic patients**, for whom Global Risk of CAD events can be determined from coronary risk factors using calculators available online (see Websites for Global Cardiovascular Risk Calculators section)
- **Symptomatic patients,** for whom we estimate the Pretest Probability that their chest-related symptoms are due to clinically significant CAD (see below):

The 3 Types of Chest Pain or Discomfort:

- **Typical Angina (Definite)** is defined as including all **3** of these characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration, such as:
    - Pressure-like
    - Radiating

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        - Dull or aching
    - Provoked by exertion or emotional stress
    - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0-1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, the Pretest Probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability[3, 27]:

Diamond Forrester Table

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very low:** < 5% pretest probability of CAD, usually not requiring stress evaluation[27]
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

OVERVIEW

MPI may be performed without diversion to SE in any of the following[3, 28]:

- Inability to exercise
    - Physical limitations precluding ability to exercise for at least 3 full minutes of Bruce protocol
    - Limited functional capacity (< 4 metabolic equivalents) **such as one** of the following:
        - Cannot take care of their activities of daily living (ADLs) or ambulate
        - Cannot walk 2 blocks on level ground
        - Cannot climb 1 flight of stairs
        - Cannot vacuum, dust, do dishes, sweep, or carry a small grocery bag
- Other Comorbidities
    - Severe chronic obstructive pulmonary disease with pulmonary function test (PFT) documentation, severe shortness of breath on minimal exertion, or requirement of home oxygen during the day

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    - Poorly controlled hypertension, with systolic BP > 180 or Diastolic BP > 120 (and clinical urgency not to delay MPI)
- ECG and Echo-Related Baseline Findings
    - Prior cardiac surgery (coronary artery bypass graft or valvular)
    - Documented poor acoustic imaging window
    - Left ventricular ejection fraction ≤ 40%
    - Pacemaker or ICD
    - Persistent atrial fibrillation
    - Resting wall motion abnormalities that would make SE interpretation difficult
    - Complete LBBB
- Risk-related scenarios
    - High pretest probability in suspected CAD
    - Intermediate or high global risk in patients requiring type IC antiarrhythmic drugs (prior to initiation of therapy and annually)
    - Arrhythmia risk with exercise
- Previously unevaluated pathologic Q waves (in two contiguous leads) defined as the following:
    - > 40 ms (1 mm) wide
    - > 2 mm deep
    - > 25% of depth of QRS complex

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) are inferred from the guidelines presented above, often requiring that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate **AND** has an interpretable ECG for ischemia during exercise[3]:

- The (symptomatic) low or intermediate pretest probability patient who is able to exercise and has an interpretable ECG
- The patient who is under evaluation for exercise-induced arrhythmia[8]
- For the evaluation of syncope or presyncope during exertion[29]
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription.

Duke Exercise ECG Treadmill Score[30]

Calculates risk from ECG treadmill alone**:**

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting.
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤ -11) categories.

An uninterpretable baseline ECG includes[27]:

- ST segment depression 1 mm or more; (not for non-specific ST- T wave changes)
- Ischemic looking T wave -- at least 2.5 mm inversions (excluding V1 and V2)

- LVH, pre excitation pattern such as WPW, a ventricular paced rhythm, or left bundle branch block
- Digitalis use
- Resting HR under 50 bpm on a medication, such as beta-blockers or calcium channel blockers, that is required for patient's treatment and cannot be stopped, with an anticipated suboptimal workload

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years. High global risk by itself generally lacks scientific support as an indication for stress imaging. There are rare exemptions, such as patients requiring IC antiarrhythmic drugs, who might require coronary risk stratification prior to initiation of the drug.

- **CAD Risk—Low**
  10-year absolute coronary or cardiovascular risk less than 10%.
- **CAD Risk—Moderate**
  10-year absolute coronary or cardiovascular risk between 10% and 20%.
- **CAD Risk—High**
  10-year absolute coronary or cardiovascular risk of greater than 20%.

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Websites for Global Cardiovascular Risk Calculators*

*Patients who have known CAD are already at high global risk and are not applicable to the calculators.[31-35]

Risk Calculator	Link to Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

Definitions of Coronary Artery Disease[2, 23, 27, 36, 37]

- Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and refers to cross-sectional narrowing when IVUS (intravascular ultrasound) is the method of determination
- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. Its incorporation into Global Risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate), generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[38]
    - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum lumen cross-sectional area on IVUS ≤ 6 square mm[27, 37, 39]
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[37, 39]
- FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow

Anginal Equivalent[27, 29, 40]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia). This may include respiratory rate, oximetry, lung exam,

etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope per se is not an anginal equivalent.

Abbreviations

AAD	Antiarrhythmic drug
ADLs	Activities of daily living
BSA	Body surface area in square meters
CABG	Coronary artery bypass grafting surgery
CAC	Coronary artery calcium
CAD	Coronary artery disease
CCTA	Coronary computed tomography angiography
CMR	Cardiovascular magnetic resonance imaging
CT(A)	Computed tomography (angiography)
DTS	Duke Treadmill Score
ECG	Electrocardiogram
FFR	Fractional flow reserve
HCM	Hypertrophic cardiomyopathy
IVUS	Intravascular ultrasound
LBBB	Left bundle-branch block
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
LVOT	Left ventricular outflow tract
MESA	Multi-Ethnic Study of Atherosclerosis
MET	Estimated metabolic equivalent of exercise
MI	Myocardial infarction
MPI	Myocardial perfusion imaging
MR	Mitral regurgitation
MS	Mitral stenosis
PCI	Percutaneous coronary intervention
PET	Positron emission tomography
PFT	Pulmonary function test
PVCs	Premature ventricular contractions
SE	Stress echocardiography
TTE	Transthoracic echocardiography
VT	Ventricular tachycardia
VF	Ventricular fibrillation
WPW	Wolff-Parkinson-White

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POLICY HISTORY

Date	Summary
February 2023	• Under Symptomatic patients without known CAD: removed "Low or intermediate pretest probability, and electrocardiogram (ECG) is uninterpretable" and "High pretest probability" and added "Low pretest probability and interpretable ECG: ECG treadmill stress test first is appropriate" and "Intermediate/High pretest probability and interpretable ECG: stress echo is appropriate" • Removed "Symptomatic patient with prior CAC ≥ 100" under Abnormal Calcium Scores (CAC)
February 2022	• Moved the sentence regarding utilization of suitable alternatives such as Stress Echocardiography and MPI to the General Information section • Clarified "intermediate lesions are 50-69%" for ischemia-producing disease • Placed Link to Overview Section in General Information • Deleted the requirement for diabetes when calcium score > 400 for stress imaging • Added Calcium score section: o Added stress imaging approval for calcium score > 100 with symptoms consistent with low to intermediate pretest probability • Changed preoperative guideline to include intermediate risk surgery with one or more risk factors AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year • Changed solid organ transplant guideline to include stem cell transplant and "any" organ transplant • Added definition of surgical risk to preop guidelines • In Background section clarified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain. " • Added definition of Q waves • Deleted sentence regarding calcium scoring within the Global Risk Section • Deleted sentence regarding using calcium score solely for risk stratification • Deleted IFR references
March 2021	• Wording changes to align with MPI • Added annual studies for patients on Flecainide • Added indication for Ca score in diabetic > 40 and calcium score > 400 with reference added • Added indicatios and reference for hypertrophic cardiomyopathy • Removed BMI > 40 as indication to allow MPI over SE

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August 2020	• For asymptomatic patients without a history of CAD, the wording for previously unevaluated was changed for Q waves and complete BBB • For newly diagnosed systolic heart failure (EF < 50%), when invasive coronary angiography has not been performed, especially when symptoms or signs of ischemia are present or suspected were further defined to state such as: o Chest pain o EKG changes such as new ST segment depression or T wave inversions o New wall motion abnormalities • Stress echo with Doppler indication further defined as exertional shortness of breath which suggests the amount of MS is worse than is seen on the resting echocardiogram • After the first five years post cardiac transplantation, patients with transplant coronary vasculopathy can be screened annually with ONE of the following: o MPI o SE o Left heart catheterization •
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added clarification of repeat testing in a patient with new or worsening symptoms and negative result at least one year prior to include the statement “AND meets one of the criteria above” • Added clarification of frequent PVCs under ventricular arrhythmias which states defined as greater than or equal to 30/hour to include “on remote monitoring” • Edited indication of planning for solid organ transplantation to remove the requirement of limited functional capacity but maintaining requirement of ≥ 3 listed risk factors • Added edits to the Coronary Artery Disease definition section • Updated and added new references
November 2019	• Added CPT code +93356
July 2019	• Stress echo for suspected CAD deleted the following indication: Repeat testing in patient with recurrent symptomatic presentation and negative result over 2 years ago • Added indications: ‘For assessment of hemodynamic significance due to atherosclerosis or following radiation therapy to the anterior or left chest, at 5 years post initiation inception of radiation and every 5 years thereafter’; and ‘Following radiation therapy to the anterior or left

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	chest, at 5 years post initiation inception of radiation and every 5 years thereafter' • Removed secondary mitral regurgitation indication under doppler evaluation section • Clarified indication as follows: Routine follow-up of asymptomatic or stable symptoms when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR less than or equal to 0.80 or stenosis greater than or equal to 70% of a major vessel) over two years ago without intervening coronary revascularization is an appropriate indication for stress imaging (MPI or SE) in patients if it will alter management •

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Reviewed / Approved by NIA Clinical Guideline Committee

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Clinical guidelines **HEART CATHETERIZATION**	**Original Date: February 2010**
CPT Codes: 93452, 93453, 93454, 93455, 93456, 93457, 93458, 93459, 93460, 93461, +93462, +93463, +93464, +93565, +93566, +93567, +93568	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_065	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR INVASIVE CORONARY ARTERIOGRAPHY[1-5]

General

- New onset or worsening of the patient's previously known anginal symptoms in a patient with a history of CABG or PCI
- Symptomatic patients with a high pretest probability
- Unheralded syncope (not near syncope), where the etiology is unclear

Stable Ischemic Heart Disease

- Exercise electrocardiogram (ECG) stress test with high-risk findings, such as Duke Score ≤ -11, ST segment elevation, hypotension, exercise-induced ventricular tachycardia (VT), or several minutes of ST segment depression post exercise[3]
- Stress imaging with high-risk findings (see Background section)
- Stress imaging with intermediate risk findings (see Background section) in a patient with one of the following:
    - Symptoms consistent with ischemia[3]
    - Unsatisfactory quality of life due to angina[2]
    - Ejection fraction (EF) < 50%[2]
- Non-invasive test with low-risk findings with new, worsening, or limiting symptoms with reasonable suspicion of cardiac origin despite optimal medical therapy (OMT) or inability to tolerate OMT[1-3]

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- New, worsening, or limiting symptoms, with known unrevascularized obstructive coronary artery disease (CAD), in a patient eligible for revascularization[1, 2]
- Discordant, equivocal, or inconclusive non-invasive evaluation in patients with suspected symptomatic stable ischemic heart disease, including the following[3, 5, 6]:
    - Low risk stress imaging with high-risk stress ECG response or stress induced typical angina[3]
    - Equivocal, uninterpretable, or inconclusive stress imaging due to issues of attenuation or other problems with interpretability[2, 3]

CCTA Abnormalities

- Symptomatic patient with one of the following[2-4]:
    - One vessel with ≥ 50% stenosis
    - A stenosis of 40-90% and FFR-CT ≤0.8[7]
    - ≥ 50% left main stenosis, **even if asymptomatic**

Heart Failure with Left Ventricular Dysfunction

- New heart failure, cardiomyopathy, or wall motion abnormality in patients who are candidates for coronary revascularization; including one of the following[2, 3, 5, 8, 9]:
    - Newly recognized heart failure in patients with known or suspected CAD
    - Symptomatic heart failure or ischemia with new, unexplained wall motion abnormality[2, 3]
    - Structural abnormality (severe mitral regurgitation or ventricular septal defect) with reason to suspect ischemic origin
    - Deterioration in clinical status of heart failure or cardiomyopathy requiring invasive evaluation for guidance or alteration in therapy
    - Clarification of the diagnosis of myocarditis versus acute coronary syndrome[10]

Ventricular Arrhythmias

- Ventricular arrhythmias, without identified non-cardiac cause:
    - Following recovery from unexplained sudden cardiac arrest[11]
    - Sustained VT or VF[3]
    - Exercise-induced VT[3]

Prior to Non-Coronary Intervention and Cardiac Surgery

- Evaluation of coronary anatomy, with consideration of coronary revascularization, prior to cardiac surgery in patients with any of the following[12-16]:
    - Symptoms of angina
    - Stress imaging with evidence of ischemia
    - Decreased LV systolic function (EF < 50%)
    - History of CAD
    - Coronary risk factors, including men > 40 and postmenopausal women
    - Non-invasive data that is inconclusive
    - Chronic severe secondary mitral regurgitation

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- Requirement for detailed assessment of coronary artery anatomy prior to aortic valve homograft surgery, pulmonary autograft (Ross procedure), or aortic root procedure
- Patients undergoing transcatheter aortic valve replacement (TAVR) or other transcatheter valve procedures
- Can be done pre-organ transplant when required by transplant center protocol in place of, but not in addition to an imaging study

Hypertrophic Cardiomyopathy

- Patients with HCM, who are candidates for SRT, and for whom there is uncertainty of LVOT obstruction on noninvasive imaging studies, invasive hemodynamic assessment with cardiac catheterization is recommended[17]
- In patients with symptoms or evidence of myocardial ischemia (CCTA also allowed)
- Prior to surgical myectomy in HCM patients who are at risk for coronary atherosclerosis (CCTA also allowed)

Post Cardiac Transplantation[18]

- Assessment for allograft vasculopathy annually for the first 5 years, followed by annual assessment in those with documented allograft vasculopathy, if stress imaging has not been performed
- Assessment of change in clinical status, including any of the following, if stress imaging has not been performed:
  - New left ventricular dysfunction
  - Symptoms of ischemia
  - Non-invasive findings of ischemia

Hemodynamic Assessment

- Indications for angiographic and/or hemodynamic assessment of valvular function or shunt physiology[3, 12, 19]
  - Assessment of bioprosthetic valve when transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) were inadequate, and cardiac magnetic resonance (CMR) or cardiac computed tomography (CCT) are not available
  - Assessment of mechanical valve prostheses when TTE and TEE are inadequate and CCT is not available
  - Discordance between non-invasive data and clinical impression of severity of valvular disease
  - Evaluation of indeterminate shunt anatomy or shunt flows/ratio
- Indications for hemodynamic assessment only[3, 19]
  - Assessment of constrictive and restrictive physiology
  - Assessment of pulmonary hypertension when non-invasive data provides inadequate information for management, or to evaluate response to intravenous drug therapy

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- Assessment of hemodynamics in heart failure, cardiomyopathy, or adult congenital heart disease, when
  - Non-invasive data is discordant or conflicts with the clinical presentation
  - Non-invasive data is inadequate for clinical management

These guidelines only cover procedures that include left heart catheterization. NIA does not manage right heart catheterization as a stand-alone procedure.

BACKGROUND

Heart catheterization is an invasive angiographic procedure used to evaluate the presence and extent of coronary artery disease (CAD).

In addition to angiography, it can also include ventriculography, aortography, acquisition of hemodynamic data, measurement of cardiac output, detection and quantification of shunts and flows, intravascular ultrasound (IVUS), and fractional flow reserve (FFR)/instantaneous wave free ratio (iFR) for determination of a lesion's hemodynamic severity. CAD stenosis ≥70% (≥50% in the left main coronary artery) is considered clinically significant or obstructive CAD.[2, 5, 6, 20]

This guideline applies to patients with a stable clinical presentation, not to those with acute coronary syndromes or acute valvular abnormalities.

In stable patients, preliminary evaluation with non-invasive cardiac testing is usually indicated prior to a recommendation for cardiac catheterization.

Stable Patients without Known CAD fall into 2 categories[2, 5, 6]:

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see Global Cardiovascular Risk Calculators section).
- **Symptomatic,** for whom the pretest probability that chest-related symptoms are due to clinically significant CAD is estimated.

The Three Types of Chest Pain or Discomfort and Pretest Probability of CAD

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Non-anginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

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Once the type of chest pain has been established from the medical record, the pretest probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability.[2, 5]

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Non-anginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

Coronary Risk Categories Derived from Non-invasive Testing[2, 4]

- **High risk (> 3% annual death or MI)**
    - Severe resting left ventricular (LV) dysfunction (LVEF < 35%) not readily explained by non-coronary causes
    - Resting perfusion abnormalities ≥ 10% of the myocardium in patients without prior history or evidence of myocardial infarction (MI)
    - Stress ECG findings including ≥ 2 mm of ST-segment depression at low workload or persisting into recovery, exercise-induced ST-segment elevation, or exercise-induced ventricular tachycardia (VT)/ventricular fibrillation (VF)
    - Severe stress-induced left ventricular (LV) dysfunction (peak exercise EF < 45% or drop in EF with stress ≥ 10%)
    - Stress-induced perfusion abnormalities involving ≥ 10% myocardium or stress segmental scores indicating multiple abnormal vascular territories
    - Stress-induced LV dilation. Transient ischemic dilation (TID) is the ratio of left ventricular area immediately post-exercise divided by the area of the 4-hour redistribution image, with an abnormal ratio defined as > 1.12[21]
    - Inducible wall motion abnormality (involving ≥ 2 segments or ≥2 vascular territories)

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- Wall motion abnormality developing at low dose of dobutamine (≤ 10 mg/kg/min) or at a low heart rate (< 120 beats/min)
- Multivessel obstructive CAD (≥ 70% stenosis) or left main stenosis (≥ 50% stenosis) on CCTA

- **Intermediate risk (1% to 3% annual death or MI)**
  - Mild or moderate resting LV dysfunction (EF 35% to 49%) not readily explained by non-coronary causes
  - Resting perfusion abnormalities in 5% to 9.9% of the myocardium in patients without a history or prior evidence of MI
  - ≥1 mm of ST-segment depression occurring with exertional symptoms
  - Stress-induced perfusion abnormalities involving 5% to 9.9% of the myocardium or stress segmental scores (in multiple segments) indicating 1 vascular territory with abnormalities but without LV dilation
  - Inducible wall motion abnormality involving 1 segment or 1 vascular territory
  - CAC score 100 to 399 Agatston units (only for use in primary prevention, not for heart catheterization decision making)[2, 3, 6, 22]
  - One vessel CAD with ≥ 70% stenosis or moderate CAD stenosis (50% to 69% stenosis) in ≥ 2 arteries on CCTA

- **Low risk (< 1% annual death or MI)**
  - Low-risk treadmill score (score ≥ 5) or no new ST segment changes or exercise-induced chest pain symptoms, when achieving maximal levels of exercise
  - Normal or small myocardial perfusion defect at rest or with stress involving < 5% of the myocardium
  - Normal stress or no change of baseline wall motion abnormalities during stress
  - CAC score < 100 Agatston units (only for use in primary prevention, not for heart catheterization decision making)[2, 3, 6, 22]
  - No coronary stenosis > 50% on CCTA

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years. **High global risk by itself generally lacks scientific support as an indication for stress imaging**.[23] There are rare exemptions, such as patients requiring I-C antiarrhythmic drugs, who might require coronary risk stratification prior to initiation of the drug, when global risk is moderate or high.

- **CAD Risk—Low**

` 10-year absolute coronary or cardiovascular risk less than 10%

- **CAD Risk—Moderate**

  10-year absolute coronary or cardiovascular risk between 10% and 20%

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- **CAD Risk—High**
  10-year absolute coronary or cardiovascular risk of greater than 20%

Websites for Global Cardiovascular Risk Calculators
Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.[22, 24-27]

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

Definitions of Coronary Artery Disease[2, 4, 6, 28]

- Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).
- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. It is not a diagnostic tool so much as it is a **risk stratification** tool. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[29]

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    - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum luminal cross-sectional area on IVUS ≤ 6 square mm[2, 20, 28]
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[20, 28]
    - iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel[20, 30-32]
- A major vessel would be a coronary vessel that would be amenable to revascularization, if indicated. This assessment is made based on the diameter of the vessel and/or the extent of myocardial territory served by the vessel.
- FFR is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow.
- Instantaneous wave-free ratio (iFR) measures the ratio of distal coronary to aortic pressure during the wave free period of diastole, with a value ≤ 0.89 considered hemodynamically significant.[30-32]

Anginal Equivalent[2, 33, 34]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia), by presentation of clinical data such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope per se is not an anginal equivalent.

Abbreviations

CABG	Coronary artery bypass grafting surgery
CAC	Coronary artery calcium
CAD	Coronary artery disease
CCT	Cardiac computed tomography
CCTA	Coronary computed tomographic angiography
CMR	Cardiac magnetic resonance
CT(A)	Computed tomography (angiography)
ECG	Electrocardiogram
EF	Ejection fraction
FFR	Fractional flow reserve
FFR-CT	Fractional flow reserve – computed tomography
HCM	Hypertrophic cardiomyopathy
iFR	Instantaneous wave-free ratio
IVUS	Intravascular ultrasound
LV	Left ventricular
LVEF	Left ventricular ejection fraction
LVOT	Left ventricular outflow tract

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MESA	Multi-Ethnic Study of Atherosclerosis
MI	Myocardial infarction
MR	Mitral regurgitation
OMT	Optimal medical therapy
PCI	Percutaneous coronary intervention
PFT	Pulmonary function test
SRT	Septal reduction therapy
TAVR	Transcatheter aortic valve replacement
TID	Transient ischemic dilation
TTE	Transthoracic echocardiography
TEE	Transesophageal echocardiography
VT	Ventricular tachycardia
VF	Ventricular fibrillation

POLICY HISTORY

Date	Summary
February 2022	• Added indications to CCTA section regarding left main disease, single vessel disease >50% stenosis • Modified indication for exercise-induced VT removing statement "requiring signs and symptoms of ischemia" • Clarified definition of intermediate findings, non-invasive testing • FFR-CT statement updated • Modified indication for newly diagnosed HF removing statement "requiring signs and symptoms of ischemia"
March 2021	• Added general section discussing indications without requiring prior noninvasive study • Removed statement on newly recognized EF <40% in patients for viability • Added pretransplant indication • Added indications and reference for hypertrophic obstructive cardiomyopathy
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Added indication for coronary angiography prior to transcatheter valve procedures in addition to transcatheter aortic valve replacement (TAVR) • Added edits to the Coronary Artery Disease definition section • Updated and added new references

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August 2019	• Added indications for new heart failure/ cardiomyopathy/wall motion abnormality, in patients who are candidates and would be eligible for coronary revascularization including one of the following: o Newly recognized reduction in ejection fraction to ≤ 50%, with intermediate risk findings on noninvasive testing and symptoms or signs of ischemia o Newly recognized reduction in ejection fraction to ≤ 40% with evidence of viability on stress imaging • Removed indication for diastolic heart failure, when symptoms, signs or stress imaging provides evidence of contributory ischemia • Clarified indication for evaluation of coronary anatomy prior to TAVR • Clarified indication for assessment of allograft vasculopathy if stress imaging has not been performed • Clarified indications for assessment of hemodynamics in heart failure, cardiomyopathy or adult congenital heart disease.

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ADDITIONAL RESOURCES

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National Imaging Associates, Inc.*	
Clinical guidelines **TUMOR IMAGING PET - ANY SITE** **(UNLISTED PET)**	**Original Date: June 2007**
CPT Codes: G0235	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_070-2	**Implementation Date: January 2023**

IMPORTANT NOTE:

PET imaging, any site, not otherwise specified, is a non-covered CPT code.

POLICY HISTORY

Date	Summary
April 2022	No changes
May 2021	No changes
May 2020	No changes
April 2019	No changes

Reviewed / Approved by NIA Clinical Guideline Committee

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GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

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National Imaging Associates, Inc.*	
Clinical guidelines **LOW FIELD MRI**	**Original Date: July 2009**
CPT Codes: S8042	**Last Revised Date: April 2022**
Guideline Number: NIA_CG_064	**Implementation Date: January 2023**

IMPORTANT NOTE

Low Field MRI services are not considered to be medically necessary, are not approvable for payment, and cannot be approved.

BACKGROUND

MRI scanners with a field strength of greater than 1.0 Tesla (T) are considered high field. The typical high field MRI units in clinical practice range between 1.0 – 3.0 Tesla. In October 2017 the FDA cleared the first 7 T MRI units.[1] The definition of mid and low field MRI is more variable with mid field units having a lower field strength range of 0.3 to 0.5 and an upper limit under 1.0 T. Low field units have field strengths below 0.3 to 0.2 T. The major disadvantage of low field strength MRI relative to higher field scanners is lower signal to noise ratios, less homogeneity in the magnetic field, lower detection of calcification, hemorrhage, or gadolinium enhancement. Lee et al showed that low field (<0.5 T) units were effective in evaluating medial meniscal, anterior cruciate ligament, and rotator cuff tears but not effective for evaluating lateral meniscal tears, osteochondral defects, or shoulder superior labrum-anterior posterior (SLAP) ligament complex pathology.[2, 3]

POLICY HISTORY

Date	Summary
April 2022	• No changes
June 2021	• No changes
May 2020	• No changes
April 2019	• No changes

1— Low-field MRI

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2. Lee CS, Davis SM, McGroder C, Stetson WB, Powell SE. Analysis of Low-Field Magnetic Resonance Imaging Scanners for Evaluation of Knee Pathology Based on Arthroscopy. *Orthop J Sports Med*. 2013;1(7):2325967113513423-2325967113513423. doi:10.1177/2325967113513423
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ADDITIONAL RESOURCES

1. Questions and Answers in MRI: Low-field disadvantages. Elster, LLC. Accessed December 21, 2021. https://mriquestions.com/disadvantages.html

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