2021
Magellan Clinical Guidelines
For Medical Necessity Review

ADVANCED IMAGING GUIDELINES

Effective January 1, 2021 – December 31, 2021

*National Imaging Associates, Inc. (NIA) is a subsidiary of Magellan Healthcare, Inc.
Guidelines for Clinical Review Determination

Preamble
Magellan 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 Magellan Healthcare 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. Magellan’s guidelines are reviewed yearly and modified when necessary following a literature search of pertinent and established clinical guidelines and accepted diagnostic imaging practices.

All inquiries should be directed to:
Magellan Healthcare
PO Box 67390
Phoenix, AZ 85082-7390
Attn: Magellan Healthcare Chief Medical Officer
# Table of contents

## ADVANCED IMAGING GUIDELINES

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>70336</td>
<td>MRI Temporomandibular Joint</td>
<td>6</td>
</tr>
<tr>
<td>70450</td>
<td>CT Head/Brain</td>
<td>10</td>
</tr>
<tr>
<td>70480</td>
<td>CT TEMPORAL BONE, MASTOID, ORBITS</td>
<td>35</td>
</tr>
<tr>
<td>70486</td>
<td>CT Maxillofacial/Sinus</td>
<td>44</td>
</tr>
<tr>
<td>70490</td>
<td>CT Soft Tissue Neck</td>
<td>52</td>
</tr>
<tr>
<td>70496</td>
<td>CT Angiography, Head</td>
<td>59</td>
</tr>
<tr>
<td>70498</td>
<td>CT Angiography, Neck</td>
<td>70</td>
</tr>
<tr>
<td>70540</td>
<td>MRI Orbit, Face, and/or Neck</td>
<td>77</td>
</tr>
<tr>
<td>70544</td>
<td>MR Angiography Head/Brain</td>
<td>90</td>
</tr>
<tr>
<td>70547</td>
<td>MR Angiography Neck</td>
<td>103</td>
</tr>
<tr>
<td>70551</td>
<td>MRI Brain (includes Internal Auditory Canal)</td>
<td>110</td>
</tr>
<tr>
<td>70554</td>
<td>Functional MRI Brain</td>
<td>148</td>
</tr>
<tr>
<td>71250</td>
<td>CT Chest (Thorax)</td>
<td>152</td>
</tr>
<tr>
<td>71275</td>
<td>CT Angiography, Chest (non coronary)</td>
<td>165</td>
</tr>
<tr>
<td>71550</td>
<td>CT Chest (Thorax)</td>
<td>173</td>
</tr>
<tr>
<td>71555</td>
<td>MR Angiography Chest</td>
<td>180</td>
</tr>
<tr>
<td>72125</td>
<td>CT Cervical Spine</td>
<td>187</td>
</tr>
<tr>
<td>72128</td>
<td>CT Thoracic Spine</td>
<td>198</td>
</tr>
<tr>
<td>72131</td>
<td>CT Lumbar Spine</td>
<td>209</td>
</tr>
<tr>
<td>72141</td>
<td>MRI Cervical Spine</td>
<td>221</td>
</tr>
<tr>
<td>72146</td>
<td>MRI Thoracic Spine</td>
<td>234</td>
</tr>
<tr>
<td>72148</td>
<td>MRI Lumbar Spine</td>
<td>246</td>
</tr>
<tr>
<td>72159</td>
<td>MR Angiography Spinal Canal</td>
<td>258</td>
</tr>
<tr>
<td>72191</td>
<td>CT Angiography, Pelvis</td>
<td>261</td>
</tr>
<tr>
<td>72192</td>
<td>CT Pelvis</td>
<td>268</td>
</tr>
<tr>
<td>72196</td>
<td>MRI Pelvis</td>
<td>278</td>
</tr>
<tr>
<td>72198</td>
<td>MR Angiography, Pelvis</td>
<td>291</td>
</tr>
<tr>
<td>73200</td>
<td>CT Upper Extremity</td>
<td>298</td>
</tr>
<tr>
<td>73206</td>
<td>CT Angiography, Upper Extremity</td>
<td>314</td>
</tr>
<tr>
<td>73220</td>
<td>MRI Upper Extremity</td>
<td>319</td>
</tr>
<tr>
<td>73225</td>
<td>MR Angiography Upper Extremity</td>
<td>332</td>
</tr>
<tr>
<td>73700</td>
<td>CT Lower Extremity (Ankle, Foot, Hip or Knee)</td>
<td>337</td>
</tr>
<tr>
<td>73706</td>
<td>CT Angiography, Lower Extremity</td>
<td>351</td>
</tr>
<tr>
<td>73720</td>
<td>MRI Lower Extremity</td>
<td>357</td>
</tr>
<tr>
<td>73725</td>
<td>MR Angiography, Lower Extremity</td>
<td>374</td>
</tr>
<tr>
<td>74150</td>
<td>CT Abdomen</td>
<td>379</td>
</tr>
<tr>
<td>74174</td>
<td>CT Angiography, Abdomen and Pelvis</td>
<td>395</td>
</tr>
</tbody>
</table>
Advanced Imaging

74175 – CT Angiography, Abdomen ................................................................. 403
74176 – CT Abdomen and Pelvis Combination .................................................. 410
74181 – MRI MRCP Abdomen ........................................................................... 428
74185 – MR Angiography, Abdomen ................................................................. 447
74261 – CT Colonoscopy Diagnostic (Virtual) ................................................... 455
74263 – CT Colonoscopy Screening (Virtual) ....................................................... 458
74712 – Fetal MRI ............................................................................................. 462
75557 – MRI Heart ............................................................................................ 465
75571 – Electron Beam Tomography (EBCT) .................................................... 481
75572 – CT Heart ............................................................................................... 486
75573 – CT Heart Congenital Studies ............................................................... 486
75574 – CTA Coronary Arteries (CCTA) ............................................................ 495
75635 – CT Angiography, Abdominal Arteries .................................................. 508
76376 – 3D Rendering (CT Multiplanar Reconstruction) .................................... 512
76380 – Follow-Up, Limited or Localized CT ..................................................... 513
76390 – MR Spectroscopy ................................................................................ 514
76497 – Unlisted CT Procedure ....................................................................... 518
76498 – Unlisted MRI Procedure ..................................................................... 518
77012 – CT Needle Guidance ........................................................................... 519
77021 – MRI Needle Guidance ........................................................................ 519
77046 – MRI Breast ........................................................................................... 520
77078 – CT Bone Density Study ...................................................................... 534
77084 – MRI Bone Marrow ............................................................................. 539
78429 – HEART PET with CT for Attenuation ................................................. 543
78451 – Myocardial Perfusion Imaging ............................................................. 557
78459 – PET Scan, Heart (Cardiac) ................................................................ 571
78472 – MUGA Scan ........................................................................................ 584
78608 – PET Scan, Brain ................................................................................ 588
78803 – Radiopharmaceutical Tumor Localization (SPECT), Single Area .......... 593
78813 – PET Scans ........................................................................................... 619
78813 – PET Scans with CT Attenuation ......................................................... 619
0042T – Cerebral Prefusion CT ....................................................................... 640
G0219 – PET Imaging whole body, melanoma - noncovered ............................ 645
G0235 – PET imaging, any site, not otherwise specified ................................... 647
G0252 – PET imaging, initial diagnosis of breast cancer .................................. 648
G0297 – Low Dose CT for Lung Cancer Screening ......................................... 649
S8042 – Low Field MRI ................................................................................... 654
70336 – MRI Temporomandibular Joint

CPT Code: 70336

INDICATIONS FOR TEMPOROMANDIBULAR JOINT (TMJ) MRI:

For evaluation of temporomandibular joint dysfunction (TMD) with suspected internal joint derangement with ALL of the following (Bag, 2014; Gauer, 2015; Petscavage, 2014):

- Persistent symptoms of facial or jaw pain, restricted range of motion, pain and/or noise with TMJ function (i.e., chewing) (Bag, 2014)
- Conservative therapy with a trial of anti-inflammatory AND behavioral modification has been unsuccessful for at least four (4) weeks
- Initial X-rays have been performed

For evaluation of Juvenile idiopathic arthritis (JIA) (Granquist, 2018, Petscavage-Thomas, 2014)

Abnormal initial x-ray or ultrasound needing additional imaging (Bag, 2014)

Pre-operative evaluation in candidates for orthognathic surgery

Post-Operative Evaluation (Hoffman, 2015)

- 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 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 include intra-articular (intracapsular) and extra-articular (extracapsular pathology). Intra-articular (intracapsular pathology) ie 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 (ASTMJS, 2001).
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 (Gauer, 2015). Ultrasound is an inexpensive and easily performed imaging modality that can also be used to evaluate the TMJ (Tu, 2018). 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) (Bag, 2014). 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. (Armijo-Olivo, 2016). 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. The preferred devices are unclear from the literature and dental consultation is required (Gauer, 2015). 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 (Ebrahim, 2012; Pficer, 2017).

**POLICY HISTORY:**

Review Date: May 2019

Review Summary:

- Updated background information and references

Review Date: May 2020

Review Summary:

Added:

- For evaluation of temporomandibular joint dysfunction (TMD) with suspected internal joint derangement with ALL of the following
  - Persistent symptoms of facial or jaw pain, restricted range of motion, pain and/or noise with TMJ function (i.e., chewing)
  - Conservative therapy with a trial of anti-inflammatory AND behavioral modification has been unsuccessful for at least four (4) weeks
  - 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
  - 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
REFERENCES:


REDUCING RADIATION EXPOSURE:

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).

INDICATIONS FOR BRAIN CT:

For evaluation of headache:
(ACR, 2019; Holle, 2013; Quinones-Hinojosa, 2003; Schafer, 2007; Wilbrink, 2009)

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity or duration)
- Cluster headaches- imaging is indicated once to eliminate secondary causes
- New 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 (ACR, 2019; Micieli, 2020; Mitsikostas, 2016):
  - Acute, new, or fluctuating neurologic deficits such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes or with signs of increased intracranial pressure (papilledema).
  - Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration

Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (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) (new or progressively worsening)
Persistent or worsening during a course of physician directed treatment (ACR, 2019; Kuruvilla, 2015; Martin, 2011)

Special considerations in the pediatric population with persistent headache (Trofimova, 2018):
  - Occipital location
  - Age < 6 years
  - Symptoms indicative of 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:
(ACR, 2019)
  - Acute, new, or fluctuating neurologic symptoms or deficits such as, sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes.
    * Not explained by underlying ocular diagnosis, glaucoma or macular degeneration

For evaluation of known or suspected stroke or vascular disease:
(ACR 2017, 2019; Jauch, 2013)
  - 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.
    * Not explained by underlying ocular diagnosis, glaucoma or macular degeneration
  - Suspected stroke with family history of aneurysm (brother, sister, parent, or child) or known coagulopathy or on anticoagulation.
  - Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms.)
  - Suspected acute subarachnoid hemorrhage (SAH).
  - Follow up for known hemorrhage, hematoma, or vascular abnormalities.
  - Suspected central venous thrombosis - see background (ACR, 2017, Bushnell, 2014)
  - Evaluation of neurological signs or symptoms in sickle cell disease (Arkuszewski, 2010; Mackin, 2014; Thust, 2014)

For evaluation of known or suspected trauma:
(ACR, 2019a; Alrajhi, 2015; Jagoda, 2008; Menditto, 2012; Polinder, 2018)
  - 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
For evaluation of suspected brain tumor, mass, or metastasis:
(ACR, 2018; Kerjnicks, 2008; NCCN, 2019)
- Suspected brain tumor with any acute, new, or fluctuating neurologic symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination or mental status changes.
  * Not explained by underlying ocular diagnosis, glaucoma or macular degeneration
- Suspected brain metastasis in or intracranial involvement patients with a history of cancer based on symptoms or examination findings (may include new or changing lymph nodes)

For evaluation of known brain tumor, mass, or metastasis:
- Follow up of known brain malignant tumor.
- Suspected recurrence with prior history of CNS cancer (either primary or secondary) based on neurological symptoms or examination findings
- 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 (NCCN, 2020)
- Follow up of known non-malignant tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors
- Follow up of known meningioma (NHS, 2018)
- Bone tumor or abnormality of the skull (Gomez, 2018)

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:
(NCCN, 2019)
- ≤ 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:
(Cendes, 2013; Gaillard, 2009; Krumholz, 2007; Ramli, 2015)
- New onset of seizures or newly identified change in seizure activity/pattern
For evaluation of known or suspected inflammatory disease or infection (e.g., meningitis or abscess) and MRI is contraindicated or cannot be performed:
(Lummel, 2016; Tunkel, 2008)
- Suspected intracranial abscess or brain infection with acute altered mental status OR positive lab findings (such as elevated WBC’s) 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 positive lab findings.
- 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 (Graham, 2000)

For evaluation of clinical assessment documenting cognitive impairment of unclear cause:
(AAN, 2017; Harvey, 2012; HQO, 2014; Narayanan, 2016)
- Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments/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).

For evaluation of movement disorders (Mascalchi, 2012):
- 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. Imaging is not indicated in essential tremor or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer’s dystonia) (Alabanese, 2011; Comella, 2019; Sharfi, 2014)

For evaluation of cranial nerve and visual abnormalities:
- Anosmia (loss of smell) (documented by objective testing) that is persistent and of unknown origin (Policeni, 2017; Rouby, 2011)
- Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit, etc.) (Chang, 2019)

Note: Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration
- Binocular diplopia with concern for intracranial pathology (Iliescu, 2017)
- Horner’s syndrome with symptoms localizing the lesion to the central nervous system (Lee, 2007)
• Evaluation of cranial neuropathy when thought to be due to tumor, stroke, or bony abnormalities of the skull base (ACR, 2017)

For evaluation of known or suspected congenital abnormality (such as hydrocephalus, craniosynostosis):
(Ashwal, 2009; Marchese, 2017; Vinocur, 2010)
• Known or suspected congenital abnormality with any acute, new, or fluctuating neurologic, motor, or mental status changes.
• Evaluation of macrocephaly in an infant/child with previously abnormal US, abnormal neurodevelopmental examination (Tan, 2018), signs of increased ICP or closed anterior fontanelle
• Microcephaly
• Craniosynostosis and other head deformities.
• Prior treatment or planned treatment for congenital abnormality.

Cerebral Spinal Fluid (CSF) Abnormalities
• Suspected or known hydrocephalus*
• Known or suspected normal pressure hydrocephalus (NPH) (Damasceno, 2015)
  o With symptoms of gait difficulty, cognitive disturbance and urinary incontinence
• Follow up shunt evaluation (Kamenova, 2018; Pople, 2002, Reddy, 2014)
  o Post operativity if indicated based on underlying disease and pre-operative radiographic findings and/or
  o 6-12 months after placement and/or
  o With neurologic symptoms that suggest shunt malfunction
• Evaluation of known or suspected cerebrospinal fluid (CSF) leakage (Severson, 2019)
• Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance (Gordon, 2019).

Pre-operative evaluation for brain/skull surgery.

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
(ACR, 2019; DeFoer, 2006; Tarrant, 2008; Thust, 2014)
• Vertigo associated with any of the following:
  o Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness or a change in sensation) (Welgampola, 2019; Yamada, 2019)
  o Progressive unilateral hearing loss
  o Risk factors for cerebrovascular disease with concern for stroke
  o After full neurologic examination and vestibular testing ENT work-up with concern for central vertigo
• Diagnosis of central sleep apnea on polysomnogram
- Children > 1 year (Felix, 2016)
- 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 (Malhotra, 2010)
- Cyclical vomiting syndrome or abdominal migraine with and with any localizing neurological symptoms (Angus-Leppan, 2018; Li BUK, 2018; Venkatesan, 2019)
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph) (ACR, 2017; Kim, 2019; Zhang, 2018)
- Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause (ACR, 2019b)
- Global developmental delay or developmental delay with abnormal neurological examination (Ali, 2015; Momen, 2011)
- 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 (Ashwal, 2004; NICE, 2020)
- Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurologic cause based on history and exam (Tieder, 2016)
  **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.
- Syncope with clinical concern for seizure or associated neurological signs or symptoms (ACP, 2012; AFP, 2020; Al-Nsoor, 2010; Strickberger, 2006)

### Indications for Combination Studies (ACR, 2017, 2019)
- 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 (Lawson, 2000).

- **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
  - Suspected venous thrombosis (dural sinus thrombosis) – Brain CTV see background

- **Brain CT/Brain CTA/Neck CTA**
  - Recent stroke or transient ischemic attack (TIA)

- **Brain CT/Cervical CT**
• For evaluation of Arnold Chiari Malformation

• Brain CT/Orbit CT-
  - 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 (Behbehani, 2007)
  - Bilateral optic disk swelling (papilledema) with visual loss (Margolin, 2019)

BACKGROUND:
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 patients 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 imaged 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 (ACR, 2012b; HIS, 2018; Jang, 2019; Spierings, 2003; Tyagi, 2012)

Migraine with Aura (Hadjikhani, 2019; IHS, 2018; Micieli, 2020)
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 patients. 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, history of vascular risk factors.

**Imaging for Stroke** – Patients 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 patient from reperfusion therapy. Functional imaging can be used to select patients 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” (Sacco, 2013). 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 (Kernan, 2014). TIA’s 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” (Easton, 2009). 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 (Hong, 2011). 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 (Kernan, 2014). 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 (Wintermark, 2013). 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.

**CT and Central Venous Thrombosis** – a CTV or MRV is indicted for the definite 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. (Bushnell, 2014; Courinho, 2015; Ferro, 2016).

**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. A patient 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. Patients with a Glasgow Coma Scale of 15 or less who also have vomiting or 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 benign tumors** (e.g., schwannomas, choroid plexus papilloma, pineocytoma, gangliocytoma) A single follow up study is appropriate after the initial diagnosis to ensure stability. Follow up of known benign tumor if symptomatic, new/changing signs or symptoms or complicating factors (Gupta, 2017). MRI is the ideal modality to follow-up meningioma, pituitary tumors, neurocutaneous syndromes and staging/surveillance for non-CNS cancers.

**CT scan and Meningitis** – In suspected bacterial meningitis, CT with contrast may be performed before lumbar puncture 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.

**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, visuoconstructual 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 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. MRI is the study of choice in the evaluation of the cranial nerves. In optic neuritis, CT has limited utility. Contrast-enhanced CT scanning of the orbits may be able to 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.

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 patients 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 (Smith, 1998). The anterior fontanelle generally closes between 10 and 24 months of age, with 3% closing between 5-9 months and 11% after 24 months (Pindrik, 2014).

CT and 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 patients 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 patient presents with associated neurological symptoms such as weakness, diplopia, sensory changes, ataxia or confusion. Magnetic resonance imaging is appropriate in the evaluation of patients 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): 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.

**POLICY HISTORY:**  
**Review Date:** August 2019  
**Review Summary:**
- 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 and cannot have an MRI
- For evaluation of headache, added:  
  - Prior history of stroke or intracranial bleed with sudden onset of severe headache(moved)  
  - Related to activity or event (sexual activity, exertion, position) (new or progressively worsening)  
  - New headaches 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  
  - Specified when MRI is contradicted for cluster headaches to eliminate secondary causes
- For evaluation of brain tumor:
• Specified ‘malignant’ for f/u of known tumor
• Added: Follow up of known benign tumor if symptomatic, new/changing signs or symptoms or complicating factors; Follow up of known meningioma if MRI is contraindicated
• Removed: Known lung cancer or rule out metastasis and/or preoperative evaluation, Metastatic melanoma (not all melanomas)

• For evaluation of suspected stroke:
  o Moved ‘patient with history of a known stroke with new and sudden onset of severe headache’
  o Separated: Family history of aneurysm

• For evaluation inflammatory disease or infections:
  o Changed meningitis with positive signs and symptoms from ‘And’ positive lab findings to ‘OR’ positive labs
  o For suspected encephalitis removed ‘severe’ headache

• For evaluation of congenital abnormality:
  o 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’ and MRI is contraindicated

• For suspected normal pressure hydrocephalus added ‘with symptoms of gait difficulty, cognitive disturbance, and urinary incontinence

• Other indications:
  o Added detail to Vertigo when MRI is contraindiated 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
  o Modified developmental delay to include: Global developmental delay or developmental delay with abnormal neurological examination
  o Added:
    ▪ Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit etc).
    ▪ Horner’s syndrome with symptoms localizing the lesion to the central nervous system
    ▪ Psychological changes with neurological deficits or a full neurological assessment completed that suggests a possible neurologic cause and MRI cannot be performed

• For Brain CT/Neck CTA: added ‘Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits’
• Removed Confirmed carotid occlusion >60%, surgery or angioplasty candidate
- Added Brain CT/Brain CTA section, including: Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache; AND Suspected venous thrombosis (dural sinus thrombosis)
- Added Brain CT/Brain CTA/Neck CT 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 intracranial pathology
- For Brain CT/Orbit CT, added: Bilateral papilledema with visual loss; 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
- Updated background information and references

**Review Date:** May 2020

**Review Summary:**
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
  - Documented absence of family history of headache
- 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
- 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 non-malignant brain tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors
- 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
- Vertigo associated with any of the following
  - Risk factors for cerebrovascular disease with concern for stroke
  - After full neurologic examination and vestibular testing with concern for central vertigo
- Combo Brain MRI/Orbit MRI
  - 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
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:
  - With a personal or family history of brain aneurysm or AVM (arteriovenous malformation)
  - Known coagulopathy or on anticoagulation
- Under New onset of headache and any of the following
  - Fever
  - Subacute head trauma
  - Pregnancy or puerperium
  - Age ≥ 50
  - Neurological deficits - Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)
- 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
- Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination
- Binocular diplopia with concern for intracranial pathology
  - Post operatively 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
- Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance
- 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)
- 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

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 brain tumor and new onset of headache.

- Removed the statement when MRI is contraindicated or cannot be performed throughout the document and
  - Replaced with 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).

Clarified:
- Cluster headaches- imaging is indicated once to eliminate secondary causes
- Evaluation of cranial neuropathy when thought to be due to tumor, stroke, or bony abnormalities of the skull base

Added:
- For evaluation of movement disorders
  - Acute onset of a movement disorder with concern for stoke 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

Notes: CT has limited utility in the chronic phases of disease. Imaging is not indicated in essential tremor or isolated focal dystonia (e.g., blepharospam, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer’s dystonia)
- Combo Brain CT/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

Deleted:
• Combo Brain CT/CTA
  o Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache
REFERENCES


American College of Radiology ACR Appropriateness Criteria® Seizures and Epilepsy. 2019.


https://acsearch.acr.org/docs/69434/Narrative/.

American Family Physician (AFP). Choosing Wisely: Avoid CT of the head in asymptomatic adult patients in the emergency department with syncope, insignificant trauma, and a normal neurological evaluation. 2020.
https://www.aafp.org/afp/recommendations/viewRecommendation.htm?recommendationId=222#.


Lawson, GR. Sedation of children for magnetic resonance imaging. Archives Dis Childhood. 2000; 82(2).


### TABLE OF CONTENTS


**INDICATIONS FOR ORBIT CT:**

CT is preferred for visualizing bony detail and calcifications. MRI is superior for the evaluation of the visual pathways, globe, and soft tissues (Hande, 2012; Kennedy, 2018)

- Abnormal external or direct eye exam (Hande, 2012):
  - Exophthalmos (proptosis) or enophthalmos
  - Ophthalmoplegia with concern for orbital pathology (Stalcup, 2013)
  - Unilateral optic disk swelling if MRI is contraindicated or cannot be performed (Hata, 2017; Margolin, 2019; Passi, 2013)
  - Documented visual field defect if MRI is contraindicated or cannot be performed (Fadzil, 2013; Kedar, 2011; Prasad, 2012; Sadun, 2011)
    - Unilateral or with optic disc abnormality **AND**
    - Not explained by an underlying diagnosis, glaucoma, or macular degeneration
  - Optic Neuritis if MRI is contraindicated or cannot be performed
    - With an atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset (CMSC, 2018; Voss, 2011)

- 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 (Hande, 2012; Kedar, 2011)
- Clinical Suspicion of orbital infection (Gavito-Higuera, 2016; Kirsch, 2017)
- Clinical Suspicion of osteomyelitis (Arunkumar, 2011; Lee, 2016)
  - Direct visualization of bony deformity
  - Abnormal X-rays
- Clinical Suspicion of Orbital Inflammatory Disease (e.g., eye pain and restricted eye movement with suspected orbital pseudotumor) (Pakdaman, 2014)
- Congenital orbital anomalies (Tawfik, 2012)

**COMBINATION OF STUDIES WITH ORBIT CT:**

- Brain CT/Orbit CT if MRI is contraindicated or cannot be performed
  - 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 (Behbehani, 2007)
  - Bilateral optic disk swelling (papilledema) with vision loss (Margolin, 2019)
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 (Lawson, 2000)

INDICATIONS FOR SELLA CT
MRI is contraindicated or cannot be performed (ACR NE, 2018; Chaudhary, 2011)
- For further evaluation of known sellar and parasellar masses
- Suspected pituitary gland disorder (Wu, 2014) based on:
  - Documented visual field defect suggesting compression of the optic chiasm; OR
  - Laboratory findings suggesting pituitary dysfunction (Freda, 2011); OR
  - Pituitary apoplexy with sudden onset of neurological and hormonal symptoms
  - Follow-up to other imaging suggesting sella (pituitary) mass

INDICATIONS FOR TEMPORAL/MASTOID/INTERNAL AUDITORY CANAL CT:

Hearing loss (documented on audiogram) (Cunnane, 2019; Sharma, 2018):
- Asymmetric Sensorineural when MRI is contraindicated (Krause, 2010; Verbist, 2012)
- Conductive or mixed (Trojanowsak, 2012)
- Congenital (Trojanowsak, 2012)
- Cochlear Implant evaluation (Juliano, 2015)

Tinnitus (Kessler, 2017; Pegge, 2017; Yew, 2014)
- Pulsatile tinnitus
- 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 (Patel, 2014; Platzek, 2014, Kann, 2016; Luntz, 2012)
  - Systemic illness or toxic appearance
  - Signs of extracranial complications (e.g., postauricular swelling/erythema, auricular protrusion, retro-orbital pain, hearing loss, tinnitus, vertigo, nystagmus)
  - 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

- Chronic Otitis Media (with or without cholesteatoma on exam) (Gomaa, 2013; Patel, 2014)
  - Failed treatment for acute otitis media

Cholesteatoma (Barath, 2011)

CSF Otorrhea (Hiremath, 2019)
**Vascular Indications** (Bozek, 2016; Muderris, 2011)
- 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** (Muncie, 2017; Strupp, 2013; Sharma, 2018, Swartz, 2005)
- 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 (Quesnel, 2010)

**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.
- 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 of VIIIth nerve tumors.
POLICY HISTORY:
Review Date: May 2019
Review Summary:

Orbit CT:
- Added clinical suspicion of osteomyelitis
- Removed orbital asymmetry; vision loss with etiology not identified on ophthalmologic; diplopia; suspected hyperthyroidism such as Graves’ disease

Combination Brain CT/Orbit CT:
- Added bilateral papilledema w/vision loss if MRI is contraindicated

Sella CT:
- Added suspected or known pituitary gland disorder

Temporal/Mastoid/IAC CT:
- 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

Review Date: May 2020
Review Summary:
Clarified:
- 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)

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
REFERENCES:


Consortium of Multiple Sclerosis Centers (CMSC). MRI Protocol and Clinical Guidelines for the Diagnosis and Follow-up of MS. February 2018.


Lawson, GR. Sedation of children for magnetic resonance imaging. *Archives Dis Childhood*. 2000; 82(2).


70486 – CT Maxillofacial/Sinus

CPT Codes: 70486, 70487, 70488, 76380

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 (Brook, 2019; Chiarella, 2017; Kaplan, 2013; Rosenfeld, 2015)
- Symptoms persist after four (4) weeks of medication, e.g., antibiotics, steroids or anti-histamines; OR
- Clinical suspicion of fungal infection (ACR, 2017; Silveira, 2019); OR
- Clinical suspicion of complications, such as (Dankbaar, 2015)
  - Preseptal, orbital, or intracranial infection (Kastner, 2014)
  - Osteomyelitis
  - Cavernous sinus thrombosis
- Recurrent acute rhinosinusitis with 4 or more annual episodes without persistent symptoms in between
- If suspected as a cause of poorly controlled asthma (endoscopic sinus surgery improves outcomes) (Vashishta, 2013)
- 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).

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) (Poorey, 2014; Sedaghat, 2015)

Refractory Asthma (Sinus CT) - these patients benefit from medical treatment and surgery together (Ragab, 2006; Sahay, 2016; Vashishta, 2013)

Anosmia noted on objective testing, is persistent, of unknown origin and MRI cannot be done (ACR, 2017; Allis, 2012; Geyer, 2008)

Suspected infection
• Osteomyelitis (after x-rays, MRI cannot be done) (Pincus, 2009)
• Abscess

Face mass (Kirsch, 2017; Koeller 2016):
• Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed (Kuno, 2014); OR
• Known or highly suspected head and neck cancer on examination (Kirsch, 2017)
• Failed 2 weeks of treatment for suspected infectious adenopathy (Haynes, 2015)

Facial trauma (ACR, 2015, 2019; Echo, 2010; Oh, 2017; Raju, 2017)
• Severe facial trauma
• Suspected facial bone fracture with indeterminate x-ray
• Post traumatic CSF (cerebrospinal fluid) rhinorrhea (for CSF otorrhea should be a Temporal Bone CT)

Salivary gland stones or clinical concern for abscess (Gadodia, 2011; Kalia, 2015; Terraz, 2013)

Granulomatosis with polyangiitis (Wegener’s granulomatosis) disease (Pakalniskis, 2015)

Suspected Osteonecrosis of the Jaw (Popovic, 2010)
• Possible etiologies: biphosphonate treatment, dental procedures, Denosumab, radiation treatment

Lesion seen on x-ray or other study requiring further characterization (primary or secondary bone tumor, metabolic disorder) (Andreu-Arasa, 2018)

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 (i.e., bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain > 2min, pain outside trigeminal nerve distribution, progression) (ACR, 2017; Hughes, 2016; Policeni, 2017)

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:
• For poorly controlled asthma associated with upper respiratory tract infection. May be performed without failing 4 consecutive weeks of treatment with medication.
Granulomatosis with polyangiitis (Wegener's granulomatosis) disease (GPA) (Jang, 2013; Lohrmann, 2006).

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.

Anosmia – Non-structural causes of anosmia: post viral symptoms, medications (Amitiptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Triflouperazine, Propylthiouracil

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 (Phal, 2007).

OVERVIEW:
Don’t order sinus computed tomography (CT) or indiscriminately prescribe antibiotics for uncomplicated acute rhinosinusitis (AAAAI, 2012). 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.

CT instead of 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.

POLICY HISTORY:
Review Date: May 2019
Review Summary:
- 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
  o Immunocompromised patient

Review Date: May 2020
Review Summary:
- 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)
  o 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)
  o Persistent or recurrent sinusitis not responding to treatment (primarily antibiotics, treatment may require a change of antibiotics)
  o 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 x-ray 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

Deleted:
- Face Mass
  - Unless increased risk for malignancy based on
    - Any of these:
      - Fixation to adjacent tissues
      - Firm consistency
      - Size >1.5 cm
      - Ulceration of overlying skin
  - Clinical concern for abscess
- Facial trauma: Physical findings of direct facial bone injury
REFERENCES:


American College of Radiology (ACR). ACR Appropriateness Criteria® Head Trauma. 2015.


INDICATIONS FOR NECK CT: (ACR, 2018b, 2018c)

Suspected tumor or cancer
- Suspicious lesions in mouth or throat (Kuno, 2014)
- Suspicious mass/tumor found on another imaging study and needing clarification (ACR, 2018b)
- Neck Mass (non-parotid region or thyroid):
  - Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed (Kuno, 2014)
  - Increased risk for malignancy (Kirsch, 2019) with one or more of the following findings (Pynnonen, 2017):
    - 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 (Haynes, 2015).
- Neck Mass (parotid) (ACR, 2018b)
  - Parotid mass found on other imaging study and needing further evaluation
  - US is the initial imaging study of a parotid region mass to determine if the location is inside or outside the gland (ACR, 2018b; Burke, 2011; Cicero, 2018)
- 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 (ACR, 2018c)
  - Staging and monitoring for recurrence of known thyroid cancer (ACR, 2018c).
  - To assess extent of thyroid tissue when other imaging suggests extension through the thoracic inlet into the mediastinum or concern for airway compression (Gharib, 2016; Lin, 2016)
  - Chest CT may be included for preoperative assessment in some cases

Pediatric patients (≤18 years old) (Wai, 2020):
- Neck masses in the pediatric population if ultrasound is inconclusive or suspicious (Brown, 2016)
- History of malignancy
Known tumor or cancer of skull base, tongue, larynx, nasopharynx, pharynx, or salivary glands
- Initial staging (Kuno, 2014)
- Restaging during treatment
- Areas difficult to visualize on follow-up examination
- Suspected recurrence or metastases based on symptoms or examination findings
  - New mass
  - Change in lymph nodes (Vogel, 2016)

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

Known or suspected deep space infections or abscesses of the pharynx or neck (Meyer, 2009)

Pre-operative evaluation.

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:
- Salivary gland stones (Cicero, 2018)
- Vocal cord lesions or vocal cord paralysis (Dankbaar, 2014)
- Diagnosed primary hyperparathyroidism when surgery is planned
  - Previous nondiagnostic ultrasound or nuclear medicine scan (Tian, 2018)
- To assess for foreign body when radiograph is inconclusive or negative (Guelfguat, 2014)
- For evaluation of tracheal stenosis (Chung, 2011; Heidinger, 2015)
- Dysphagia after appropriate work up including fluoroscopy, modified barium swallow, or biphasic esophagram (ACR, 2018a)
- 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 (Quesnel, 2010)
- Objective cranial nerve palsy (CN IX-XII) if MRI is contraindicated or cannot be performed (for evaluation of the extracranial nerve course) (Mumtaz, 2014; Policeni, 2017)

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 (Pynnonen, 2017).

POLICY HISTORY:
Review Date: April 2019
Review Summary:
- Suspected Tumor or Cancer:
  - 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’.
  - Added: “Ultrasound should be completed as the initial imaging”
  - 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

Review Date: May 2020
Review Summary:
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):
  - Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed
  - Increased risk for malignancy
  - Failed 2 weeks of treatment for suspected infectious adenopathy
- Under increased risk for malignancy
History of cancer

Added:
- Neck Mass (parotid)
  - 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
  - Staging and monitoring for recurrence of known thyroid cancer
- Pediatric patients (≤18 years old)
  - Neck masses in the pediatric population if ultrasound is inconclusive or suspicious
  - History of malignancy
- Under known tumor or cancer of skull base, tongue, larynx, nasopharynx, pharynx, or salivary glands
  - 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)
  - 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
  - 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
REFERENCES:


70496 – CT Angiography, Head

CPT Codes: 70496

INDICATIONS FOR BRAIN CTA:
Patients with claustrophobia, limited ability to cooperate or an implanted device may be better suited for CTA, whereas those with renal disease or iodine contrast allergy should have MRA (Chen, 2018).

For evaluation of suspected intracranial vascular disease (ACR, 2017, 2019):

Aneurysm screening:
- Screening for suspected intracranial aneurysm in patient whose parent, brother, sister, or child has history of intracranial aneurysm.
  Note: If there is a first-degree familial history, repeat study is recommended every 5 years (Chalouhi, 2011).
- Screening for aneurysm in polycystic kidney disease (after age 30), Loeys-Dietz syndrome, fibromuscular dysplasia, spontaneous coronary arteries dissection (SCAD), or known aortic coarctation (Hayes, 2018; Hitchcock, 2016; Macaya, 2019).

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 work-up (Whitehead, 2019, Yeh, 2010, Yuan, 2018).
  - Negative Brain CT; AND
  - Negative Lumbar Puncture; OR
  - Negative Brain MRI
- Isolated third nerve palsy (oculomotor) with pupil involvement to evaluate for aneurysm (Pula, 2016).
- Pulsatile tinnitus to identify a vascular etiology (Hofmann, 2013; Pegge, 2017).

Cerebrovascular Disease

Ischemic
- Recent ischemic stroke or transient ischemic attack (See Background section) (Sanelli, 2014; Wintermark, 2013).
- 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 (Lima-Neto 2017; Searls, 2012).

Hemorrhagic
- Known subarachnoid hemorrhage (SAH) (Colen, 2007).
- Known cerebral intraparenchymal hemorrhage with concern for underlying vascular abnormality
Venous and MRV is contraindicated or cannot be performed- CTV* (Waleki, 2015).
- Suspected venous thrombosis (dural sinus thrombosis)
- Distinguishing benign intracranial hypertension (pseudotumor cerebri) from dural sinus thrombosis (Agarwal, 2010; Higgins 2005).

Sickle cells disease (ischemic and/or hemorrhagic) and MRV is contraindicated or cannot be performed (Abboud, 2003; Thust, 2014)
- 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, plasma viscosity) (Berlit, 2014)
- 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 (Godasi, 2019; Zucconi, 2011).

Other intracranial vascular disease
- Suspected Moyomoya disease (Ancelet, 2015; Tarasow, 2011).
- Suspected reversible cerebral vasoconstriction syndrome (Singhal, 2016).

For evaluation of known intracranial vascular disease (ACR, 2017, 2019):
- Known intracranial aneurysm or vascular malformation (AVM or dural arteriovenous fistula)
- Vascular abnormality visualized on previous brain imaging that is equivocal or needs further evaluation
- Known vertebrobasilar insufficiency (VBI) (Lima-Neto, 2017; Searls, 2012).
- Known vasculitis, reversible cerebral vasoconstriction syndrome or Moyomoya disease (Ancelet, 2015; Godasi, 2019; Singhal, 2016; Tarasow, 2011).

Pre-operative/procedural evaluation for treatment, procedure, intervention, or brain/skull surgery (Farsad, 2009).

Post-operative/procedural evaluation (Sanelli, 2004; Wallace, 2007):
- 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 (Sanelli, 2014).
- 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 (Lima-Neto, 2017; Searls, 2012).
- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (Franz, 2012; Shakir, 2016).
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 (Brott, 2011; DaCosta, 2019; Marquardt, 2010)

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 (AAN, 2010; Brott, 2011; Rerkasem, 2011)

Pulsatile tinnitus to identify vascular etiology (Hofmann, 2013; Pegge, 2017).

Indications for Brain CT/Brain CTA combination studies (ACR, 2017, 2019):
- 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
- Suspected venous thrombosis (dural sinus thrombosis) – CTV and 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) (ACR, 2017, 2019)
- 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

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 ≤ 5 mm is higher than that with digital subtraction angiography (DSA). Most aneurysms missed with CTA are ≤ 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) 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 into 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 imaging (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 (ACR, 2017, 2019; Lee, 2012).

**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” (Sacco, 2013). 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 (Kernan, 2014). 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” (Easton, 2009). 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 (Hong, 2011).

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 (Kernan, 2014). 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 (Wintermark, 2013).

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.

**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, Moyamoya 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 (Delgado, 2009).

**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 (Bushnell, 2014; Courinho, 2015; Ferro, 2016; Waleki, 2015).

**MRA and dissection**- Cranioceeral 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 (Franz, 2012; Liang, 2013; Mundinger, 2013; Simon, 2019). 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 (Nash, 2019; Shakir, 2016).

**POLICY HISTORY:**
**Review Date:** August 2019  
**Review Summary:**  
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  
- 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:
  - Suspected vertebrobasilar insufficiency (VBI) symptoms  
  - CTV for suspected central venous thrombosis  
- For Brain CTA/Neck CTA combination studies:
  - Removed the past two-week restriction from ‘recent stroke or TIA’  
  - Clarified CVA symptoms to include - known or suspected carotid or cerebral artery occlusion with sudden onset of numbness or incoordination  
  - Added spontaneous injuries due to weakness of vessel wall leading to dissection  
  - 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  
  - 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:
  - Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache  
  - Suspected venous thrombosis (dural sinus thrombosis)  
- Added section for Brain CT/Brain CTA/Neck CTA combination studies, including:
  - Recent stroke or transient ischemic attack (TIA)  
  - 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

**Review Date:** May 2020  
**Review Summary:**  
- 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
  - Negative Brain CT; AND
  - Negative Lumbar Puncture; OR
  - 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)
- 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
REFERENCES


INDICATIONS FOR NECK CTA:
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 (Adla, 2015).

For evaluation of known or suspected extracranial vascular disease:

Cerebrovascular Disease
- Recent ischemic stroke or transient ischemic attack (ACR, 2017; 2019; Sanelli, 2014).
- 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) (Brott, 2011; DaCosta, 209; Marquardt, 2010).
- 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) (AAN; 2010; Brott, 2011; Rerkasem, 2011).

Aneurysm screening:
Screening for aneurysm in fibromuscular dysplasia or spontaneous coronary arteries dissection (SCAD) (Hayes, 2018; Hitchcock, 2014; Macaya, 2019).

Tumor/pulsatile mass
- Carotid body tumors, or other masses such as a paraganglioma, arteriovenous fistula pseudoaneurysm, atypical lymphovascular malformation (Nguyen, 2011).
  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
Takayasu arteritis based on findings in other blood vessels on previous imaging (Zhu, 2012)
- Giant cell arteritis (Abdel Razek, 2014; Koster, 2018)
- Subclavian steal syndrome when ultrasound is positive or indeterminate or for planning interventions (Potter, 2014)
- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (Franz, 2012; Shakir, 2016)
- Horner’s syndrome (miosis, ptosis, and anhidrosis) (Kim, 2012).
- Known extracranial vascular disease that needs follow-up or further evaluation

Pre-operative evaluation
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) (ACR, 2017; 2019; Wintermark, 2013)
- 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 (Lima-Neto 2017; Searls, 2012).
- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (Franz, 2012; Shakir, 2016).
- 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 (Brott, 2011; DaCosta, 2019; Marquardt, 2010)
- 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 (AAN, 2010; Brott, 2011; Rerkasem, 2011)
- Pulsatile tinnitus (subjective or objective) for vascular etiology (Pegge, 2017)

BACKGROUND:

For vascular disease, MRA and CTA are generally comparable. There is no current literature comparing the efficacy of contrast enhanced CT to CTA or MRI and MRA for evaluation of pulsatile neck mass, so any are approvable (Guneyli, 2014). 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.

CTA and dissection- Cranio-cervical 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 (Franz, 2012; Liang, 2013; Mundinger, 2013; Simon, 2019). Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms. There
is often minor trauma or precipitating factor (ie 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 (Nash, 2019; Shakir, 2016).

**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” (Sacco, 2013). 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 (Kernan, 2014). 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” (Easton, 2009). 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 (Hong, 2011).

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 (Kernan, 2014). 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 (Wintermark, 2013).

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 (Easton, 2009; Hong, 2011; Kernan, 2014; Sacco, 2013; Wintermark, 2013).

**POLICY HISTORY:**
**Review Date:** April 2019
**Review Summary:**
- 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

Review Date: May 2020

Review Summary:

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
- 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
REFERENCES:


70540 – MRI Orbit, Face, and/or Neck

CPT Codes: 70540, 70542, 70543

A single authorization for CPT code 70540, 70542, or 70543 includes imaging of the Orbit, Face, Sinuses, and Neck. Multiple authorizations are not required.

INDICATIONS FOR ORBIT MRI:
MRI is superior for the evaluation of the visual pathways, globe and soft tissues, CT is preferred for visualizing bony detail and calcifications (Hande, 2012; Kennedy, 2018)

- Abnormal external or direct eye exam
  - Exophthalmos (proptosis) or enophthalmos
  - Ophthalmoplegia with concern for orbital pathology
  - Unilateral optic disk swelling (Hata, 2017; Margolin, 2019; Passi, 2013)
  - Documented visual field defect (Fadzil, 2013; Kedar, 2011; Prasad, 2012; Sadun, 2011)
    - Unilateral or with optic disc abnormality; **AND**
    - Not explained by underlying diagnosis, glaucoma, or macular degeneration
  - Optic Neuritis (Gala, 2015; Srikajon, 2018; Voss, 2011)
    - If atypical presentation, severe visual impairment, or poor recovery following initial onset or treatment onset (CMSC, 2018)

- Orbital trauma (Lin, 2012; Sung, 2014)
  - Physical findings of direct eye injury
  - Suspected orbital trauma with indeterminate x-ray or ultrasound

- Orbital or ocular mass/tumor, suspected or known (Hande, 2012; Kedar, 2011)

- Clinical Suspicion of orbital infection (Hande, 2012; Kennedy, 2018)

- Clinical Suspicion of osteomyelitis (Arunkumar, 2011; Lee, 2016)
  - Direct visualization of bony deformity
  - Abnormal x-rays

- Clinical Suspicion of Orbital Inflammatory Disease (e.g., eye pain and restricted eye movement with suspected orbital pseudotumor) (Pakdaman, 2014)

- Congenital orbital anomalies

INDICATIONS FOR FACE/SINUS MRI:

- Rhinosinusitis (Kirsch, 2017)
  - Clinical Suspicion of fungal infection (Gavito-Higuera, 2016)
Clinical Suspicion of orbital or intracranial complications such as (Arunkumar, 2011; Lee, 2016)
  - Preseptal, orbital, or central nervous system infection
  - Osteomyelitis
  - Cavernous sinus thrombosis

- **Sinonasal obstruction, suspected-mass** (Kirsch, 2017; Rosenfeld, 2015)

- **Suspected infection**
  - Osteomyelitis (after x-rays) (Pincus, 2009)
  - Abscess

- Anosmia on objective testing that is persistent and of unknown origin (Policeni, 2017; Rouby, 2011; Zaghouani, 2013)

- **Granulomatosis** with polyangiitis (Wegener’s granulomatosis) disease (Pakalniskis, 2015)

- **Face mass** (Kirsch, 2017; Koeller, 2016):
  - Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed (Kuno, 2014)
  - Known or highly suspected head and neck cancer on examination (Kirsch, 2017)
  - Failed 2 weeks of treatment for suspected infectious adenopathy (Haynes, 2015).

- **Facial trauma** (Echo, 2010; Lin, 2012; Raju, 2017; Sung, 2014)
  - Physical findings of direct facial bone injury
  - Post traumatic CSF rhinorrhea (for CSF otorrhea Temporal Bone imaging is recommended) (Oh, 2017; Snetty, 2015)

- **Trigeminal neuralgia/neuropathy** (for evaluation of the extracranial nerve course)
  - 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) (ACR, 2017; Hughes, 2016; Policeni, 2017)

**INDICATIONS FOR NECK MRI:**

- **Suspected tumor or cancer** (ACR, 2018a):
  - Suspicious lesions in mouth or throat (Kuno, 2014).
  - Suspicious mass/tumor found on another imaging study and needing clarification

- **Neck mass** (non-parotid or thyroid)
  - Present on physical exam and remains non-diagnostic after ultrasound is completed (Kuno, 2014)

  **Note:** For discrete cystic lesions of the neck, an ultrasound should be performed as initial imaging unless there is a high suspicion of malignancy
Increased risk for malignancy with one or more of the following findings (Pynnonen, 2017):
- 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 (Haynes, 2015).

Neck Mass (parotid) (ACR, 2018a)
- 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) - US is the initial imaging study of a thyroid region mass. CT is preferred to MRI in the evaluation of thyroid masses since there is less respiratory motion artifact (ACR, 2018b)
- Staging and monitoring for recurrence of known thyroid cancer (ACR, 2018b).
- To assess extent of thyroid tissue when other imaging suggests extension through the thoracic inlet into the mediastinum or concern for airway compression (Gharib 2016; Lin, 2016)

NOTE: Chest CT may be included for preoperative assessment in some cases

Pediatric patients (≤ 18 years old) (Wai, 2020):
- Neck masses in the pediatric population if ultrasound is inconclusive or suspicious (Brown, 2016)
- History of malignancy

Known or suspected deep space infections or abscesses of the pharynx or neck (Meyer, 2009)

Other indications for a Neck MRI:
- MR Sialography to evaluate salivary ducts (Burke, 2011; Ren, 2015)
- Vocal cord lesions or vocal cord paralysis (Dankbaar, 2014).
- Diagnosed primary hyperparathyroidism when surgery is planned
  - Previous nondiagnostic ultrasound or nuclear medicine scan (Khan, 2014; Piciucchi, 2012).
- 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 (Quesnel, 2010)
- Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course) (ACR, 2017; Mumtaz, 2014; Policeni, 2017)

OTHER 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 (Kuno, 2013)
- Restaging during treatment
• Suspected recurrence or new metastases based on symptoms or examination findings
  o New mass
  o Change in lymph nodes (Hoang, 2013)
• 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.

INDICATIONS FOR COMBINATION STUDIES: ORBIT/FACE/ SINUS/NECK MRI WITH BRAIN MRI.
• 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 (Lawson, 2000).

Brain and Orbit MRI
• 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 (Behbehani, 2007)
• Bilateral optic disk swelling (papilledema) with vision loss (Margolin, 2019)
• Optic Neuritis if atypical presentation, severe visual impairment, or poor recovery following initial onset or treatment onset (CMSC, 2018)
• Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent, or bilateral optic neuritis (Wingerchuk, 2015)

Brain and Sinus MRI
• Anosmia on objective testing that is persistent and of unknown origin (ACR, 2017; Policeni, 2017; Zaghouani, 2013)
• Granulomatosis with polyangiitis (Wegener’s granulomatosis) disease (Pakalniskis, 2015)

Brain and Neck MRI
• Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course) (ACR, 2017; Mumtaz, 2014; Policeni, 2017)

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 (Amitiptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Triflouperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause.

**POLICY HISTORY:**
- **Review Date:** July 2019
- **Review Summary:**
  - **ORBIT MRI:**
    - Removed: Orbital asymmetry and Suspected hyperthyroidism (such as Graves’ disease)
    - Added: Clinical suspicion of osteomyelitis
  - **Face/Sinus MRI**
    - Added specifics to Face Mass:
      - Present on physical exam and remains non-diagnostic after x-ray or ultrasound is completed (Kuno, 2014)
      - Clinical concern for abscess
      - Failed 2 weeks of treatment for suspected infectious adenopathy (Haynes, 2015).
      - 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)
  - **Other Indications**
    - 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
• Added: Bilateral papilledema with vision loss AND Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent, or bilateral optic neuritis

**Review Date:** May 2020

**Review Summary:**

**Clarified:**

**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
  - Osteomyelitis (after x-rays)
  - Abscess
• Facial Trauma
  - 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)
  - 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 non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders
  
  • Bilateral optic disk swelling (papilledema) with vision loss

**Added:**

**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
  - Unilateral or with optic disc abnormality
• Congenital orbital anomalies

**Added:**

**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)

Added:

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

Added:

Neck
• 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

Added:

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

Added:

Combo
• Added sub Combo sections
Brain and Orbit
   - Optic Neuritis if atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset
     - Brain and Sinus
     - Brain and Neck

Deleted:
Orbit
- Unilateral optic disk swelling papilledema approve dedicated Orbits MRI even if Brain MRI approved

Deleted:
Face/Sinus
- Clinical Suspicion of osteomyelitis
  - Direct visualization of lesion over bone
  - Abnormal x-ray
- Face Mass
  - Prior history of tumor with suspicion of recurrence
- Facial trauma
  - 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
REFERENCES:


Consortium of Multiple Sclerosis Centers (CMSC). MRI protocol and clinical guidelines for the diagnosis and follow-up of MS. February 2018.


Lawson, GR. Sedation of children for magnetic resonance imaging. Archives Dis Childhood. 2000; 82(2).


TABLE OF CONTENTS


70544 – MR Angiography Head/Brain
CPT Codes: 70544, 70545, 70546

INDICATIONS FOR BRAIN (HEAD) MR Angiography/MR Venography:

For evaluation of suspected intracranial vascular disease (ACR, 2017, 2019)

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 (Chalouhi, 2011).
- Screening for aneurysm in polycystic kidney disease (after age 30), Loeys-Dietz syndrome, fibromuscular dysplasia, spontaneous coronary arteries dissection (SCAD), or known aortic coarctation (Hayes, 2018; Hitchcock, 2016; Macaya, 2019)

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 work-up (Whitehead, 2019, Yeh, 2010, Yuan, 2005):
  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 (Pula, 2016).
- Pulsatile tinnitus to identify a vascular etiology (Hofmann, 2013; Pegge, 2017).

Cerebrovascular Disease

Ischemic
- Recent ischemic stroke or transient ischemic attack (See Background section) (Sanelli, 2014; Wintermark, 2013).
- 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 (Lima-Neto, 2017; Pirau, 2019; Searls, 2012).

Hemorrhagic
- Known subarachnoid hemorrhage (SAH)
- Known cerebral intraparenchymal hemorrhage with concern for underlying vascular abnormality

Venous - MRV*
- Suspected central venous thrombosis (dural sinus thrombosis)
• Distinguishing benign intracranial hypertension (pseudotumor cerebri) from dural sinus thrombosis (Agarwal, 2010; Aldossary, 2018).

Sickle cells disease (ischemic and/or hemorrhagic) (Abboud, 2003; Thust, 2014)
• 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, plasma viscosity) (Berlit, 2014)
• 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 (Godasi, 2019; Zuccoli, 2011).

Other intracranial vascular disease
• Suspected Moyomoya disease (Ancelet, 2015; Tarasow, 2011).
• Suspected reversible cerebral vasoconstriction syndrome (Singhal, 2016).

For evaluation of known intracranial vascular disease (ACR, 2017, 2019):
• Known intracranial aneurysm or vascular malformation (AVM or dural arteriovenous fistula)
• Vascular abnormality visualized on previous brain imaging that is equivocal or needs further evaluation
• Known vertebrobasilar insufficiency (VBI) (Lima-Neto, 2017; Searls, 2012).
• Known vasculitis, reversible cerebral vasoconstriction syndrome or Moyomoya disease (Ancelet, 2015; Godasi, 2019; Obusez, 2014; Signhal, 2016; Tarasow, 2011).

Other indications for a Brain MRA:
• Refractory trigeminal neuralgia when done for surgical planning (Leal, 2010).

Pre-operative/procedural evaluation for treatment, procedure, intervention, or brain/skull surgery

Post-operative/procedural evaluation (Lee, 2015; Serafin, 2012):
• 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 (ACR, 2017, 2019):
• Recent ischemic stroke or transient ischemic attack (TIA) (Sanelli, 2014).
• 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 (Lima-Neto, 2017; Pirau, 2019; Searls, 2012).
• Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (Franz, 2012; Shakir, 2016).
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 (Brott, 2011; DaCosta, 2019; Marquardt, 2010)

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 (AAN, 2010; Brott, 2011; Rerkasem, 2011)

Pulsatile tinnitus to identify vascular etiology (Hofmann, 2013; Pegge, 2017).

Indications for Brain MRI/Brain MRA combination studies (ACR, 2017, 2019)

- Recent ischemic stroke or transient ischemic attack
- Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up (Whitehead, 2019, Yeh, 2010, Yuan, 2005):
  - 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
- Suspected venous thrombosis (dural sinus thrombosis) – MRV*

Indications for Brain MRI/Brain MRA/Neck MRA combination studies:

- Recent ischemic stroke or transient ischemic attack (TIA) (ACR, 2017, 2019)
- 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 (Lawson, 2000).

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.

Three different techniques of MRA/MRV are: time of flight (both 2D and 3D TOF), phase contrast (PC), and contrasted 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 (Chen, 2018).

**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 imaging (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. (ACR, 2017, 2019; Lee, 2012).

**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” (Sacco, 2013). 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 (Kernan, 2014). 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” (Easton, 2009). 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 (Hong, 2011).

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 (Kernan, 2014).
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 (Wintermark, 2013).

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.

**MRA and Intracerebral Hemorrhage** – MRA is useful as a screening tool for an underlying vascular (Bekelis, 2012) 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.

**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 (Ayanzen, 2000).

**MRV and Central Venous Thrombosis** – a MR Venogram is indicted 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 (Bushnell, 2014; Courinho, 2015; Ferro, 2016).
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 (Whitehead, 2019).

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 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 (Franz, 2012; Liang, 2013; Mundinger, 2013; Simon, 2019). Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms. There is often minor trauma or precipitating factor (ie 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 (Nash, 2019; Shakir, 2016).

POLICY HISTORY:
Review Date: July 2019
Review Summary:
- 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:
  - Removed the past two-week restriction from ‘recent stroke or TIA’
  - Clarified CVA symptoms to include - known or suspected carotid or cerebral artery occlusion with sudden onset of numbness or incoordination
  - Added spontaneous injuries due to weakness of vessel wall leading to dissection
  - 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
  - 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:
  - Recent stroke or transient ischemic attack
  - Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache
  - Suspected venous thrombosis (dural sinus thrombosis)
• Added section for Brain MRI/Brain MRA/Neck MRA combination studies, including:
  - Recent stroke or transient ischemic attack (TIA)
  - 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

Review Date: May 2020
Review Summary:
• 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
  - Negative Brain CT; AND
  - Negative Lumbar Puncture; OR
  - 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
REFERENCES


http://www.ajnr.org/content/21/1/74.long.


TABLE OF CONTENTS


INDICATIONS FOR NECK MRA:

For evaluation of known or suspected extracranial vascular disease:

Cerebrovascular Disease
- Recent ischemic stroke or transient ischemic attack (ACR, 2017, 2019; Sanelli, 2014).
- 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) (Brott, 2011; DaCosta, 2019; Marquardt, 2010).
- 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) (AAN; 2010; Brott, 2011; Rerkasem, 2011)

Aneurysm screening:
- Screening for aneurysm in fibromuscular dysplasia or spontaneous coronary arteries dissection (SCAD) (Hayes, 2018; Hitchcock, 2014; Macaya, 2019).

Tumor/pulsatile mass
- Pulsatile mass on exam after Ultrasound (US)
- Known Carotid body tumors, or other masses such as a paraganglioma, arteriovenous fistula, pseudoaneurysm, atypical lymphovascular malformation (Nguyen, 2011).

Other extracranial vascular disease
- Takayasu arteritis based on findings in other blood vessels on previous imaging (Zhu, 2012)
- Giant cell arteritis (Abdel Razek, 2014; Koster, 2018)
- Subclavian steal syndrome when ultrasound is positive or indeterminate or for planning interventions (Potter, 2014)
- Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (Franz, 2012; Shakir, 2016)
- Horner’s syndrome (miosis, ptosis, and anhidrosis) (Kim, 2012)
- Known extracranial vascular disease that needs follow-up or further evaluation

Pre-operative evaluation

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) (ACR, 2017, 2019; Wintermark, 2013)
• 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 (Lima-Neto, 2017; Searls, 2012).
• Suspected carotid or vertebral artery dissection; due to trauma or spontaneous due to weakness of vessel wall leading to dissection (Franz, 2012; Shakir, 2016).
• 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 (Brott, 2011; DaCosta, 2019; Marquardt, 2010)
• 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 (Brott, 2011; DaCosta, 2019; Rerkasem, 2011)
• For evaluation of pulsatile tinnitus (subjective or objective) for vascular etiology (Pegge, 2017)

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

BACKGROUND:
For vascular disease, in general, MRA and CTA are comparable. There is no current literature comparing 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 (ACR, 2016).

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 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, goswell coma score less than 8 without CT findings, massive epistaxis, cervical bruif or thrill (Franz, 2012; Liang, 2013; Mundinger, 2013; Simon, 2019). Spontaneous dissection presents with headache, neck pain with neurological signs or symptoms.

There is often minor trauma or precipitating factor (ie 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 (Nash, 2019; Shakir, 2016).

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 - 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” (Sacco, 2013). 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 (Kernan, 2014). 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” (Easton, 2009). 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 (Hong, 2011).

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 stoke 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 (Kernan, 2014). 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 (Wintermark, 2013).

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:
Review Date: April 2019
Review Summary:
• 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
Review Date: May 2020
Review Summary:
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
REFERENCES:


70551 – MRI Brain (includes Internal Auditory Canal)

CPT Codes:
70551, 70552, 70553 – Brain MRI
70540, 70542, 70543 – IAC

INDICATIONS FOR BRAIN MRI:

For evaluation of headache:
(ACR, 2019; Holle, 2013; Quinones-Hinojosa, 2003; Schafer, 2007; Wilbrink, 2009)
• Chronic headache with a change in character/pattern (e.g., more frequent, increased severity, or duration).
• Cluster headaches - imaging is indicated once to eliminate secondary causes
• New acute headache, sudden onset:
  o With a personal or family history (brother, sister, parent, or child) of brain aneurysm or AVM (arteriovenous malformation) OR
  o < 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.
  o Prior history of stroke or intracranial bleed
  o Known coagulopathy or on anticoagulation
• New onset of headache with any of the following (ACR, 2019; Micieli, 2020; Mitsikostas, 2016):
  o Acute, new, or fluctuating neurologic deficits such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes or with signs of increased intracranial pressure (papilledema)
    * Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration
  Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)
  o History of cancer or significantly immunocompromised
  o Fever
  o Subacute head trauma
  o Pregnancy or puerperium (Hamilton, 2020; Shobeiri, 2019)
  o Age ≥ 50
  o Severe unilateral headache with radiation to or from the neck, associated with suspicion of carotid or vertebral artery dissection.
  o Related to activity or event (sexual activity, exertion, position) (new or progressively worsening)
  o Persistent or progressively worsening during a course of physician directed treatment (ACR, 2019; Kuruvilla, 2015; Martin, 2011)
• Special considerations in the pediatric population with persistent headache (Trofimova, 2018):
For evaluation of neurologic symptoms or deficits:
(ACR, 2019)
• Acute, new, or fluctuating neurologic symptoms or deficits such as, sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes.
* Not explained by underlying ocular diagnosis, glaucoma or macular degeneration

For evaluation of known or suspected stroke or vascular disease:
(ACR 2017, 2019; Jauch, 2013)
• 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
*Not explained by underlying ocular diagnosis, glaucoma or macular degeneration
• Suspected stroke with a personal or family history (brother, sister, parent or child) of aneurysm or known coagulopathy or on anticoagulation.
• Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms)
• Evaluation of suspected acute subarachnoid hemorrhage (SAH).
• Follow up for known hemorrhage, hematoma or vascular abnormalities.
• Suspected central venous thrombosis - see background (ACR, 2017, Bushnell, 2014)
• Evaluation of neurological signs or symptoms in sickle cell disease (Mackin, 2014; Thust, 2014)

For evaluation of known or suspected trauma:
(ACR, 2019, Jagoda, 2008; Polinder, 2018)
• Known or suspected trauma or injury to the head with documentation of one or more of the following acute, new, or fluctuating:
  o Focal neurologic findings
  o Motor changes
  o Mental status changes
  o Amnesia
  o Vomiting
  o Seizures
  o Headache
  o Signs of increased intracranial pressure
• Known coagulopathy or on anticoagulation
• Known or suspected skull fracture by physical exam and positive x-ray.
• 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:
(Kerjnick, 2008; NCCN, 2019)
• Suspected brain tumor with any acute, new, or fluctuating neurologic symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes.
  * Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration
• 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)

Suspected Pituitary Tumors:
(ACR, 2018; GHR, 2000; Kannan, 2013; Majumdar, 2013; Shalender, 2018)
• With the following:
  o Neurologic findings (e.g. visual field deficit suggesting compression of the optic chiasm)
  o 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)
  o 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 e.g., stress, pregnancy, hypothyroidism, medication)
  o Central Diabetes Insipidus (low ADH)
  o 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 (Faizah, 2012)
  o Pituitary apoplexy with sudden onset of neurological and hormonal symptoms

For evaluation of known brain tumor, mass, or metastasis:
• Follow up of known malignant brain tumor
• Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination findings
• 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 (NCCN, 2020)
• Follow up of known non-malignant brain tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors
• Follow up of known meningioma (NHS, 2018)
- If <2cm or heavily calcified at 2 years and 5 years
- > 2cm annually for 3 years and then scans at 5 years and 10 years.
- Multiple meningiomas, annually
- 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
- New signs or symptoms
- Functioning adenoma - to assess response to treatment and 1-year follow-up after drug holiday (Stoller, 2012)
- Asymptomatic Macroadenoma (≥ 10mm) follow up every 6-18 months, post-surgical follow up 1-2 years after surgery (Dekkers, 2008)
- Asymptomatic, non-functioning Microadenoma < 10mm repeat in one year; if stable, repeat every 2-3 years (Lake, 2013)

### Tumor evaluation and monitoring in neurocutaneous syndromes – see background
- Follow of known pineal cyst (≥ 5mm) if there are atypical features or symptoms (e.g., headaches, gaze paresis, ataxia, papilledema, nausea/vomiting) (Cauley, 2009; Jussila 2017)
  - < 4 years old, serial imaging is warranted
  - > 4 years old, repeat imaging only if symptomatic i.e. headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction.

### For screening for known Non-CNS Cancer - see background (NCCN, 2020)

- 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
- Li Fraumeni syndrome- Annually (Cureus, 2018)
- Von Hippel Lindau – Every 2 years, starting at age of 8 years (Rednam, 2017).
- Tuberous Sclerosis – Every 1-3 years, until the age of 25 years (Kreuger, 2013)
- MEN1 – Every 3-5 years, starting at the age of 5 years (Brandi, 2001)
- NF-2- Brain IAC: Annually starting, from age of 10 years (Evans, 2017)
Sturge Weber Syndrome: Once, after age 1 to rule out intracranial involvement after; in patients <1 year, only if symptomatic (Comi, 2011).

**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:** (NCCN, 2019)
- ≤ 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:**
(ACR, 2019; Cendes, 2016; Gaillard, 2009; Ho, 2013; Krumholz, 2007; Ramli, 2015)
- New onset of an unprovoked seizure in adults
- Newly identified change in seizure activity/pattern
- Known seizure disorder without previous imaging
- Medically refractory epilepsy
- Imaging indications for new onset seizures in the pediatric population (Hirtz, 2000; Kimia, 2012; Sadeq, 2016; Sahikj, 2019)
  - 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):**
(CMSC, 2018; Thompson, 2017; Traboulsee, 2016)
- 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 (6-12 months for high risk, 12-24 months for low risk)

**For evaluation of known multiple sclerosis (MS):**
(CMSC, 2018)
- 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
- Progressive Multifocal Leukoencephalopathy (PML) surveillance for patients on natalizumab

**For evaluation of known or suspected infectious or inflammatory disease (e.g., meningitis or abscess)**
(Lummel, 2016; Oliveira, 2014)
- Suspected intracranial abscess or brain infection with acute altered mental status or with positive lab findings (such as elevated WBC’s) 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 >50 with temporal headache, abrupt visual changes, jaw claudication, temporal artery tenderness, constitutional symptoms or elevated ESR (D’Souza, 2016; Diamantopoulos, 2014; Klink, 2014; Salehi, 2016); 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
- Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with positive lab findings.
- 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.

For evaluation of clinical assessment documenting cognitive impairment of unclear cause: (Harvey 2012; HQO, 2014; Narayanan, 2016)
- Mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments/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).

For evaluation of movement disorders: (ACR, 2019a; Albanese, 2011; Mascalchi, 2012; McFarland, 2014; Pyatigorskaya, 2014; Sharifi, 2014)
- For evaluation of suspected Parkinson’s with atypical feature or unresponsive to levodopa
- For evaluation of new non-Parkinson 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 or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer’s dystonia) (Alabanese, 2011; Comella, 2019; Sharfi, 2014)

For evaluation of cranial nerve and visual abnormalities:
- Anosmia (loss of smell) documented by objective testing that is persistent and of unknown origin (Policeni, 2017; Rouby, 2011)
- Optic neuritis
• Abnormal eye findings on physical or neurologic examination (papilledema, pathologic nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit, etc) (Chang, 2019)
  Note: Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration
• Binocular diplopia with concern for intracranial pathology (Iliescu, 2017)
• Horner’s syndrome with symptoms localizing the lesion to the central nervous system (Lee, 2007).
• 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) (Cruccu, 2016)
• Bell’s Palsy- if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset (Quesnel, 2010)
• Hemifacial spasm (Hermier, 2019)
• Other objective cranial nerve palsy (CN IX-XII) (ACR, 2017; Mumtaz, 2014; Policeni, 2017)

For evaluation of known or suspected congenital abnormality (such as hydrocephalus, craniosynostosis) (Ashwal, 2009; Vinocur, 2010)
• Known or suspected congenital abnormality with any acute, new, or fluctuating neurologic, motor, or mental status changes.
• Evaluation of macrocephaly in an infant/child with previously abnormal US, abnormal neurodevelopmental examination (Tan, 2018), signs of increased ICP or closed anterior fontanelle.
• Evaluation of microcephaly.
• Evaluation of craniosynostosis and other skull deformities. CT is preferred imaging to assess bony structures; MRI imaging is preferred to assess intracranial soft tissue
• Prior treatment OR treatment planned for congenital abnormality.

Cerebral Spinal Fluid (CSF) Abnormalities
• Suspected or known hydrocephalus*
• Initial imaging of a suspected or known Arnold Chiari malformation *
• Initial evaluation for a known syrinx or syringomyelia*
• Known or suspected normal pressure hydrocephalus (NPH) (Damasceno, 2015)
  o With symptoms of gait difficulty, cognitive disturbance and urinary incontinence
  o Follow up shunt evaluation (Kamenova, 2018; Pople, 2002, Reddy, 2014) Post operativity if indicated based on underlying disease and pre-operative radiographic findings and/or
  o 6-12 months after placement and/or
  o With neurologic symptoms that suggest shunt malfunction
• Evaluation of known or suspected cerebrospinal fluid (CSF) leakage (Severson, 2019)
• Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance (Gordon 2019; NORD, 2017).
• CSF flow study for evaluation and management of CSF flow disorders (Bradley, 2016; Mohammad, 2019)
*Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection etc (NORD, 2014)

Pre-operative evaluation for brain/skull surgery:
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 (Welgampola, 2019; Yamada, 2019)
  - 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
- Diagnosis of central sleep apnea on polysomnogram
  - Children > 1 year (Felix, 2016)
  - 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 (Malhotra, 2010)
- Syncope with clinical concern for seizure or associated neurological signs or symptoms (Al-Nsoor, 2010; Strickberger, 2006)
- Cyclic vomiting syndrome or abdominal migraine with any localizing neurological symptoms (Angus-Leppan, 2018; Li BUK, 2018; Venkatesan, 2019)
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph) (ACR, 2017; Kim, 2019; Zhang, 2018)
- Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause (ACR, 2019b)
- Global developmental delay or developmental delay with abnormal neurological examination (Ali, 2015; Momen, 2011)
- 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 (Ashwal, 2004; NICE, 2020)
- Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam (Tieder, 2016)

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.
- Suspected cholesteatoma.
- Suspected glomus tumor.
• Asymmetric sensorineural hearing loss on audiogram.
• CSF otorrhea (MRI for intermittant leak, CT for active leaks) (Hiremath, 2019)
• 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) (Patel, 2014; Platzek, 2014)
• 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 (Quesnel, 2010)

Indications for combination studies: (ACR, 2017, 2019)
• 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.

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

• Brain MRI/Brain MRA
  o Recent ischemic stroke or transient ischemic attack
  o Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up (Whitehead, 2019, Yeh, 2010, Yuan, 2005):
    ▪ Negative Brain CT; **AND**
    ▪ Negative Lumbar Puncture
  o Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
  o Suspected venous thrombosis (dural sinus thrombosis) – Brain MRV see background

• Brain MRI/Brain MRA/Neck MRA
  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 vascular and intracranial pathology (Lawson, 2000).

• Brain MRI/Cervical MRI
  o For evaluation of Arnold Chiari Malformation.
  o Suspected MS with new or changing symptoms consistent with cervical spinal cord disease.
  o For follow-up of known multiple sclerosis (MS)
  o Follow up to the initiation or change in medication for patient with known Multiple Sclerosis

• Brain MRI/Orbit MRI
  o Unilateral papilledema 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 (Behbehani, 2007)
- Bilateral optic disk swelling (papilledema) with visual loss (Margolin, 2019)
- Optic Neuritis if atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset (CMSC, 2018)
- Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent or bilateral optic neuritis (Wingerchuk, 2015)

### Brain MRI/FACE/SINUS/NECK MRI
- Anosmia on objective testing (Policeni, 2017; Zaghouani, 2013)
- Trigeminal neuralgia that meets the above criteria (Hughes 2016; Policeni, 2017)
- Bells/hemifacial spasm that meets above criteria
- Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course) (Mumtaz, 2014; Policeni, 2017)
- Granulomatosis with polyangiitis (Wegener’s granulomatosis) disease (Pakalniskis, 2015)

### 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 (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 imaged 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 (ACR, 2012b; HIS, 2018; Jang, 2019; Spierings, 2003; Tyagi, 2012)

**Migraine with aura** (Hadjikhani, 2019; IHS, 2018; Micieli, 2020)
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 patients. 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, history of vascular risk factors.

**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” (Sacco, 2013). 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 (Kernan, 2014). TIA’s 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” (Easton, 2009). 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 (Hong, 2011).

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 (Kernan, 2014). 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 (Wintermark, 2013). 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.

**MRI and Central Venous Thrombosis** – a MV 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, 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 (Bushnell, 2014; Courinho, 2015; Ferro, 2016).

**MRI and benign tumors** (e.g., schwannomas, choroid plexus papilloma, pineocytoma, gangliocytoma) A single follow up study is appropriate after the initial diagnosis to ensure stability. Follow up of known benign tumor if symptomatic, new/changing signs or symptoms or complicating factors (Gupta, 2017). In neurocutaneous and hereditary cancer syndromes follow-up surveillance may also be indicted (see below).

**Galactorrhea and MRI**: Imaging is not indicated in isolated galactorrhea without elevated prolactin (normoprolactinemic) (Huang, 2012; Sridevi, 2018).

**MRI and Meningioma** (NHS, 2018) – For incidental meningiomas, most patients who progressed did so within 5 years of diagnosis (Islam, 2019). Small (<2cm) meningiomas rarely grow sufficiently to produce symptoms within 5 years. Heavily calcified meningiomas rarely grow. Patients with multiple meningiomas should have annual scans indefinitely, despite treatment because of the possibility of further meningiomas developing. For surveillance post treatment:
- Solitary convexity WHO Grade 1 meningiomas - MRI scan at 2½ years post-operatively
- Solitary skull base or falcine origin WHO Grade 1 meningiomas- MRI scans at 1 year, 2 years, 3½ years and 5 years post-operatively. If a recurrence is detected continue annual scans.
- WHO Grade 2 meningiomas- MRI scan at 6 months, 1 then annually to 5 years. If a recurrence is detected continue annual scans.
- WHO Grade 3 meningiomas - 6-monthly MRI scans for 3 years, then annual scans to 5 years. If a recurrence is detected continue annual scans.
- Patients who have had radiosurgery, including those being treated for a recurrence, should have scans at 6 months, then annually for 3 years, a scan at 5 years and a final scan at 10 years.
<table>
<thead>
<tr>
<th>(NON BRAIN/CNS) CANCER</th>
<th>PRECONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutaneous melanoma</td>
<td>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</td>
</tr>
<tr>
<td>Testicular cancer-Seminoma</td>
<td>If high risk such as beta HCG &gt;5000IU/L, or multiple lung or visceral mets, choriocarcinoma, neurological symptoms, or AFP&gt;10,000ng/ml</td>
</tr>
<tr>
<td>Merkel cell carcinoma</td>
<td>Default staging screening, but especially for high risk (≥stage IIIb, immunosuppression)</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>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</td>
</tr>
</tbody>
</table>

**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 clinical evaluation and for follow-up of known intracranial tumors (Borofsky, 2013). 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 (Evans, 2017). In patients with **Tuberous Sclerosis**, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities (Krueger, 2013). In **Von Hippel Lindau Syndrome**, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years (Rednam, 2017). In **Sturge Weber Syndrome**, MRI can rule out intracranial involvement after only after age 1 and is recommended in patients <1 year only if symptomatic (Comi, 2011).

**MRI and Positron Emission Tomography (PET) for Chronic Seizures** – When MRI is performed in the evaluation of patients 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 patients with MRI-negative temporal lobe epilepsy.

**Multiple Sclerosis** (Rovira, 2014; Saguil, 2014; Thompson, 2017)
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. There is an expanding amount of available disease-modifying treatments which are effective in slowing down disease progression especially in the early stages. Though they are expensive and can have serious side effects. 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 patient-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 patients. In the revised MC Donald Criteria, MRI findings can be used to establish dissemination in both time and space.

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 below). If there are recurrent episodes of variable neurological signs or symptoms not attributable to another cause with clinical concern for MS imaging is warranted as well.
<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depressed mood</td>
<td>Ataxia</td>
</tr>
<tr>
<td>Memory loss/cognitive changes</td>
<td>Dysmetria</td>
</tr>
<tr>
<td>Dizziness or vertigo</td>
<td>Decreased sensation (pain, vibration, position)</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Decreased strength</td>
</tr>
<tr>
<td>Hearing loss and tinnitus</td>
<td>Hyperreflexia, spasticity</td>
</tr>
<tr>
<td>Heat sensitivity (Uhthoff Phenomenon)</td>
<td>Nystagmus</td>
</tr>
<tr>
<td>Incoordination and gait disturbances</td>
<td>Lhermitte’s sign</td>
</tr>
<tr>
<td>Pain</td>
<td>Visual defects (internuclear ophthalmoplegia,</td>
</tr>
<tr>
<td></td>
<td>optic disc pallor, red color desaturation,</td>
</tr>
<tr>
<td></td>
<td>reduced visual acuity)</td>
</tr>
<tr>
<td>Sensory disturbances (dysesthesias, numbness,</td>
<td></td>
</tr>
<tr>
<td>paresthesias)</td>
<td></td>
</tr>
<tr>
<td>Urinary symptoms</td>
<td></td>
</tr>
<tr>
<td>Visual disturbances (diplopia, oscillopsia)</td>
<td></td>
</tr>
<tr>
<td>Weakness</td>
<td></td>
</tr>
</tbody>
</table>

**MRI and Neuromyelitis optica spectrum disorders (NMOSD) (Wingerchuk, 2015)** - 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.
**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, visuoconstructual 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.

**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 (Amitiptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Triflouperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause (Geyer, 2008)

**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 (Smith, 1998). The anterior fontanelle generally closes between 10 and 24 months of age, with 3% closing between 5-9 months and 11% after 24 months (Pindrik, 2014).

**MRI and 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 patients who cannot undergo MRI (Damasceno, 2015).

**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 patient presents with associated neurological symptoms such as weakness, diplopia, sensory changes, ataxia, or confusion. Magnetic resonance imaging is appropriate in the evaluation of patients 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): 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.

**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
- 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.

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 (Whitehead, 2019).

**POLICY HISTORY**

**Review Date:** August 2019

**Review Summary:**
- 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:
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
  - 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)
  - 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
- 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

**Review Date:** May 2020

**Review Summary:**

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
  - 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
- 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 > 50
  o 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
  o Symptoms indicative of intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting
  o 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., hypopituitarism, 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 e.g. stress, pregnancy, hypothyroidism, medication)
- Note: Galactorrhea without elevated prolactin, imaging is not indicated
- 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
  - If <2cm or heavily calcified at 2 years and 5 years
  - > 2cm annually for 3 years and then scans at 5 years and 10 years.
  - Multiple meningiomas, annually
  - 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

- New signs or symptoms
- 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
  - < 4 years old, serial imaging is warranted
> 4 years old, repeat imaging only if symptomatic i.e. headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction

- For screening for known Non-CNS Cancer
  - 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
  - AML
  - Cutaneous melanoma
  - Testicular Cancer-Seminoma
  - Gestational Trophoblastic Neoplasia
  - Bladder cancer

- 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

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
- MRI indicated 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)
  - Post operatively 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

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
  - 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
REFERENCES


American College of Radiology ACR Appropriateness Criteria® Seizures and Epilepsy. 2019.


Kernan WN, Ovbiagele B, Black HR, et al. Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: A guideline for healthcare professionals from the American Heart
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawson, GR. Sedation of children for magnetic resonance imaging. Archives Dis Childhood. 2000; 82(2).</td>
</tr>
</tbody>
</table>


INDICATIONS FOR FUNCTIONAL BRAIN MRI (ACR, 2017)

Pre-operative/procedural Evaluation (Bizzi, 2008; Petrella, 2006)
In the following where fMRI may have a significant role in the mapping 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 (Jiao, 2017; Stancanello, 2017; Vysotski, 2018).
- Pre-operative evaluation for epilepsy surgery (Benjamin, 2018; Janecek, 2013).
- Brain tumor for radiation treatment planning (Kovacs, 2011; Wang 2015; Wengenroth, 2011).

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 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 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.

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.

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 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.

POLICY HISTORY:
Review Date: August 2019
Review Summary:
• 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.

Review Date: May 2020
Review Summary:
• Updated references
• Reordered indications
REFFENCES:


Binder JR. Functional MRI is a valid noninvasive alternative to Wada testing. Epilepsy Behav. 2011; 20:214-222.


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 (G0297). 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:

Group 1:
- Individual is between 55-80 years of age; AND
- There is at least a 30 pack-year history of cigarette smoking; AND
- If the individual is a former smoker, that individual had quit smoking within the previous 15 years.

Group 2:
- Age ≥ 50 years old; AND
- ≥ 20 pack-year history of smoking; AND
- Additional risk factors (other than second-hand smoke)*

*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.

**Nodule on Initial LDCT:**
(Wood, 2018)
- If multiple nodules, the largest and type is used for decision

**Lung Nodules** (Bueno, 2018)
- 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)
**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

**Table 1: 2017 Fleischner Society Guidelines for Management of Incidentally Detected Pulmonary Nodules**

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

**Known Cancer:**  
(Carter, 2018; Hong, 2014; Lee, 2014)  
- For follow-up intervals for malignancies (NCCN, 2019)
• Cancer staging (includes unknown primary)
• Cancer restaging
• Suspicious signs or symptoms of recurrence
• Suspected cancer based on prior imaging (Greco, 2012)

**Lung or Chest Wall Mass** (Mullan, 2011):
(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 (Kumar, 2015)

**Interstitial Lung Disease:**
(ACR, 2019; Vij, 2013)
• 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:
  o Shortness of breath
  o Persistent dyspnea
  o Persistent cough
• Monitoring treatment response of known interstitial lung disease
• Patients with known collagen vascular disease (Antoniou, 2009)
• Guidance in selection of the most appropriate site for biopsy of diffuse lung disease (ACR, 2015)

**Chronic Cough (> 8 weeks) and chest x-ray completed** (Turner, 2016):
• After evaluation for other causes and failed treatment for those diagnosed with:
  o Asthma
  o Gastroesophageal Reflux Disease
  o Discontinuation of ACE inhibitors
  o Post nasal drip
• Clinical concern for bronchiectasis

**Tuberculosis (TB):**
(Ko, 2018)
• Known or suspected tuberculosis and initial chest x-ray done

**Infection Follow-up Imaging:**
• Abscess, empyema, or pleural effusions on chest x-ray (Dean, 2016)
• For evaluation of non-resolving pneumonia or inflammatory disease documented by at least two imaging studies:
  o Unimproved with 4 weeks of antibiotic treatment; OR
  o Unresolved at 8 weeks (Bryl, 2018; Little, 2014)

**Pneumothorax on Chest X-ray** (Melamed, 2017)
Vocal Cord Paralysis on Endoscopic Exam (Paquette, 2012)
- Neck and Chest CT is an approvable combo

Granulomatosis with Polyangiitis (Wegener’s Granulomatosis) (Li, 2018)

Vascular Disease:
- CT chest is not preferred study for vascular disease, CTA should be considered. See Chest CTA guideline.
- Chest CT can be used to detect and follow-up thoracic aortic aneurysms. See Background section.

Suspected Pulmonary Embolism (PE):
- Chest CT not approvable for PE

Congenital Malformations
- Thoracic malformation on chest x-ray (Ferreira, 2015)
- Congenital Heart Disease with pulmonary hypertension (Pascall, 2018)

Hemoptysis after x-ray completed (ACR, 2019; Ketai, 2014)

Pre-operative evaluation

Post-operative/procedural evaluation:
- Post-surgical follow up when records document medical reason requiring additional imaging
- Pre-operative evaluation for Electromagnetic Navigation Bronchoscopy (Khan, 2016)

Chest Wall Pain (after initial evaluation with chest x-ray and/or rib films) (Winzenberg, 2015)
- History of known or suspected cancer
- Signs and symptoms of infection, such as:
  - Accompanying fever
  - Elevated inflammatory markers
  - Known infection at other sites

Combination of studies with Chest CT:
- 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

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.
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 (Erbel, 2014; Hannuksela, 2015; Hiratzka, 2010)
  o Echocardiogram shows aneurysm
  o Echocardiogram inconclusive of proximal aorta and first degree relative with thoracic aneurysm
  o Chest x-ray shows possible aneurysm
• Follow-up after established Thoracic Aneurysm (above these sizes surgery is usually recommended) (Erbel, 2014; Hannuksela 2015; Hiratzka, 2010)
  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

CT and Interstitial Lung Disease (ACR, 2019) - 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 (Proulx, 2009) - 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.

CT for Management of Hemoptysis – 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 nodules. 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 (ACR, 2018) - CT 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 (ACR, 2019) - 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.” CT may be of value in the severely immunocompromised patient 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 (Loverdos, 2019) - 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.

POLICY HISTORY:
Review Date: May 2019
Review Summary:
- 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.

Review Date: May 2020
Review Summary:
- For Annual Lung Cancer Screening:
  - Changed upper age limit from 77 to 80 yrs old
  - 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:
  - 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)
  - 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:
• 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:
  - *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*
  - *Patients with known collagen vascular disease*
  - *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:
  - CT chest is not preferred study for vascular disease, CTA should be considered. See Chest CTA guideline.
  - Chest CT can be used to detect and follow-up thoracic aortic aneurysms.

• Added indication: Chest Wall Pain
  - *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
REFERENCES:


Bryl B, Barlow E, Davies H. P182 Follow up chest X-rays (CXR) after community acquired pneumonia (CAP): Are they done and are they useful? BMJ. 2018; 73(4).


71275 – CT Angiography, Chest (non coronary)

CPT Codes: 71275

INDICATIONS FOR CHEST CTA:
Some indications are for magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), computed tomography (CT), or computed tomography angiography (CTA). More than one should not be approved at the same time.

Suspected Pulmonary Embolism (PE)
(ACCP, 2013; ACR, 2016; Corrigan, 2016; Kirsch, 2017; Konstantinides, 2014)
- High risk for PE based on shock or hypotension
- Positive D-dimer (Corrigan, 2016; Konstantinides, 2014)

Vascular Disease
- Superior vena cava (SVC) syndrome (Friedman, 2017)
- Subclavian Steal Syndrome after positive or inconclusive ultrasound (Osiro, 2012; Potter, 2014)
- Thoracic Outlet Syndrome (ACR, 2014; Povlsen, 2018)
- Takayasu’s arteritis (Keser, 2014)
- Clinical concern for Acute Aortic dissection (ACR, 2017; Barman, 2014)
  - Sudden painful ripping sensation in the chest or back and may include
    - New diastolic murmur
    - Cardiac tamponade
    - Distant heart sounds
    - Hypotension or shock
  - 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) (Erbel, 2014; Hannuksela 2015; Hiratzka, 2010)
  - 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
Thoracic Aortic Disease

- If TTE was not performed, was technically inadequate, or if imaging is required beyond the proximal ascending aorta

Initial/Screening:

- Screening of first-degree relatives of individuals with a thoracic aortic aneurysm (defined as ≥ 50% above normal) or dissection, or if an associated high-risk mutation is present
  - If one or more first degree relatives of a patient with a known thoracic aortic aneurysm or dissection, have thoracic aortic dilatation, aneurysm or dissection, then imaging of 2nd degree relatives is reasonable
  - Evaluation of the ascending aorta in suspected connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (e.g., Marfan syndrome, Ehlers Danlos or Loeys-Dietz syndromes) at time of diagnosis
  - Patients with Turner’s syndrome should undergo imaging to assess for bicuspid aortic valve, coarctation of the aorta or dilatation of the ascending or thoracic aorta. If the initial imaging is normal and there are no additional risk factors for dissection, imaging can be done every 5-10 years.
  - Screening of first-degree relatives of patients with a bicuspid aortic valve

Follow-up known aneurysm/vascular pathology:

- Six months follow up after initial finding of a dilated thoracic aorta, for assessment of rate of change
- Biannual (twice/year) follow up of enlarged aortic root ≥ 4.5 cm or showing growth rate ≥ 0.5 cm/year
- Evaluation of the ascending aorta in known connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (e.g., Marfan syndrome, Ehlers Danlos or Loeys-Dietz syndromes) 6 months after initial imaging for growth rate assessment, followed by annual imaging, or biannual (twice yearly) if diameter ≥ 4.5 or expanding ≥ 0.5 cm/yr
- Turner’s syndrome - If an abnormality exists on initial imaging, annual imaging is recommended
- 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
- Re-evaluation (<1 y, generally twice a year) of the size and morphology of the aortic sinuses and ascending aorta in patients with a bicuspid AV with 1 of the following:
  - Aortic diameter ≥ 4.5 cm
  - Rapid rate of change in aortic diameter when an annual growth rate of ≥ 0.5 cm is suspected.
  - Family history (first-degree relative) of aortic dissection
- Follow up post medical treatment of aortic disease:
  - 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
**Congenital Malformations**

- Thoracic malformation on other imaging (chest x-ray, echocardiogram, GI study, or inconclusive CT) (Ferreira, 2015; Hellinger, 2011; Karaosmanoglu, 2015; Poletto, 2017)
- Congenital heart disease with pulmonary hypertension (Pascall, 2018)
- Pulmonary sequestration (Al-Timmy, 2016; Long, 2016)

**Pulmonary Hypertension** based on other testing (Ascha, 2017; Rose-Jones, 2015)

- Echocardiogram
- Right heart catheterization

**Atrial fibrillation with ablation planned** (Kolandaivelu, 2012)

**Preoperative evaluation**

**Post-operative/procedural evaluation**

- Post-operative complications (Bennet, 2017; Choudhury, 2017)
- Routine post-operative evaluation of:
  - Thoracic endovascular aneurysm repair
    - 1 month, then at
    - 6 months if initial abnormal or if for aortic dissection, then
    - Annually for 5 years
  - Open surgical repair
    - Once every 5 years

**Chest CTA and Abdomen CTA or Abdomen/Pelvis CTA**

- Transcatheter Aortic Valve Replacement (TAVR) (Achenbach, 2012; ACR, 2017)
- Acute aortic dissection (Barman, 2014)
- Takayasu’s arteritis (Keser, 2014)
- Post-operative complications (Bennet, 2017; Choudhury, 2017)

**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 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 (Konstantinides, 2020):

- Evidence of current or prior DVT;
- HR > 100;
- Cancer diagnosis;
- Recent surgery or prolonged immobilization;
- Hemoptyis;
- 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 aortic after stent-grafting and can be performed efficiently with fast scanning speed and high spatial and temporal resolution.

**POLICY HISTORY:**
**Review Date:** May 2019
**Review Summary:**
- Expanded vascular indications including:
  - Superior vena cava syndrome
Takayasu’s arteritis
• 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

Review Date: May 2020

Review Summary:
• For Suspected Pulmonary Embolism, removed: ‘Low Risk is not approved’ section
• Moved Vascular Disease content from Chest CT to Chest CTA, including:
  • Initial evaluation of aneurysm
    ▪ 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)
  • 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
• Thoracic Aortic Disease
  • 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’
REFERENCES:


INDICATIONS FOR CHEST MRI:
Some indications are for magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), computed tomography (CT), or computed tomography angiography (CTA). More than one should not be approved at the same time.

Chest Mass (non-lung parenchymal)
• Mass or lesion, including lymphadenopathy, after non-diagnostic x-ray or ultrasound, Chest CT indicated for pulmonary nodule.
• Thymoma screening in Myasthenia Gravis patients (Kumar, 2015)

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

Vascular Disease (Kircher, 2012; Rajiah, 2013)
• Superior vena cava (SVC) syndrome (Friedman, 2017)
• Subclavian Steal Syndrome after positive or inconclusive ultrasound (Osiro, 2012; Potter, 2014)
• Thoracic Outlet Syndrome (ACR, 2014; Chavhan, 2017; Povlsen, 2018)
• Takayasu’s arteritis (Keser, 2014)
• Clinical concern for acute aortic dissection (ACR, 2017; Barman, 2014)
  o Sudden painful ripping sensation in the chest or back and may include
    ▪ New diastolic murmur
    ▪ Cardiac tamponade
    ▪ Distant heart sounds
    ▪ Hypotension or shock

Thoracic Aortic Disease
• (Chest CTA or MRA is preferred for vascular pathology) (ACR, 2019)

Thoracic Outlet Syndrome (ACR, 2014; Chavhan, 2017; Povlsen, 2018; Smith, 2015)
• Chest CTA or MRA is preferred for vascular pathology (ACR, 2019)

Brachial Plexopathy (Vijayasarithi, 2016)
Chest MRI is preferred study vs. neck or shoulder MRI

**Congenital Malformations**
- Thoracic malformation on other imaging (chest x-ray, echocardiogram, gastrointestinal study, or inconclusive CT) (Ferreira 2015, Hellinger 2011, Karaosmanoglu 2015, Poletto 2017)
- Congenital heart disease with pulmonary hypertension (Pascall 2018)
- Pulmonary sequestration (Al-Timmy 2016; Long, 2016)

**Pulmonary hypertension based on other testing** (Ascha 2017, Rose-Jones 2015)
- Echocardiogram
- Right heart catheterization

**Atrial fibrillation with ablation planned** (Kolandaivelu 2012)

**Preoperative Evaluation**

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

---

**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.

**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:**
**Review Date:** May 2019
**Review Summary:**
- Expanded indications including: vascular and congenital anomalies
- Updated thoracic aortic section and reformatted to match other guidelines.

**Review Date:** May 2020
**Review Summary:**
- Added Chest Wall Pain section:
  - **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
- 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*
REFERENCES:


Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM guidelines for the diagnosis and management of patients with Thoracic Aortic Disease: a report of the


71555 – MR Angiography Chest

CPT Codes: 71555

INDICATIONS FOR CHEST MRA:

Magnetic resonance angiography (MRA) or computed tomography angiography (CTA) may be used for several indications but not both.

Vascular Disease

- Superior vena cava (SVC) syndrome (Friedman, 2017)
- Subclavian Steal Syndrome after positive or inconclusive ultrasound (Osiero, 2012; Potter, 2014)
- Thoracic Outlet Syndrome (ACR, 2014; Chavhan, 2017; Povlsen, 2018)
- Takayasu’s arteritis (Keser, 2014)
- Clinical concern for acute aortic dissection (ACR, 2017; Barman, 2014)
  - 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)

Thoracic Aortic Disease

If TTE was not performed, was technically inadequate, or if imaging is required beyond the proximal ascending aorta

Initial/Screening:

- Screening of first-degree relatives of individuals with a thoracic aortic aneurysm (defined as ≥ 50% above normal) or dissection, or if an associated high-risk mutation is present
  - If one or more first degree relatives of a patient with a known thoracic aortic aneurysm or dissection, have thoracic aortic dilatation, aneurysm or dissection, then imaging of 2nd degree relatives is reasonable
- Evaluation of the ascending aorta in suspected connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (e.g., Marfan syndrome, Ehlers Danlos or Loeys-Dietz syndromes) at time of diagnosis
- Patients with Turner’s syndrome should undergo imaging to assess for bicuspid aortic valve, coarctation of the aorta or dilation of the ascending or thoracic aorta. If the initial imaging is normal and there are no additional risk factors for dissection, imaging can be done every 5-10 years.
- Screening of first-degree relatives of patients with a bicuspid aortic valve
Follow-up known aneurysm/vascular pathology:
- Six months follow up after initial finding of a dilated thoracic aorta, for assessment of rate of change
- Biannual (twice/year) follow up of enlarged aortic root \( \geq 4.5 \) cm or showing growth rate \( \geq 0.5 \) cm/year
- Evaluation of the ascending aorta in known connective tissue disease or genetic conditions that predispose to aortic aneurysm or dissection (e.g., Marfan syndrome, Ehlers Danlos or Loeys-Dietz syndromes) 6 months after initial imaging for growth rate assessment, followed by annual imaging, or biannual (twice yearly) if diameter \( \geq 4.5 \) or expanding \( \geq 0.5 \) cm/yr
- Turner’s syndrome - If an abnormality exists on initial imaging, annual imaging is recommended
- 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
- Re-evaluation (<1 y, generally twice a year) of the size and morphology of the aortic sinuses and ascending aorta in patients with a bicuspid AV with 1 of the following:
  - Aortic diameter \( \geq 4.5 \) cm
  - Rapid rate of change in aortic diameter when an annual growth rate of \( \geq 0.5 \) cm is suspected.
  - Family history (first-degree relative) of aortic dissection
- Follow up post medical treatment of aortic disease:
  - 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

Congenital Malformations
- Thoracic malformation on other imaging (chest x-ray, echocardiogram, gastrointestinal study, or inconclusive CT) (Ferreira, 2015; Hellinger, 2011; Karaosmanoglu, 2015; Poletto, 2017)
- Congenital heart disease with pulmonary hypertension (Pascall, 2018)
- Pulmonary Sequestration (Al-Timmy, 2016; Long, 2016)

Pulmonary Hypertension based on other testing (Ascha, 2017; Rose-Jones, 2015):
- Echocardiogram
- Right heart catheterization

Atrial fibrillation with ablation planned (Kolandaivelu, 2012)

Pre-operative Evaluation

Post-operative/procedural evaluation
- Post op complications (Bennet, 2017; Choudhury, 2017)
- Routine post-operative (SVS, 2018; Uthof, 2012)
  - Thoracic endovascular aneurysm repair
    - 1 month
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. It provides images of normal as well as diseased blood vessels and 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 which is 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.

Studies show mixed results regarding the value of MRA v 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 (Li, 2009).

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.

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

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.

POLICY HISTORY:
Review Date: May 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• 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’
REFERENCES:


INDICATIONS FOR CERVICAL SPINE CT:

For evaluation of back pain with any of the following when Cervical Spine MRI is contraindicated (Allegri, 2016)

- With new or worsening objective neurologic deficits on exam
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months (ACR, 2013; Eubanks, 2010)
- 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 (NASS, 2013)).

For evaluation of trauma or acute injury (ACR, 2018)

- Presents with any of the following neurological deficits: muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- With progression or worsening of symptoms during the course of conservative treatment*.
- When the patient is clinically unevaluable or there are preliminary imaging findings (X-ray or CT) needing further evaluation.
- History of underlying spinal abnormalities (i.e. ankylosing spondylitis) (Koivikko, 2008)
- When office notes specify the patient meets NEXUS (National Emergency X-Radiography Utilization Study) or CCR (Canadian Cervical Rules) criteria for imaging (ACR, 2018):
  - 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” (ACR, 2018)).

For evaluation of neurologic deficits when Cervical Spine MRI is contraindicated or inappropriate (ACR, 2013; NASS, 2010)

- With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g. Babinski, Hoffman’s) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level.

For evaluation of known fracture (ACR, 2012)
- 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.

**CT myelogram is indicated when MRI is contraindicated** (ACR, 2019; NASS, 2010)
- Demonstration of the site of a CSF leak (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

**Ossification Posterior Longitudinal Ligament (OPPL)** (Choi, 2011)
- CT to evaluate the calcification and MR for evaluation of cord
  - Both CT and MRI would be approvable if surgery is planned as signal changes in the cord would suggest a poorer prognosis after surgery.

**For evaluation of suspected myelopathy when Cervical Spine MRI is contraindicated**
(ACR, 2015; Behrbalk, 2013; Davies, 2018; Vilaca, 2016; Waly, 2017)
- 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 (Signs: unsteadiness, broad-based gait, increased muscle tone, weakness and wasting of the upper and lower limbs; diminished sensation to light touch, temperature, proprioception, vibration; limb hyperreflexia and pathologic reflexes; bowel and bladder dysfunction in more severe cases).

**For evaluation of known or new compression fractures with worsening back pain** (ACR, 2018)
- With history of malignancy (if MRI is contraindicated)
- With an associated new focal neurologic deficit
- Prior to a planned surgery/intervention or if the results of the CT will change management.

**For evaluation of known tumor, cancer, or evidence of metastasis with any of the following** (MRI is usually the preferred study, but CT may help characterize solitary indeterminate lesions (Kim, 2012))
- For staging of known tumor
- For follow-up evaluation of patient undergoing active cancer treatment.
- Presents with new signs or symptoms (e.g. physical, laboratory, and/or imaging findings) of new tumor or change in tumor.
- With evidence of metastasis on bone scan or previous imaging study.
- Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or neck that pain occurs at night, and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine when MRI cannot be done (ACR, 2018; Ziu, 2019).

**For evaluation of suspected tumor when Cervical Spine MRI is contraindicated or inappropriate** (ACR, 2018)
- Prior abnormal or indeterminate imaging that requires further clarification.
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 when Cervical Spine MRI is contraindicated (ACR, 2018)

- Infection:
  o As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016)
  o Follow up imaging of infection
    ▪ With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)
- In rheumatoid arthritis with neurologic signs/symptoms, or evidence of subluxation on radiographs (lateral radiograph in flexion and neutral should be the initial study) (Colebatch, 2013; Tehranzadeh, 2017)
  o 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 (Henderson, 2017)

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma when Cervical Spine MRI is contraindicated (ACR, 2015; Nagashima, 2010)

- As evidenced by signs/symptoms, laboratory, or prior imaging findings.

As part of initial post-operative/procedural evaluation (“CT best examination to assess for hardware complication, extent of fusion” (ACR, 2015; Rao, 2018) and MRI for cord, nerve root compression, disc pathology, or post-op infection):

- 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.
- Changing neurologic status post-operatively.
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
- Residual or recurrent symptoms with any of the following neurological deficits: Upper extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

Other Indications for a Cervical Spine CT:

- For preoperative evaluation and Cervical Spine MRI is contraindicated
- CT discogram
TABLE OF CONTENTS

- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS; Duz, 2008; Milhorat, 2009; NIH), and MRI is contraindicated.
- Known Arnold-Chiari syndrome and Cervical Spine MRI is contraindicated.
- Congenital abnormalities in the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016) when MRI is contraindicated or for characterization of bony detail.
- Syrinx or syringomyelia (known or suspected) and Cervical Spine MRI is contraindicated:
  - With neurologic findings and/or predisposing conditions (e.g. Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis (Timpone, 2015)),
  - To further characterize a suspicious abnormality seen on prior imaging.
  - Known syrinx with worsening symptoms.
- CSF leak highly suspected and supported by patient history and/or physical exam findings (CT myelogram).
- For pediatric population and MRI is contraindicated (ACR, 2016)
  - Red flags that prompt imaging should include the presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more.
  - Back pain associated with suspected inflammation, infection, or malignancy
- In rheumatoid arthritis with neurologic signs or symptoms, evidence of subluxation or positive radiograph (lateral radiograph in flexion and neutral should be the initial study) when MRI is contraindicated or for surgical treatment planning (Colebatch, 2013)

COMBINATION STUDIES WITH CERVICAL SPINE CT:

Cervical/Thoracic/Lumbar CTs:
- CT myelogram when MRI is contraindicated
- Post-procedure (discogram) CT.
- Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 (ACR, 2018; Strahle, 2015).
- Any combination of these for spinal survey in patient with metastases.
- For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015).
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high risk cutaneous stigmata (Duz, 2008; Milhorat, 2009), when anesthesia required for imaging and MRI is contraindicated.
- Drop metastasis from brain or spine when MRI contraindicated (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram).

Cervical MRI/CT
- For unstable craniocervical junction.

Brain CT/Cervical CT
- For evaluation of Arnold-Chiari Malformation and Cervical Spine MRI is contraindicated.
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.

**Home Exercise Program - (HEP)/ Therapy – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015; Last, 2009):
• 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%) (Graeber, 2019)
• 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 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%) (Vilaca, 2016).

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.
**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 by conditions, e.g., new neurological deficits; onset of joint tenderness of a localized area of the spine; new abnormal nerve conduction studies; exacerbation of chronic neck or back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

**Ossification Posterior Longitudinal Ligament (OPLL)** (Choi, 2011) - Most common in cervical spine (rare but more severe in thoracic spine).

**MRI and Cutaneous Stigmata** (Dias, 2015)

<table>
<thead>
<tr>
<th>TABLE 1 Risk Stratification for Various Cutaneous Markers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Risk</strong></td>
</tr>
<tr>
<td>Hypertrichosis</td>
</tr>
<tr>
<td>Infantile hemangiomia</td>
</tr>
<tr>
<td>Atretic meningiome</td>
</tr>
<tr>
<td>DST</td>
</tr>
<tr>
<td>Subcutaneous lipoma</td>
</tr>
<tr>
<td>Caudal appendage</td>
</tr>
<tr>
<td>Segmental hemangiomas in association with LUMBAR syndrome</td>
</tr>
<tr>
<td><strong>Intermediate Risk</strong></td>
</tr>
<tr>
<td>Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined, or PWS when darker red and well defined)</td>
</tr>
<tr>
<td>Cocygeal dimple</td>
</tr>
<tr>
<td>Light hair</td>
</tr>
<tr>
<td>Isolated café au lait spots</td>
</tr>
<tr>
<td>Mongolian spots</td>
</tr>
<tr>
<td>Hypo- and hypermelanotic macules or papules</td>
</tr>
<tr>
<td>Deviated or forked gluteal cleft</td>
</tr>
<tr>
<td>Nonmidline lesions</td>
</tr>
</tbody>
</table>

LUMBAR, lower body hemangiomia and other cutaneous defects, urogenital abnormalities, ulcersations, 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 (ACR, 2018).

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 (Ziu, 2019).
Cervical Spine Trauma Imaging (ACR, 2018): 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 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 (ACR, 2019; Pomerantz, 2016).

POLICY HISTORY:
Review Date: June 2019
Review Summary:
- 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

Review Date: May 2020

Review Summary:

- 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
  - Added Osteopathic Manipulative medicine to conservative care therapy
REFERENCES:


72128 – CT Thoracic Spine

CPT Codes: 72128, 72129, 72130

INDICATIONS FOR THORACIC SPINE CT:

For evaluation of back pain with any of the following when Thoracic Spine MRI is contraindicated (AANS/CNS, 2014; Allegri, 2016; Jarvik, 2015; Last, 2009)
- With new or worsening objective neurologic deficits on exam
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months (ACR, 2013; Eubanks, 2010).
- 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 (NASS, 2013)).

For evaluation of trauma or acute injury (ACR, 2018)
- Presents with any of the following neurological deficits: muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- 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 (DISH) (ACR, 2018; Koivikko, 2008)

For evaluation of known fracture
- 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.

For evaluation of neurologic deficits when Thoracic Spine MRI is contraindicated or inappropriate
- With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g. Babinski, Hoffman’s) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level.

CT myelogram is indicated when signs and symptoms are incongruent with MRI findings or MRI cannot be performed/contraindicated (Grams, 2010; Morita, 2011; Naganawa, 2011; NASS, 2012; Ozdoba, 2011)

For evaluation of suspected myelopathy when Thoracic Spine MRI is contraindicated (ACR, 2015; Ando, 2019; Behrbalk, 2013; Hou, 2016)
- Does not require conservative care
• Concurrent cervical/thoracic imaging not recommended
• Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with
• With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g. Babinski, Hoffman’s) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level.

Ossification Posterior Longitudinal Ligament (OPPL) (Choi, 2011)
• Most common in cervical spine (rare but more severe in thoracic spine)
• CT to evaluate the calcification and MR for evaluation of cord.
  o Both CT and MRI would be approvable if surgery is planned as signal changes in the cord would suggest a poorer prognosis after surgery

For evaluation of known or new compression fractures with worsening back pain (ACR, 2018)
• With history of malignancy (if MRI is contraindicated)
• With an associated new focal neurologic deficit
• Prior to a planned surgery/intervention or if the results of the CT will change management.

For evaluation of known tumor, cancer, or evidence of metastasis with any of the following (MRI is usually the preferred study, but CT may help characterize solitary indeterminate bone lesions) (Kim, 2012)
• For staging of known tumor.
• For follow-up evaluation of patient undergoing active cancer treatment.
• Presents with new signs or symptoms (e.g., physical, laboratory, and/or imaging findings) of new tumor or change in tumor.
• With evidence of metastasis on bone scan or previous imaging study.
• New or increasing non-traumatic thoracic back pain or radiculopathy or back that pain occurs at night, and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine and MRI is contraindicated (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor when Thoracic Spine MRI is contraindicated or inappropriate (ACR, 2018)
• Prior abnormal or indeterminate imaging that requires further clarification.

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 when Thoracic MRI is contraindicated (ACR, 2018; Lerner, 2018)
• Infection:
As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016)
Follow up imaging of infection
   ▪ With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma when Thoracic MRI is contraindicated (ACR, 2018)
   • As evidenced by signs/symptoms, laboratory, or prior imaging findings.

As part of initial post-operative / procedural evaluation (“CT best examination to assess for hardware complication, extent of fusion” (ACR, 2015; Rao, 2018) and MRI for cord, nerve root compression, disc pathology, or post-op infection):
   • 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.
   • Changing neurologic status post-operatively.
   • Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
   • Residual or recurrent symptoms with any of the following neurological deficits: Lower extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

Other Indications for a Thoracic Spine CT:
   • For preoperative evaluation and Thoracic MRI is contraindicated
   • 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.
   • CT discogram.
   • Suspected cord compression with any of the following neurologic deficits, e.g., extremity weakness, sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence and Thoracic Spine MRI is contraindicated.
   • Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS; Duz, 2008; Milhorat, 2009; NIH) when Thoracic Spine MRI is contraindicated
   • Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Seiper, 2009)
   Known Arnold-Chiari syndrome and Thoracic MRI is contraindicated (Milhorat, 2009; Strahle, 2015).
   • Congenital abnormalities when Thoracic Spine MRI is contraindicated or for characterization of bony detail (Trenga, 2016):
     o In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)
     o Back pain and vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging.
     o Scoliosis with any of the following:
- Progressive spinal deformity;
- Neurologic deficit;
- Early onset;
- Atypical curve (e.g., short segment, >30 degree kyphosis, left thoracic curve, associated organ anomalies);
- Pre-operative planning; OR
  - When office notes clearly document how imaging will change management.

- Syrinx or syringomyelia (known or suspected): and Thoracic Spine MRI is contraindicated:
  - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis (Timpone, 2015)),
  - To further characterize a suspicious abnormality seen on prior imaging.
  - Known syrinx with worsening symptoms.
- CSF leak highly suspected and supported by patient history and/or physical exam findings (CT myelogram).
- For pediatric population (ACR, 2016)
  - Red flags that prompt imaging should include the presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more and initial radiographs preformed (ACR, 2016).
  - Back pain associated with suspected inflammation, infection, or malignancy

**COMBINATION STUDIES WITH THORACIC SPINE CT:**

**Cervical/Thoracic/Lumbar CTs:**
- CT myelogram or discogram.
- Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 (ACR, 2018; Strahle, 2015).
- Any combination of these for spinal survey in patient with metastases.
- For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation and Spine MRI is contraindicated. (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015).
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or cutaneous stigmata (AANS; Duz, 2008; Milhorat, 2009), when anesthesia required for imaging and MRI is contraindicated.
- Drop metastasis from brain or spine when MRI contraindicated (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram).
- CSF leak highly suspected and supported by patient history and/or physical exam findings

**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 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 (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Seiper, 2014):

- 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 sacroilitis, 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, and/or chiropractic care.

**Home Exercise Program - (HEP)/Therapy – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015; Last, 2009):

- 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.

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%) (Vitzthum, 2007).

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 and CT may be indicated when MRI is contraindicated, 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 conduction 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 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 (Pomerantz, 2016).

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 (as listed above)
  - Achilles reflex absent on both sides
  - Sexual dysfunction that can come on suddenly
  - Absent anal reflex and bulbocavernosus reflex
MRI and Cutaneous Stigmata (Dias, 2015)

### TABLE 1 Risk Stratification for Various Cutaneous Markers

<table>
<thead>
<tr>
<th>High Risk</th>
<th>Intermediate Risk</th>
<th>Low Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertrichosis</td>
<td>Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined, or PWS when darker red and well defined)</td>
<td>Coccygeal dimple</td>
</tr>
<tr>
<td>Infantile hemangioma</td>
<td>Light hair</td>
<td>Isolated café au lait spots</td>
</tr>
<tr>
<td>Atretic meningiocele</td>
<td>Mongolian spots</td>
<td>Hypo- and hypermelanotic macules or papules</td>
</tr>
<tr>
<td>DST</td>
<td></td>
<td>Deviated or forked gluteal cleft</td>
</tr>
<tr>
<td>Subcutaneous lipoma</td>
<td></td>
<td>Nonmidline lesions</td>
</tr>
<tr>
<td>Caudal appendage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segmental hemangiomas in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>association with LUMBAR syndrome</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 (ACR, 2018).

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 (Ziu, 2019).

**POLICY HISTORY:**

**Review Date:** June 2019

**Review Summary:**

- 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

- Spinal cord stimulator
- New or increasing back pain in cancer patients with high suspicion of mets

**Review Date:** May 2020

**Review Summary:**
- For evaluation of neurologic deficits when new deficits are present
- Removed pars defect section
- Added ankylosing spondylitis for evaluation of trauma/acute injury
- 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
REFERENCES:


72131 – CT Lumbar Spine

CPT Codes: 72131, 72132, 72133

INDICATIONS FOR LUMBAR SPINE CT:

For evaluation of back pain with any of the following when Lumbar Spine MRI is contraindicated (AAFP, 2012; AANSCNS, 2014; ACA, 2017; ACEP, 2014; ACR, 2015; Chou, 2007; Jarvik, 2015; Last, 2009; NASS, 2013)

- With new or worsening objective neurologic deficits 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*.
- 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 (NASS, 2013)).

For evaluation of neurologic deficits when Lumbar Spine MRI is contraindicated or inappropriate

- With any of the following new neurological deficits: lower extremity muscular weakness; abnormal reflexes; abnormal sensory changes along a particular dermatome (nerve distribution) as documented on exam; evidence of Cauda Equina Syndrome; bowel or bladder dysfunction; new foot drop.

For evaluation of known fracture

- To assess union of a fracture where physical examination, plain radiographs, or prior imaging suggests delayed or non-healing
- To determine position of known fracture fragments.

CT myelogram is indicated when signs and symptoms are incongruent with MRI findings or MRI cannot be performed/contraindicated (Grams, 2010; Morita, 2011; Naganawa, 2011; NASS, 2012; Ozdoba; 2011)

For evaluation of trauma or acute injury (ACR, 2018; Chou, 2007, Koivikko, 2008)

- Presents with any of the following neurological deficits: radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution)].
- 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 (DISH))

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 (Cohen, 2005; Kobayashi, 2013; Rush, 2015) when MRI is contraindicated.

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) (Matesan, 2016).

For evaluation of known or new compression fractures with worsening back pain (ACR, 2018)
• With history of malignancy when MRI is contraindicated.
• With an associated new focal neurologic deficit
• Prior to a planned surgery/intervention or if the results of the MRI will change management.

For evaluation of known tumor, cancer, or evidence of metastasis with any of the following (Last, 2009) (MRI is usually the preferred study, but CT may help characterize solitary indeterminate bone lesions) (Kim, 2012).
• For staging of known tumor.
• For follow-up evaluation of patient undergoing active cancer treatment.
• Presents with new signs or symptoms (e.g., physical, laboratory, and/or imaging findings) of new tumor or change in tumor.
• With evidence of metastasis on bone scan or previous imaging study.
• Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back that pain occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor when Lumbar Spine MRI is contraindicated or inappropriate (ACR, 2015)
• Prior abnormal or indeterminate imaging that requires further clarification

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 when Lumbar Spine MRI is contraindicated (ACR, 2015; Last, 2009; Lerner, 2018)
• Infection:
  o As evidenced by signs and/or symptoms, laboratory (i.e. abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016)
  o Follow up imaging of infection
    ▪ With worsening symptoms/laboratory values (i.e. white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)
For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma and Lumbar Spine MRI is contraindicated (ACR, 2015)
• As evidenced by signs/symptoms, laboratory, or prior imaging findings.

As part of initial post-operative / procedural evaluation (“CT best examination to assess for hardware complication, extent of fusion” (ACR, 2015; Rao, 2018) and MRI for cord, nerve root compression, disc pathology, or post-op infection):
• 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.
• Changing neurologic status post-operatively.
• Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
• Residual or recurrent symptoms with any of the following neurological deficits: Lower extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

Other indications for a Lumbar Spine CT
• For preoperative evaluation and Lumbar Spine MRI is contraindicated
• CT discogram.
• 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, or associated with other cutaneous markers) (Choi, 2018; D’Alessandro, 2009) in patients < 6 months should have ultrasound) when Lumbar Spine MRI is contraindicated.
• Tethered cord or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS 2019; Duz, 2008; Milhorat, 2009) when Lumbar Spine MRI is contraindicated.
• For suspected Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup
• Known Arnold-Chiari syndrome and Lumbar Spine MRI is contraindicated (Milhorat, 2009; Strahle, 2015).
• Congenital abnormalities when Lumbar Spine MRI is contraindicated or for characterization of boney detail (Trenga, 2016):
  o In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)
  o Back pain and vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging.
  o Scoliosis with any of the following:
    ▪ Progressive spinal deformity;
    ▪ Neurologic deficit;
    ▪ Early onset;
    ▪ Atypical curve (e.g., short segment, > 30 degree kyphosis, left thoracic curve, associated organ anomalies);
    ▪ Pre-operative planning; OR
When office notes clearly document how imaging will change management.
- CSF leak highly suspected and supported by patient history and/or physical exam findings (CT Myelogram)
- For pediatric population if MRI is contraindicated (ACR, 2016)
  - Red flags that prompt imaging should include the presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more and initial radiographs preformed (ACR, 2016).
  - Back pain associated with suspected inflammation, infection, or malignancy

COMBINATION STUDIES WITH LUMBAR SPINE CT:
Cervical/Thoracic/Lumbar CTs:
- CT myelogram or discogram
- Any combination of these for scoliosis survey in infant/child when MRI is contraindicated (Strahle, 2015).
- Any combination of these for spinal survey in patient with metastasis.
- For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015) and Lumbar Spine MRI is contraindicated.
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or cutaneous stigmata (AANS 2019; Duz, 2008; Milhorat, 2009; NIH), when anesthesia required for imaging and MRI is contraindicated.
- Drop metastasis from the brain or spine when MRI contraindicated (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram).
- CSF leak highly suspected and supported by patient history and/or physical exam findings

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 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 (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Seiper, 2014):
- 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 sacroilitis, 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 or chiropractic care.

**Home Exercise Program - (HEP)/Therapy – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015; Last, 2009):
• 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 Cutaneous Stigmata (Dias, 2015)

<table>
<thead>
<tr>
<th>TABLE 1 Risk Stratification for Various Cutaneous Markers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Risk</strong></td>
</tr>
<tr>
<td>Hypertrichosis</td>
</tr>
<tr>
<td>Infantile hemangioma</td>
</tr>
<tr>
<td>Atretic meningoele</td>
</tr>
<tr>
<td>DST</td>
</tr>
<tr>
<td>Subcutaneous lipoma</td>
</tr>
<tr>
<td>Caudal appendage</td>
</tr>
<tr>
<td>Segmental hemangiomas</td>
</tr>
<tr>
<td>in association with LUMBAR syndrome</td>
</tr>
<tr>
<td><strong>Intermediate Risk</strong></td>
</tr>
<tr>
<td>Capillary malformations (also referred to as NFS or saimon patch when pink and poorly defined, or PWS when darker red and well defined)</td>
</tr>
<tr>
<td>Coccygeal dimple</td>
</tr>
<tr>
<td>Light hair</td>
</tr>
<tr>
<td>Isolated café au lait spots</td>
</tr>
<tr>
<td>Mongolian spots</td>
</tr>
<tr>
<td>Hypo- and hypermelanotic macules or papules</td>
</tr>
<tr>
<td>Deviated or forked gluteal cleft</td>
</tr>
<tr>
<td>Nonmidline lesions</td>
</tr>
</tbody>
</table>

LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.

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 which 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 early diagnose and treatment 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 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%) (Graeber, 2019)
- 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.

**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 (D’ Alessandro, 2009). High-risk cutaneous stigmata in neonates include hemangiomas, upraised lesions (i.e., masses, tails, and hairy patches), and multiple cutaneous stigmata.

Spina Bifida Occulta (AANS, 2020)
• 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 (ACR, 2018).

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 (Ziu, 2019).

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 (as listed above)
  - 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.

**POLICY HISTORY:**
**Review Date:** June 2019
**Review Summary:**
- Added CT myelogram
- 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

**Review Date:** May 2020
**Review Summary:**
- 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
# REFERENCES:


72141 – MRI Cervical Spine

CPT Codes: 72141, 72142, 72156

INDICATIONS FOR CERVICAL SPINE MRI:

For evaluation of neck pain with any of the following (Allegri, 2016)
- With new or worsening objective neurologic deficits on exam
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months (ACR, 2013; Eubanks, 2010).
- 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 (NASS, 2013)).

For evaluation of neurologic deficits (ACR, 2013; NASS, 2010)
- With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g., Babinski, Chaddock Sign, Hoffman’s) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level (Acharya, 2019).

As part of initial post-operative / procedural evaluation (“CT best examination to assess for hardware complication, extent of fusion” (ACR, 2015; Rao, 2018) and MRI for cord, nerve root compression, disc pathology or post-op infection):
- 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)
- Changing neurologic status post-operatively.
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
- Residual or recurrent symptoms with any of the following neurological deficits: upper extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

For evaluation of suspected myelopathy (ACR, 2015; Behrbalk, 2013; Davies, 2018; Vilaca, 2016)
- Does not require conservative care
- Concurrent cervical/thoracic imaging not recommended
- 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
• Signs: unsteadiness, broad-based gait, increased muscle tone, weakness and wasting of the upper and lower limbs; diminished sensation to light touch, temperature, proprioception, vibration; limb hyperreflexia and pathologic reflexes (upper or lower extremity); bowel and bladder dysfunction in more severe cases.

For evaluation of known or suspected multiple sclerosis (MS) (ACR, 2015; Filippi, 2016)
• Evidence of MS on recent baseline Brain MRI.
• Suspected MS with new or changing symptoms consistent with cervical spinal cord disease (focal neurologic deficit or clinical sign, e.g., Lhermitte sign).
• Follow up of known Multiple Sclerosis.
• Follow up to the initiation or change in medication for patient with known Multiple Sclerosis.
• Cervical and/or Thoracic MRI for evaluation of suspected multiple sclerosis (MS) when Brain MRI does not fulfill diagnostic criteria (Filippi, 2016).
• Cervical and/or Thoracic MRI for evaluation of neuromyelitis optica spectrum disorders (recurrent or bilateral optic neuritis; recurrent transverse myelitis) (Wingerchuk, 2015)

For evaluation of trauma or acute injury (ACR, 2018)
• Presents with any of the following neurological deficits: muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
• With progression or worsening of symptoms during the course of conservative treatment*.
• History of underlying spinal abnormalities (i.e. ankylosing spondylitis) (Koivikko, 2008)
• 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:
  o CT for initial imaging.
  o MRI when suspect spinal cord or nerve root injury or when patient is obtunded, and CT is negative.
  o CT or MRI for treatment planning of unstable spine.
(“MRI and CT provide complementary information. When indicated It is appropriate to perform both examinations”) (ACR, 2018).

For evaluation of known or new compression fractures with worsening neck pain (ACR, 2018):
• With history of malignancy
  o To aid in differentiation of benign osteoperotic fractures from metastatic disease
    ▪ A follow up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher (indeterminate) benign osteoperotic fracture from metastatic disease (Kumar, 2016)
• With an associated new focal neurologic deficit
• Prior to a planned surgery/intervention or if the results of the MRI will change management.
For evaluation of known tumor, cancer, or evidence of 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) (Kim, 2012)
- For staging of known tumor.
- For follow-up evaluation of patients undergoing active cancer treatment.
- Presents with new signs or symptoms (e.g., physical, laboratory, and/or imaging findings) of new tumor or change in tumor.
- With evidence of metastasis on bone scan or previous imaging study.
- Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or neck that pain occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor (ACR, 2018)
- Prior abnormal or indeterminate imaging that requires further clarification.

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 (ACR, 2018)
- Infection:
  - As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016).
  - Follow up imaging of infection
    - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)
- In rheumatoid arthritis with neurologic signs/symptoms, or evidence of subluxation on radiographs (lateral radiograph in flexion and neutral should be the initial study) (Colebatch, 2013; Tehranzadeh, 2017)
  - Patients with negative radiographs but symptoms suggestive of cervical instability or in patients with neurologic deficits MRI is indicated (Gillick, 2015)
- 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 (Henderson, 2017)

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma (ACR, 2015; Nagashima, 2010)
As evidenced by signs/symptoms, laboratory, or prior imaging findings.
Other Indications for a Cervical Spine MRI:

- For preoperative evaluation/planning.
- Suspected cord compression with any of the following neurological deficits: extremity weakness; sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence.
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS, 2019; Duz, 2008; Milhorat, 2009).
- Known Arnold-Chiari syndrome.
  - Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis for new or changing signs/symptoms or exam findings (Hitson, 2015)
- Congenital abnormalities (Trenga, 2016):
  - In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)
  - Back pain and vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging.
  - Scoliosis with any of the following:
    - Progressive spinal deformity;
    - Neurologic deficit;
    - 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
- Syrinx or syringomyelia (known or suspected):
  - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis (Timpone, 2015)),
  - To further characterize a suspicious abnormality seen on prior imaging.
  - Known syrinx with worsening symptoms.
- CSF leak highly suspected and supported by patient history and/or physical exam findings.
- For pediatric population (ACR, 2016)
  - Red flags that prompt imaging should include the presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more.
  - Back pain associated with suspected inflammation, infection, or malignancy

Ossification Posterior Longitudinal Ligament (OPLL) (Choi, 2011):

- CT to evaluate the calcification and MR for evaluation of cord.
  - Both CT and MRI would be approvable if surgery is planned, as signal changes in the cord would suggest a poorer prognosis after surgery

COMBINATION OF STUDIES WITH CERVICAL SPINE MRI:

Cervical/Thoracic/Lumbar MRIs:

- Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 (ACR, 2018; SRS, 2019; Strahle, 2015).
Any combination of these for spinal survey in patient with metastases.

For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015).

Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS, 2019; Duz, 2008; Milhorat, 2009), when anesthesia required for imaging.

Drop metastasis from brain or spine (imaging also includes brain).

Suspected Leptomeningeal carcinomatosis (LC) (Shah, 2011)

Tumor evaluation and monitoring in neurocutaneous syndromes - See Background

CSF leak highly suspected and supported by patient history and/or physical exam findings

**Cervical and Thoracic Combination MRI**

- Transverse Myelitis- with appropriate clinical symptoms (e.g., bilateral weakness, sensory disturbance, and autonomic dysfunction which typically evolve over hours or days (Goh, 2011); elevated protein on cerebrospinal fluid (CSF) analysis)

**Cervical MRI/CT**

For unstable craniocervical junction

**Brain MRI/Cervical MRI –**

- For evaluation of Arnold Chiari malformation.
- For follow-up of known Multiple Sclerosis (MS) (Filippi, 2016).
- Suspected MS with new or changing symptoms consistent with cervical spinal cord disease.
- Follow up to the initiation or change in medication for patient with known Multiple Sclerosis

**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.

**Home Exercise Program - (HEP)/ Therapy** – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015; Last, 2009):

- 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%) (Vilaca, 2016).

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%) (Graebner, 2019)
  - High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms.

MRI and Cutaneous Stigmata (Dias, 2015)

<table>
<thead>
<tr>
<th>TABLE 1 Risk Stratification for Various Cutaneous Markers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Risk</strong></td>
</tr>
<tr>
<td>Hypertrichosis</td>
</tr>
<tr>
<td>Infantile hemangioma</td>
</tr>
<tr>
<td>Atretic meningocoele</td>
</tr>
<tr>
<td>DST</td>
</tr>
<tr>
<td>Subcutaneous lipoma</td>
</tr>
<tr>
<td>Caudal appendage</td>
</tr>
<tr>
<td>Segmental hemangiomas in association with LUMBAR syndrome</td>
</tr>
</tbody>
</table>

LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.

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 the 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.

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, homogenous, 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.

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) (Choi, 2011) - 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 (ACR, 2018).

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. 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 (Ziu, 2019).

**Cervical Spine Trauma Imaging** (ACR, 2018): 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 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 clinical evaluation and for follow-up of known intracranial tumors (Borofsky, 2013).
- 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 (Evans, 2017).
- In patients with Tuberous Sclerosis, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities (Krueger, 2013).
- In Von Hippel Lindau Syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years (Von Hippel-Lindau, 2017).
- In Sturge Weber Syndrome, Brain MRI can rule out intracranial involvement after only after age 1 and is recommended in patients <1 year only if symptomatic (Comi, 2011).

**POLICY HISTORY:**

**Review Date:** June 2019

**Review Summary:**

- 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 pediatrics 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 with back pain;
- For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated with 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

**Review Date:** May 2020

**Review Summary:**
- Added:
  - For evaluation of neurologic deficits are new
  - 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 transverse myelitis
  - 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
  - Added to background of imaging of infection
  - Added Osteopathic Manipulative medicine to conservative care therapy
REFERENCES:


Davies BM, Smith EK. Degenerative cervical myelopathy. BMJ. 2018; 360 doi: https://doi.org/10.1136/bmj.k186.


72146 – MRI Thoracic Spine
CPT Codes: 72146, 72147, 72157

INDICATIONS FOR THORACIC SPINE MRI:

For evaluation of back pain with any of the following (Allegri, 2016; ANSCNS, 2014; Jarvik, 2015)
• With new or worsening objective neurologic deficits 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*.
• 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 (NASS, 2013)).

For evaluation of neurologic deficits
• With any of the following new neurological deficits: extremity muscular weakness (Acharya, 2019); pathologic (e.g., Babinski) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; evidence of Cauda Equina Syndrome; bowel or bladder dysfunction; spasticity, sensory or motor level (Stolper, 2017).

For evaluation of suspected myelopathy (ACR, 2015; Behrbalk, 2013; Hou, 2016)
• Does not require conservative care
• Concurrent cervical/thoracic imaging not recommended
• Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with
• With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g. Babinski, Hoffman’s) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level.

For evaluation of known or suspected multiple sclerosis (MS)
• Suspected MS with new or changing symptoms consistent with thoracic spinal cord disease (i.e., transverse myelitis, progressive myelopathy)
• Follow up of known Multiple Sclerosis with known thoracic involvement (CMSC, 2018)
• Follow up to the initiation or change in medication for patient with known Multiple Sclerosis with thoracic involvement (CMSC, 2018)
• Cervical and/or Thoracic MRI for evaluation of suspected multiple sclerosis (MS) when Brain MRI does not fulfill diagnostic criteria (Filippi, 2016)
• Cervical and/or Thoracic MRI for evaluation of neuromyelitis optica spectrum disorders (recurrent or bilateral optic neuritis; recurrent transverse myelitis) (Wingerchuk, 2015)
For evaluation of trauma or acute injury
- Presents with any of the following neurological deficits: muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- With progression or worsening of symptoms during the course of conservative treatment*.
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis) (Koivikko, 2008)

Ossification Posterior Longitudinal Ligament (OPLL) (Choi, 2011)
- CT to evaluate the calcification and MR for evaluation of cord.
  - Both CT and MRI would be approvable if surgery is planned as signal changes in the cord would suggest a poorer prognosis after surgery.

For evaluation of known or new compression fractures with worsening back pain (ACR, 2018)
- With history of malignancy
- With an associated new focal neurologic deficit
- Prior to a planned surgery/intervention or if the results of the MRI will change management.
- To aid in differentiation of benign osteoperotic fractures from metastatic disease
- A follow up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher benign osteoperotic fracture from metastatic disease (Kumar, 2016)

For evaluation of known tumor, cancer, or evidence of metastasis with any of the following (MRI is usually the preferred study, but CT may help characterize solitary indeterminate lesions). (Kim, 2012)
- For staging of known tumor
- For follow-up evaluation of patient undergoing active cancer treatment.
- Presents with new signs or symptoms (e.g. physical, laboratory and/or imaging findings) of new tumor or change in tumor
- With evidence of metastasis on bone scan or previous imaging study.
- New or increasing non-traumatic thoracic back pain or radiculopathy or back that pain occurs at night, and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor
(ACR, 2015)
- Prior abnormal or indeterminate imaging that requires further clarification.

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:
- \( \leq 5 \) 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
(ACR, 2015; Lerner, 2018)
- Infection
As evidenced by signs and/or symptoms, laboratory (i.e. abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016).

Follow up imaging of infection
- With worsening symptoms/laboratory values (i.e. white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma (ACR, 2015)
- As evidenced by signs/symptoms, laboratory, or prior imaging findings.

As part of initial post-operative / procedural evaluation (“CT best examination to assess for hardware complication, extent of fusion” (ACR, 2015; Rao, 2018) and MRI for cord, nerve root compression, disc pathology or post-op infection):
- 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.
- Changing neurologic status post-operatively.
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
- Residual or recurrent symptoms with any of the following neurological deficits: Lower extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

Other Indications for a Thoracic Spine MRI
- For preoperative evaluation (Cohen, 2012)
- Prior to spinal cord stimulator to exclude canal stenosis if no prior MRI imaging of the thoracic spine has been done recently (Carayannopoulos, 2019).
- Suspected cord compression with any of the following neurological deficits: extremity weakness; sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence.
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS, 2019; Milhorat, 2009).
- Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup
- Known Arnold-Chiari syndrome (Milhorat, 2009; Strahle, 2015).
  - Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis for new or changing signs/symptoms or exam findings (Hitson, 2015)
- Congenital abnormalities (Trenga, 2016):
  - In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)
  - Back pain and vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging.
  - Scoliosis with any of the following:
    - Progressive spinal deformity;
    - Neurologic deficit;
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

- Syrinx or syringomyelia (known or suspected) (Magge, 2011):
  - With neurologic findings and/or predisposing conditions (e.g. Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis (Timpone, 2015)),
  - To further characterize a suspicious abnormality seen on prior imaging.
  - Known syrinx with worsening symptoms.

- For pediatric population (ACR, 2016)
  - Red flags that prompt imaging should include one or more of the following: presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more and initial radiographs preformed (ACR, 2016).
  - Back pain associated with suspected inflammation, infection, or malignancy

COMBINATION STUDIES WITH THORACIC SPINE MRI:
Cervical/Thoracic/Lumbar MRIs
- Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 (ACR, 2018; Strahle, 2015).
- Any combination of these for spinal survey in patient with metastases.
- For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015).
- Suspected Leptomeningeal carcinomatosis (LC) (Shah, 2011)
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or cutaneous stigmata (AANS, 2019; Milhorat, 2009), when anesthesia required for imaging
- Drop metastasis from brain or spine (imaging also includes brain).
- Tumor evaluation and monitoring in neurocutaneous syndromes - See Background
- CSF leak highly suspected and supported by patient history and/or physical exam findings.

Cervical and Thoracic Combination MRI
- Transverse Myelitis- with appropriate clinical symptoms (i.e. bilateral weakness, sensory disturbance, and autonomic dysfunction which typically evolve over hours or days (Goh, 2011); elevated protein on cerebrospinal fluid (CSF) analysis)

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 (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Seiper, 2014):

- 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 sacroilitis, 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 (ACR, 2015; Last, 2009):

- 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%) (Graeber, 2019)
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

MRI and Cutaneous Stigmata (Dias, 2015)
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%) (Vitzthum, 2007).

Ossification Posterior Longitudinal Ligament (OPLL) (Choi, 2011) - 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

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. Imaging is important to obtain early diagnose 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, it has the ability to 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 (ACR, 2018).

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 (Ziu, 2019).

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 (as listed above)
  - 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-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.
POLICY HISTORY:

Review Date: June 2019

Review Summary:

- 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
  - Myelopathy
  - Pre op for spinal cord stimulator
  - Evaluation of MS including NMO disorders and recurrent transverse myelitis
  - Back pain in cancer patients with known active cancer in tumors that tend to metastasize
  - Expanded on tethered cord in Other Indications for Imaging and added content on sacral dimple

Review Date: May 2020

Review Summary:

- Added
  - For evaluation of neurologic deficits when new deficits are present
  - Removed pars defect section
  - Added ankylosing spondylitis for evaluation of trauma/acute injury
  - Added follow up of osteoporotic fracture from metastatic disease
  - Added transverse myelitis
  - 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
REFERENCES:


Table of Contents


Consortium of Multiple Sclerosis Centers (CMSC). 2018 Revised guidelines of the consortium of MS centers MRI protocol for the diagnosis and follow-up of MS. 2018.


Kumar Y, Hayashi D. Role of magnetic resonance imaging in acute spinal trauma: A pictorial review. *BMC Musculoskelet Disord.* 2016; 17:310.


INDICATIONS FOR LUMBAR SPINE MRI:

For evaluation of back pain with any of the following:
(AAFP, 2012; ACEP, 2014; ACR, 2015; Allegri, 2016; Ammendolia, 2015; Jarvik, 2015; Last, 2009; NASS, 2013; Quaseem, 2017; Schneider, 2019)
- With new or worsening objective neurologic deficits 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*
- 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 (NASS, 2013)).

For evaluation of neurologic deficits
- With any of the following new neurological deficits: lower extremity muscular weakness; abnormal reflexes; abnormal sensory changes along a particular dermatome (nerve distribution) as documented on exam; evidence of Cauda Equina Syndrome; bowel or bladder dysfunction; new foot drop.

For evaluation of trauma or acute injury
(ACR, 2012; Quaseem, 2017)
- Presents with any of the following neurological deficits: radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- With progression or worsening of symptoms during the course of conservative treatment*.
- History of underlying spinal abnormalities (i.e. ankylosing spondylitis) (Koivikko, 2008)

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 (Cohen, 2005; Kobayashi, 2013; Rush, 2015)

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) (Matesan, 2016).

For evaluation of known or new compression fractures with worsening back pain (ACR, 2018)
- With history of malignancy
  - To aid in differentiation of benign osteoperotic fractures from metastatic disease
A follow up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher benign osteoperotic fracture from metastatic disease

- With an associated new focal neurologic deficit
- Prior to a planned surgery/intervention or if the results of the MRI will change management.

For evaluation of known tumor, cancer, or evidence of metastasis with any of the following: (Last, 2009) (MRI is usually the preferred study, but CT may help characterize solitary indeterminate bone lesions) (ACR, 2018; Kim, 2012)

- For staging of known tumor.
- For follow-up evaluation of patient undergoing active cancer treatment.
- Presents with new signs or symptoms (e.g., physical, laboratory and/or imaging findings) of new tumor or change in tumor
- With evidence of metastasis on bone scan or previous imaging study.
- Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back that pain occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor
(ACR, 2018)

- Prior abnormal or indeterminate imaging that requires further clarification.

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
(ACR, 2018; Last, 2009; Lener, 2018)

- Infection:
  - As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016).
  - Follow up imaging of infection
    - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma
(ACR, 2018)

- As evidenced by signs/symptoms, laboratory, or prior imaging findings.

As part of initial post-operative / procedural evaluation (“CT best examination to assess for hardware complication, extent of fusion” (ACR, 2018; Rao, 2018) and MRI for cord, nerve root compression, disc pathology, or post-op infection):
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.

- Changing neurologic status post-operatively.
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
- Residual or recurrent symptoms with any of the following neurological deficits: Lower extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

Other Indications for a Lumbar Spine MRI
- For preoperative evaluation.
- Suspected cord compression with any of the following neurological deficits: extremity weakness; sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence.
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS, 2019; Duz, 2008; Milhorat, 2009).
- 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, or associated with other cutaneous markers) (D’Alessandro, 2009) in patients <6 months should have ultrasound.
- For suspected Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup
- Known Arnold-Chiari syndrome (Milhorat, 2009; Strahle, 2015).
- Congenital abnormalities (Trenga, 2016):
  - In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)
  - Back pain in a child with vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) seen on preliminary imaging.
  - Scoliosis with any of the following:
    - Progressive spinal deformity;
    - Neurologic deficit;
    - 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.
- CSF leak highly suspected and supported by patient history and/or physical exam findings.
- For pediatric population (ACR, 2016)
  - Red flags that prompt imaging should include one or more of the following: presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more and initial radiographs preformed (ACR, 2016).
  - Back pain associated with suspected inflammation, infection, or malignancy

COMBINATION OF STUDIES WITH LUMBAR SPINE MRI:
Cervical/Thoracic/Lumbar MRIs:
• Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 (ACR, 2018; Strahle, 2015).  
• Any combination of these for spinal survey in patient with metastasis.  
• For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015)  
• Suspected Leptomeningeal carcinomatosis (LC) (Shah, 2011)  
• Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS, 2019; Duz, 2008; Milhorat, 2009), when anesthesia required for imaging.  
• Drop metastasis from brain or spine (imaging also includes brain).  
• Tumor evaluation and monitoring in neurocutaneous syndromes - See Background  
• CSF leak highly suspected and supported by patient history and/or physical exam findings  

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 month), associated with morning stiffness not relieved with rest (usually age at onset < 40). It is associated with any of the following (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Seiper, 2014):  
• 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 sacroilitis, 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 (ACR, 2015; Last, 2009):  
• 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%) (Graeber, 2019)
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

**MRI and Cutaneous Stigmata** (Dias, 2015)

<table>
<thead>
<tr>
<th>TABLE 1 Risk Stratification for Various Cutaneous Markers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Risk</strong></td>
</tr>
<tr>
<td>Hypertrichosis</td>
</tr>
<tr>
<td>Infantile hemangioma</td>
</tr>
<tr>
<td>Atretic meningiocele</td>
</tr>
<tr>
<td>DST</td>
</tr>
<tr>
<td>Subcutaneous lipoma</td>
</tr>
<tr>
<td>Caudal appendage</td>
</tr>
<tr>
<td>Segmental hemangiomas in association with LUMBAR syndrome</td>
</tr>
<tr>
<td><strong>Intermediate Risk</strong></td>
</tr>
<tr>
<td>Capillary malformations (also referred to as NFS or salmon)</td>
</tr>
<tr>
<td>Patch when pink and poorly defined, or PWS when darker red and well defined)</td>
</tr>
<tr>
<td><strong>Low Risk</strong></td>
</tr>
<tr>
<td>Coccygeal dimple</td>
</tr>
<tr>
<td>Light hair</td>
</tr>
<tr>
<td>Isolated café au lait spots</td>
</tr>
<tr>
<td>Mongolian spots</td>
</tr>
<tr>
<td>Hypo- and hypermelanotic macules or papules</td>
</tr>
<tr>
<td>Deviated or forked gluteal cleft</td>
</tr>
<tr>
<td>Nonmidline lesions</td>
</tr>
</tbody>
</table>

**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.

**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 (D’ Alessandro, 2009). High-risk
cutaneous stigmata in neonates include hemangiomas, upraised lesions (i.e., masses, tails, and hairy patches), and multiple cutaneous stigmata.

**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

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** (AANS, 2020)

- 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 hemangiomia 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 (ACR, 2018).

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 (Ziu, 2019).

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 (as listed above)
  - 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 (Borofsky, 2013).
- 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 (Evans, 2017).
- In patients with Tuberous Sclerosis, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities (Krueger, 2013).
- In Von Hippel Lindau Syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years (Von Hippel-Lindau, 2017).
- In Sturge Weber Syndrome, Brain MRI can rule out intracranial involvement after only after age 1 and is recommended in patients <1 year only if symptomatic (Comi, 2011).

POLICY HISTORY:
Review Date: June 2019
Review Summary:
- 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

**Review Date:** May 2020

**Review Summary:**
- **Added:**
  - For evaluation of neurologic deficits added new deficits
  - Added ankylosing spondylitis for evaluation of trauma/acute injury
  - Added follow up of osteoperotic fracture from metastatic disease
  - Added Osteopathic Manipulative medicine to conservative care therapy
  - Added suspected leptomeningeal carcinomatosis to combination spine imaging
  - 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
  - Added spina bifida occulta to background section
REFERENCES:


INDICATIONS FOR SPINAL CANAL Magnetic Resonance Angiography (MRA):

- For the evaluation of spinal arteriovenous malformation (AVM) (Amarouche, 2015; Mathur, 2017; NINDS, 2019; Shin, 2019)
- Myelopathy when the suspected etiology is compromise of blood flow or drainage to the spinal cord (ACR, 2015; Vargas, 2015).
- 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 (ACR, 2015; Vargas, 2015).
- 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) (Goldberg, 2010; Montalvo, 2018).
- 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) (Backes, 2008; Mordasini, 2011; Vargas, 2010).
- 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 (Mathur, 2017).

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 - Typically, contrast enhanced 3 D 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 range of 69-100% but with modern equipment both MRA and CTA detection rates should approach 100% (Backes, 2008). 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 (Backes, 2008). MRI has the advantage over CT of being able to detect areas of ischemia through the use of diffusion weighted imaging.
Mathur et al showed a 100% sensitivity in detecting recurrent spinal arteriovenous fistulas post treatment (Mathur, 2017).

**Spinal Arteriovenous Malformations (AVMs)** – Spinal cord arteriovenous malformations are comprised of snarled tangles of arteries and veins which affect the spinal cord. They are fed by spinal cord arteries and drained by spinal cord veins. 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 defines the vascular malformation and may assist in determining treatment (NIH, 2015).

**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 artery of Adamkiewicz. 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. 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 (Vargas, 2015).

**POLICY HISTORY:**
**Review Date:** June 2019
**Review Summary:**
- Updated background information and references

**Review Date:** May 2020
**Review Summary:**
- Reordered indications and background information
- Updated references
REFERENCES:


72191 – CT Angiography, Pelvis

CPT Codes: 72191

IMPORTANT NOTE:
Abd/Pelvis CTA & Lower Extremity CTA Runoff Requests: 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 PELVIS CT Angiography / CT Venography - Abdominal CTA can be added when indicated:

For evaluation of known or suspected vascular disease (Eren, 2010)

- 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), and 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 (Khosa, 2011; Uberoi, 2011; Wanhainen, 2019)
  - 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) (Wanhainen, 2019)
- Suspected retroperitoneal hematoma or hemorrhage (to determine a vascular source of hemorrhage in the setting of trauma, tumor invasion, fistula or vasculitis; otherwise CT (rather than CTA) is sufficient and the modality of choice for diagnosing hemorrhage.
- 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) (Bookwalter, 2019; Knuttilen, 2015).
- For evaluation of venous thrombosis in the inferior vena cava (Aw-Zoretic, 2016).
- Venous thrombosis if previous studies have not resulted in a clear diagnosis (ACR, 2013).
- Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate) (Certik, 2015; Smillie, 2015).
• For known and/or suspected mesenteric ischemia/ischemic colitis (can include abdomen CTA) (ACR, 2018).

Other vascular indications
• For suspected May-Thurner Syndrome (iliac vein compression syndrome) (can include abdomen CTA) (Al-Nouri, 2011; Kalu, 2013)
• 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 (ACR, 2014; Clerc, 2017).
• For evaluation of erectile dysfunction when a vascular cause is suspected and Doppler ultrasound is inconclusive (Shindel, 2018)
• For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (Kadian-Dodov, 2016)
• For patients with vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time vascular study of the abdomen and pelvis.
• For Loey’s-Dietz vascular imaging every two years (include abdomen CTA) (Chu, 2014)
• For spontaneous coronary artery dissection (SCAT) at time of coronary arteriography (includes CTA abdomen) (Crousillat, 2020)

Pre-operative evaluation (ACR, 2017)
• 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 (ACR, 2017)
• Prior to uterine artery embolization for fibroids (MRA preferred) (Maciel, 2017)

Post-operative or post-procedural evaluation
• Evaluation of post-operative complications of renal transplant allograft (Bultman, 2014).
• 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 (ACR, 2017; Chaikof, 2018; Uberoi, 2011).
  o Routine, baseline study (post-op/intervention) is warranted within 1-3 months.
  o Asymptomatic at six (6) month intervals, for one (1) year, then annually.
  o Symptomatic/complications related to stent graft – more frequent imaging may be needed.
  o 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 CTA and Abdomen CTA or Abdomen/Pelvis CTA combo

- For preoperative or preprocedural evaluation such as TAVR (transcatheter aortic valve replacement) or transcatheter venous ablation (ACR, 2017; Ohana, 2015).
- Acute aortic dissection (Barman, 2014).
- Takayasu’s arteritis (Keser, 2014).
- Marfan syndrome
- Loeys-Dietz syndrome
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post-operative complications (Bennet, 2017; Choudhury, 2017)

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 (Clerc, 2017).

Follow-up of asymptomatic, incidentally detected iliac artery aneurysms:
The definition of an iliac artery aneurysm (IAA) is dilation 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 mm is considered aneurysmal. There are four types of isolated iliac aneurysms 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 (Wainhanen, 2019)

POLICY HISTORY:
Review Date: June 2019
Review Summary:
- 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

Review Date: May 2020

Review Summary:
• Added evaluation of FMD, Vascular Ehlers-Danlos syndrome, Loetz-Dietz and SCAD
• Added uterine artery embolization
• Added combo studies
REFERENCES:


INDICATIONS FOR PELVIS CT:

Initial staging of prostate cancer
Prostate cancer for intermediate risk or greater (+- abdomen CT) when PSA levels ≥10 ng/mL or biopsy GS ≥7, or clinically advanced disease (T2b, T2c, T3, or T4) AND nomogram (e.g., Partin, Cancer of Prostate Risk Assessment CAPRA) indicating probability of lymph node involvement >10% (NCCN, 2019).

Known prostate cancer for workup of recurrence and response to treatment when there is a contraindication for MRI (NCCN, 2019)
- 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 or for further evaluation of abnormality seen on ultrasound (US) or when US would be inconclusive (ACR, 2013, 2014).
- 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.
- Follow-up of Known Cancer (Bourgioti, 2016; NCCN, 2019):
  - 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 or an abnormal lab value.

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 (ACR, 2018; Cartwright, 2015)
- Suspected perianal fistula or occult anorectal abscess (MRI preferred) (Liang, 2014; O’Malley, 2012; Vogel, 2016)
• Suspected infection (based on elevated WBC, fever, anorexia or nausea and vomiting) in the pelvis.
• CT cystourethrogramy (CTCUG) in the preoperative setting (Maciejewski, 2015)
• For suspected urethral stricture or periurethral pathology only if MRI cannot be done (Aldamahori, 2018; Lv, 2016).

**For evaluation of known infection or inflammatory disease follow up**
(ACR, 2013, 2014)
• 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-ano or perianal Crohn’s disease (MRI preferred) (Vogel, 2016)
• 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 Crohn’s disease with abdominal pain, chronic diarrhea, or bloody diarrhea, fatigue, or when there is a high clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy (ACR, 2019; Arif-Tiwari, 2019; Lichtenstein, 2018).
• For ulcerative colitis that is suspected clinically, however abdominal symptoms are not explained by endoscopy (Rubin, 2019)
• 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 recurrence or worsening signs/symptoms requiring re-evaluation, or for monitoring therapy (ACR, 2019)

**For evaluation of known or suspected vascular disease (e.g., aneurysms, hematomas)**
(Khosa, 2011; Uberoi, 2011)
• 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
  o Known or suspected iliac artery aneurysm > 2.5 cm AND equivocal or indeterminate ultrasound results
  o Prior imaging (e.g., ultrasound) demonstrating iliac artery aneurysm > 2.5 cm in diameter
  o Suspected complications of known aneurysm as evidenced by clinical findings such as new onset of pelvic pain.
  o 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) (Wainhainen, 2019)
• Scheduled follow-up evaluation of aorto/iliac endograft or stent.
  o Routine, baseline study (post-op/intervention) is warranted within 1-3 months (Chaikof, 2018).
  o Asymptomatic at six (6) month intervals, for one (1) year, then annually.
Symptomatic/complications related to stent graft – more frequent imaging may be needed.

- Suspected retroperitoneal hematoma or hemorrhage.

**For suspected or known hernia:**

- For pelvic pain due to a suspected occult, spigelian or incisional hernia when physical exam or 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)

**Musculoskeletal Indications:**

- Known or suspected aseptic/avascular necrosis of hip(s) and MRI is contraindicated after completion of initial x-ray (ACR, 2015).
- Sacroilitis (infectious or inflammatory) after completion of initial x-ray and MRI is contraindicated (ACR, 2016; Jans, 2014; Kang, 2015).
- 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**

(ACR, 2012)

- 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 preoperative planning of complex pelvic fractures.

**Other Indications for Pelvic CT:**

- Subacute or chronic pelvic pain not explained by previous imaging/procedure (ACR, 2018).
- For assessment of pelvic congestion syndrome when findings on ultrasound are indeterminate (CTA/MRA preferred) (Bookwalter, 2019)
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound (Hoshino, 2016)
- For evaluation of suspected May-Thurner syndrome (CTV/MRV preferred) (Ibrahim, 2012; Wanneling, 2012)
- For further evaluation of an isolated right varicocele with additional signs and symptoms that suggest malignancy or suspicious prior imaging (Gleason, 2019)
- To provide an alternative to initial or follow-up of an indeterminate or inconclusive finding on ultrasound and MRI cannot be done.
- To locate an intrauterine device after ultrasound and plain x-ray are equivocal or non-diagnostic (imaging of the abdomen may also be indicated) (Boortz, 2012; Nowitski, 2015)
- For diagnosis or to guide treatment of urachal anomalies when ultrasound is non-diagnostic (Buddha, 2019; Villavicencio, 2016)
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 (Davis, 2016; Yanny, 2012) 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.

If an Abdomen/Pelvis CT combo is indicated and the Abdomen CT has already been approved, then the Pelvis CT may be approved.

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** (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 chiropractic care.

**Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015):
- 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.

Ultrasound should be considered prior to a request for Pelvis CT for the following evaluations:
- 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 (Borofsky, 2018). 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 (Simons, 2018) 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 (Robinson, 2013). According to Miller et al “Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias...” (Miller, 2014). Based on this analysis MRI is recommended only when ultrasound and CT have been performed and fail to make a diagnosis.

POLICY HISTORY:
Review Date: June 2019
Review Summary:
- 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:
  - to provide an alternative to initial or f/u of an indeterminate or inconclusive finding on US and MRI cannot be performed
  - suspected perianal fistula;
  - 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

**Review Date:** May 2020

**Review Summary:**
- 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
REFERENCES:


72196 – MRI Pelvis

CPT Codes: 72195, 72196, 72197

INDICATIONS FOR PELVIC MRI:

Click here for Fetal MRI indications

Initial pelvic imaging for staging of prostate cancer:
(NCCN, 2019)
- For prostate cancer when intermediate risk or greater and prostate specific antigen (PSA) level ≥ 10 ng/mL, or biopsy GS ≥ 7, or clinically advanced disease (T2b, T2c, T3, or T4) AND nomogram (e.g., Partin, Cancer of Prostate Risk Assessment (CAPRA)) indicating probability of lymph node involvement >10% (NCCN, 2019)

Known prostate cancer for workup of recurrence and response to treatment:
(NCCN, 2019)
- Initial treatment by active surveillance (asymptomatic very low, or low or intermediate risk with expected patient survival ≥ 10 years):
  o Initial multiparametric MRI (mpMRI) for patients who chose active surveillance
  o mpMRI to be repeated no more than every 12 months unless clinically indicated
- Initial treatment by radical prostatectomy:
  o Failure of PSA to fall to undetectable level or PSA detectable and rising on at least 2 subsequent determinations
- Initial treatment radiation therapy:
  o Post-radiation therapy (Post-RT) rising PSA or positive digital exam and is candidate for local therapy

Indication for prostate MRI (suspected prostate cancer)
(Bjurlin, 2018; Borofsky, 2018; EAU, 2018; Elkhoury, 2019)
- Rising or persistent elevated PSA (with lab reports on 2 or more separate days); OR
- Suspicious digital rectal exam (DRE)
  AND
- At least 15-year life expectancy AND negative prior biopsy

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 (ACR, 2013, 2014)
- Further evaluation of abnormality seen on ultrasound (US) or when US is inconclusive (ACR, 2013, 2014).

Initial staging of known cancer:
  o Initial staging of pre-treatment endometrial cancer for all tumor grades (ACR, 2020)
- Follow-up of known cancer (Bourgioti, 2016; NCCN, 2019):
Follow-up of known cancer of patient undergoing active treatment within the past year.

Known cancer with suspected pelvic metastasis based on a sign, symptom, or an abnormal lab value.

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 and preliminary imaging has been performed or is contraindicated (includes MR urography (MRU) which includes abdomen MRI when indicated)

(ACR, 2013; Cartwright, 2015)

- Suspected perianal fistula
- Suspected infection (based on elevated WBC, fever, anorexia or nausea and vomiting) in the pelvis.
- For suspected urethral stricture or periurethral pathology (Aldamanhori, 2018; Lv, 2016)

For evaluation of known infection or inflammatory disease follow up:

(ACR, 2013; 2014; Vogel, 2016)

- 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 Crohn’s disease with abdominal pain, chronic diarrhea, or bloody diarrhea, fatigue, or when there is a high clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy (ACR, 2019; Arif-Tiwari, 2019; Lichtenstein, 2018).
- For ulcerative colitis that is suspected clinically, however abdominal symptoms are not explained by endoscopy (Rubin, 2019)
- For MR enterography (MRE) if CT or MRI of the abdomen and pelvis are inconclusive.
- Known inflammatory bowel disease (Crohn’s or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation, or for monitoring therapy (ACR, 2019)

For suspected or known hernia:

- For pelvic pain due to a suspected occult, spigelian, or incisional hernia when physical exam or prior imaging are non-diagnostic or equivocal or if requested as a preoperative study
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 (Lee, 2017; Paksoy, 2016).

For confirming diagnosis of a recurrent hernia when ultrasound is negative or nondiagnostic

For hernia with suspected complications (e.g., Bowel obstruction or strangulation or non-reducible)

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 remains non-diagnostic after x-ray or ultrasound.
- Evaluation of suspected fracture and/or injury when initial imaging is inconclusive or needs further evaluation; or for confirmed stress (fatigue) fracture for “return to play” evaluation (ACR, 2016).
- For evaluation of known or suspected aseptic/avascular necrosis of hip(s) after completion of initial x-ray (ACR, 2015).
- Sacroiliitis (infectious or inflammatory) after completion of initial x-ray (ACR, 2016; Jans, 2014).
- Sacroiliac Joint Dysfunction when there is (Jans, 2014):
  - 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 (ACR, 2016; Muniz-Neto, 2018):
  - 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 comments below regarding diagnosis) (Wadhwa, 2016)
- For suspicion of meralgia paresthetica when prior testing is inconclusive (diagnostic nerve block; electrodiagnostic testing; AND somatosensory evoked potentials) (Ally, 2019; Cheatham, 2013)
- 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 (Hoon Ro, 2018)
- For further evaluation of congenital anomalies of the sacrum and pelvis and initial imaging has been performed.

Other Indications for a Pelvic MRI:

- Subacute or chronic pain not explained by previous imaging/preprocedure (ACR, 2018)
- For location or evaluation of undescended testes in adults and in children, including determination of location of testes, if ordered by a specialist (Kolon, 2014)
• 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 (ACR, 2018).
• For evaluation of abnormal uterine bleeding when ultrasound findings are indeterminate (ACR, 2020)
• For evaluation of uterus prior to and after embolization (MRA preferred) (Deshmukh, 2012).
• For evaluation of endometriosis when preliminary imaging has been completed or to follow up known endometriosis (ACR, 2012; Siegelman, 2012)
• For further evaluation of suspected adenomyosis when ultrasound is inconclusive (Cunningham, 2018)
• Prior to uterine surgery if there is abnormality suspected on prior ultrasound.
• For suspected placenta accreta or percreta when ultrasound is indeterminate (Kilcoyne, 2017)
• For further assessment of a scrotal or penile mass when ultrasound is inconclusive (Kirkham, 2012; Parker, 2015)
• For investigation of a malfunctioning penile prosthesis
• Suspected urethral diverticula and other imaging is inconclusive (Dwarkasing, 2011)
• For evaluation of adenomyosis when ultrasound is equivocal, especially in the case of suspected focal adenomyoma when it will help determine if surgery is indicated (Li, 2018)
• For suspected pelvic congestion syndrome in patients with chronic pelvic pain when other imaging is non-diagnostic (Knuttinen, 2015)
• For suspected patent urachus or other urachal abnormalities when ultrasound is non diagnostic (Buddha, 2019; Villavicencio, 2016)
• For evaluation of suspected pelvic floor weakness in women with functional disorders such as urinary or fecal incontinence, obstructed defecation, and pelvic organ prolapse (Garcia del Sato, 2014)
• MR defecography for suspected structural cause of defecatory outlet obstruction to confirm diagnosis if other testing is equivocal (anorectal manometry and balloon expulsion testing) (Wald, 2014)
• 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 (Hoshino, 2016)
• 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 (Gleason, 2019)
• Surveillance MRI (include abdomen) every 2-3 years for patients with Hereditary Paraganglioma syndromes Type 1-5 (Benn, 2015)
• In hematospermia in men over 40, if Transrectal ultrasound is negative or inconclusive (Allen, 2017)

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 (Davis, 2016; Yanny, 2012) 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 (Prayer, 2017) or when fetal surgery is planned and/or to make a decision about therapy, delivery or to advise the family about prognosis (ACR-SPR, 2015; SPR, 2011). 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:**
(ACR, 2019)
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.

**PI-RADS 1** – Very low (clinically significant cancer is highly unlikely to be present)
**PI-RADS 2** – Low (clinically significant cancer is unlikely to be present)
**PI-RADS 3** – Intermediate (the presence of clinically significant cancer is equivocal)
**PI-RADS 4** – High (clinically significant cancer is likely to be present)
**PI-RADS 5** – Very high (clinically significant cancer is highly likely to be present)

*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 chiropractic care.
**Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015; Last, 2009):

- 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 and despite the advances in ultrasound technology, ultrasound cannot reliably identify intra-abdominal testes, which comprise 20% of all undescended testes (Tasian, 2011). 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, or extrinsic compression, or trauma (ACR, 2016). 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 (Wadhwa, 2016)

**MRI and Prostate Cancer** – Although prostate cancer is the second leading cause of cancer in men, the majority of 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 which 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 (Borofsky, 2018). 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 (Bjurlin, 2018; JAMA, 2019).

Per NCCN, 2019, 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 (Robinson, 2013). According to Miller et al “Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias...” (Miller, 2014). 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 (Lee, 2017).

**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 adjunct to pelvic US. CA 125 has been shown to be increased with fibroids, adenomyosis, pancreatic cancer, endometriosis, tuberculosis, and interstitial lung disease, etc. MRI is not indicated as a first line test (Tahmasebi, 2018).

**POLICY HISTORY:**
**Review Date:** June 2019
**Review Summary:**
- Added the following indications:
  - rising or persistent elevated PSA OR suspicious DRE and at least 15 yr life expectancy and negative prior biopsy
  - suspected perianal fistula
  - 6 months time specification for f/u of known or suspected post-operative complication involving hips or pelvis
  - for confirmed stress (fatigue) fracture for “return to play” evaluation
  - post operative complications after pelvic floor surgery
  - 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
  - suspected placenta accrete or percreta when US is indeterminate
  - further assessment of a scrotal or penile mass when ultrasound is inconclusive
  - investigation of a malfunctioning penile prosthesis
  - suspected urethral diverticula and other imaging is inconclusive
  - evaluation of adenomyosis when ultrasound is equivocal, especially in the case of suspected focal adenomyoma when it will help determine if surgery is indicated
  - suspected pelvic congestion syndrome in patients with chronic pelvic pain when other imaging is non-diagnostic
  - suspected patent urachus when ultrasound is non diagnostic
  - evaluation of enlargement of organ abnormality seen on previous imaging - to provide an alternative to an indeterminate or inconclusive ultrasound
  - PI-RADS information to background section
  - Home exercise program information updated to include dates and duration of failed PT and other

**Review Date:** May 2020

**Review Summary:**
- 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
REFERENCES


TABLE OF CONTENTS


72198 – MR Angiography, Pelvis

CPT Codes: 72198

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: Abdominal MRA can be added when indicated

For evaluation of known or suspected pelvic vascular disease:
- 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), and fistulas, intramural hematoma, and vasculitis.
- Evidence of vascular abnormality seen on prior imaging studies.
- For suspected pelvic extent of aortic dissection.
- For evaluation of known or suspected aneurysms limited to the pelvis or evaluating pelvic extent of aortic aneurysm (Khosa, 2011; Uberoi, 2011; Wanhainen, 2019)
  - 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) (Wainhainen, 2019).
- Suspected retroperitoneal hematoma or hemorrhage (to determine a vascular source of hemorrhage in the setting of trauma, tumor invasion, fistula or vasculitis, (CT rather than MRA/CTA) is sufficient and the modality of choice for diagnosing hemorrhage (Abe, 2010).
- 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) (Bookwater, 2019; Knuttilnen, 2015)
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound (Hoshino, 2016)
- For evaluation of venous thrombus in the inferior vena cava (Aw-Zoretic, 2016)
- Venous thrombosis if previous studies have not resulted in a clear diagnosis (ACR, 2013).
Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate) (Certik, 2015).

For known or suspected mesenteric ischemia (ACR, 2018)

Other vascular indications:

- For suspected May-Thurner Syndrome (iliac vein compression syndrome) (Al-Nouri 2011; Kalu, 2013)
- For patients with fibromuscular dysplasia (FMD) a one-time vascular study of the abdomen and pelvis (Baradhi, 2019; Kadlian-Dodov, 2016)
- For patients with Ehlers-Danlos or Marfan syndrome, recommend a one-time vascular study of the abdomen and pelvis
- For Loeys-Dietz vascular imaging every two years include abdomen MRA (Chu, 2014)

Pre-operative evaluation:
(ACR, 2017)

- 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 CTA/MRA abdomen (ACR, 2017)
- Prior to uterine artery embolization for fibroids (Maciel, 2017)

Post-operative or post-procedural evaluation:

- Evaluation for post-operative complications of renal transplant allograft (Bultman, 2014)
- 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.
  - Routine, baseline study (post-op/intervention) is warranted within 1-3 months (Chaikof, 2018; Uberoi, 2011).
  - 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.

Chest MRA, Abdomen MRA, or Abdomen/Pelvis MRA combo

- Acute aortic dissection (CTA or CT preferred)
- Takayasu’s arteritis
- Marfan syndrome
- Loeys-Dietz syndrome
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:
Bruit: 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 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 (Clerc, 2017).

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 (Abe, 2010).

**POLICY HISTORY:**
**Review Date:** May 2019
**Review Summary:**
- 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

**Review Date:** May 2020
**Review Summary:**
- 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-Danlo, Marfans, Loetz-Dietz
- Added for surgical planning breast reconstruction Deep inferior epigastric arteries
- Added prior to uterine artery embolization
- Added indications for combo imaging
REFERENCES:


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 done (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.

- **Shoulder (Bencardino, 2013; Jain, 2017; Loh, 2016; Somerville, 2017)**
  - Any positive test listed
    - Neer’s Sign
    - Hawkins’s sign
    - Jobe’s test (empty can)
    - Drop Arm test
    - Full can test
    - Hornblower’s sign
    - Anterior Shoulder Apprehension test (Bankart Lesion)
    - Load and Shift test (Bankart Lesion)
    - O’Brien Test

- **Elbow (Kane, 2014; Karbach, 2017)**
  - Any positive test listed
    - Valgus stress
    - Posterolateral rotatory drawer test

- **Wrist (Panday, 2014; Ruston, 2013)**
  - Any positive test listed
    - Watson test (scaphoid shift test)
    - Scapholunate ballottement test
    - Reagan test (lunotriquetral ballottement test)

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 (Katz, 2013; Mordecai, 2014) (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 done

- TFCC (triangular fibrocartilage complex) injury (Barlow, 2016; Ng, 2017)
- SLAP (superior labral anterior to posterior complex) lesions (Somerville, 2017)

**Extremity Mass**
- Mass or lesion after non-diagnostic x-ray or ultrasound (ACR, 2017)
  - 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 (Subhawong, 2010)
  - If there is a contraindication to MRI

**Known Cancer of the Extremity**
(Fitzgerald, 2015; Holzapfel, 2015; Kircher, 2012; Morrison, 2013; NCCN, 2019)
- Cancer staging
- Cancer Restaging
- Signs or symptoms of recurrence

**Infection of Bone or Joint** (Dodwell, 2013; Glaudemans, 2019)
MRI and nuclear medicine studies are recommended for acute infection as they are more sensitive in detecting early changes of osteomyelitis (Mandell, 2017). CT is better at demonstrating findings of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) as well as detecting soft tissue gas and foreign bodies (Fayad, 2007).
- 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
  - Laboratory findings of infection include:
    - Elevated ESR or CRP
    - Elevated white blood cell count
    - Positive joint aspiration
Osteonecrosis (Avascular necrosis (AVN)) [MRI is contraindicated or cannot be done] (Felten, 2019; Murphey, 2014, 2016; Wenham, 2014)
- 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 (Fukushima, 2010), sickle cell anemia (Wali, 2011))

Inflammatory Arthropathy (e.g., Rheumatoid Arthritis), and MRI is contraindicated or cannot be done (Colebatch, 2013; Sudol-Szopinska, 2013)
- Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
- Imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR) (Colebatch, 2013).
- To determine change in treatment or when diagnosis is uncertain prior to start of treatment

Crystalline Arthropathy
- Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (Chou, 2017)

Bone Fracture
- Suspected stress or insufficiency fracture with a negative initial x-ray (ACR, 2016; Sadineni, 2015)
  - Repeat x-rays in 10-14 days if negative or non-diagnostic.
- Intra-articular fractures or carpal bone fractures or instability that may require surgery (Kaewlai, 2008)
- Suspected scaphoid fracture with negative x-rays
- 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 (Morshed, 2014; Salih, 2015)

Occult wrist ganglion, after indeterminate or negative ultrasound and MRI is contraindicated or cannot be done (Meena, 2014)
- Clinical suspicion and failed 4 weeks conservative treatment including all of the following:
  - Activity modification
  - Rest, ice, or heat
  - Splinting or orthotics
  - Medication

Osteochondral lesions (defects, fractures, osteochondritis dissecans) and x-ray done (Smith, 2012; Tuite, 2014; Van Bergen, 2016; Van Dijk, 2010)
- 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 (Rajani, 2016)

**Foreign Body** (Laya, 2017)
- Indeterminate x-ray and ultrasound

**Tendon or Muscle Rupture after x-ray** and MRI is contraindicated or cannot be done (Garras, 2012; Peck, 2017; Wilkins, 2012)
- Clinical suspicion based on mechanism of injury and physical findings

**Peripheral Nerve Entrapment** and MRI is contraindicated or cannot be done, including any of the following (Domkundwar, 2017; Dong, 2012; Donovan, 2010; Meyer, 2018; Tos, 2015):
- 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** (Vijayasarathi, 2016) and MRI is contraindicated or cannot be done

**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 (Fritz, 2014, 2015)

**Note:** Any test that suggest joint impingement or instability requires further imaging (list is not all inconclusive)
### Table 1: Positive Orthopedic Joint Tests, Upper Extremity

**ELBOW**
- Moving valgus stress test
- Hook test
- Passive forearm pronation
- Biceps squeeze test
- Biceps Aponeurosis (BA) flex test
- Table top relocation test

**SHOULDER**
- Anterior draw/anterior load and shift
- Apprehension test
- Drop Arm Test
- Dropping sign
- External rotation lag sign 0 and 90 degrees
- Full can test
- Grind test
- Hawkins or Neer impingement
- Hook test
- Hornsblower test
- HERI (hyper extension-internal rotation)
- Internal rotation lag sign
- Jobe (empty can)
- Lift off test
- Popeye sign
- Posterior draw
- Shift and load test
- Sulcus
- Surprise test
- Yocum

**WRIST**
- Snuff box pain (after initial x-ray)
- Derby relocation test
- Ulnar foveal sign/test
- Press test
- Ulnocarpal stress test (if concern for TFCC tear)
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 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, (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:

- 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 xray absorption and does not correct for scatter (Boas, 2012). Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (Chou, 2017).

**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, etc. 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, and 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. Computed tomography (CT) is another diagnostic tool for patients who have symptoms of a scaphoid fracture but have negative findings on conventional 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.

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 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** (Ramirez, 2019; Redler, 2019; Small, 2018) - 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.

**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.

**POLICY HISTORY:**
**Review Date:** May 2019
**Review Summary:**
• 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)

**Review Date:** May 2020

**Review Summary:**
• 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 osteomyelitis
• Added information about crystalline arthropathy and dual energy CT
• Added information about nonunion/delayed union
• Included loose bodies or synovial chondromatosis
REFERENCES:


TABLE OF CONTENTS


Sinha S, Peach AH. Diagnosis and management of soft tissue sarcoma. *BMJ.* 2010; 341:c7170.


When a separate CTA and CT exam is requested, documentation requires a medical reason that clearly indicates why additional CT imaging of the lower extremity is needed.

**INDICATIONS FOR UPPER EXTREMITY CTA/CTV (Computed Tomography Angiogram/Computed Tomography Venogram):**

**Hand Ischemia** (Hotchkiss, 2014; Wong, 2016)
- 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 (McMahan, 2010)
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (Rosyd, 2017)
- After stenting or surgery with signs of recurrence or indeterminate ultrasound (Pollak, 2012)

**Deep Venous Thrombosis or Embolism** after abnormal ultrasound (ACR, 2014; Dill, 2014; Heil, 2017)
- 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 (Bozlar, 2014)

**Clinical suspicion of vascular disease** with abnormal or indeterminate ultrasound (Bozlar, 2013)
- Tumor invasion (Jin, 2018; Kransdorf, 2017)
- Trauma (Wani, 2012)
- Vasculitis (Fonseka, 2017; Hotchkiss, 2014)
- Aneurysm (Verikokos, 2014)
- Stenosis/occlusions (Menke, 2010; Rafailidis, 2018)

**Hemodialysis Graft Dysfunction**, after Doppler ultrasound not adequate for treatment decisions (Murphy, 2017)

**Vascular Malformation** (Madani, 2015; Obara, 2019) - If MRA is contraindicated
- Non diagnostic doppler ultrasound
Note: CTA useful in delineating high flow lesions such as an arteriovenous malformation.

Pre-operative/procedural evaluation:
• Pre-operative evaluation for a planned surgery or procedure (Ahmed, 2017).

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. (Conte, 2019; Cooper, 2018)

Special Circumstances (Weiss, 2017):
• 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

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:
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:**
**REVIEW DATE:** May 2019
**REVIEW SUMMARY:**
- Reformatted/modified indications to include hand ischemia; deep venous thrombosis or embolism and clinical suspicion of vascular disease
- Updated background information and references

**Review Date:** May 2020
**Review Summary:**
- 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
REFERENCES:


73220 – MRI Upper Extremity

CPT Codes: 73218, 73219, 73220, 73221, 73222, 73223

INDICATIONS FOR UPPER EXTREMITY MRI (HAND, WRIST, ARM, ELBOW or SHOULDER) (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 (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.

- Shoulder (Bencardino, 2013; Jain, 2017; Loh, 2016, Somerville, 2017)
  - Any positive test listed
    - Rotator cuff weakness (van Kampen, 2014)
    - Neer’s Sign
    - Hawkins’s sign
    - Jobe’s test
    - Dropping Sign
    - Full can test
    - Hornblower’s sign
    - Anterior Shoulder Apprehension test (Bankart Lesion)
    - Load and Shift test (Bankart Lesion)
    - O’Brien Test

- Elbow (Kane 2014, Karbach 2017)
  - Any positive test listed
    - Valgus stress
    - Posterolateral rotatory drawer test

- Wrist (Panday, 2014; Ruston, 2013)
  - Any positive test listed
    - Watson test (scaphoid shift test)
    - Scapholunate ballottement test
    - Reagan test (lunotriquetral ballottement test)

Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed (Park, 2010; Pieters, 2020)

- 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.

**Extremity Mass**
- Mass or lesion after non-diagnostic x-ray or ultrasound (ACR, 2017)
  - If superficial, then ultrasound is the initial study.
  - If deep, then x-ray is the initial study.

**Known Cancer of the Extremity** (Fitzgerald, 2015; Holzapfel, 2015; Kircher, 2012; Morrison, 2013; NCCN, 2019)
- Cancer staging
- Cancer Restaging
- Signs or symptoms of recurrence

**Infection of Bone or Joint**
(Beaman, 2017; Dodwell, 2013; Glaudemans, 2019)
- 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
  - Laboratory findings of infection include:
    - Elevated ESR or CRP
    - Elevated white blood cell count
    - Positive joint aspiration

**Osteonecrosis (e.g., Avascular necrosis (AVN))**
(Felten, 2019; Murphey, 2014; 2016)
- Abnormal x-ray
- Normal X-rays but symptomatic and high risk (e.g., glucocorticosteroid use, renal transplant recipient, glycogen storage disease, alcohol abuse (Fukushima, 2010), sickle cell anemia (Wali, 2011))

For evaluation of known or suspected autoimmune disease (e.g., rheumatoid arthritis):
- Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
- Imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR (Colebatch, 2013; Narvaez, 2010).

**Bone Fracture or Ligament Injury**
- Suspected stress or insufficiency fracture with a negative initial x-ray (ACR, 2016; Sadineni, 2015; Yin, 2010)
  - Repeat x-rays in 10-14 days if negative or non-diagnostic
- Pathologic fracture on x-ray (Fayad, 2005)
Intra articular 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 (Morshed, 2014).
Clinical suspicion based on mechanism of injury and physical findings and x-ray completed
  - TFCC (triangular fibrocartilage complex) injury (Barlow, 2016; Ng, 2017)
  - SLAP (superior labral anterior to posterior complex) lesions (Somerville, 2017)

Occult wrist ganglion, after indeterminate ultrasound (Meena, 2014)
Clinical suspicion and failed 4 weeks conservative treatment including all of the below:
  - Activity modification
  - Rest, ice, or heat
  - Splinting or orthotics
  - Medication

Osteochondral Lesions (defects, fractures, osteochondritis dissecans) and x-ray done (Smith, 2012; Tuite, 2014; Van Dijk, 2010; Van Bergen, 2016)
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 (Rajani, 2016)

Foreign Body (Laya, 2017)
Indeterminate x-ray and ultrasound

Tendon or Muscle Rupture after x-ray (Garras, 2012; Peck, 2017; Wilkins, 2012)
Clinical suspicion based on mechanism of injury and physical findings

Peripheral Nerve Entrapment (Domkundwar, 2017; Dong, 2012, Donovan, 2010; Meyer, 2018; Tos, 2015)
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 (Vijayasarathi, 2016)

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 (Fritz, 2014; 2015)
Table 1: Positive Orthopedic Joint Tests, Upper Extremity

**ELBOW**
- Moving valgus stress test
- Hook test
- Passive forearm pronation
- Biceps squeeze test
- Biceps Aponeurosis (BA) flex test
- Table top relocation test

**SHOULDER**
- Anterior draw/anterior load and shift
- Apprehension test
- Drop Arm Test
- Dropping sign
- External rotation lag sign 0 and 90 degrees
- Full can test
- Grind test
- Hawkins or Neer impingement
- Hook test
- Hornsblower test
- HERI (hyper extension-internal rotation)
- Internal rotation lag sign
- Jobe (empty can)
- Lift off test
- Popeye sign
- Posterior draw
- Shift and load test
- Sulcus
- Surprise test
- Yocum

**WRIST**
- Snuff box pain (after initial x-ray)
- Derby relocation test
- Ulnar foveal sign/test
- Press test
- Ulnocarpal stress test (if concern for TFCC tear)
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 has the ability to 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, (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:
• 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.

**Adhesive Capsulitis a.k.a. Frozen Shoulder** (Ramirez, 2019; Redler, 2019; Small, 2018) - 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.

**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.
POLICY HISTORY:

Review Date: May 2019
Review Summary:
- 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)

Review Date: May 2020
Review Summary:
- 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.
REFERENCES:


Sinha S, Peach AH. Diagnosis and management of soft tissue sarcoma. *BMJ*. 2010; 341:c7170.


INDICATIONS FOR UPPER EXTREMITY MRA/MRV

Hand Ischemia:
(Bae, 2015; Hotchkiss, 2014; Wong, 2016)
• Arterial Doppler not needed with any of these acute symptoms:
  o Ischemic ulceration without segmental temperature change.
  o Ischemic ulceration with painful ischemia.
  o Acute sustained loss of perfusion with or without acral ulceration.
  o Imminent loss of digit.
• Clinical symptoms without the above features, arterial Doppler abnormal and will change management
  o Includes Raynaud’s (can be associated with scleroderma), Buerger disease, and other vasculopathies (McMahan, 2010)
• Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (Rosyd, 2017)
• After stenting or surgery with signs of recurrence or indeterminate ultrasound (Pollak, 2012)

Deep Venous Thrombosis or Embolism:
(Dill, 2014; Heil, 2017)
• 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 (Bozlar, 2014)

Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound or other imaging (Bozlar, 2013)
• Tumor invasion (Jin, 2018; Kransdorf, 2018)
• Trauma (Wani, 2012)
• Vasculitis (Fonseca, 2017; Hotchkiss, 2014)
• Aneurysm (Verikokos, 2014)
• Stenosis/occlusions (Menke, 2010)

Vascular Malformation (Madani, 2015; Obara, 2019)
• Non diagnostic doppler ultrasound
Pre-operative/procedural evaluation:
• Pre-operative evaluation for a planned surgery or procedure (Ahmed, 2017).

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 (Weiss, 2017):
• High suspicion of an acute arterial obstruction - Arteriography preferred (the gold standard).
• Renal impairment
  o Not on dialysis
    ▪ Mild to moderate, GFR 30-89 ml/min MRA can be done
    ▪ Severe, GFR < 30 ml/min MRA without contrast
  o On dialysis
    ▪ CTA with contrast can be done
• Doppler ultrasound can be useful in evaluating bypass grafts

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 DVT of the upper extremity is by far the most common type. Indwelling venous devices such as catheters, pacemakers, and defibrillators put patients at the highest risk of thrombus. Central venous catheters, which are difficult to place, such as those requiring multiple insertion attempts, are noted to have increased incidence of associated thrombus [9]. Other risk factors associated with higher likelihood of UEDVT include advanced age, previous thrombophlebitis, postoperative state, hypercoagulability, heart failure, cancer, right-heart procedures, and intensive care unit admissions” (ACR, 2014).

MRA/MRV 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.

MRA/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
morbidity 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 (Conte, 2019; Kim, 2008).

**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:**
**REVIEW DATE:** May 2019
**REVIEW SUMMARY:**
- Reformatted/modified indications to include hand ischemia; deep venous thrombosis or embolism and clinical suspicion of vascular disease
- Updated background information and references

**Review Date:** May 2020
**Review Summary:**
- 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
REFERENCES:


73700 – CT Lower Extremity (Ankle, Foot, Hip or Knee)
CPT Codes: 73700, 73701, 73702

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
  - Positive drawer sign ≥ 4 days after injury (Vuurbreg, 2018)
- Knee (Bennett, 2012; Doral, 2018; Katz, 2013; Mohankumar, 2014; Slaughter, 2014; Smith, 2015; Tuite, 2014)
  - Any positive test listed
    - McMurray’s
    - Thessaly
    - Apley’s
    - Lachman’s
    - Anterior or Posterior Drawer sign
    - Varus or valgus stress
    - Acute mechanical locking of the knee not due to guarding (Hussin, 2014)
- Hip
  - Anterior Impingement sign (labral tear) (Hananouchi, 2012; Naraghi, 2015; Ward, 2013)
- Posterior Impingement sign (labral tear) (Groh, 2009)

Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed and a MRI is contraindicated or cannot be performed (Katz, 2013; Mordecai, 2014) (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 (Groh, 2009; Mintz, 2017)
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 (Abousayed, 2017; Thorpe, 2012)

Extremity Mass
- Mass or lesion after non-diagnostic x-ray or ultrasound (Murphey, 2018) and MRI cannot be performed. CT is better than MRI to evaluate mass calcification or bone involvement and may complement or replace MRI (Subhawong, 2010)
  - 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.
  - If there is a contraindication to MRI

Known Cancer of the Extremity
(Fitzgerald, 2015; Holzapfel, 2015; Kircher, 2012; Morrison, 2013; NCCN, 2019)
- Cancer staging
- Cancer Restaging
- Signs or symptoms of recurrence

Infection of Bone or Joint (Dodwell, 2013; Glaudemans, 2019)
Note: MRI and nuclear medicine studies are recommended for acute infection as they are more sensitive in detecting early changes of osteomyelitis (Mandell, 2017). CT is better at demonstrating findings of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) as well as detecting soft tissue gas and foreign bodies (Fayad, 2007).
- 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
  - Laboratory findings of infection include:
    - Elevated ESR or CRP
    - Elevated white blood cell count
    - Positive joint aspiration
- A suspicion of osteomyelitis of the foot in patients with diabetes (Walker, 199)

Osteonecrosis (Avascular necrosis (AVN), Legg-Calve-Perthes Disease) when MRI is contraindicated or cannot be performed (Felten, 2019; Murphey, 2014; 2016)
- 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 (Fukushima, 2010), sickle cell anemia (Wali, 2011))
For evaluation of known or suspected autoimmune disease (e.g. rheumatoid arthritis) and MRI is contraindicated:
• Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
• Imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g., RF, ANA, CRP, ESR) (Colebatch, 2013).
• To determine change in treatment or when diagnosis is uncertain prior to start of treatment

Crystalline Arthropathy
• Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (Chou, 2017)

Trauma
Bone Fracture
• Suspected stress or insufficiency fracture with a negative initial x-ray (Berncardino, 2017; Patel, 2011; Sadineni, 2015):
  o If hips and MRI cannot be done
  o If other parts of the extremities and repeat x-rays in 10-14 are negative or non-diagnostic
  o If at high risk for a complete fracture with conservative therapy and MRI cannot be done (Kellar, 2020)
• Suspected acute hip fracture with initial x-rays negative or non-diagnostic (Gill, 2013; Ross, 2019)
Intra articular fractures that may require surgery (i.e., depressed tibial plateau fracture) (Prat-Fabregat, 2017)
• 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 (Morshed, 2014; Salih, 2015)

Tendon or Muscle Rupture after X-Ray and MRI is contraindicated or cannot be done (Garras, 2012; Peck, 2017; Wilkins, 2012)
• 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 (Wheless, 2018) if MRI is contraindicated (ACR, 2019)
• 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:
  o Extreme pain, inability to stand, audible pop at time of injury, very swollen joint, leg numbness
• Abnormal x-ray:
  o Large joint effusion on x-ray knee effusion (Cecava, 2018)

Osteochondral Lesions (defects, fractures, osteochondritis dissecans) and x-ray done (if MRI contraindicated or cannot be done)
(Mintz 2017; Smith, 2012; Tuite, 2014; Van Bergen, 2015; Van Dijk, 2010)

- Clinical suspicion based on mechanism of injury and physical findings

**Foreign Body** (Laya, 2017)

- Indeterminate x-ray and ultrasound

**Loose bodies or synovial chondromatosis seen on x-ray or ultrasound**

- In the setting of joint pain (Rajani, 2016)

**Peripheral Nerve Entrapment when MRI is contraindicated, including any of the following:** (Domkundwar, 2017; Dong 2012; Donovan, 2010; Tos, 2015)

- 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 (Guggenberger, 2014; Sabharwal, 2008)

- Osteoid Osteoma after an x-ray is done (Iyer, 2012)
- Painful flatfoot (Pes planus) deformity with suspected tarsal coalition, not responsive to active conservative care (Bouchard, 2014)
  - When MRI cannot be done; **OR**
  - Extra-articular coalition is suspected (bony bridges around the joints); **OR**
  - When needed for surgical planning (Glaser, 2016)
- 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 (See exclusions*)

*CT or MRI requests are *not* approvable for the following total knee arthroplasty (TKA) procedures:
  - Procedures utilizing computer-navigated or patient-specific or gender-specific instrumentation (Johnson, 2011)
  - Bicompartmental arthroplasty (investigational at this time) (Dudhniwala, 2016)
Note: 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.

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 (Fritz, 2014, 2015)

Table 1: Positive Orthopedic Joint Tests, Lower Extremity

<table>
<thead>
<tr>
<th>ANKLE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior draw</td>
<td>Thompson</td>
<td>Thumb squeeze test</td>
</tr>
<tr>
<td></td>
<td>Mulder click</td>
<td></td>
</tr>
<tr>
<td>HIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trendelenburg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KNEE</td>
<td>Anterior draw</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pivot Shift Test</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lachman</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posterior tibial Sag</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posterior Draw</td>
<td></td>
</tr>
<tr>
<td></td>
<td>McMurray’s Test</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thessaly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valgus stress</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Varus stress</td>
<td></td>
</tr>
</tbody>
</table>

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:

- 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 (Boas, 2012). Dual-energy CT can be used to characterize crystal deposition disease, such as gout versus CPPD (Chou, 2017).

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-Calvé-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 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 also 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.

POLICY HISTORY:
Review Date: May 2019
Review Summary:

- Reformating 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

- 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)

**Review Date:** May 2020

**Review Summary:**

- 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
REFERENCES:


Sinha S, Peach AH. Diagnosis and management of soft tissue sarcoma. BMJ. 2010; 341:c7170.


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 one 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 (Shishehbor, 2016; Weiss, 2018)
  - Ischemic rest pain
  - Tissue loss
  - Gangrene
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (ankle/brachial index, arterial Doppler) (Rosyd, 2017)
- After stenting or surgery with signs of recurrent symptoms OR abnormal ankle/brachial index; abnormal or indeterminate arterial Doppler, OR pulse volume recording) (Pollak, 2012)

Popliteal Artery Entrapment Syndrome with abnormal arterial ultrasound (Williams, 2015)

Deep Venous Thrombosis with clinical suspicion of lower extremity DVT after abnormal or non-diagnostic ultrasound where a positive study would change management (Hanley, 2013; Karande, 2016; Katz, 2014)

Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound or other imaging

- Tumor invasion (Kransdorf, 2018)
- Trauma (Wani, 2012)
- Vasculitis (Fonseca, 2017)
- Aneurysm (Verikokos, 2014)
- Stenosis/occlusions (Menke, 2010)

Hemodialysis Graft Dysfunction after Doppler ultrasound not adequate for treatment decisions (Murphy, 2017)

Vascular Malformation (Madani, 2015; Obara, 2019) - If MRA is contraindicated
Non diagnostic doppler ultrasound

Note: CTA useful in delineating high flow lesions such as an arteriovenous malformation.

Evaluation of traumatic injuries to the LE with clinical findings suggestive of arterial injury (Wani, 2012).

For assessment/evaluation of known vascular disease/condition.

Pre-operative/procedural evaluation:
• Pre-operative evaluation for a planned surgery or procedure (Ahmed, 2017)

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 (Conte, 2019; Cooper 2018)

Special Circumstances (Weiss, 2017):
• High suspicion of an acute arterial obstruction - Arteriography preferred (the gold standard).
• Renal impairment
  o Not on dialysis
    ▪ Mild to moderate, GFR 30-89 ml/min MRA can be done
    ▪ Severe, GFR < 30 ml/min MRA without contrast
  o On dialysis
    ▪ CTA with contrast can be done
• Doppler ultrasound can be useful in evaluating bypass grafts

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.

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. Preventative Services Task Force) does not recommend routine screening for peripheral vascular disease in asymptomatic patients. High risk patients (e.g., diabetics) may be screened with ABI (ankle brachial index) and duplex ultrasound.

**POLICY HISTORY:**
**Review Date:** May 2019
**Review Summary:**
- Added indication for deep venous thrombosis
- Reformatting and new references.

**Review Date:** May 2020
**Review Summary:**
- 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
REFERENCES:


73720 – MRI Lower Extremity

CPT Codes: 73718, 73719, 73720, 73721, 73722, 73723

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 (Fox, 2018):
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
  - Positive drawer sign ≥ 4 days after injury (Vuurberg, 2018)

- Knee (Bennett, 2012; Doral, 2018; Katz, 2013; Mohankumar, 2014; Slaughter, 2014; Smith, 2015; Tuite, 2014)
  - Joint instability or meniscal injury on exam, demonstrated with a positive
    - McMurray’s
    - Thessaly
    - Apley’s
    - Lachman’s
    - Anterior or Posterior Drawer sign
    - Varus or valgus stress
    - Acute mechanical locking of the knee not due to guarding (Hussin, 2014)

- Hip
  - Anterior Impingement sign (labral tear) (Hananouchi, 2012; Naraghi, 2015; Ward, 2013)
  - Posterior Impingement sign (labral tear) (Groh, 2009)

Joint or muscle pain without positive findings on an orthopedic exam as listed above, after x-ray completed (Katz, 2013; Mordecai, 2014) (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 (Groh, 2009; Mintz, 2017)

Painful acquired or congenital flatfoot deformity in an adult, after x-ray completed
• After failure of active conservative therapy listed above (Abousayed, 2017; Thorpe, 2012)

**Extremity Mass**

• Mass or lesion after non-diagnostic x-ray or ultrasound (Murphey, 2018)
  - 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**
(Fitzgerald, 2015; Holzapfel, 2015; Kircher, 2012; Morrison, 2013; NCCN, 2019)

• Cancer staging
• Cancer Restaging
• Signs or symptoms of recurrence

**Infection of Bone or Joint**
(Beaman, 2017; Dodwell, 2013, Glaudemans, 2019)

• 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
• A suspicion of osteomyelitis of the foot in patients with diabetes after initial x-ray (ACR, 2019)

**Osteonecrosis (e.g., Avascular Necrosis (AVN), Legg-Calve-Perthes Disease)**
(Felten, 2019; Murphey, 2014)

• Abnormal x-ray
• Normal or Indeterminate X-rays, but symptomatic and high risk
  - Glucocorticosteroid use
  - Renal Transplant recipient
  - Alcohol abuse (Fukushima, 2010)
  - Sickle Cell Anemia (Wali, 2011)

**For evaluation of known or suspected autoimmune disease (e.g. rheumatoid arthritis):**

• Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
• Imaging of a single joint for diagnosis or response to therapy after plain films and appropriate lab tests (e.g. RF, ANA, CRP, ESR) (Colebatch, 2013).
• To determine change in treatment or when diagnosis is uncertain prior to start of treatment (Colebatch, 2013)
**Trauma**

**Bone Fracture**

- Suspected stress or insufficiency fracture with a negative initial x-ray (Bencardino, 2017; Sadineni, 2015):
  - If hips, then approve an immediate MRI
  - Suspicion of a hip fracture in a pregnant patient does not require an initial x-ray
  - If other parts of the extremities and repeat x-rays in 10-14 days are negative or nondiagnostic
  - If at high risk for a complete fracture with conservative therapy, then immediate MRI is warranted (Kellar, 2020)
- Suspected acute hip fracture with initial x-rays negative or non-diagnostic (Ross, 2019; Gill, 2013)
- Pathologic fracture on x-ray (Fayad, 2005)
- Intra articular fractures that may require surgery. (e.g., depressed tibial plateau fracture) (Prat-Fabregat, 2017)
- 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 (Morshed, 2014)

**Tendon or Muscle Rupture after X-Ray** (Garras, 2012; Peck, 2017; Rubin, 2012; Wilkins, 2012)
- 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 (Cecava, 2018; Wheeless, 2018)
- 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 (Cecava, 2018)

**Osteochondral lesions** (defects, fractures, osteochondritis dissecans) and x-ray done (Mintz, 2017; Smith, 2012; Tuite, 2014; Van Dijk, 2010)
- Clinical suspicion based on mechanism of injury and physical findings

**Foreign Body**
(Laya, 2017)
- Indeterminate x-ray and ultrasound

**Loose bodies or synovial chondromatosis seen on xray or ultrasound**
- In the setting of joint pain (Rajani, 2016)
Hip Impingement (Femoroacetabular Impingement)
- With negative, equivocal, or non diagnostic x-rays (Mintz, 2017) (and imaging would change treatment – active conservative care or surgery are the two mainstays of treatment) (Kekatpure, 2017)
- To determine candidacy for hip preservation surgery (Li, 2016)

Known or suspected inflammatory myopathies: (Includes polymyositis, dermatomyositis, immune-mediated necrotizing myopathy, inclusion body myositis) (Jia, 2017; Joyce, 2012)
- For diagnosis
- For biopsy planning

Peripheral Nerve Entrapment
(Domkundwar, 2017; Dong, 2012; Donovan, 2010; Tos, 2015)
- 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

Pediatrics:
- Painful flatfoot deformity with suspected tarsal coalition, not responsive to active conservative care (Bouchard, 2014).
- Slipped Capital Femoral Epiphysis with negative frog leg and AP x-rays of the hips but clinically suspected) (Hesper, 2017; Kamegaya, 2011; Peck, 2017)
  - Drehman sign
  - Limited internal rotation of the hip
  - Consider imaging the asymptomatic contralateral hip with a normal xray to detect early SCFE if prophylactic surgery is planned (Balch Samora, 2018)
- Chronic Recurrent Multifocal Osteomyelitis after initial work-up (labs and x-ray) (Roderick, 2016)
- Acute limp in a child 5 or less years old, concern for infection (initial x-rays not needed) (Safdar, 2018)
- 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 (Iyer, 2012)

Pre-operative/procedural evaluation:
- Pre-operative evaluation for a planned surgery or procedure (See exclusions*)
*CT or MRI requests are NOT approvable for the following total knee arthroplasty (TKA) procedures:
- Procedures utilizing computer-navigated or patient-specific or gender-specific instrumentation (Johnson, 2011)
- Bicompartmental arthroplasty (investigational at this time) (Dudhniwala, 2016)

**Note**: 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.

**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 (Fritz, 2014, 2015)
Table 1: Positive Orthopedic Joint Tests, Lower Extremity

ANKLE
- Posterior draw
- Thompson
- Thumb squeeze test
- Mulder click

HIP
- Trendelenburg

KNEE
- Anterior draw
- Pivot Shift Test
- Lachman
- Posterior tibial Sag
- Posterior Draw
- McMurray’s Test
- Thessaly
- Valgus stress
- Varus stress

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 has the ability to 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, (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:
- 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 (Glaudemans, 2019).

**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” (ACR, 2016)

**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 he plans 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 abduction 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.

**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.
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 also 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-proonation, 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 (Glaser, 2016).

**MRI and Chronic Recurrent Multifocal Osteomyelitis** - Noninfectious inflammation of the bone in children, can have non elevated inflammatory markers and a normal CBC. 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). Can approve MRI 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 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.”
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.

POLICY HISTORY:

Review Date: May 2019
Review Summary:
- 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)

Review Date: January 2020
Review Summary:
- Added ‘infection of bone or joint section’ previously omitted in error

Review Date: May 2020
Review Summary:
- 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
TABLE OF CONTENTS

- 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
REFERENCES:


TABLE OF CONTENTS


2021 Magellan Clinical Guidelines-Advanced Imaging


TABLE OF CONTENTS


<table>
<thead>
<tr>
<th>Reference</th>
</tr>
</thead>
</table>


73725 – MR Angiography, Lower Extremity

CPT Code: 73725

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 (Shishehbor, 2016; Weiss, 2018)
  - Ischemic rest pain
  - Tissue loss
  - Gangrene
- Claudication with abnormal (ankle/brachial index, pulse volume recording or arterial Doppler (Ahmed, 2017; Pollak, 2012, 2013)
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (ankle/brachial index, arterial Doppler) (Rosyd, 2017)
- After stenting or surgery with signs of recurrent symptoms OR abnormal ankle/brachial index; abnormal or indeterminate arterial Doppler, OR pulse volume recording) (Pollak, 2012)

Popliteal Artery Entrapment Syndrome with abnormal arterial ultrasound (Williams, 2015)

Deep Venous Thrombosis with clinical suspicion of lower extremity DVT after abnormal or non-diagnostic ultrasound where a positive study would change management (Hanley, 2013; Karande, 2016; Katz, 2014)

Clinical suspicion of vascular disease with abnormal or indeterminate ultrasound or other imaging
- Tumor invasion (Jin, 2018; Kransdorf, 2018)
- Trauma (Wani, 2012)
- Vasculitis (Fonseka, 2017)
- Aneurysm (Verikokos, 2014)
- Stenosis/occlusions (Menke, 2010)

For assessment/evaluation of suspected or known vascular disease/condition
Vascular Malformation (Madani, 2015; Obara, 2019)

- Non diagnostic doppler ultrasound

Pre-operative/procedural evaluation:
- Pre-operative evaluation for a planned surgery or procedure (Ahmed, 2017).

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. (Conte, 2019; Cooper, 2018)

Special Circumstances (Weiss, 2017):
- 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

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.

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)” (ACR 2017)
photoplethysmography (PPG), and transcutaneous oxygen pressure measurement (TcPO2).

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:**
*Review Date: May 2019*
**Review Summary:**
- 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

*Review Date: May 2020*
**Review Summary:**
- 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
REFERENCES:


Gerhard-Herman MD, Gornik HL. AHA/ACC guideline on the management of patients with lower extremity peripheral artery disease: A report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. *J Am Coll Cardiol.* 2017 Mar; 69(11).


74150 – CT Abdomen

CPT Codes: 74150, 74160, 74170

INDICATIONS FOR ABDOMEN CT:
Note: For syndromes for which imaging starts in the pediatric age group, MRI preferred

Abdominal Pain for Unknown Etiology:
- CT allowed after initial workup inconclusive
  - Initial imaging such as, ultrasound, scope study, or x-ray
  - 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 (ACR, 2018; Lehtimaki, 2017)

Evaluation of suspicious known mass/tumors (unconfirmed diagnosis of cancer) for further evaluation of indeterminate or questionable findings:
- Initial evaluation of a palpable abdominal or abdominal wall mass/tumor found by physical exam or imaging study, such as ultrasound (US) (ACR, 2019).
- Follow-up of known cancer (Bourgioti, 2016; NCCN, 2019):
  - Follow-up of known cancer of patient undergoing active treatment within the past year.
  - Known cancer with suspected abdominal metastasis based on a sign, symptom or an abnormal lab value.

For evaluation of suspected infection or inflammatory disease based on exam or discovered on previous imaging:
(ACR, 2018; Cartwright, 2015; Sartelli, 2015)
- 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 (Ecanow, 2015)

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 (Fassanacht, 2018; Meek, 2013)
- 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 (Kamilaris, 2019).

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) (Varshney, 2017)

LIVER:

Indeterminate liver lesion > 1 cm seen on ultrasound **(ACR, 2020)

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 (Bruix, 2011; Lee, 2014; Marquardt, 2016; Mayo-Smith, 2017)). (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 (Vagvala, 2018).

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* (Horowitz, 2017; Vagvala, 2018)

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 (Marrero, 2014)

Pre-procedure for transjugular intrahepatic portosystemic shunt (TIPS) (Gaba, 2011; Farsad, 2014)

In patients with Beckwith-Wiedemann syndrome and abnormal ultrasound or rising AFP and MRI is contraindicated (Kalish, 2017).

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 and duct communication is present and there are no high risk characteristics (see background section) (Elta, 2018):

- For incidental and asymptomatic cysts <5 mm, one follow-up at three years (Pandey, 2019)
- 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

Yearly surveillance for individuals determined to have an increased lifetime risk of developing pancreatic cancer (if MRI/MRCP and EUS contraindicated) 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), and Hereditary Pancreatitis starting at age 40 or 20 years after first attack)** (Hu, 2018; Syngal, 2015; NCCN, 2019).

- 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 (ACR, 2019; Vagvala, 2018).

Presentation with atypical signs and symptoms including equivocal amylase and lipase (Mathur, 2015) Severe acute pancreatitis, 72-96 hours after onset of symptoms (Leppaniemi, 2019) Known necrotizing pancreatitis requiring follow up.

Pancreatitis by history, (including pancreatic pseudocyst) with abdominal pain suspicious for worsening, or re-exacerbation

For localization of an insulinoma once diagnosis is confirmed (Vinik, 2017).

**RENNAL:**

- For an indeterminate renal mass on other imaging (ACR, 2014)
- Active surveillance for indeterminate cystic renal mass, not a simple renal cyst (Richard, 2017) (see Bosniak criteria in comment section)
- Active surveillance for patients with tuberous sclerosis and known angiomyolipoma (AML) if MRI is contraindicated (Vos, 2018)
- 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) (Varshney, 2017).
- Follow up for solid renal masses under 1 cm at 6 and 12 months then annually (Herts, 2018)
- Active surveillance for renal cell carcinoma in patients with Birt-Hogg syndrome every 36 months (Gupta, 2017)

**SPLEEN:**

- Incidental findings of the spleen that are indeterminate on other imaging

**Other Indications for an Abdominal CT:**

- Abdominal pain suspected to be due to an occult, spigelian, incisional or epigastric hernia when physical exam and initial laboratory/urine testing (to exclude other etiologies) and prior imaging is non-diagnostic or equivocal (Abdelmohsen, 2017; Lassandro, 2011; Miller, 2014; Robinson, 2013) and limited to the abdomen.
- Suspected incarceration or strangulation based on physical exam or prior imaging (Halligan, 2018).

**For evaluation of suspected infection or for follow-up known infection:**

- 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 (from any cause) if 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

For evaluation of suspected inflammatory disease or follow-up (also approve CT pelvis):
- For suspected of inflammatory bowel disease (Crohn’s or ulcerative colitis) with abdominal pain, and persistent diarrhea, or bloody diarrhea (Arif-Tiwari, 2019; Kilcoyne, 2016).
- Known inflammatory bowel disease, (Crohn’s or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation

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, 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.

Combination studies with Abdomen CT:
- 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.

If an Abdomen/Pelvis CT combo is indicated and the Abdomen CT has already been approved, then the Pelvis CT may be approved.

**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 involving the abdomen and pelvis. 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, 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.

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 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.

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 (Bruijx, 2011). 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 (Bruijx, 2011; Marquardt, 2016) 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 (Patil, 2013), not neoplasm. Others advocate for combined ultrasound and AFP for screening (Tan, 2011; Tzartzeva, 2018) 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.

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 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 (ACR, 2017).

- **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).”

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” (Heimbach, 2018).

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 loco regional 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 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-antitrypsin 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 (Willatt, 2018).

**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, 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 (Tobias, 2012).

**CT of the kidney:** Recommendations for follow up of a complex cystic renal mass are made using Bosniak criteria (Muglia, 2014):

- **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 (Richard, 2017)
Bosniak IV malignant cystic renal mass with enhancing soft tissue components; resection favored, malignant until proven otherwise

**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) (NCCN, 2019; Goggins, 2020; Daly, 2020). 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 (Stoeffel, 2019).

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 ratio of greater than 0.3 has been found in virtually all patients with insulinoma or other islet cell disease (Vinik, 2017).

**Surveillance of Pancreatic Cysts:** Some pancreatic cysts have the potential for malignant transformation to invasive ductal adenocarcinoma, hence the need for intervention vs surveillance, however the data is unclear as to the risk of cancer. Cyst surveillance can be offered to patients with asymptomatic cysts presumed to be IPMN’s or MCN’s. 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 calibre 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 (Elta, 2018;).
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 (Kwo, 2017).

Combination request of Abdomen CT/Chest CT - A Chest CT will produce images to the level of L3. Documentation for combo is required.

POLICY HISTORY:
Review Date: May 2019
Review Summary:
- For evaluation of suspected infection or inflammatory disease, Added:
  - Right upper quadrant pain for suspected biliary disease with negative or equivocal US or HIDA scan
  - 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
  - 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
  - Added: To locate a pheochromocytoma once there is clear biochemical evidence
  - 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
- 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

Review Date: May 2020
Review Summary:
- 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
- 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.
REFERENCES:


Charnow JA. CT Scans Overused in Emergency Departments for Kidney Stone Imaging, Renal and Urology News, American Urological Association Meeting, 2019


INDICATIONS FOR ABDOMEN/PELVIS CT Angiography/CT Venography:

For evaluation of known or suspected abdominal/pelvis vascular disease:

Arterial Disease:
- Evaluation of known or suspected aortic aneurysm (Chaikof, 2018; Khosa, 2013; Kumar, 2017)
  - 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) (Wanhainen, 2019)
- 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 (ACR, 2018; Thakur, 2018).
- Evidence of vascular abnormality seen on prior imaging studies.
- For suspected aortic dissection (Baliga, 2014)
- Suspected retroperitoneal hematoma or hemorrhage: to determine vascular source of hemorrhage, in setting of trauma, tumor invasion, fistula or vasculitis, otherwise CT abdomen and pelvis may be sufficient for diagnosing hemorrhage (Ioannou, 2018)
- 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 (ACR, 2014; Clerc, 2017; Strate, 2016).
- For evaluation of suspected mesenteric ischemia (ACR, 2018; Aw-Zoretic, 2016; Bala, 2017; Thakur, 2018)

Venous disease:
- Venous thrombosis if previous studies have not resulted in a clear diagnosis.
- For May-Thurner syndrome (Ibrahim, 2012; Wan-Ling, 2012)
- For evaluation of venous thrombosis in the inferior vena cava (IVC) (Aw-Zuretic, 2016).

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 AAA
• For imaging of the deep inferior epigastric arteries for surgical planning (breast reconstructive surgery) (ACR, 2017)

**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 month (ACR, 2017; Chaikof, 2018; Uberoi, 2011).
  - 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 patients with fibromuscular dysplasia (FMD) a one-time study can be approved (Kadian-Dodov, 2016).
• For patients with Vascular Ehlers-Danlos syndrome or Marfan syndrome, recommend a one-time study.
• For Loeys-Dietz imaging at least every two years (Chu, 2014).
• For assessment in patients with spontaneous coronary artery dissection (SCAD), can have at time of coronary angiography (Crousillat, 2020).
• For hemodynamically unstable patients (Saltzman, 2019)
• Vascular invasion or displacement by tumor (Conventional CT or MRI also appropriate) (Certik, 2015).

**Chest CTA/Abdomen/Pelvis CTA combo:**
• Transcatheter Aortic Valve Replacement (TAVR) (Achenbach, 2012; ACR, 2017)
• Acute Aortic dissection (Barman, 2014)
• Takayasu’s arteritis (Keser, 2014)
• Marfan syndrome
• Loeys-Dietz syndrome
• Spontaneous coronary artery dissection (SCAD)
• Vascular Ehlers-Danlos syndrome
• Post-operative complications (Bennet, 2017; Choudhury, 2017)
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.

Abd/Pelvis CTA & Lower Extremity CTA Runoff Requests: 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.

Bruit - 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, arteriosclerosis, 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 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 (Strate, 2016).

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.
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 (Chaikof, 2018):

2.5-2.9 cm: ..........5yr
3.0-3.4 cm:...........3yr
3.5-3.9 cm:.........2yr
4.0-4.4 cm:..........1yr
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 (Chaikof, 2018):

>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 (Chaikof, 2018)

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 (Wainansen, 2019).

**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 (Clerc, 2017). 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, 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 (Abe, 2010).

POLICY HISTORY:
Review Date: May 2019
Review Summary:
• Added indications for vascular disease for iliac artery aneurysm; complications of known aneurysm; surveillance imaging timeline; hemodynamically unstable patients; evaluation of venous thrombosis in 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

Review Date: May 2020
Review Summary:
• Added FMD, SCAD, Marfans, etc.
• Added May-Thurner
• Removed CTA for renal artery stenosis
• Added combo study section
REFERENCES:


INDICATIONS FOR ABDOMEN CT Angiography/CT Venography (CTA/CTV):

For evaluation of known or suspected abdominal vascular disease:
- For known large vessel diseases (celiac, splenic, renal arteries/veins), e.g., aneurysm, dissection, compression syndromes, arteriovenous malformations (AVMs), and 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 (Ibrahim, 2018; Junternamms, 2018):
- Evidence of vascular abnormality seen on prior imaging studies and limited to the abdomen.
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (CTA or MRA) (Kadian-Dodov, 2016)
- For patients with Vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time study of the abdomen and pelvis (CTA/MRA)
- For Leutz-Dietz imaging at least every two years (Chu, 2014).
- For assessment in patients with spontaneous coronary artery dissection (SCAD) can be done at time of coronary angiography (also approve CTA pelvis) (Crousillat, 2020).
- Evaluation of known or suspected aortic aneurysm (approve CTA/MRA abdomen and pelvis) (Chaikof, 2018; Khosa, 2013, Kumar, 2017):
  - 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 >2.5cm 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 2.0-2.9cm and annually for 3.0-3.4 cm if Doppler ultrasound inconclusive. If > 3.5cm, < 6 month follow up (and consider intervention) (Wanhainen, 2019).
- For May-Thurner syndrome (include pelvic CTV) (Ibrahim 2012; Wan-Ling, 2012)
- Suspected retroperitoneal hematoma or hemorrhage (to determine vascular source of hemorrhage in setting of trauma, tumor invasion, fistula, or vasculitis; otherwise CT (rather than CTA) is sufficient and the modality of choice for diagnosing hemorrhage).
- For evaluation of suspected mesenteric ischemia (can approve CTA/MRA abdomen and pelvis) (ACR, 2018).
- Suspected renal vein thrombosis in patient with known renal mass or from other causes (Mazhar, 2018)
- Venous thrombosis if previous studies have not resulted in a clear diagnosis and limited to the abdomen.
- 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 evaluation of transjugular intrahepatic portosystemic shunt (TIPS) when Doppler ultrasound indicates suspected complications (Darcy, 2012; Dariushnia, 2016; Farsad, 2014; Raissi, 2019).
• 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 (Akbeyaz, 2017; Bailey, 2018; Gulas, 2018; Hartman, 2009; Harvin, 2017; Mohammed, 2012; Tullus, 2010; Whelton, 2018):
  o Unsuccessful control after treatment with 3 or more (>2) anti-hypertensive medication at optimal dosing and one should be a diuretic.
  o Acute elevation of creatinine after initiation of an angiotension converting enzyme inhibitor (ACE inhibitor) or angiotension receptor blocker (ARB).
  o Asymmetric kidney size noted on ultrasound.
  o Onset of hypertension in a person younger than age 30 without any other risk factors or family history of hypertension**.
  o Significant hypertension (diastolic blood pressure > 110 mm Hg) in a young adult (i.e., younger than 35 years) suggestive of fibromuscular dysplasia (Kong, 2018)
  o Diagnosis of a syndrome with a higher risk of vascular disease, such as neurofibromatosis, tuberous sclerosis and Williams’ syndrome.
  o New onset of hypertension after age 50.
  o Acute rise in blood pressure in a person with previously stable blood pressures.
  o Flash pulmonary edema without identifiable causes.
  o Malignant or accelerated hypertension.
  o Bruit heard over renal artery and hypertension.

Pre-operative evaluation:
• 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 (ACR, 2017)

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 (CTA abdomen and pelvis should be approved) (Chaikof, 2018; Uberoi, 2011).
  o 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.

**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) (Achenbach, 2012; ACR, 2017)
- Acute Aortic dissection (Barman, 2014)
- Takayasu’s arteritis (Keser, 2014)
- Marfans syndrome
- Loetz-Dietz
- Spontaneous coronary artery dissection (SCAD)
- Vascular Ehlers-Danlos syndrome
- Post op complications (Bennet, 2017; Choudhury, 2017)
- Significant post-traumatic or post-procedural vascular complications

**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 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.

**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 (Duan, 2014).**

Asymptomatic Aneurysms may require treatment when:
- Diameter is > 2 cm
- Identified during pregnancy
- Multiple aneurysms are present
- Hepatic transplant

**POLICY HISTORY:**
**Review Date:** May 2019
**Review Summary:**
- 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

**Review Date:** May 2020
**Review Summary:**
- 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

**REFERENCES:**


Wan-Ling, MW., Wen-Sheng, T.et.al. Comprehensive MDCT Evaluation of Patients with Suspected May-Thurner Syndrome. AJR, 2012;199(5)


INDICATIONS FOR ABDOMEN/PELVIS COMPUTED TOMOGRAPHY (CT):
This includes CTU (CT urography) and CTE (CT enterography).

For evaluation of suspected infection or inflammatory disease:
(ACR, 2013; Cartwright, 2015)
- Suspected diverticulitis or acute appendicitis for initial imaging along with **ONE** of the following (Linzay, 2018):
  - WBC Elevated
  - Fever
  - Anorexia
  - Nausea and vomiting
- Suspected appendicitis in a child (<age 18) (AAP/ACS; ACR, 2018; Baker, 2020; Sanchez, 2016) when ultrasound is inconclusive or cannot be completed due to body habitus or inability to cooperate
- Use ultrasound or MRI in pregnant women with suspected appendicitis (ACR, 2018)
- For acute non-localized abdominal pain and fever, no recent surgery (ACR, 2018)
- For suspected retroperitoneal fibrosis after labs and inconclusive ultrasound (Runowska, 2016)

For follow up evaluation of known infection or inflammatory disease:
(ACR, 2019; Cartwright, 2015)
- 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) (ACR, 2018; Cartwright, 2015)
- 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 (ACR, 2019)
- Known inflammatory bowel disease, (Crohn’s or Ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation or for monitoring therapy (ACR, 2019)
- 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 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
**For evaluation of hematuria (includes CT urography (CTU))**:

(ACR, 2019; Davis, 2012; Sharp, 2013)

- For hematuria (should be documented by greater than 3 red blood cells (RBC) per high-power field on urinalysis and not based on a dipstick test) (Davis, 2012)
- For non-infectious macroscopic or gross hematuria

**Suspected or known acute pancreatitis** (ACR, 2019):

- For first time presentation with pain and abnormal amylase and lipase and < 48-72 hours, when ultrasound is inconclusive.
- Suspected acute pancreatitis with atypical signs and symptoms, and when a diagnosis other than pancreatitis may be possible.
- Known necrotizing pancreatitis.

**For evaluation of a suspected or known hernia:**

- Abdominal/pelvic pain suspected to be due to an occult, umbilical, Spigelian, incisional, hernia when physical exam or prior imaging is non-diagnostic or equivocal or if requested as a preoperative study.
- Hernia with suspected complications (e.g. bowel obstruction or strangulation) (Lassandro, 2011; Miller, 2014; Robinson, 2013)
- Complex ventral hernia that is ≥ 10 cm for pre-operative planning (Halligan, 2018)

**Suspected inflammatory bowel disease (includes CT enterography)**

- Suspected Crohn’s disease (consider MRE for patients under 35) with abdominal pain, chronic diarrhea, or bloody diarrhea, fatigue, or when there is a high clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy (ACR, 2019; Lichtenstein, 2018)
- For ulcerative colitis that is suspected clinically however abdominal symptoms are not explained by endoscopy (Rubin, 2019)
- For CT enterography (CTE) if a CT scan is inconclusive

**For evaluation of known or suspected kidney or ureteral stones:**

(Choosing Wisely, 2018; Fontanelle, 2019; Moore, 2019)

- For patients <35 with a typical presentation and adequate pain relief, no imaging necessary.
- For acute renal colic in patients <55 and inadequate analgesia OR with an atypical presentation, OR with an abnormal or indeterminate ultrasound
- In patients with acute flank pain age > 75
- In patients >55 with a prior history of stones and a typical presentation, no imaging (or ultrasound first).
- In middle aged patients (≥55) with no history of stones OR an atypical presentation, OR if ultrasound is inconclusive, non-diagnostic or shows an abnormality needing further evaluation, i.e., hydronephrosis or alternate diagnosis being considered.
- Pregnant and pediatric patients should have ultrasound as the initial imaging study if indicated (MRU preferred if further imaging indicated).
For pre-operative planning related to percutaneous nephrolithotomy (PCNL), extracorporeal shock wave lithotripsy (SWL) or ureteroscopic procedure and no imaging has been done in the last 30 days, or if passage or movement of stones will change management (Assimos, 2016).

For post-operative stone follow-up related to SWL or ureteroscopic procedures:
  o Symptomatic patients with known radiolucent stones
  o Symptomatic patients with radiopaque calculi, following a non-diagnostic KUB or ultrasound

Asymptomatic patients with abnormal findings on another study (e.g., hydronephrosis) (Fulgham, 2012)

**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 (Bonkat, 2017) or symptoms resolve and then recur within 2 weeks (Grabe, 2015)
- For a complicated patient with history of diabetes, stone disease or prior urinary tract surgery, or who is immunocompromised and is not responding to treatment (ACR, 2018).

**For evaluation of Recurrent Urinary tract Infections in women (defined as at least 3 episodes of uncomplicated infection in the past twelve months)** (Tononlini, 2016; Seminerio, 2011):

- When there is suspicion of renal calculi or outflow obstruction (Anger 2019; Bonkat 2017)
- Suspect an anatomic abnormality based on prior imaging (i.e., Cystocele, diverticulum, congenital anomaly) (Dason, 2011)
- For recurrent lower urinary tract infections in a female who are non-responders to conventional therapy or have known underlying risk factors (ACR, 2020)
- For evaluation of a non-diagnostic ultrasound with hydronephrosis
- Men with UTI symptoms
  o ≥ age 60, initial infection (Schaeffer, 2016)
  o < age 60 with two or more infections

**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 (ACR, 2019; Paulson, 2015)

**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

**Evaluation of suspicious or known mass/tumors:**

- 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 (ACR, 2013, 2014).
- New evidence of an unknown primary (Greco, 2012)
• 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) (Smereka, 2017)

• For follow up of mesenteric panniculitis (Mclaughlin, 2013; Putte-Kaiser, 2014; Kaya, 2018) or lymphadenitis (Helbling, 2017) when another diagnosis is suspected after initial imaging or there is a failure of symptom resolution

• Prostate cancer when intermediate risk or greater, PSA levels ≥10 ng/mL, or biopsy Gleason Score ≥7 (Grade Group ≥2), or clinically advanced disease (T2b, T2c, T3, or T4) AND nomogram (e.g., Partin, Cancer of Prostate Risk Assessment CAPRA) indicating probability of lymph node involvement >10%) (NCCN, 2019; Reese, 2012; Tosian, 2017).

• Follow-up of known cancer (Bourgioti, 2016; NCCN, 2019b)
  o Follow-up of known cancer of patient undergoing active treatment within the past year
  o Known cancer with suspected abdominal/pelvic metastasis based on a sign, symptom or an abnormal lab value

**Suspected colonic or mesenteric ischemia** (Dhatt, 2015) **CTA also appropriate** (ACR, 2018)

**For suspected small bowel bleeding when endoscopy and capsule endoscopy are inconclusive or negative** (Pasha, 2017)

**For evaluation of known or suspected aortic aneurysm - CTA or MRA are the gold standards and preferred after ultrasound** (ACR, 2018; Kumar, 2017) **has been completed, however CT also approvable** (Chaikof, 2018):

• 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)

• 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 (Chaikof, 2018; Uberoi, 2011).
  o Asymptomatic at six (6) month intervals, for one (1) year, then annually.
  o 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:
(ACR, 2012)
- 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
  (ACR, 2012)

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.

Other Indications for Abdomen/Pelvic CT Combo:
- Persistent abdomen/pelvic pain not explained by previous imaging/procedure
- To locate a pheochromocytoma once there is clear biochemical evidence
- For B symptoms of fevers to more than 101° F, drenching night sweats, and unexplained weight loss of more than 10% of body weight over 6 months, if CXR, labs and an ultrasound of the abdomen and pelvis have been completed (can also approve chest CT) (Cheson, 2014).
- 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 (Gaddey, 2014).
- Unexplained weight loss of 5% of body weight in six months confirmed by documentation to include the following (Bosch, 2017; Wong, 2014):
  - Related history and abdominal exam
  - Chest x-ray
  - Abdominal ultrasound
  - Lab tests, must include TSH
  - Colonoscopy if patient fifty plus (50+) years old
- Acute abdominal pain in patients sixty-five (65) years or older (ACR, 2018; Lehtimaki, 2016)
- In the work up 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 (Chen, 2010; Dalakis, 2015; Titulaer, 2011)
- For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound (Hoshino, 2016)
- For elevation of carcinoembryonic antigen (CEA) in a patient with no cancer history after complete clinical work up (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 comment section).
- For fever of unknown origin (temperature of ≥101 degrees for a minimum of 3 weeks) after standard diagnostic tests are negative (see comment section) (Brown, 2019)
For evaluation of suspected May-Thurner syndrome (CTV/MRV preferred) (Ibrahim, 2012; Wan-Ling, 2012)

For further evaluation of an isolated right varicocele with additional signs and symptoms that suggest malignancy or suspicious prior imaging (Gleason, 2019)

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

**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. 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, followed by MRI in appropriate situations. 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:**

CT Imaging for renal colic and hematuria: There are over 2 million annual emergency visits for suspected renal colic in the US and CT is performed in over 90% of patients diagnosed with kidney stones (Moore, 2019). 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 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 (ACR, 2020).
CT Imaging for abdominal aortic aneurysms: 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. 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 (ACR 2018). 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 >7 cm the risk of rupture goes to 7% per year.

**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. Initial evaluation of AAA is accurately made by ultrasound. 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: ............5yr
- 3.0-3.4 cm: .......... 3yr
- 3.5-3.9 cm: ..........2yr
- 4.0-4.4 cm: ..........1yr
- 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 (SVS, 2018):

- >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 (Chaikof, 2018).

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 (ACR AUC 2018).
CT for elevation of CEA with no history of a previous CEA-producing tumor:
CEA is not normally elevated after birth, but when elevated 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 and clinical exam, and smoking history. Investigation would include repeat CEA, full blood count, and 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 (Hall, 2019).

CT and Fever of Unknown Origin:
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, HIV antibody test (Brown, 2019)

CT and screening for occult malignancy- In patients with a dermatomyositis, an initial screen with CT chest and abdomen recommended 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) (Carrier, 2015). 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 (Jara-Palomares, 2017; Fernandes, 2019). Paraneoplastic neurologic syndromes fall into this category. They are rare, often sub acutely manifesting conditions associated with malignant neoplasms and 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 (Sundermann, 2017).

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.

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.

Consider alternatives to CT imaging in patients with Crohn disease: 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 ileocolonoscopy. 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 have a low sensitivity. Fecal calprotectin is helpful test which can help differentiate IBD from irritable bowel syndrome, as well as in assessment of disease activity, monitoring disease 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 also used for monitoring disease activity in Crohn’s. (Cappello, 2016).

Initial evaluation of abdominal aortic aneurysm (AAA) - Initial evaluation of AAA is accurately made by ultrasound.

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 (Robinson, 2013). According to Miller, et al “Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias…” (Miller, 2014). Based on this analysis, MRI is recommended only when ultrasound and CT have been performed and fail to make a diagnosis.

POLICY HISTORY:
Review Date: May 2019
Review Summary:
• 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 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

Review Date: May 2020

Review Summary:
• 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
REFERENCES:


74181 – MRI MRCP Abdomen

CPT Codes: 74181, 74182, 74183, S8037

IMPORTANT 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.

This study includes MRU (MR urography) and MRE (MR enterography).

INDICATIONS FOR ABDOMEN MRI

Evaluation of suspicious known mass/tumors (unconfirmed diagnosis of cancer) 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 (ACR, 2019).
- Follow-up of known cancer (Bourgioti, 2016; NCCN, 2019):
  - Follow-up of known cancer of patient undergoing active treatment within the past year
  - Known cancer with suspected abdominal metastasis based on a sign, symptom or an abnormal lab value

For evaluation of an organ or abnormality seen on previous imaging:

ADRENAL:

- To locate a pheochromocytoma once there is clear biochemical evidence** (Lenders, 2014)
- Suspected adrenal secreting tumor after full clinical and biochemical work up (Fassanacht, 2018; Meek, 2013).
- 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 (Kamilaris, 2019)
- For patients with Von Hippel Lindau (VHL) surveillance at least every other year starting at age 16 (Abdominal ultrasound starting at age 8) (Varshney, 2017)
- Surveillance MRI (include pelvis) every 2-3 years for patients with Hereditary Paraganglioma syndromes types 1-5 (Benn, 2015)
LIVER:
- Indeterminate liver lesion ≥ 1cm seen on prior imaging (ACR, 2020).
- 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 (ACR, 2017; Bruix, 2011; Lee, 2014; Marquardt, 2016)).
- 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* (Arif-Tawari, 2017)
- 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) (Bowlus, 2019)
- For jaundice or abnormal liver function tests after equivocal or abnormal ultrasound (Vagvala, 2018)
- For follow up of focal nodular hyperplasia (FNH) annually if US is inconclusive (Marrero, 2014)
- For elastography in chronic liver disease to stage hepatic fibrosis (ACR, 2019)
- In patients with Beckwith-Wiedemann syndrome and abnormal ultrasound or rising AFP (Kalish, 2017).

Evaluation of iron overload in the following settings:
- Initial evaluation of liver iron in Hemochromatosis diagnosed in lieu of liver biopsy (Labranche, 2018)
- Annual evaluation for high risk patients: transfusion-dependent thalassemia major, sickle cell disease and other congenital anemias (Wood, 2014)

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) (Elta, 2018):
  - For incidental and asymptomatic cysts <5 mm, one follow-up at three years (Pandev, 2019)
  - 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.
  - For 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
o 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** (Hu, 2018; NCCN, 2019; Syngal, 2015)
  
- 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) (Vinik, 2017)

RENAI

- For an indeterminate renal mass on other imaging (ACR, 2014)
- Active surveillance for indeterminate cystic renal mass, not a simple renal cyst (Richard, 2017) (See Bosniak criteria in comment section).
- Follow up for solid renal masses under 1 cm at 6 and 12 months, then annually (Herts, 2018)
- Annual surveillance for patient with tuberous sclerosis and known angiomyolipomas (Vos, 2018)
- 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) (Varshney, 2017).
- Active surveillance for renal cell carcinoma in patients with Birt-Hogg syndrome every 36 months (Gupta, 2017).
- MRU (may also approve MR pelvis for MR urography) for recurrent urinary tract infections in females (≥ 3 infections over 12-month period) (ACR, 2020)

SPLEEN:

- Incidental findings of the spleen on ultrasound or CT that are indeterminate (Thut, 2017)

Suspected Hernia

- Occult, spigelian, incisional or epiastric hernia when physical exam or prior imaging (ultrasound AND CT) is non-diagnostic or equivocal (Abdelmohsen, 2017; Lassandro, 2011; Miller, 2014; Robinson, 2013) and limited to the abdomen
- Suspected incarceration or strangulation based on physical exam or prior imaging (CT preferred) (Halligan, 2018).

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 (from any cause) if 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 (Cartwright, 2015)

**For evaluation of suspected inflammatory bowel disease or follow-up (includes MR enterography and can also approve Pelvis MRI/MRE):**
- For suspected Crohn’s disease with abdominal pain, chronic diarrhea, or bloody diarrhea, fatigue, or when there is a high clinical suspicion after complete work up including physical exam, labs, endoscopy with biopsy (ACR, 2019; Arif-Tiwari, 2019; Lichtenstein, 2018).
- For ulcerative colitis that is suspected clinically, however abdominal symptoms are not explained by endoscopy (Rubin, 2019)
- For MR enterography (MRE) if CT or MRI of the abdomen and pelvis are inconclusive.
- Known inflammatory bowel disease (Crohn’s or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation, or for monitoring therapy (ACR, 2019)

**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
- For B symptoms of fevers more than 101 F, drenching night sweats, and unexplained with weight loss of more than 10% of body weight over 6 months, if CXR labs and an ultrasound of the abdomen and pelvis have been completed (Cheson, 2014)
- Unexplained weight loss of 10% of body weight in two months (patient history is acceptable); with second MD visit documenting further decline in weight (Gaddey, 2014)
- Unexplained weight loss of 5% of body weight in six months confirmed by documentation to include the following (Bosch, 2017; Wong, 2014):
  - 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 (Brown, 2019)
- For suspected or known retroperitoneal fibrosis after complete workup and ultrasound to determine extent of disease (Runowska, 2016)
- To screen patients with dermatomyositis for occult malignancy (Titlauer, 2011)
• For diffuse, unexplained lower extremity edema with negative or inconclusive ultrasound (Hoshino, 2016)
• For suspected May-Thurner syndrome (CTV/MRV preferred) (Ibrahim, 2012; Wan-Ling, 2012)
• For further evaluation of an isolated right varicocele with additional signs and symptoms that suggest malignancy or suspicious prior imaging findings (Gleason, 2019)

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:
(ACR, 2019; Akisik, 2013; Lindor, 2015)

• To confirm choledocholithiasis in patients in the acute setting after ultrasound has been completed (ACR, 2019; Buxbaum, 2019; Williams, 2017)
• 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) (ACR 2019; Mathur, 2015).
• 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) (ACR 2019; Mathur, 2015).
• Evaluation of suspected congenital anomaly of the pancreaticobiliary tract, e.g., aberrant ducts, pancreas divisum or related complications (Griffin, 2012).
• For confirmation of choledochal cyst, after ultrasound has been done (Katabathina, 2015).
• 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 an Abdomen/Pelvis MRI combo is 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 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 (Arif-Tiwari, 2019).

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) (Qiu, 2015). Secretin-enhanced MR Cholangiopancreatography has been recently developed to improve the diagnostic quality of MRCP images (Tirkes, 2013).

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 (ACR, 2019). 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 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:
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 (Bruix, 2011). 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 (Bruix, 2011; Marquardt, 2016) 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 (Patil, 2013), not neoplasm. Others advocate for combined ultrasound and AFP for screening (Tan, 2011; Tzartzeva, 2018) 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.
MRI or MRCP for surveillance of cholangiocarcinoma in patients with PSC, other risk factors:  
Cholangiocarcinoma is a very aggressive cancer with 95% of patients dying within 5 years, and is increasing globally. 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 (Bowlus, 2019).

The strongest risk factors for both intrahepatic and extrahepatic cholangiocarcinoma are choledochal cysts for both iCCA and eCCA; cirrhosis for iCCA>eCCA; and choledocholithiasis for eCCA>iCCA (Clements, 2020)

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-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, 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 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 (Tobias, 2012)

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, TP53 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) (Daly, 2020; Goggins, 2020; NCCN, 2019).

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 (Stoeffel, 2019).

**Surveillance of Pancreatic Cysts:** Some pancreatic cysts have the potential for malignant transformation to invasive ductal adenocarcinoma, hence the need for intervention vs surveillance, however the data is unclear as to the risk of cancer. Cyst surveillance can be offered to patients with asymptomatic cysts presumed to be IPMN’s or MCN’s. 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 calibre 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 (Elta, 2018).

**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 (Vinik, 2017).

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 (Kwo, 2017).
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 (Muglia, 2014):
- 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 (Richard, 2017)
- 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 (Robinson, 2013). According to Miller, et al “Magnetic resonance imaging is generally not considered a first- or even second-line evaluation modality for hernias...” (Miller, 2014). 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 postsurgical biliary and/or surgical anastomoses.

**POLICY HISTORY:**
**Review Date:** May 2019
**Review Summary:**
- 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:
  - Old: Suspected adrenal mass > 4 cm and there is a history of primary malignancy
  - 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

**Review Date:** May 2020
**Review Summary:**
**MRCP:**
- Added to confirm choleodolithiasis 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
• Beckwith 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
• 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; FOU: 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, Insulinoma work up, and CT and elevated LFT’s.
REFERENCES:


Bruix J, Sherman M, American Association for the Study of Liver Diseases. Management of


TABLE OF CONTENTS


https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5849938/.


INDICATIONS FOR ABDOMEN MR Angiography/MR Venography:

For evaluation of known or suspected abdominal vascular disease:

Arterial Disease:
- Evaluation of known or suspected aortic aneurysm (also approve MRA pelvis) (Chaikof, 2018; Khosa, 2013; Khumar, 2017):
  - 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) (Wainhainen, 2019)
- 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), and 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 (Ibrahim, 2018; Junternamms, 2018)
- To determine the vascular source of retroperitoneal hematoma or hemorrhage (to determine a vascular source of hemorrhage in the setting of trauma, tumor invasion, fistula or vasculitis when CTA is contraindicated
- For evaluation of suspected acute mesenteric ischemia/ischemic colitis when CTA is contraindicated (ACR, 2018).
- For suspected chronic mesenteric ischemia
- Evidence of vascular abnormality seen on prior imaging studies and limited to the abdomen.
- For evaluation of known or suspected renal artery stenosis or resistant hypertension in the setting of normal renal function or impaired renal function unrelated to recent medication (ACR, 2017) demonstrated by any of the following (Hartman, 2009; Tullus, 2010):
  - Unsuccessful control after treatment with 3 or more (>2) anti-hypertensive medication at optimal dosing.
  - Acute elevation of creatinine after initiation of an angiotension converting enzyme inhibitor (ACE inhibitor) or angiotension 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.

**Venous Disease**

- Suspected renal vein thrombosis in patient with known renal mass or from other causes (Mazhar, 2018).
- Venous thrombosis if previous studies have not resulted in a clear diagnosis (add pelvis MRA/MRV when appropriate).
- For diffuse unexplained lower extremity edema with negative or inconclusive ultrasound (Hoshino, 2016)
- For May-Thurner syndrome (include pelvic MRV) (Ibrahim 2012; Wan-Ling, 2012)
- In pregnant women with suspected deep venous thrombosis (DVT) (vs serial compression ultrasound) (include pelvis MRV for iliac veins) (Bates, 2018)

**Pre-operative evaluation:**

- 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 MRA (ACR, 2017)

**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) (Chaikof, 2018; Uberoi, 2011).
  - 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.
Other Vascular indications:
- For patients with fibromuscular dysplasia (FMD), a one-time vascular study of the abdomen and pelvis (CTA or MRA) (Kadian-Dodov, 2016)
- For patients with Vascular Ehlers-Danlos syndrome or Marfan syndrome recommend a one-time study of the abdomen and pelvis (CTA/MRA)
- For Loetz-Dietz imaging at least every two years (Chu, 2014)
- 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 transjugular intrahepatic portosystemic shunt (TIPS) when Doppler ultrasound indicates suspected complications
- Kidney failure or renal insufficiency if initial evaluation performed with Ultrasound is inconclusive.

Chest MRA/Abdomen/Pelvic MRA combo:
- Acute aortic dissection (CTA or CT preferred) (Barman, 2014)
- Takayasi’s arteritis (Kaser, 2014)
- Marfan syndrome
- Vascular Ehlers-Danlos syndrome
- Post-operative complications

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. 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.

Abd/Pelvis MRA & Lower Extremity MRA Runoff Requests: Two (2) authorization requests are required, one Abd MRA, CPT code 74185 and one for Lower Extremity MRA, CPT code 73725. This will provide imaging of the abdomen, pelvis, and both legs.
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 aorta is defined as diameter ≥ 3.0 cm or dilatation of the aorta ≥ 1.5x the normal diameter (Khosa, 2013). Initial evaluation of AAA is accurately made by ultrasound. 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.

Asymptomatic Aneurysms require treatment when:
- The diameter is greater than 2 cm
- Identified during pregnancy
- Multiple aneurysms are present
- Hepatic transplant

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 (Khosa, 2013):

- 2.5-2.9 cm:...........5yr
- 3.0-3.4 cm:...........3yr
- 3.5-3.9 cm:...........2yr
- 4.0-4.4 cm:...........1yr
- 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 (SVS, 2018):

- >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 (Chaikof, 2018).

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 (ACR, 2018).
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 anatomy and the 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 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 (Clerc, 2017).

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 (Abe, 2010).

POLICY HISTORY:
Review Date: May 2019
Review Summary:
- 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

Review Date: May 2020
Review Summary:
- 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
REFERENCES:


74261 – CT Colonoscopy Diagnostic (Virtual)

CPT Codes: 74261, 74262

INDICATIONS FOR CT COLONOGRAPHY (VIRTUAL COLONOSCOPY):

For diagnostic (symptomatic patient) evaluation when conventional colonoscopy is contraindicated or could not be completed:
(ACR, 2018; NCCN, 2019; 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, 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.

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 methods 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:
Review Date: April 2019
Review Summary:
• Corrected terminology to “CT Colonography” and “Virtual Colonoscopy”
• Updated references

Review Date: May 2020
Review Summary:
• Updated indications for diagnostic study
REFERENCES:


INDICATIONS FOR CT COLONOGRAPHY (VIRTUAL COLONOSCOPY) SCREENING:

- CT (computer tomographic) colonography (CTC) is considered medically appropriate as an alternative to colonoscopy for screening asymptomatic individuals in the following settings:
  - For average or moderate risk individuals as defined below:
    - Age ≥ 50 years, for initial screening and every 5 years after initial negative screen (ACR, 2018)
    - Screening starting at age 45 for African Americans.
    - Screening to age 75 or ≤10 years of life expectancy
    - One time screening age 76-85 if no prior study has been completed (depending on comorbidities and life expectancy)
    - When endoscopy is medically contraindicated or not possible (e.g., patient is unable to undergo sedation or has medical conditions such as recent myocardial infarction, recent colonic surgery, a bleeding disorder, or severe lung and/or heart disease
    - For a patient with a first-degree family member with history of colorectal cancer or adenoma
    - After a positive fecal occult blood test (FOBT) or positive fecal immunochemical test (FIT)
  - For a patient at above average risk with a documented reason for not having a colonoscopy.

For Average or Moderate Risk Individuals:

- 50 – 75 years of age, Asymptomatic AND WITHOUT any of the following:
  - A family history of known genetic disorders that predispose them to a high lifetime risk of colorectal cancer (ACR, 2019; ACS, 2018; NCCN, 2019; Rex, 2017) see background section
  - A personal history of inflammatory bowel disease (ACR, 2019; ACS, 2018; NCCN, 2019; Rex, 2017)

NOTE: Patients with these indications should undergo colonoscopy.

BACKGROUND:

The goal of CTC, sometimes referred to as CT colonography or virtual colonoscopy screening is to reduce colorectal cancer mortality through cancer prevention and early detection. Virtual colonoscopy is an American Cancer Society-recommended screening exam that has been shown in studies in the United States and abroad to increase screening rates where offered. Virtual colonoscopy has been proven comparably accurate to colonoscopy in most people of screening age. Mandatory insurance coverage of CT colonography and the other USPSTF-recognized exams is a major step forward in the
battle against colorectal cancer (USPSTF, 2016). CT colonography has replaced double-contrast barium enema for nearly all indications as it is more effective and better tolerated.

OVERVIEW: CTC is a minimally invasive structural examination of the colon and rectum to evaluate for colorectal polyps or neoplasms in the asymptomatic patient. These guidelines have been updated based on revised ACR Appropriateness Criteria for Colorectal Cancer Screening for average or moderate risk individuals. The American College of Radiology Imaging Network (ACRIN) National CTC Trial is the largest multicenter trial to date with 2,531 asymptomatic patients included. The per patient sensitivity for detecting adenomas >6 mm was 78%, >=10 mm was 84%. Of the 105 references used for this revised guideline, 98 are categorized as diagnostic references. NCCN guidelines 2019 recommend CT colonography every 5 years with a sensitivity of 96% for colorectal cancer (colonoscopy 95%), and specificity of 86%-98% (polyps ≥ 10mm; 80%-93% ≥ 6mm) vs 90% for colonoscopy.

Relative Contraindications to CTC include: symptomatic acute colitis, acute diarrhea, recent acute diverticulitis, recent colorectal surgery, symptomatic colon-containing abdominal wall hernia, small bowel obstruction, Lynch syndrome, Polyposis syndromes including classical familial adenomatous polyposis, attenuated familial adenomatous polyposis, MUTYH-associated polyposis, Peutz-Jeghers syndrome, Juvenile polyposis syndrome, Cowden syndrome/PTEN hamaroma tumor syndrome, Li-Fraumeni syndrome (NCCN, 2019)

It is not indicated for routine follow up of inflammatory bowel disease, hereditary polyposis or non-polypsis cancer syndromes, evaluation of anal canal disease, or the pregnant or potentially pregnant patient. For all high risk individuals colonoscopy is preferred.

Other Recommendations: .
It is suggested that screening begin in African Americans at age 45 years. It should also be noted that the American Cancer Society now recommends that screening be initiated starting at age 45; and recommends 6 test options for CRC screening; annual FIT or HSgFOBT, mt-sDNA every three years, colonoscopy every 10 years, CTC every 5 years, and FS every 5 years (Wolf, 2018).

POLICY HISTORY:
Review Date: April 2019
Review Summary:
• Corrected terminology to “CT Colonography” and “Virtual Colonoscopy”
• Added indication: “Average risk individuals after positive fecal occult blood test or positive fecal immunochemical test indicating a relative elevation in risk
• Added Background information regarding the difference between screening and surveillance
• Updated references
Review Date: May 2020
Review Summary:
• Now approvable every 5 years for asymptomatic screening from age 50-75 (45 in African Americans) for average to moderate risk individuals
• Listed indications for colonoscopy rather than virtual including inflammatory bowel disease, cancer syndromes
REFERENCES:


74712 – Fetal MRI

CPT Codes: 74712, +74713

(For evaluating the placenta or imaging the maternal pelvis without need for fetal assessment, use the Pelvic MRI guideline)

INDICATIONS:
• To better define or confirm a known or suspected abnormality of the fetus after ultrasound has been performed during the second trimester (Prayer, 2017) or when fetal surgery is planned, and/or to make a decision about therapy, delivery or to advise the family about prognosis (ACR-SPR, 2015; SPR, 2011).

Safety guidelines and possible contraindications:

There are no documented fetal indications for the use of MRI contrast, but there may be rare instances where contrast is considered potentially helpful in assessing the pregnant patient’s anatomy or pathology. However, it’s use is controversial with uncertainty surrounding the risk of possible fetal effects because gadolinium is water soluble and can cross the placenta.

The decision to administer contrast must be made on a case-by-case basis by the covering level 2 MR personnel-designated attending radiologist who will assess the risk-benefit ratio for that particular patient. The decision to administer a gadolinium-based MR contrast agent to pregnant patients should be accompanied by a well-documented and thoughtful risk-benefit analysis (ACOG, 2017).

BACKGROUND:

MRI not only contributes to diagnosis, but also serves as an important guide to treatment, delivery planning, and counseling. However, sonography is the screening modality of choice in the fetus. The advantage of MRI over ultrasound is its ability to image deep soft tissue structures without relying on the skill of the operator, or limitations of patient body habitus. Fetal MRI should be performed only for a valid medical reason and only after careful consideration of sonographic findings or family history of an abnormality for which screening with MRI might be beneficial. According to the American College of Obstetricians and Gynecologists’ Committee on Obstetric Practice the preponderance of animal studies demonstrate no risk of teratogenesis to the fetus and tissue heating from MRI scanners is negligible near the uterus. Furthermore, in human studies of patients undergoing MRI there has been no acoustic injuries to the fetus during prenatal MRI (ACOG, 2017).

POLICY HISTORY:

Review Date: June 2019

Review Summary:
For known or suspected abnormality of the fetus after ultrasound, added time restriction ‘during the second trimester’ and included ‘to make a decision about therapy, delivery, or to advise the family about prognosis’

- Updated background information and references

**Review Date:** May 2020

**Review Summary:**
- No substantive changes
REFERENCES:


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 MAGNETIC RESONANCE (CMR)

Cardiomyopathy & Heart Failure
(Doherty, 2019; Patel, 2013; Yancy, 2013)
- To assess systolic and diastolic function in the evaluation of a newly diagnosed cardiomyopathy
- Suspected infiltrative disease such as amyloidosis, sarcoidosis (Birnie, 2014), 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, when TTE is inadequate for diagnosis, management or operative planning, or when tissue characterization (degree of fibrosis) will impact indications for ICD
- 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 (Doherty, 2017)
- Pre TAVR assessment if the patient has not undergone cardiac CT (Otto, 2017)
Prior to transcatheter mitral valve intervention, when TTE and TEE result in uncertain assessment of the severity of mitral regurgitation (Bonow, 2020; Wunderlich, 2018)

Suspected clinically significant bioprosthetic valvular dysfunction and inadequate images from TTE and TEE (Doherty, 2017)

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

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 for:
  - Device stability
  - To exclude device migration
  - To assess for device leaks

Pre-Ablation Planning
- Evaluation of left atrium and pulmonary veins prior to radiofrequency ablation for atrial fibrillation, if cardiac CT has not been done

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 conditions that predispose to aortic aneurysm or dissection, such as Marfan’s, Ehler’s Danlos or Loetz-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)**
(Sachdeva, 2020)

- 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
  - 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 (3–5 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 when a stress echocardiogram (SE) cannot be performed.
  - If the patient cannot walk and would otherwise be a candidate for a pharmacologic MPI a CMR can be performed
  - If the patient is able to 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
BACKGROUND
(Pennell, 2010)

- 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** (Brignole, 2013; Indik, 2017; Nazarian, 2017; Russo, 2017)
  
  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.

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 (Shah 2014)
  - 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 (Hirshfeld, 2018)

OVERVIEW

**CMR in CORONARY ARTERY DISEASE (CAD)**
(Fihn, 2012; Montalescot, 2013; Wolk, 2013)

Stable patients without known CAD fall into 2 categories (Fihn, 2012; Montalescot, 2013; Wolk, 2013):

- **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

Once the type of chest pain has been established from the medical record, the pretest probability of CAD (meaning obstructive CAD defined as coronary arterial narrowing ≥ 50%) is estimated from the Diamond Forrester Table below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability (Wolk, 2013):
<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40 – 49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>50 – 59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>≥ 60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

- **Very low**: < 5% pretest probability of CAD, usually not requiring stress evaluation (Fihn 2012)
- **Low**: 5-10% pretest probability of CAD
- **Intermediate**: 10%-90% pretest probability of CAD
- **High**: > 90% pretest probability of CA

**Abbreviations**

- ARVD/C: Arrhythmogenic right ventricular dysplasia/cardiomyopathy
- CABG: Coronary artery bypass grafting surgery
- CAD: Coronary artery disease
- CMR: Cardiac magnetic resonance (imaging)
- CT: Computed tomography
- ECG: Electrocardiogram
- ICD: Implantable cardioverter-defibrillator
- LBBB: Left bundle-branch block
- LV: Left ventricular
- MPI: Myocardial perfusion imaging
- MR: Mitral regurgitation
- MR(I): Magnetic resonance (imaging)
- RV: Right ventricle
- SE: Stress echocardiography
- TAVR: Transcatheter Aortic Valve Replacement
- TTE: Transthoracic Echo
- TEE: Trainsesophageal Echo
- VT: Ventricular tachycardia
TABLE OF CONTENTS

POLICY HISTORY:
Review Date: July 2019
Review Summary:
- 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

Review Date: March 2020
Review Summary:
- 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:
  - Edited indication to assess systolic and diastolic function in the evaluation of a newly diagnosed cardiomyopathy
  - Added the following to suspected infiltrative disease such as amyloidosis, sarcoidosis, hemochromatosis, or endomyocardial fibrosis: if PET has not been performed
  - Added suspected inherited or acquired cardiomyopathy
  - 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
  - Added clinical symptoms and signs consistent with a cardiac diagnosis known to cause presyncope/syncope (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
  - 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
  - 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:
  - For assessment of atrial septal anatomy and atrial septal aneurysm
  - For assessment of suitability for percutaneous device closure
- Added section on Assessment Following LAA Occlusion including the following indications:
  - 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)
• 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
REFERENCES


Cardiovascular-Implantable-Electronic-Devices


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
(Arnet, 2019; Blankstein, 2017; Goff, 2014; Greenland, 2018; Hecht, 2017; Mahabadi, 2017; McClelland, 2015; Nasir, 2015; Pender, 2016; Piepoli, 2016)
• In the context of shared decision making for patients aged 40 to 75, (without clinical atherosclerotic cardiovascular disease), with intermediate-to-low 10-year risk (5 - 20%), with documentation that the CAC score is necessary to adjust management, such as statin therapy (Hecht, 2017; Michos, 2017; Stone, 2013; Wilkins, 2018)
• Patients who are over 75 or younger than 40 years old can be considered for CAC testing when there is well-documented evidence that the results could alter management (Tota-Maharaj, 2012)
  o 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, such as family history of premature CAD (Greenland, 2018; Hecht, 2017)
  o 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 (Blankstein, 2017; Michos, 2017; Nasir, 2015)
  o CAC testing may be repeated for risk re-assessment after a minimum of 5 years, if documentation indicates it will alter management (Greenland, 2018; Hecht, 2017; Michos, 2017). It should not be repeated if the patient already has two CAC Scores of zero 5 years apart or has a score ≥ 400 (Greenland, 2018)

BACKGROUND:
(Blankstein, 2017; Greenland, 2018; Hecht, 2017)
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 (McClelland 2015). A CAC Score > 0 is a highly specific feature of coronary atherosclerosis.

CAC score > 100 can also provide support for aspirin therapy (Hecht, 2017; Miedema, 2014) and statin therapy (Mortenen, 2018).

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**
(Arnet, 2019; D’Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007)

<table>
<thead>
<tr>
<th>Risk Calculator</th>
<th>Website for Online Calculator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reynolds Risk Score</td>
<td><a href="http://www.reynoldsriskscore.org/">http://www.reynoldsriskscore.org/</a></td>
</tr>
<tr>
<td>Can use if no diabetes</td>
<td></td>
</tr>
<tr>
<td>Unique for use of family history</td>
<td></td>
</tr>
<tr>
<td>Pooled Cohort Equation</td>
<td><a href="http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example">http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example</a></td>
</tr>
</tbody>
</table>

**Risk Tiers:**
- **Low** < 10%.
- **Moderate** 10% - 20%.
- **High risk** ≥20%.

**Abbreviations**
- ASCVD: Atherosclerotic cardiovascular disease
- CAC: Coronary artery calcium
- CAD: Coronary artery disease
- CCT: Cardiac computed tomography
- EBCT: Electron beam computed tomography
POLICY HISTORY:
Review Date: July 22, 2019
Review Summary:
- 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.

Review Date: March 2020
Review Summary:
- 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
REFERENCES


Wilkins JT, Lloyd-Jones DM. USPSTF recommendations for assessment of cardiovascular risk with nontraditional risk factors, finding the right tests for the right patients (Editorial). *JAMA*. 2018; 320(3):242-244.

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)
(Douglas, 2011; Taylor, 2010)

Congenital Heart Disease (Sachdeva, 2020)

For all indications below, either CT or CMR can be done:

- 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
- 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
TABLE OF CONTENTS

- 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: 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) (Marcus, 2010; te Riele, 2015)

**Infective Endocarditis**

**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 (Doherty, 2017)
- 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 (Nishimura, 2014)

**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 (Baumgartner, 2017; Doherty, 2017; Nishimura, 2014)
- 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] (Klein, 2013; Pennell, 2010)

**Electrophysiologic Procedure Planning** (Taylor, 2010)
- 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**
- 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 (Pison, 2015; Schoenhagen, 2010)
- Evaluation for suitability of transcatheter mitral valve procedures, alone or in addition to TEE (Wunderlich, 2018)

**Aortic Pathology** (Baumgartner, 2014; Bhave, 2018; Doherty, 2017, 2018; Erbel 2014; Hendel 2006; Hiratzka 2010; Nishimura 2014; Svensson 2013)
- 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 (see table below for top normal sizes) 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 (defined as ≥ 50% above top normal) or dissection, or an associated high-risk mutation for thoracic aneurysm in common
  - Screening second degree relative of a patient with thoracic aortic aneurysm (defined as ≥ 50% above top normal), 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 that is above top normal for age, gender, and size up to 4.4 cm.
  - Biannual (twice/yr) follow up of enlarged aortic root ≥ 4.5 cm (> 4.5 cm for bicuspid aortic valve) or showing growth rate ≥ 0.5 cm/year
- 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 patients 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:
  o Structures of the heart (chambers, valves, great vessels, masses, etc.), as in this guideline
  o Quantitative level of calcium in the walls of the coronary arteries, in the separate coronary artery calcium (CAC) scoring guideline

OVERVIEW
(Taylor, 2010)

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. structures (Sachdeva, 2020)

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 (Klein, 2013).
TABLE OF CONTENTS

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
MI  Myocardial infarction
MPI  Myocardial perfusion Imaging or cardiac nuclear imaging
MR(I)  Magnetic resonance (imaging)
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
TTE  Transthoracic echocardiography

POLICY HISTORY:
Review Date: July 22, 2019
Review Summary:
- 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)
Review Date: March 2020

Review Summary:

- 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

- Extensive update to the indications for Congenital Heart Disease to include the following:
  - For all indications noted, 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
  - 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:
  - CT and CMR provide 3D anatomic relationship of the blood vessels and cardiac anatomic structures
  - Discussion of cardiac myxoma

- Updated and added new references
REFERENCES


Cardiology Foundation Appropriate Use Criteria Task Force, the Society of Cardiovascular Computed Tomography, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the North American Society for Cardiovascular Imaging, the Society for Cardiovascular Angiography and Interventions, and the Society for Cardiovascular Magnetic Resonance. *J Am Coll Cardiol*. 2010; 56(22): 1864-1894.


75574 – CTA Coronary Arteries (CCTA)

CPT Codes: 75574

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)
(Fihn, 2012; Montalescot, 2013; Taylor, 2010; Wolk, 2014)

Evaluation in Suspected Coronary Artery Disease (CAD):
(Cheng, 2011; Douglas, 2015; Fordyce, 2016; Newby, 2015)

- Intermediate or high pretest probability patients in whom stress echo cannot be performed (see Background section)
- Low pretest probability patients in whom either exercise electrocardiogram (ECG) stressor stress echo cannot be performed (see Background section)
- Appropriate exercise ECG stress test with low Duke Treadmill Score (≥ 5) and continued symptoms concerning for CAD
- Exercise ECG stress test with intermediate Duke Treadmill Score (- 10 to + 4) in whom stress echo cannot be performed
- 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 (Taylor, 2010; Wolk, 2013)
- Newly diagnosed clinical systolic heart failure (ejection fraction [EF] < 50%) without recent CAD evaluation, in the presence of angina or an anginal equivalent (Patel, 2012; Patel, 2013; Taylor, 2010; Wolk, 2013)
- Reduced EF (EF ≤ 40%) as an alternative to invasive coronary arteriography
- Before valve surgery or transcatheter intervention as an alternative to coronary angiography (Baumgartner, 2017; Chaikriangkrai, 2018; Nishimura, 2014)
- To establish the etiology of mitral regurgitation (Nishimura, 2014)
- Evaluation of coronary anomaly or aneurysm (CMR favored in young patients) (Bluemke, 2008; Grani, 2017; Newburger, 2016; Sachdeva, 2020)
  - Evaluation prior to planned repair
  - Evaluation due to change in clinical status and/or new concerning signs or symptoms
- Evaluation of coronary artery bypass grafts, to assess (Eisenberg, 2017; Taylor, 2010):
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) equipment to obtain detailed volumetric images of the coronary blood vessels. Cardiac CT perfusion can be added to the CCTA, with increasing data regarding its diagnostic accuracy (Nakamura, 2018; Pontone, 2018).

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 (Abbara, 2016).

Coronary artery disease (CAD) stenosis ≥ 70% is considered clinically significant or obstructive CAD. Hemodynamically or functionally significant CAD means the degree of stenosis is severe enough to cause ischemia. This is discussed in more detail in the Overview section (Fihn, 2012; Montalescot, 2013; Wolk, 2013).

Stable patients without known CAD fall into 2 categories (Fihn, 2012; Montalescot, 2013; Wolk, 2013):

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see Part III in the Background 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 (Wolk, 2013):
### TABLE OF CONTENTS

#### 2021 Magellan Clinical Guidelines
- Advanced Imaging

---

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40 – 49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>50 – 59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>≥ 60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

- **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

**Scenarios that support MPI over SE**
(Henzlova, 2016)

**Poor Quality Echo Image**
- Obesity with body mass index (BMI) > 40 kg/m² or poor acoustic imaging window

**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 ≤ 40%
- 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)
• Poorly controlled atrial fibrillation/ectopy
• Resting wall motion abnormalities that would make SE interpretation difficult
• Complete LBBB

Risk Related
• High pretest probability in suspected CAD
• 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 (Wolk, 2013):

• The (symptomatic) low or intermediate pretest probability patient who is able to exercise and has an interpretable ECG (Wolk, 2014)
• 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 (Shen, 2017)

Duke Exercise ECG Treadmill Score (Mark, 1987)
Calculates risk from ECG treadmill alone:

• The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - \((5 \times \text{ST deviation in mm or 0.1 mV increments}) - (4 \times \text{exercise angina score})\), 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 \(\geq +5\)), intermediate risk (with scores ranging from -10 to +4), and high-risk (with a score of \(\leq -11\)) categories

An uninterpretable baseline ECG includes (Fihn, 2012):

• 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
• 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 EKG 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 (Cheng, 2011).

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.
(Arnet, 2019; D’Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007)

<table>
<thead>
<tr>
<th>Risk Calculator</th>
<th>Websites for Online Calculator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reynolds Risk Score</td>
<td><a href="http://www.reynoldsriskscore.org/">http://www.reynoldsriskscore.org/</a></td>
</tr>
<tr>
<td>Can use if no diabetes</td>
<td></td>
</tr>
<tr>
<td>Unique for use of family history</td>
<td></td>
</tr>
<tr>
<td>Pooled Cohort Equation</td>
<td><a href="http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example">http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example</a></td>
</tr>
<tr>
<td>MESA Risk Calculator</td>
<td><a href="https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx">https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx</a></td>
</tr>
<tr>
<td>With addition of Coronary Artery Calcium Score, for CAD-only risk</td>
<td></td>
</tr>
</tbody>
</table>
Coronary Artery Calcium Scoring  
(Arnett, 2019)

**Non-contrast** coronary computed tomography (non-contrast coronary CT) and its older technological version, electron beam computed tomography (EBCT), provide quantitative coronary artery calcium scoring, which is appropriate for further evaluation of coronary risk in asymptomatic patients without known cardiovascular disease, who are at low to intermediate or intermediate global risk for coronary or overall cardiovascular disease. Non-contrast coronary CT (computed tomography) and EBCT are supported by a separate CPT code and guideline document with references titled EBCT or Non-Contrast Coronary CT.

Definitions of Coronary Artery Disease  
(Fihn, 2012; Lofti, 2018; Mintz, 2016; Montalescot, 2013; Patel, 2017)

- 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 (Patel, 2017).
- 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; borderline lesions are 40 - 70% (Fihn, 2012)
  - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum luminal cross sectional area on IVUS ≤ 6 square mm (Fihn, 2012; Lofti, 2018; Mintz, 2016)
  - FFR (fractional flow reserve) ≤ 0.80 for a major vessel (Lofti, 2018; Mintz, 2016)
  - iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel (Davies, 2017; Gotberg, 2017; Lofti, 2018)
  - 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.
- 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 (Davies, 2017; Gotberg, 2017).
• Newer technology that estimates FFR from CCTA images is covered under the separate NIA Guideline for FFR-CT.

**Anginal Equivalent**
(Fihn, 2012; Moya, 2009; Shen, 2017)

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**

ACS  Acute coronary syndrome  
CABG  Coronary artery bypass grafting surgery  
CAD  Coronary artery disease  
CCS  Coronary calcium score  
CCTA  Coronary computed tomography angiography  
ECG  Electrocardiogram  
MI  Myocardial infarction  
MPI  Myocardial Perfusion Imaging  
PCI  Percutaneous coronary intervention  
SE  Stress echocardiography  
TTE  Transthoracic echocardiography

**POLICY HISTORY:**

**Review Date:** July 20, 2019  
**Review Summary:**  
• 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

**Review Date:** March 2020  
**Review Summary:**
• 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
REFERENCES:


Taylor AJ, Cerqueira MC, Hodgson JM, et al. ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 Appropriate use criteria for cardiac computed tomography: A report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the Society of Cardiovascular Computed Tomography, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the North American Society for


75635 – CT Angiography, Abdominal Arteries

CPT Codes: 75635

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 seen on previous imaging in the abdominal aorta and/or legs.

For evaluation of known or suspected abdominal, pelvic, or peripheral vascular disease: (ACR, 2016; Ahmed, 2017, Conte, 2015, Werncke, 2015)

- Without critical ischemic changes doppler ultrasound should be indeterminate or inconclusive
- For known or suspected peripheral arterial disease with claudication when non-invasive studies (pulse volume recording, ankle-brachial index, toe brachial index, segmental pressures or 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 (Shishehbor, 2016; Weiss, 2018)
  - Ischemic rest pain
  - Tissue loss
  - Gangrene
- Clinical concern for vascular cause of ulcers with abnormal or indeterminate ultrasound (ankle/brachial index, arterial Doppler) (Rosyd, 2017)

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.
- 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 (Pollack, 2012)
BACKGROUND:
Computed tomography angiography (CTA) provides a cost-effective and accurate imaging assessment in patients with aortic dissections, or peripheral arterial disease. High resolution CTA may be used in the diagnosis and follow-up of patients with aortic dissection and lower extremity 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 (Conte, 2015) “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. The presence of a normal ABI at rest and following exercise almost excludes atherosclerotic disease as a cause for leg claudication (Ahmed, 2017; Stoner, 2016). When an ABI is >1.40 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”. 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” (Ahmed, 2017).

Follow up imaging post vascular surgery procedures has not been well researched without clear surveillance protocols in place. Clinical exam, ABI and EUS within the first month of endovascular therapy generally recommended to assess for residual stenosis, and again at 6 and 12 months, then annually. More sophisticated imaging with CTA or MRA, or invasive catheter angiography reserved for complex cases (Zierler, 2018).

POLICY HISTORY:
Review Date: May 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• 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
REFERENCES:


76376 – 3D Rendering (CT Multiplanar Reconstruction)

CPT Codes: 76376, 76377

IMPORTANT NOTE:

These procedures should always be approved.

This organization does not review these services for medical necessity.

POLICY HISTORY:
Review Date: April 2019
Review Summary: No changes

Review Date: May 2020
Review Summary: No changes
76380– Follow-Up, Limited or Localized CT
CPT Codes: 70486, 70487, 70488, 76380

See 70486 – CT Maxillofacial/Sinus
76390 – MR Spectroscopy

CPT Codes: 76390

INDICATIONS FOR BRAIN MRS (ACR, 2019)

- For the evaluation of a recurrent or residual brain tumor from post-treatment changes e.g., radiation necrosis (Chuang, 2016)
- For further evaluation a brain lesion to distinguish a brain tumor from other non-tumor diagnoses (e.g. abscess or other infectious or inflammatory process) (Alam, 2011; Majos 2009)

BACKGROUND:
(Alam 2011; Hellström 2018)

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 imaging of brain tumors carefully designed, multi-center trials complying with criteria of evidence-based medicine have not yet been completed (Horska, 2010)

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 new, 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 (Barajas, 2009; Chuang, 2016; Smith, 2009). However, no consensus exists regarding the value of this in clinical decision making and no approach has yet been validated to be sufficiently accurate (Chuang, 2016; Sundgren, 2009; Walker, 2014).

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 need for a definite conclusion for the utility of MRS for this indication. Therefore, it remains experimental/investigational (Abrigo, 2018; Wang, 2016).

**Cystic lesions vs. cystic metastasis or cystic primary neoplasm** – MRS may determine the concentration of certain brain metabolites whose ratios help in distinguishing abscesses from cystic necrotic tumors. For example, an increased choline signal or the ratio of certain brain metabolites may indicate the presence of cancerous cells. MRS may be used to diagnose the disease and to determine appropriate treatment (Mishra, 2004).

**MRS in other diseases** A role for MRS has been suggested in the management of neurodegenerative disease, epilepsy, and stroke. However, to better define this role, 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 (Oz, 2014).

**POLICY HISTORY:**

**Review Date:** July 2019  
**Review Summary:**
- Deleted therapeutic f/u indication
- Added tumor versus non tumor indication
- Updated background info and refs

**Review Date:** May 2020  
**Review Summary:**
- Updated references
REFERENCES


http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1064986.


76497 – Unlisted CT Procedure
76498 – Unlisted MRI Procedure

CPT Codes:
76497 - Unlisted CT
76498 – Unlisted MRI

IMPORTANT NOTE:

The CPT code that has been selected is considered to be an “unlisted code”.

CPT Code 76498, Unlisted MRI, can be used in the context of radiation treatment planning.

For all other studies, another CPT code should be selected that describes the specific service being requested, otherwise this procedure cannot be approved.

POLICY HISTORY:
Review Date: August 22, 2019
Review Summary: No changes.

Review Date: May 2019
Review Summary: No changes
77012 – CT Needle Guidance
77021 – MRI Needle Guidance

CPT Code:
CT: 77011, 77012, 77013, 77014
MRI: 77021, 77022

IMPORTANT NOTE:
The CPT codes describe the CT or MRI “guidance” component of a diagnostic procedure. Requests for these services should always be approved. This organization does not review these for medical necessity.

POLICY HISTORY:
Review Date: April 2019
Review Summary: No changes

Review Date: May 2020
Review Summary: No changes
INDICATIONS FOR BREAST MRI:
(Please see boxed statements below for State of Connecticut and State of North Carolina specific requirements)

NO HISTORY OF KNOWN BREAST CANCER:
For screening examination to detect breast cancer in any of the following situations:

- A Breast Cancer Risk Assessment (preferably using the Breast Cancer Consortium Risk Model (BCSC) which incorporates breast density, the International Breast Cancer Intervention Study model (IBIS); the Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm model (BOADICEA), the modified Gail (NCCN, 2019) (also known as Breast Cancer Risk assessment tool (BCRAT) or Tyler-Cusick or other validated risk assessment models) that identifies the patient as having a lifetime risk of 20% or greater of developing breast cancer.
  - Approve annually beginning 10 years prior to youngest family member’s age at diagnosis but not before age 30 (ACR, 2018; ASBrS, 2017; Levitan, 2019; Marino, 2018; NCCN, 2019).
- Patients with history 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 (NCCN, 2018).
- Patients with known BRCA 1/2 mutation.
  - Approve annually starting at age 25 (ASBrS, 2017; NCCN, 2019).
- Patients not yet tested for BRCA gene, but with known BRCA mutation in first degree relative.
  - Approve annually starting at age 25 (ASBrS, 2017; NCCN, 2019).
- Personal history of germline mutations known to predispose to a high risk of breast cancer (NCCN, 2019):
  - Li-Fraumeni syndrome (TP53 mutation)
    - Begin age 20-29 or age at earliest diagnosed breast cancer in family
  - Cowden syndrome (PTEN) or Bannayan-Riley-Ruvalcaba syndrome (BRRS)
    - Begin 30-35 or 5-10 y before earliest breast cancer in family
  - ATM
    - Begin age 40
  - CDH1
    - Begin age 30
  - CHEK2
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 (ASBrS, 2017; Geiss, 2017; Yader, 2018).
- Inconclusive or conflicting findings on a screening mammogram or ultrasound when the finding is not a palpable or a discrete mass.
- For cases of new nipple inversion when mammographic and sonographic findings are inconclusive and a biopsy cannot be performed (Killelea, 2019).
- Patients diagnosed with biopsy-proven lobular neoplasia, i.e., ADH/ALH (atypical ductal hyperplasia/Atypical Lobular Hyperplasia) or LCIS (Lobular Carcinoma in Situ) (ASBrS, 2017; Monticciolo, 2017; NCCN, 2019).
- Spontaneous unilateral serous or bloody nipple discharge when conventional imaging is normal and there is no palpable mass (ASBrS, 2017; Bahl, 2015; NCCN, 2019).
- Paget’s disease of the nipple: to detect underlying ductal carcinoma when conventional imaging is normal and there is no palpable mass (ASBrS, 2017).
- For a phylloides 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 (Grau, 2019).
- 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) (Lee, 2018; Panigrahi, 2019; Spick, 2018).

HISTORY OF KNOWN BREAST CANCER:

- Yearly surveillance for history of breast cancer and dense breast tissue on mammography (ACR, 2018).
- Yearly surveillance for individuals with personal history of breast cancer diagnosed before age 50 (ACR, 2018)
- To identify primary cancer in a patient with axillary nodal adenocarcinoma and unidentified primary tumor (NCCN, 2019).

Staging, treatment, and surveillance of patients with a known history of Breast Cancer:
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 (ASBrS, 2017; NCCN, 2019).

For invasive lobular carcinoma that is poorly defined by mammography, ultrasound and physical exam (NCCN, 2019).

During or after treatment: To identify candidates for breast conserving therapy or evaluate response to treatment, including preoperative neoadjuvant therapy [within three (3) months] (ASBrS, 2017).

Yearly surveillance in patients with genetic or other risk factors placing them at high risk for a new cancer or recurrence (ASBrS, 2017; Park, 2018).

For evaluation of identified lesion, mass or abnormality in breast in any of the following situations:

- For evaluation of breast lesion, identifying whether single or multi-focal, in patient with newly diagnosed breast cancer (ASBrS, 2017; NCCN, 2018).
- For evaluation of suspicious mass, lesion, distortion or abnormality of breast in patient with history of breast cancer when other imaging is inconclusive.

Silicone Implants:

MRI is not indicated for evaluation of saline implant complications or for asymptomatic silicone implants.

(ACR, 2018; Laurence, 2018)

- Confirmation of suspected silicone gel-filled breast implant ruptures in asymptomatic 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 (ACR, 2018; ASbrS, 2017).
- 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 (ASBrS, 2017; NCCN, 2019; Susnik, 2018; Wong, 2018).

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 (ACR, 2018).
BACKGROUND:
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 (Panourgies, 2018). Breast MRI should be bilateral except for those with a history of mastectomy or when the MRI is being performed expressly to further evaluate or follow findings in one breast. 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 - 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” (ASBrS, 2017; NCCN, 2019).

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. 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 are variable depending on several factors including location, type of practice ie. private or academic, and whether the practice has breast specialists. Also, the exact notification requirements vary as well as insurance coverage from state to state. Screening ultrasound was most utilized (53%) and most available in the Northeast (80%). Connecticut 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 (Choudhery, 2020).

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. (Kerlikowske, 2019). For women whose only risk is increased breast density, ultrasound can be considered for adjunctive screening (Monticciolo, 2018). 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 (Bakker, 2019; Destounis, 2020; Kerlikowski, 2019).

MRI and Breast Cancer Risk Associated with certain Syndromes -
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 (NCCN, 2019).
NF-1 - Mammography starting at age 30; breast MRI may be considered.
There is currently no evidence that RAD51C and RAD51D genes are associated with increased risk of breast cancer. Insufficient evidence for FANCC, MRE11A, or MUTYH heterozygotes, or RECQL4, RAD50, RINT1, SLX4, SMARCA4, or XRCC2. For STK11 (associated with Peutz-Jeghers syndrome) breast cancer risk is 8% at age 40, 13% age 50 and 31% at age 60, 45% age 70.
Abbreviated Breast MRI- Among women with dense breasts undergoing screening, this technique, compared with digital breast tomosynthesis, was associated with significantly higher rate of detection of invasive cancer and further research is needed. A clinical trial is now underway (ClinicalTrials.gov:NCT02933489). A total acquisition time of 10 minutes is needed to image the breasts (Comstock, 2020).

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 (NCCN, 2019).

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 results obtained from the MRI. 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 (ACR, 2018).

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 (ACR, 2020).

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 (ACR, 2018).
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” (ACR, 2016).

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 …” (ASBrS, 2017). 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 (NCCN, 2019).

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 (ACR, 2018).

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” (ACR, 2016). 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 (ACR, 2016).

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% (Lee, 2018). In an average risk screening population of 2120 women and 3,861 MRI exams 4.9% of MRI exams were BI-RADS 3 (Kuhl, 2017). 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 the definition was still evolving during the study periods. At this writing the appropriate use of BI-RADS 3 for breast MRI has not been fully defined (Panigrahi, 2019). “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 intramammary lymph node or fibroadenoma” (Lee, 2018). The reported malignancy rate is ≤ 2% for lesions classified as BI-RADS 3 (Lee, 2018; Spick, 2018).

**POLICY HISTORY:**
**Review Date:** April 2019
**Review Summary:**
- 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:
  - 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
  - During or after treatment to identify candidates for breast conserving therapy or evaluate response to treatment, including preoperative neoadjuvant therapy [within three (3) months]
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

**POLICY HISTORY:**

**Review Date:** September 2019

**Review Summary:**
- Added state specific language boxes for State of Connecticut and State of North Carolina

**Review Date:** May 2020

**Review Summary:**
- Added not indicated for saline implants, or asymptomatic silicone without prior imaging
- Added gold standard for symptomatic saline 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
REFERENCES:


Levitan DE. Which Breast Cancer Risk Models are Most Accurate? Breast Cancer News. February 27, 2019


INDICATIONS FOR CT BONE DENSITY STUDY:

For first time baseline study:
(ACR, 2016; Cosman, 2014; Curry, 2018; ISCD, 2019; Jeremiah, 2015)

Patient with suspected osteoporosis or osteopenia meeting any of the following criteria when DEXA scanning is not available or for patients with advanced degenerative changes of the spine or who are severely obese (BMI >35 kg/m²) that may limit the efficacy of DEXA 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 m²)
  - A history of fracture
  - High risk medications (e.g., Steroids or glucocorticosteroids, anti-convulsants, heparin, lithium, estrogen receptor modulators, calcitonin, or biphosphonates)
  - 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, etc.).
- Men aged 70 or older
- Individuals with fragility fractures seen on other imaging studies.
- Loss of body height (>4 cm (>1.5 inches)) (ACR, 2016)
- Amenorrhea for greater than 1 year before the age of 42
- Eating disorders, including anorexia nervosa and bulimia
- Individuals who have had gastric bypass for obesity (accuracy of dexa may be affected by obesity)

For follow-up of individuals with known osteoporosis or osteopenia:
(Eastell, 2019; Shoback, 2020)

- 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 biphosphonates, 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).
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:
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) 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 (ACR 2016; Cosman, 2014)

Fracture Risk Assessment* - The fracture risk assessment (FRAX) tool developed by the World Health Organization 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.

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 USPSTF now recommends screening of 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.

POLICY HISTORY:
Review Date: April 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• Changed indications for asymptomatic women and men
• Added imaging for men age>70
• Updated timing for follow up studies
REFERENCES:


Centre for Metabolic Bone Diseases (CMBD), University of Sheffield, UK. Fracture Risk Assessment Tool (FRAX). https://www.sheffield.ac.uk/FRAX/tool.jsp.


77084 – MRI Bone Marrow

CPT Codes: 77084

INDICATIONS FOR BONE MARROW MRI (images entire body):

For the diagnosis, staging and follow-up of patients with multiple myeloma, as well as, leukemia and other related hematological malignancies (Angtuaco, 2004; Dutoit, 2016)

Suspected progression of smoldering multiple myeloma (SMM) to multiple myeloma (MM) or high risk SMM patients (Caers, 2016; IMWG, 2015).

• 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) (Laudermann, 2016; Simpson, 2014; Voit, 2015).

• 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:

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.

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 in order 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” (Navarro, 2017).

MRI findings are included as one of the International Myeloma Working Group (IMWG) diagnostic criteria of active myeloma (Dutoit, 2016). Although MRI is not the only imaging tool for diagnosis, when “more than one focal lesion on MRI that is at least 5mm 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” (IMWG, 2015; Kumar, 2020). 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” (Dutoit, 2016). 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 (Caers, 2016).

**POLICY HISTORY:**
**Review Date:** April 2019
**Review Summary:**
- 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

**Review Date:** May 2020
**Review Summary:**
- Added description of Whole body bone marrow MRI in background section
• Added Low dose CT in evaluation of myeloma, in background section
• Updated references
REFERENCES:


78429 – HEART PET with CT for Attenuation

CPT Code:  78459, 78491, 78492, +78434, 78429, 78430, 78431, 78432, 78433

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 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 pretest probability and unable to exercise
- Intermediate pre-test probability with an uninterpretable electrocardiogram (ECG) or unable to exercise (Wolk, 2014)
- High pretest probability
- 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
- Previously unevaluated ECG evidence of possible myocardial ischemia including substantial ischemic ST segment or T wave abnormalities
- Previously unevaluated pathologic Q waves
- Unevaluated complete left bundle branch block

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), but patient’s current symptoms indicate an intermediate or 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)
- An intermediate evaluation by prior stress imaging (within the past 2 years)
FOLLOW-UP OF PATIENTS POST CORONARY REVASCULARIZATION (PCI or CABG) When LVEF is ≤ 40% and revascularization is under consideration

- **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)

- **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 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 (EF < 50%), especially with symptoms or signs of ischemia unless invasive coronary angiography is immediately planned (Fihn, 2012; Patel, 2013; Yancy, 2013)
- Reduced LVEF ≤ 50% requiring myocardial viability assessment to assist with decisions regarding coronary (Diversion from PET not required when LVEF less than or equal to 40%) (Patel, 2013; Tsai, 2014; Yancy, 2013)
- 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 (Al-Khatib, 2018)
  - 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), in intermediate and high global risk patients (SE diversion not required) (Reiffel, 2015)

Assessment of hemodynamic significance of one of the following documented conditions (Anagnostopoulou, 2004):
  o Anomalous coronary arteries (Grani, 2017)
  o Muscle bridging of coronary artery (perform with exercise stress) (Sorajja, 2018)

Coronary aneurysms in Kawasaki’s disease (McCrandle, 2017) or due to atherosclerosis

Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter (Lancellotti, 2013)

**Cardiac Sarcoidosis** (Birnie, 2016; Blankstein, 2016; Vita, 2018)
  o Evaluation and therapy monitoring in patients with sarcoidosis, after documentation of suspected cardiac involvement by echo or ECG, when CMR has not been performed
  o Evaluation of suspected cardiac sarcoid, after CMR has shown equivocal or negative findings in the setting of a high clinical suspicion (Vita, 2018)

Evaluation of CMR findings showing highly probable cardiac sarcoidosis, when PET could serve to identify inflammation and the consequent potential role for immunosuppressive therapy (Vita, 2018)
  o Initial and follow up PET in monitoring therapy for cardiac sarcoid with immunosuppressive therapy, typically about 4 times over 2 years

**Infective Endocarditis**
  o 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 (Doherty, 2017; Habib, 2016; Wang, 2018)

**Aortitis**
  o For diagnosis and surveillance of Aortitis, PET/CT or PET/MRI hybrid imaging (Bhave, 2018)

**PRIOR TO ELECTIVE NON-CARDIAC SURGERY** (When neither SE nor MPI have provided or are expected to provide optimal imaging)
  o Patients who have no other indication for a non-invasive coronary evaluation, but are referred for preoperative cardiac evaluation, are eligible for MPI if all 4 criteria are met:
    o Surgery is supra-inguinal vascular, intrathoracic, or intra-abdominal;
    AND
    o The patient has at least one of the additional cardiac complication risk factors:
      ▪ Ischemic Heart Disease
      ▪ History of stroke or TIA
      ▪ History of congestive heart failure or ejection fraction ≤ 35%
      ▪ Insulin-requiring diabetes mellitus
Creatinine ≥ 2.0 mg/dl

AND

- 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

AND

- There has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, and the results of such a test would be likely to substantially alter therapy and/or preclude proceeding with the intended surgery.

- Planning for solid organ transplantation is an indication for preoperative MPI, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year and with ≥ 3 of the following risk factors (SE diversion not required) (Lentine, 2012):
  - Age > 60
  - Smoking
  - Hypertension
  - Dyslipidemia
  - Left ventricular hypertrophy
  - 1 year on dialysis (for renal transplant patients)
  - Diabetes mellitus
  - Prior ischemic heart disease

POST CARDIAC TRANSPLANT (SE diversion not required)

(McArdle, 2012)

- Annually, for the first five years post cardiac transplantation, in patient not undergoing annual 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

BACKGROUND

(Bateman, 2016; Fazel, 2011)

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 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

- For assessment of suspected significant hibernating myocardium in the presence of known severe major vessel CAD, when EF is below 40%, in order to determine a patient’s potential benefit from coronary revascularization (Patel, 2013; Tsai, 2014; Yancy, 2013)
- When strong suspicion of balanced ischemia is noted, and further non-invasive coronary evaluation required, PET can be used, without diversion from PET (Bengel, 2009)
- Prior alternative perfusion (MPI or CMR) imaging resulted in an indeterminate evaluation for CAD
- Cardiac positron emission tomography (PET) can characterize myocardial blood flow by perfusion scanning with either rubidium-82 (Rb-82) or nitrogen-13 (N-13) ammonia
- PET 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.
- PET can be use 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 (Fihn, 2012; Montalescot, 2013; Wolk, 2013)

- **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

Once the type of chest pain has been established from the medical record, the Pretest Probability of CAD (meaning obstructive CAD defined as coronary arterial narrowing ≥ 50%) is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability (Fihn, 2012; Wolk, 2013):
### TABLE OF CONTENTS

#### 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 (Wolk, 2013):

- The (symptomatic) low or intermediate pretest probability patient who is able to exercise and has an interpretable ECG (Wolk, 2014)
- 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 (Shen, 2017)

**Duke Exercise ECG Treadmill Score** calculates risk from ECG treadmill alone (Mark, 1987):

- 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 (Fihn, 2012):

- 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)
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, 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 (D’Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007).*

<table>
<thead>
<tr>
<th>Risk Calculator</th>
<th>Websites for Online Calculator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can use if no diabetes</td>
<td></td>
</tr>
<tr>
<td>Unique for use of family history</td>
<td></td>
</tr>
<tr>
<td>MESA Risk Calculator</td>
<td><a href="https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx">https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx</a></td>
</tr>
<tr>
<td>With addition of Coronary Artery Calcium Score, for CAD-only risk</td>
<td></td>
</tr>
</tbody>
</table>

**Definitions of Coronary Artery Disease**
(Fihn, 2012; Montalescot, 2013; Patel, 2017)
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; borderline lesions are 40 - 70% (Fihn, 2012)
  - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum lumen cross sectional area on IVUS ≤ 6 square mm (Fihn, 2012; Lofti, 2018)
  - FFR (fractional flow reserve) ≤ 0.80 for a major vessel (Lofti, 2018)
  - iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel (Davies, 2017; Gotberg, 2017)
  - 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.
- iFR (instantaneous wave-free ratio) measures the ratio of distal coronary to aortic pressure during the wave free period of diastole, with a value ≤ 0.89 considered hemodynamically significant (Davies, 2017; Gotberg, 2017).
- Newer technology that estimates FFR from CCTA image is covered under the separate NIA Guideline for FFR-CT.

**Anginal Equivalent**
(Fihn, 2012; Shen, 2017)

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.
TABLE OF CONTENTS

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADLs</td>
<td>Activities of daily living</td>
</tr>
<tr>
<td>CAD</td>
<td>Coronary artery disease</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiogram</td>
</tr>
<tr>
<td>FFR</td>
<td>Fractional flow reserve</td>
</tr>
<tr>
<td>LBBB</td>
<td>Left bundle-branch block</td>
</tr>
<tr>
<td>LVEF</td>
<td>Left ventricular ejection fraction</td>
</tr>
<tr>
<td>LVH</td>
<td>Left ventricular hypertrophy</td>
</tr>
<tr>
<td>MI</td>
<td>Myocardial infarction</td>
</tr>
<tr>
<td>MET</td>
<td>Estimated metabolic equivalent of exercise</td>
</tr>
<tr>
<td>MPI</td>
<td>Myocardial perfusion imaging</td>
</tr>
<tr>
<td>PFT</td>
<td>Pulmonary function test</td>
</tr>
<tr>
<td>PVCs</td>
<td>Premature ventricular contractions</td>
</tr>
<tr>
<td>SE</td>
<td>Stress echocardiography</td>
</tr>
<tr>
<td>VT</td>
<td>Ventricular tachycardia</td>
</tr>
<tr>
<td>VF</td>
<td>Ventricular fibrillation</td>
</tr>
<tr>
<td>WPW</td>
<td>Wolf Parkinson White</td>
</tr>
</tbody>
</table>

Policy History:
Review Date: March 2020
Review Summary:

- 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:
  - 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
REFERENCES


78451 – Myocardial Perfusion Imaging

CPT Code: 78451, 78452, 78453, 78454, 78466, 78468, 78469, 78481, 78483, 78499

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 MPI
(Fihn 2012, Hendel 2009, Montalescot 2013, Wolk 2014)

SUSPECTED Coronary Artery Disease (CAD)

Symptomatic patients without known CAD (Use Diamond Forrester table)

- Low pretest probability and unable to exercise
- Intermediate pre-test probability with an uninterpretable ECG or unable to exercise (Wolk 2014)
- High pretest probability (Stress Echocardiogram [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
- Previously unevaluated complete left bundle branch block

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 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. 30 - 70% lesions)
- Non-diagnostic exercise stress test with inability to achieve target heart rate (THR)
• An indeterminate (equivocal, borderline, or discordant) evaluation by prior stress imaging (SE or CMR) within the past 2 years

FOLLOW-UP OF PATENTS POST CORONARY REVASCULARIZATION (PCI or CABG) (Wolk, 2014)

• **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 only for patients with a history of silent ischemia or a history of a prior left main stent (Wolk, 2014).

**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 (MPI or SE), 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 (MPI or SE) in patients if it will alter management

SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION

• 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 (EF < 50%) with symptoms or signs of ischemia unless invasive coronary angiography is immediately planned (SE diversion not required) (Fihn, 2012; Patel, 2013; Yancy, 2013)

• LVEF ≤ 50% requiring myocardial viability assessment to assist with decisions regarding coronary revascularization (Patel, 2013; Yancy, 2013)

• Ventricular arrhythmias
  - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise induced VT, when invasive coronary arteriography is not immediately planned (Al-Khatib 2018) (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 (Zimetbaum 2018)
• Prior to Class IC antiarrhythmic drug initiation (Propafenone or Flecanide), in intermediate and high global risk patients (SE diversion not required) (Reiffel, 2015)
• Assessment of hemodynamic significance of one of the following documented conditions:
  o Anomalous coronary arteries (Grani, 2017)
  o Myocardial bridging of coronary artery
• Coronary aneurysms in Kawasaki’s disease (Newburger, 2016) or due to atherosclerosis
• Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter (Lancellotti, 2013)

PRIOR TO ELECTIVE NON-CARDIAC SURGERY

• Patients who have no above indication for non-invasive coronary evaluation, but are referred for preoperative cardiac evaluation, are eligible for MPI if all 4 criteria are met:
  o Surgery is supra-inguinal vascular, intrathoracic, or intra-abdominal; AND
  o The patient has at least one of the additional cardiac complication risk factors:
    ▪ Ischemic Heart Disease
    ▪ History of stroke or transient ischemic attack (TIA)
    ▪ History of congestive heart failure or ejection fraction ≤ 35%
    ▪ Insulin-requiring diabetes mellitus
    ▪ Creatinine ≥ 2.0 mg/dl
  AND
  o 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
  AND
  o There has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year; and the results of such a test would be likely to substantially alter therapy and/or preclude proceeding with the intended surgery.

• Planning for solid organ transplantation is an indication for preoperative MPI, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year and with ≥ 3 of the following risk factors: (SE diversion not required) (Lentine, 2012):
  ▪ Age > 60
  ▪ Smoking
  ▪ Hypertension
  ▪ Dyslipidemia
  ▪ Left ventricular hypertrophy
  ▪ > 1 year on dialysis (for renal transplant patients)
  ▪ Diabetes mellitus
  ▪ Prior ischemic heart disease
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 if invasive coronary arteriography is not planned

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 (Pagnanelli, 2017).

Stable patients without known CAD fall into 2 categories (Fihn, 2012; Montalescot, 2013; Wolk, 2013):

- **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

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 (Fihn 2012, Wolk 2013):
<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>≥ 60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

- **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 SE in any of the following (Henzlova, 2016; Wolk, 2013):

- **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)
  - Obesity with body mass index (BMI) over 40 kg/m2 or 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 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)  
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 (Wolk, 2013):  
The (symptomatic) low or intermediate pretest probability patient who can exercise and has an interpretable ECG (Wolk, 2014)  
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 (Shen, 2017)

Duke Exercise ECG Treadmill Score (Mark 1987)  
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 (Fihn, 2012):  
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

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 or patients with a CAC score > 400 Agatston units, 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***
Arnet, 2019; D’Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007)

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.

<table>
<thead>
<tr>
<th>Risk Calculator</th>
<th>Websites for Online Calculator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reynolds Risk Score</td>
<td><a href="http://www.reynoldsriskscore.org/">http://www.reynoldsriskscore.org/</a></td>
</tr>
<tr>
<td>Can use if no diabetes</td>
<td></td>
</tr>
<tr>
<td>Unique for use of family history</td>
<td></td>
</tr>
<tr>
<td>Pooled Cohort Equation</td>
<td><a href="http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example">http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example</a></td>
</tr>
<tr>
<td>MESA Risk Calculator</td>
<td><a href="https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx">https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx</a></td>
</tr>
<tr>
<td>With addition of Coronary Artery Calcium Score, for CAD-only risk</td>
<td></td>
</tr>
</tbody>
</table>

**Definitions of Coronary Artery Disease**
(Fihn, 2012; Mintz, 2016; Montalescot, 2013; Patel, 2017)

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; borderline lesions are 40 - 70% (Fihn, 2012)
- For a left main artery, suggested by a percentage stenosis ≥ 50% (Fihn, 2012; Lofti, 2018; Mintz, 2016)
- FFR (fractional flow reserve) ≤ 0.80 for a major vessel (Lofti, 2018; Mintz, 2016)
- 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
(Fihn, 2012; Shen, 2017)

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

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADLs</td>
<td>Activities of daily living</td>
</tr>
<tr>
<td>BSA</td>
<td>Body surface area in square meters</td>
</tr>
<tr>
<td>CAD</td>
<td>Coronary artery disease</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiogram</td>
</tr>
<tr>
<td>FFR</td>
<td>Fractional flow reserve</td>
</tr>
<tr>
<td>LBBB</td>
<td>Left bundle-branch block</td>
</tr>
<tr>
<td>LVEF</td>
<td>Left ventricular ejection fraction</td>
</tr>
<tr>
<td>LVH</td>
<td>Left ventricular hypertrophy</td>
</tr>
<tr>
<td>MI</td>
<td>Myocardial infarction</td>
</tr>
<tr>
<td>MET</td>
<td>Estimated metabolic equivalent of exercise</td>
</tr>
<tr>
<td>MPI</td>
<td>Myocardial perfusion imaging</td>
</tr>
<tr>
<td>PFT</td>
<td>Pulmonary function test</td>
</tr>
<tr>
<td>PVCs</td>
<td>Premature ventricular contractions</td>
</tr>
<tr>
<td>SE</td>
<td>Stress echocardiography</td>
</tr>
<tr>
<td>VT</td>
<td>Ventricular tachycardia</td>
</tr>
<tr>
<td>VF</td>
<td>Ventricular fibrillation</td>
</tr>
<tr>
<td>WPW</td>
<td>Wolf Parkinson White</td>
</tr>
</tbody>
</table>
POLICY HISTORY:

Review Date: July 23, 2019

Review Summary:

- 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 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 EKG 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

Review Date: March 2020

Review Summary:

- 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 definition section
- Updated and added new references
REFERENCES


Einstein, A. Effects of radiation exposure from cardiac imaging: How good are the data? JACC. 2012; 59(6):553-565. Available at: http://content.onlinejacc.org/cgi/content/short/59/6/553


78459 – PET Scan, Heart (Cardiac)

CPT Codes: 78459, 78491, 78492, +78434

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 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
- High pretest probability
- 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
- Previously unevaluated ECG evidence of possible myocardial ischemia including substantial ischemic ST segment or T wave abnormalities
- Previously unevaluated pathologic Q waves
- Unevaluated complete left bundle branch block

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), but patient’s current symptoms indicate an intermediate or 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)
- An intermediate evaluation by prior stress imaging (within the past 2 years)

FOLLOW-UP OF PATIENTS POST CORONARY REVASCULARIZATION (PCI or CABG) When LVEF is ≤ 40% and revascularization is under consideration

- 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)**

- **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 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 (EF < 50%), especially with symptoms or signs of ischemia unless invasive coronary angiography is immediately planned (Fihn, 2012; Patel, 2013; Yancy, 2013)
- Reduced LVEF ≤ 50% requiring myocardial viability assessment to assist with decisions regarding coronary (Diversion from PET not required when LVEF less than or equal to 40%) (Patel, 2013; Tsai, 2014; Yancy, 2013)
- 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 (Al-Khatib, 2018)
  - 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), in intermediate and high global risk patients (SE diversion not required) (Reiffel, 2015)
- Assessment of hemodynamic significance of one of the following documented conditions (Anagnostopoulos, 2004):
  - Anomalous coronary arteries (Grani, 2017)
  - Muscle bridging of coronary artery (perform with exercise stress) (Sorajja, 2018)
• Coronary aneurysms in Kawasaki’s disease (McCrindle, 2017) or due to atherosclerosis
• Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter (Lancellotti, 2013)

**Cardiac Sarcoidosis** (Birnie, 2016; Blankstein, 2016; Vita, 2018)
  - 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 (Vita, 2018)
• Evaluation of CMR findings showing highly probable cardiac sarcoidosis, when PET could serve to identify inflammation and the consequent potential role for immunosuppressive therapy (Vita, 2018)
  - Initial and follow up PET in monitoring therapy for cardiac sarcoid with immunosuppressive therapy, typically about 4 times over 2 years

**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 (Doherty, 2017; Habib, 2016; Wang, 2018)

**Aortitis**
  - For diagnosis and surveillance of Aortitis, PET/CT or PET/MRI hybrid imaging (Bhave, 2018)

**PRIOR TO ELECTIVE NON-CARDIAC SURGERY (When neither SE nor MPI have provided or are expected to provide optimal imaging)**
• Patients who have no other indication for a non-invasive coronary evaluation, but are referred for preoperative cardiac evaluation, are eligible for MPI if **all 4 criteria** are met:
  - Surgery is supra-inguinal vascular, intrathoracic, or intra-abdominal;
  - The patient has at least one of the additional cardiac complication risk factors:
    - Ischemic Heart Disease
    - History of stroke or TIA
    - History of congestive heart failure or ejection fraction ≤ 35%
    - Insulin-requiring diabetes mellitus
    - Creatinine ≥ 2.0 mg/dl
  - 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
AND

- There has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, and the results of such a test would be likely to substantially alter therapy and/or preclude proceeding with the intended surgery.

- Planning for solid organ transplantation is an indication for preoperative MPI, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year with ≥ 3 of the following risk factors (SE diversion not required) (Lentine, 2012):
  - Age > 60
  - Smoking
  - Hypertension
  - Dyslipidemia
  - Left ventricular hypertrophy
  - 1 year on dialysis (for renal transplant patients)
  - Diabetes mellitus
  - Prior ischemic heart disease

POST CARDIAC TRANSPLANT (SE diversion not required)
(McArule, 2012)

- 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

BACKGROUND
(Bateman, 2016; Fazel, 2011)

- 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
- For assessment of suspected significant hibernating myocardium in the presence of known severe major vessel CAD, when EF is below 40%, in order to determine a patient’s potential benefit from coronary revascularization (Patel, 2013; Tsai, 2014; Yancy, 2013)
- When strong suspicion of balanced ischemia is noted, and further non-invasive coronary evaluation required, PET can be used, without diversion from PET (Bengel, 2009)
- Prior alternative perfusion (MPI or CMR) imaging resulted in an indeterminate evaluation for CAD
- Cardiac positron emission tomography (PET) can characterize myocardial blood flow by perfusion scanning with either rubidium-82 (Rb-82) or nitrogen-13 (N-13) ammonia
- PET 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.
PET can be use 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 (Fihn, 2012; Montalescot, 2013; Wolk, 2013):

- **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

Once the type of chest pain has been established from the medical record, the Pretest Probability of CAD (meaning obstructive CAD defined as coronary arterial narrowing ≥ 50%) is estimated from the Diamond Forrester Table below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability (Fihn, 2012; Wolk, 2013):

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40 – 49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>50 – 59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>≥ 60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

- Very Low: < 5% pretest probability, usually not requiring stress evaluation
- **Low**: 5 - 10% pretest probability of CAD
- **Intermediate**: 10% - 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 (Wolk 2013):

- The (symptomatic) low or intermediate pretest probability patient who is able to exercise and has an interpretable ECG (Wolk, 2014)
- 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 (Shen, 2017)

**Duke Exercise ECG Treadmill Score** (Mark, 1987)
Calculates risk from ECG treadmill alone:

- The equation for calculating the Duke treadmill score (DTS) is: $DTS = \text{exercise time in minutes} - (5 \times \text{ST deviation in mm or } 0.1 \text{ mV increments}) - (4 \times \text{exercise angina score})$, 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 $\geq + 5$), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of $\leq - 11$) categories.

An uninterpretable baseline ECG includes (Fihn, 2012):
- 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

**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 or patients with a CAC score > 400 Agatston units, 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***
(Arnet, 2019; D’Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007)

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.

<table>
<thead>
<tr>
<th>Risk Calculator</th>
<th>Websites for Online Calculator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can use if no diabetes</td>
<td></td>
</tr>
<tr>
<td>Unique for use of family history</td>
<td></td>
</tr>
<tr>
<td>MESA Risk Calculator</td>
<td><a href="https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx">https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx</a></td>
</tr>
<tr>
<td>With addition of Coronary Artery</td>
<td></td>
</tr>
<tr>
<td>Calcium Score, for CAD-only risk</td>
<td></td>
</tr>
</tbody>
</table>

**Definitions of Coronary Artery Disease**
(Fihn, 2012; Montalescot, 2013; Patel, 2017)

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; borderline lesions are 40 - 70% (Fihn, 2012)
For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum lumen cross sectional area on IVUS ≤ 6 square mm (Fihn, 2012; Lofti, 2018)

- FFR (fractional flow reserve) ≤ 0.80 for a major vessel (Lofti, 2018)
- iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel (Davies, 2017; Gotberg, 2017; Lofti, 2018)
- 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.
- iFR (instantaneous wave-free ratio) measures the ratio of distal coronary to aortic pressure during the wave free period of diastole, with a value ≤ 0.89 considered hemodynamically significant (Davies, 2017; Gotberg, 2017).
- Newer technology that estimates FFR from CCTA image is covered under the separate NIA Guideline for FFR-CT.

**Anginal Equivalent**
(Fihn, 2012; Shen, 2017)

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
- CAD: Coronary artery disease
- ECG: Electrocardiogram
- FFR: Fractional flow reserve
- LBBB: Left bundle-branch block
- LVEF: Left ventricular ejection fraction
- LVH: Left ventricular hypertrophy
- MI: Myocardial infarction
- MET: Estimated metabolic equivalent of exercise
- MPI: Myocardial perfusion imaging
- PFT: Pulmonary function test
Policy History:
Review Date: August 2019
Review Summary:
• 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

November 2019
• Removed CPT code +0482T and replaced with code +78434

Review Date: March 2020
Review Summary:
• 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
REFERENCES


|--------------------------------------------------|


78472 – MUGA Scan

CPT Codes: 78472, 78473, 78494, +78496

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
(Doherty, 2019)

• 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:
  o When ventricular function is required for management, and transthoracic echocardiography (TTE) or other imaging has proven inadequate (Patel, 2013; Yancy, 2013)
  o 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
  o 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 (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

BACKGROUND:
(Friedman, 2006; Mitra, 2012; Patel, 2013; Ritchie, 1995)

Multiple-gated acquisition (MUGA) scanning uses radio-labelled 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:

Review Date: July 23, 2019

Review Summary:

- 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:
  - In the course of cardiotoxic chemotherapy when TTE images are inadequate to evaluate left ventricular systolic function (Patel 2013, Plana 2014, Yancy 2013, Zamorano 2016):
    - 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
    - In patients with EF < 50% on TTE receiving potentially cardiotoxic chemotherapy, more frequent monitoring (every 4 weeks) may be appropriate
    - Removed section on Radionuclide Angiography, Combination of Other Studies with MUGA, section on TTE and strain

Review Date: March 2020

Review Summary:

- 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.
REFERENCES:


## 78608 – PET Scan, Brain

**CPT Codes:** 78608, 78609

### INDICATIONS FOR BRAIN PET SCAN using FDG (Fluorodeoxyglucose):
(Albano, 2018; de-Bonilla-Damiá, 2017; Jones, 2016; Lewitschnig, 2013; Maza, 2013)

**Known brain tumor or cancer:**
- To differentiate radiation necrosis or post treatment change from residual/recurrent tumor on brain MRI* ([NCCN, 2020](#))
- To differentiate low from high grade glioma when brain MRI* is inconclusive (Dunet, 2016; Verger, 2017)
- For evaluation of primary brain lymphoma when brain MRI* is inconclusive
- To guide intervention/biopsy

**To determine operability of refractory seizures** (Govil-Dalela, 2018; Jones, 2016; Tang, 2019)

**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 for the type and area(s) of requested imaging.

**Mild Cognitive Impairment or Dementia:**
(Motara, 2017)

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 an initial insufficient evaluation with a brain MRI* and both of the following have been met ([ACR, 2015; Bohnen, 2011](#)):

- Objective cognitive impairment (Albert, 2011; Iaccarino, 2017)
  - Mini Mental Status Evaluation (MMSE) or Montreal Cognitive Assessment (MoCA) less than 26 ([Davis, 2015](#)); OR
  - Neuropsychological testing showing at least mild cognitive impairment ([Caminiti, 2018; Inui, 2017](#))
- Potential treatable causes assessed and addressed (Albert, 2011)
  - Metabolic such as thyroid or vitamin deficiency, anemia, or toxic metabolic encephalopathy
  - Medication side effects ([Campbell, 2010](#))
  - Medical causes such as vascular or traumatic or inflammatory

*Note: Brain CT if brain MRI is contraindicated*

### BACKGROUND:
TABLE OF CONTENTS

Positron Emission Tomography (PET) scanning using FDG (fluorodeoxyglucose) assesses brain metabolism and perfusion. Uses include identifying epileptic foci prior to surgery, differentiation of residual tumor versus scar, and causes of cognitive decline (Wippold, 2015).

Current agents which show promise in assessing plaques of the protein beta-amyloid include: florbetapir F 18, florbetaben F 18, and flutemetamol F 18 with PET. PET/MR is also being studied (Zhang, 2017). Some other new agents look at the tau protein and microglial activation.

POLICY HISTORY:
Review Date: June 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• 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
REFERENCES


American College of Radiology (ACR). ACR-ASNR Practice Parameter for Brain PET/CT Imaging in Dementia. 2015.


INDICATIONS FOR A BONE/JOINT SPECT/SPECT CT SCAN:

When routine dynamic planar imaging is insufficient (ACR, 2017; Bartel, 2018; Donohoe, 2020; NCCN, 2020; O’Sullivan, 2017).

- Screening evaluation of patients with recent / active malignancy presenting with elevated alkaline phosphatase, or bone pain or new pathological fracture
- Staging or Restaging evaluation for the following, when recent overlapping whole body imaging (CT or PETCT of the chest, abdomen and pelvis) has not been done.

**Note:** For known bone metastases, whole body planar bone scan for staging and restaging is typically sufficient.

  - Breast cancer≥ stage IIA
  - Prostate cancer with PSA ≥ 10 or Gleason ≥7 or ≥T3 or before radionuclide bone therapy
  - Monitoring of exclusively or predominantly bone metastases

- For all cancers, if other imaging (any of CT/MRI/ PETCT) could not be done or are inconclusive in evaluation of bone metastases
- For all other cancers, prior to and during radionuclide bone therapy.
- Detection of osteomyelitis and/or discitis with documented history of having a plain x-ray AND an MRI of the area performed, unless MRI is contraindicated, technically limited or inconclusive (Tamm, 2017).
• Detection of early avascular necrosis, bone infarct, or bone graft viability and patient has had a plain x-ray OR a CT of the suspicious area and MRI is contraindicated or inconclusive (Diederichs, 2017).

• Detection of stress fractures (includes pars interarticularis) and other occult skeletal trauma and patient has localized pain in the suspected area after negative or inconclusive x-ray (Bartel, 2018). (If history of recent MRI of suspected area, those MRI results should be either negative or inconclusive to necessitate bone SPECT.)

• Resolution of questionable/inconclusive abnormal skeletal radiographs when MRI or CT is inconclusive or cannot be performed.

• 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)

• For evaluation of unexplained extremity pain when clinical criteria and other imaging (x-ray, MRI, Ultrasound or CT) evaluation is inconclusive (e.g., differentiating complex regional pain syndrome from other causes of pain) (Ha, 2015; Huellner, 2013; Kwon, 2011; Shin, 2017).

• 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:**

Single-photon emission computed tomography (SPECT) is a nuclear medicine imaging technique 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 (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 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 Single-Photon Emission Computed Tomography (SPECT or 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 vs MRI for some indications (Deidrichs, 2017; Ha, 2015; Huellner, 2013; Israel, 2019)
Nuclear medicine bone imaging is commonly performed with Technicium-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. Technetium 99m sulfur colloid scan is typically used concordantly for marrow mapping.

When indicated, for patients with impaired renal function who cannot receive iodinated or gadolinium based contrast agents or undergo MRI for other reasons, SPECT imaging can improve the performance of conventional planar nuclear bone imaging. Although $^{18}$F 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” (O’Sullivan, 2015).

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 (Shin, 2017). In general, scintigraphy is more specific than MRI. SPECT imaging however is not routinely used for this indication.

**INDICATIONS FOR NON-BONE INFECTION / INFLAMMATION SPECT/SPECT CT:**

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

**BACKGROUND:**

Infection seeking tracers labelled with single-photon-emitting radionuclides include autologous leukocytes [white blood cells (WBC)] labelled with 99mTc-hexamethylpropyleneamine oxime (HMPAO) or $^{111}$In-diethylenetriaminepentaaceticacid (DTPA). Imaging is typically completed the same day (tc labelled agents) or the 2nd day (Indium labelled agents). CT portion of SPECT CT localizes the infection agent accumulation to the anatomic site. These are 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.

**INDICATIONS FOR TUMOR SPECT/SPECT CT:**

- 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-123 meta-iodobenzylguanidine (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.
- Lymphoscintigraphy with sentinel node localizations, for preoperative planning in melanoma, breast, and gynecological cancers

**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 Imaging are used to assess neuroendocrine tumors for somatostatin (SSTR) receptors so as to enable treatment with somatostatin analogs such as Octreotide acetate (Sandostatin).

177Lu-Dotatate is a treatment for neuroendocrine cancers that have SSTR expression as seen on Gallium 68 PET or Indium 111 pentreotide/ Octotide imaging. 90Y- ibrutinomab tiuxetan or Zevalin® is used as treatment for refractory non hodgkins lymphoma and may need initial biodistribution assessment with Indium111 ibrutinomab tiuxetan. Therapeutic agents have some gamma or bremsstrahlung radiation that can be harnessed to image, to 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 see if involved, in which case the cancer is upstaged. For exact anatomic correlation, SPECT/ SPECTCT is preferred, but may not be done due to time constraints before surgery. It is limited to newer systems with faster SPECT CT acquisition times or if planar imaging is inconclusive.
INDICATIONS FOR CARDIAC SPECT/SPECT CT:
As addressed in MPI and MUGA guidelines.

INDICATIONS FOR NECK SPECT/SPECT CT (NON-CANCER):
- Clinically or laboratory proven hyperparathyroidism AND ultrasound of the neck completed.
- Abnormal Thyroid tests and planar imaging is inconclusive for a focal lesion.

BACKGROUND:
Parathyroid adenomas are evaluated typically initially by cervical ultrasound. Parathyroid SPECT/SPECTCT with Tc99m sestamibi, or iodine/ sestamibi tracers 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.

INDICATIONS FOR LUNG SPECT/SPECTCT:
- 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.

BACKGROUND:
Ventilation Perfusion scans are typically done for pulmonary embolism assessment when Chest CTA cannot be done; or for young patients, or in pregnancy when they have a normal chest x-ray (ATS 2011, 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 (similar to CTA) have enabled planar images to be the preferred method of evaluation of acute PE (Pulmonary Embolism). 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.
INDICATIONS FOR A BRAIN SPECT/ SPECT CT (ACR, 2016):

- For preoperative localization of epileptic foci after EEG, Brain MRI and PET are done and insufficient (Duncan, 2016; Von Oertzen, 2018).
- For patient with history of stroke or trauma with recent Brain CT or MRI AND there are acute neurological changes or deficits not explained on the recent imaging study (ACR, 2016)
- To evaluate cerebrovascular reserve in planning appropriate endovascular vascular intervention or neurovascular surgical approach (ACR, 2016)
- DAT scan for suspected Parkinsonian syndromes (PS), to help differentiate essential tremor, drug induced parkinsonism from parkinsonian syndromes; or for early/ inconclusive parkinsonian features or dementia (Isaacson, 2017; Kupsch, 2013, SNMMI, 2011).
- Brain perfusion study for evaluation of brain death when CT or MRI already done AND planar images have inconclusive findings (SNMMI, 2012).
- 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:

Brain tracers injected 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 done 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 are usually evaluated with brain MRI (or brain CT if there is a contraindication to brain MRI). However, if these are inconclusive, or limited, or could not be done, or 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 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 (ACR, 2015).
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’s 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.

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
  - Brain/spine or respective site imaging already done with appropriate CT/ MRI / CT myelography, and deemed to be insufficient; AND
  - Planar images are insufficient.
- 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 (Ma, 2015). 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 (Damasceno, 2015; Halperin, 2015).
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 (Lloyd, 2008), 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 (Epstein, 2013; Lloyd, 2008). Diagnosis using scintigraphy requires intrathecal administration of radionuclide followed by imaging typically at 3, 6, 24, 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 (Eljazzar, 2019; Hiremath, 2019; Lipschitz, 2019).

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 (Lin, 2017). Radionuclide cisternography was found to be more sensitive than CT myelography in a few limited case series (Hashizume 2012; Wiesemann, 2006; Yoo, 2008). 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 (Martineau, 2020). SPECT-CT allows improved anatomical localization and characterization (Arai, 2012; Novotny, 2009).

**INDICATIONS FOR RENAL SPECT/ SPECTCT (ACR, 2017; SNMMI, 2018):**

Complex clinical scenarios involving the following indications wherein cross sectional imaging and routine nuclear medicine dynamic planar imaging is insufficient alone:

- 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; **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 (ACR, 2015, 2017)
- For diagnosis of reno-vascular hypertension with signs, symptoms, laboratory findings, or other imaging supporting the need for such a diagnosis when MRA or CTA cannot be performed or is contraindicated; **AND**
  - Duplex Ultrasound is inconclusive; **AND**
The patient has adequate renal function (GFR >30) mL/min/1.73 m2.) to undergo the study (ACR, 2017)

- Further evaluation of renal perfusion and split function after completion of ultrasound including in the setting of surgery, trauma, infection, congenital and mass abnormalities (ACR, 2017).
- Diagnosis of renal transplant complications after ultrasound has been performed (ACR, 2017).
- 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, and washout is therefore easier to evaluate. $^{99m}$Tc-DTPA (diethylene triamine pentaacetic acid) is filtered purely by the glomerulus and thus can be used both to image the kidney and to measure glomerular filtration rate. Tc $^{99m}$ 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 (ACR, 2017).

Renal scintigraphy can be used to screen for post operative 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, congenital and mass abnormalities.

**INDICATIONS FOR ABDOMEN / PELVIS SPECT/ SPECT CT SCAN:**

- Hepatic radioembolization (ACR-ABR-ASTRO-SIR-SNMMI 2019):
  - For evaluation of pulmonary and gastrointestinal shunts or dosimetry calculations prior to procedure.
  - Post procedure imaging within 24 hours to confirm distribution
- For evaluation of intermittent/ occult Gastrointestinal bleeding after initial workup is indeterminate/contraindicated (scopes, CT/CTA) AND planar images are insufficient to localize the bleed (ACR, 2015).
- For evaluation of indeterminate or vascular hepatic lesions or bleed, when CT/MRI are contraindicated/inconclusive (ACR, 2017).
- For evaluation of indeterminate accessory splenic tissue/asplenia when CT/MRI are contraindicated/inconclusive (ACR, 2015).
- Liver transplant function and complications when ultrasound/CT/MR are indeterminate or contraindicated (ACR, 2017)
- Localization of suspected ectopic/residual gastric tissue (e.g., meckel’s diverticulum) (ACR, 2015).
- For localization of abnormalities in hepatobiliary scintigraphy (e.g., biliary abnormalities/leaks) when ultrasound (in infants) or CT is inconclusive/contraindicated (ACR, 2017)
- Peritoneal imaging when planar imaging is insufficient AND CT is inconclusive/ contraindicated (ACR, 2015).
- 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) (Grady, 2016).

Tc99m sulfur colloid (and sometimes Tc99m RBC) ARE used to identify indeterminate vascular hepatic lesions such as hemangiomas, 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 glass or resin microspheres. Tc99m MAA arterial injection before the procedure is needed to ensure that an excessive uncorrectable shunt of the treatment agent to the lungs or the GI tract is not present. Post procedure bremsstrahlung planar imaging (using the Y90 embolization agent), SPECT, SPECT/CT, is recommended within 24 hours of the conclusion of the procedure to document the placement of the devices and assess for significant extrahepatic shunting.

Peritoneal imaging includes evaluation of patency of peritoneovenous shunts, diaphragmatic perforations or peritoneal loculations, especially prior to intraperitoneal chemotherapy. This is done by injection of tc99m MAA into the peritoneal cavity.

SPECT / SPECTCT in hepatobiliary imaging can help localize abnormalities in hepatobiliary imaging 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 done 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.
POLICY HISTORY

BONE/JOINT SPECT/SPECT CT SCAN:
Review Date: April 2019
Review Summary:
• Emphasized the indication is for High Risk patients and not routine workup for all patients with cancer
• Updated references
Review Date: May 2020
Review Summary:
• 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”

NON-BONE INFECTION/ INFLAMMATION SPECT/SPECT CT:
Review Date: May 2020
Review Summary:
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:
Review Date: May 2020
Review Summary:
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.
• Lymphoscintigraphy with sentinel node localizations, for preoperative planning in melanoma, breast, and gynecological cancers

CARDIAC SPECT/SPECT CT:
NECK SPECT/SPECT CT (NON-CANCER):
Review Date: May 2020
Review Summary:
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:
Review Date: May 2020
Review Summary:
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.

BRAIN SPECT/SPECT CT:
Review Date: April 2019
Review Summary: Updated references only
Review Date: May 2020
Review Summary:
- 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

RADIONUCLIDE CISTERNOGRAPHY (CSF) SPECT/SPECT CT SCAN:
Review Date: April 2019
Review Summary:
• Added content explaining this study is appropriate after other imaging has been completed or is contraindicated
• Updated references

Review Date: May 2020
Review Summary:
• Initial indications distilled into one for all CSF imaging
• Abbreviated background, added references

RENAL SPECT/SPECT CT:
Review Date: April 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• 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.

ABDOMEN/PELVIS SPECT/ SPECT CT SCAN:
Review Date: April 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• 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
REFERENCES:

BONE/JOINT


**NON-BONE INFECTION/INFLAMMATION**


**TUMOR**


NECK (NON-CANCER)


LUNG
American College of Radiology (ACR). ACR–SPR–STR practice parameter for the performance of
TABLE OF CONTENTS


**BRAIN**


**CEREBROSPINAL FLUID (CSF)**


RENAL


**ABDOMEN/ PELVIS**


78813 – PET Scans
78816 – PET Scans with CT Attenuation

CPT Codes:
78811 - Limited area e.g. Chest, head/neck
78812 - Skull base to mid thigh
78813 - Whole Body
78814 - With CT attenuation (Limited area e.g. Chest, head/neck)
78815 - With CT attenuation (Skull base to mid thigh)
78816 - With CT attenuation (Whole Body)

ADULT AND PEDIATRIC MALIGNANCIES (NCCN, 2019, 2020)

The appropriateness of an ordered PET/CT study is fully dependent on the answer to the question of which radiopharmaceutical will be used for the PET/CT. This guideline only covers the radiopharmaceuticals F$^{18}$ FDG, Ga$^{68}$ Dotatate, F$^{18}$ Fluciclovine (Axumin).

FDG-PET/CT (fluorodeoxyglucose-positron emission tomography):

For Lung Nodule seen on LDCT or CT+ contrast:
- Solid Component of Dominant Nodule ≥ 8mm
- 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

INDICATED FOR BIOPSY PROVEN CANCER OR STRONGLY SUSPECTED, BASED ON OTHER DIAGNOSTIC TESTING, INCLUDING:

<table>
<thead>
<tr>
<th>CANCER (FDG PET/CT)</th>
<th>INITIAL STAGING</th>
<th>RESTAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenal (other than pheochromocytoma/paraganglioma)</td>
<td>Not Indicated</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>AIDS related Kaposi Sarcoma</td>
<td>with prior inconclusive imaging</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>CANCER (FDG PET/CT)</td>
<td>INITIAL STAGING</td>
<td>RESTAGING</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>ALL (Acute Lymphoblastic Leukemia)</td>
<td>lymphomatous extramedullary disease</td>
<td>lymphomatous extramedullary disease</td>
</tr>
<tr>
<td>AML (Acute Myelogenous Leukemia)</td>
<td>If suspected extramedullary involvement</td>
<td>If suspected/known extramedullary involvement</td>
</tr>
<tr>
<td>Anal</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Anaplastic Thyroid Cancer</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>BCC (Basal Cell Carcinoma (of the skin))</td>
<td>Not Indicated</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>Bladder</td>
<td>Muscle invasive only, with prior inconclusive imaging</td>
<td>Metastatic only, with prior inconclusive imaging</td>
</tr>
<tr>
<td>Breast</td>
<td>stage IIb and above</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Castleman’s disease</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Cervical</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Chordoma</td>
<td>with prior inconclusive imaging</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>CLL (Chronic Lymphocytic Leukemia) /SLL (Small Lymphocytic Leukemia)</td>
<td>For suspected high-grade transformation or to guide biopsy</td>
<td>with accelerated CLL or to guide biopsy</td>
</tr>
<tr>
<td>Colorectal</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Chondrosarcoma (bone)</td>
<td>Not Indicated</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>Endometrial</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Esophageal and esophagogastric junction</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>CANCER (FDG PET/CT)</td>
<td>INITIAL STAGING</td>
<td>RESTAGING</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ewing sarcoma- osseous</td>
<td>with MR/CT of local area disease and Chest CT and prior inconclusive bone scan</td>
<td>with prior inconclusive bone scan; or prior PET/CT demonstrated disease not seen on other imaging modalities</td>
</tr>
<tr>
<td>Extrahepatic Cholangiocarcinoma</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Gallbladder</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Gastric Cancer</td>
<td>with prior inconclusive imaging or if radiation is being considered</td>
<td>with prior inconclusive imaging. PET/CT is indicated for post radiation imaging</td>
</tr>
<tr>
<td></td>
<td><strong>(Not indicated for T1N0M0 or M1)</strong></td>
<td></td>
</tr>
<tr>
<td>Gestational trophoblastic cancer</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Head and neck (including mucosal melanoma of the head and neck)</td>
<td><strong>Indicated</strong> - May be done in conjunction with a dedicated face/neck CT/MRI when surgery or radiation is planned</td>
<td><strong>Indicated</strong> (If final PET/CT is equivocal or borderline for residual disease, a repeat PET/CT at &gt; 6 weeks may help identify those that can be safely observed without additional surgery)</td>
</tr>
<tr>
<td>Hepatocellular / Intrahepatic Cholangiocarcinoma</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Langerhans Cell</td>
<td><strong>Indicated</strong></td>
<td><strong>Indicated</strong></td>
</tr>
<tr>
<td>Histiocytosis</td>
<td><strong>Not indicated</strong></td>
<td><strong>Not indicated</strong></td>
</tr>
<tr>
<td>-predominantly osseous disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-non osseous disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td><strong>Indicated</strong></td>
<td><strong>Indicated</strong></td>
</tr>
<tr>
<td>• ALL non-small cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CANCER (FDG PET/CT)</td>
<td>INITIAL STAGING</td>
<td>RESTAGING</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Limited stage small cell stage I-III except T3/T4</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Lung</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Extensive small cell (Stage IV and T3/T4)</td>
<td><strong>Not indicated</strong></td>
<td><strong>Not Indicated</strong></td>
</tr>
<tr>
<td>Lymphoma (Non -Hodgkins and Hodgkins)</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Medullary Thyroid Cancer</td>
<td><strong>FDG Not Indicated (see Dotatate below)</strong></td>
<td>when calcitonin levels $\geq$ 150 pg/ml or CEA levels $&gt;5$ ng/ml post-surgery with prior insufficient Dotatate scan</td>
</tr>
<tr>
<td>Melanoma (See Uveal melanoma below for indications)</td>
<td>only stage III, IV</td>
<td>only stage III, IV</td>
</tr>
<tr>
<td>Merkel cell</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Mesothelioma (pleural)</td>
<td>Indicated only prior to surgery for stage I-IIIA</td>
<td>Indicated only prior to surgery for stage I-IIIA</td>
</tr>
<tr>
<td>Multiple Myeloma</td>
<td>Indicated</td>
<td>Indicated - Active myeloma/plasmacytoma only</td>
</tr>
<tr>
<td>- smoldering myeloma (asymptomatic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- active myeloma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- plasmacytoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovarian/Fallopian tube Cancer/ Primary peritoneal cancer</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Occult primary</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Osteosarcoma- Osseous</td>
<td>with MR/CT of local area disease and Chest CT and prior inconclusive bone scan</td>
<td>with prior inconclusive bone scan or prior PET/CT demonstrated disease not seen on other imaging modalities</td>
</tr>
<tr>
<td>CANCER (FDG PET/CT)</td>
<td>INITIAL STAGING</td>
<td>RESTAGING</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Other malignancies</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
</tbody>
</table>
| Pancreatic cancer                         | o with prior inconclusive imaging OR  
|                                          | o with any of the following high-risk features:  
|                                          | o borderline resectable disease  
|                                          | o markedly elevated CA19-9 >180 U/ml  
|                                          | o large primary tumor/lymph nodes  
|                                          | o very symptomatic (jaundice, symptomatic gastric outlet obstruction, venous thromboembolism, extreme pain and excessive weight loss) | Not Indicated                                                             |
| Penile                                    | with prior inconclusive imaging                                                | with prior inconclusive imaging                                          |
| Poorly differentiated or dedifferentiated | with prior negative or inconclusive Ga68 Dotatate scan                        | with prior negative or inconclusive Ga68 Dotatate scan  
| neuroendocrine tumors                     |                                                                                | For pheochromocytoma/paraganglioma, extrapulmonary large/small cell- FDG PET/CT may be done before a Dotatate scan after inconclusive CT |
| prostate cancer                           | Not Indicated                                                                 | Not Indicated                                                             |

*See F18-Fluciclovine section below*
<table>
<thead>
<tr>
<th>CANCER (FDG PET/CT)</th>
<th>INITIAL STAGING</th>
<th>RESTAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal</td>
<td>Not Indicated</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>Skin squamous cell</td>
<td>with prior inconclusive imaging</td>
<td>Not Indicated</td>
</tr>
<tr>
<td>Small bowel adenocarcinoma</td>
<td>Not indicated</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Soft tissue sarcoma (e.g., soft tissue Ewing sarcoma and osteosarcoma)/ GIST/ Rhabdomyosarcoma</td>
<td>with prior inconclusive imaging</td>
<td>Pediatric- Indicated</td>
</tr>
<tr>
<td>Testicular</td>
<td>Seminoma- Not Indicated Non seminoma- Not Indicated</td>
<td>Seminoma- with prior inconclusive imaging or residual mass &gt;3cm or 6 weeks post chemotherapy (If final PET/CT is equivocal or borderline for residual disease PET/CT, a repeat PET/CT a ≥ 6 weeks may help identify those that can be safely observed without additional surgery) Non seminoma- Not Indicated</td>
</tr>
<tr>
<td>Thymoma and thymic cancer</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Thyroid (papillary/follicular/Hurthle)</td>
<td>Not Indicated</td>
<td>1. A thyroidectomy and radiiodine ablation initially; AND 2. Stimulated serum thyroglobulin &gt;2 ng/ml or high anti- thyroglobulin antibody (anti-Tg Ab) &gt;1 year after treatment AND 3. Current OR two prior stimulated whole body I-131/ I-123 scans are negative (a current scan is</td>
</tr>
<tr>
<td>CANCER (FDG PET/CT)</td>
<td>INITIAL STAGING</td>
<td>RESTAGING</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Uterine</td>
<td>with prior inconclusive imaging</td>
<td>with prior inconclusive imaging</td>
</tr>
<tr>
<td>Uveal Melanoma</td>
<td>Not Indicated</td>
<td>With prior inconclusive imaging</td>
</tr>
<tr>
<td>Vaginal</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>Vulvar</td>
<td>≥T2 or after prior inconclusive imaging</td>
<td>Indicated</td>
</tr>
</tbody>
</table>

**GA^68 DOTATATE**

<table>
<thead>
<tr>
<th>CANCER (GA68 DOTATATE PET/CT)</th>
<th>INITIAL STAGING AND RESTAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinoid</td>
<td>• Biopsy proven AND to determine eligibility for Lutetium-177 therapy</td>
</tr>
<tr>
<td>Extrapulmonary large/small cell</td>
<td>OR</td>
</tr>
<tr>
<td>MEN-1/MEN-2 Syndromes</td>
<td>• Biopsy proven AND prior CT/ MRI insufficient for any of:</td>
</tr>
<tr>
<td>Neuroendocrine tumors</td>
<td>o Determine extent of treatment plan</td>
</tr>
<tr>
<td>Pheochromocytoma/paragangioma</td>
<td>o Determine if candidate for invasive diagnostic/therapeutic procedure</td>
</tr>
<tr>
<td></td>
<td>o Determine optimal anatomic location for invasive procedure</td>
</tr>
<tr>
<td></td>
<td>o Restaging or monitoring response to active treatment, and/or evaluation for suspicion of recurrence due to new or changing signs/symptoms and rising biomarkers (asymptomatic surveillance is not approvable).</td>
</tr>
<tr>
<td>Medullary thyroid Cancer</td>
<td>Initial staging- Prior CT/ MRI insufficient for any of:</td>
</tr>
<tr>
<td></td>
<td>- Determine extent of treatment plan</td>
</tr>
<tr>
<td></td>
<td>- Determine if candidate for invasive diagnostic/therapeutic procedure</td>
</tr>
<tr>
<td></td>
<td>- Determine optimal anatomic location for invasive procedure</td>
</tr>
<tr>
<td></td>
<td>Restaging- when calcitonin levels ≥ 150 pg/ml or CEA levels &gt;5 ng/ml post surgery</td>
</tr>
</tbody>
</table>
# F18 FLUCICLOVINE (AXUMIN)

## CANCER (F18 FLUCICLOVINE (AXUMIN))

<table>
<thead>
<tr>
<th>CANCER (F18 FLUCICLOVINE (AXUMIN))</th>
<th>INITIAL STAGING</th>
<th>RESTAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prostate Cancer</td>
<td>With prior inconclusive bone scan with no CT/MRI correlate; or inconclusive bone SPECT/CT</td>
<td>With rising/persistent PSA AND after CT/MRI has been performed and is insufficient for detection of metastases</td>
</tr>
</tbody>
</table>

## SUBSEQUENT TREATMENT STRATEGY:

- For restaging or monitoring response to 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.
- 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.
- Asymptomatic surveillance is not approvable.

## 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 (RSNA, 2018).
- 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

**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 (eg, bone scan, PET/CT)
• Increasing tumor markers (eg, carcinoembryonic antigen [CEA], CA 15-3, CA27.29)

PET/CT also helps to differentiate active tumor from necrotic or inactive scar tissue, malignant from benign tissue, and recurrent tumor from nondescript benign changes.

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.

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/CT 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.

**Langerhans Cell Histiocytosis** (Jessop, 2020; Daldrup-Link, 2001; Obert, 2017; Phillips, 2009). The most common type of histocytosis, with variable presentations and sites involvement. The osseous structures are the most common site of involvement. PET/CT is highly sensitive and specific for whole body evaluation as FDG is a metabolite of the histocyte cell and allows for a reproducible evaluation for response to effectiveness of treatment on restaging exams. Some studies suggest PET/CT that 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 maybe delayed. PET/CT is however not the modality of choice in assessing disease response of lung or brain lesions, in these scenarios Chest CT (HRCT) and Brain MRI would be the test of choice, respectively.

**POLICY HISTORY:**
**Review Date:** September 2019
**Review Summary:**
• 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 F¹⁸ FDG, Ga⁶⁸ Dotatate, F¹⁸ Fluciclovine (NCCN 2019):”

• Under noncovered for F¹⁸ FDG, Ga⁶⁸ Dotatate, F¹⁸ 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
  ▪ Adrenal (except pheochromocytoma/ paraganglioma) - Initial or Restaging
  ▪ Smoldering Myeloma - except to discern smoldering from active myeloma with negative skeletal survey
  ▪ ALL (Acute Lymphoblastic Leukemia)/ AML (Acute Myelogenous Leukemia) - Unless prior imaging suggests lymphomatous involvement
  ▪ BCC (Basal Cell Carcinoma (of the skin))
  ▪ 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
  - Unless prior CT imaging suggest lymphomatous involvement
- AML – acute myelogenous leukemia
  - 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):
  - Colorectal
  - Ovarian/ fallopian
  - Sarcoma/ GIST/ Uterine/Rhabdomyosarcoma
  - Chordoma
  - Muscle invasive bladder cancer
  - Endometrial Cancer
  - Penile (for palpable nodes only)
  - Occult Primary
  - Pancreatic Cancer (unless high risk features: borderline resectable, markedly elevated CA19-9 > 180 U/ml, large primary tumor/ lymph nodes)
  - Skin squamous Cell Carcinoma
  - Gallbladder/ Extrahepatic Cholangiocarcinoma
  - 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\textsuperscript{18}FDG, Ga\textsuperscript{68} Dotate, F\textsuperscript{18}Fluciclovine PET is delayed 2 - 3 months 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”
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 F¹⁸ FDG, Ga⁶⁸ Dotatate, F¹⁸ 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 F¹⁸ FDG, Ga⁶⁸ Dotatate, F¹⁸ Fluciclovineavid on prior PET/CT imaging if done, and other imaging (ie: US, CT, MRI, NM) is inconclusive in determining a 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)”
• 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, Soutiero 2019)”
• 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 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”
  o Modified last part of the last sentence as follows: “and rising biomarkers (asymptomatic surveillance is not approvable). “

• Under 18F-Fluciclovine PET/CT SCAN:
  o Added “(Axumin)” after 18F-Fluciclovine
  o Removed reference “(Bach-Gansmo, 2017)”
  o 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)”
  o Removed:” Known prostate cancer for workup of recurrence and response to treatment:”
  o “Initial treatment by radical prostatectomy with” was replaced by “Post radical prostatectomy with”
  o “Initial treatment radiation therapy with” was replaced by “Post radiation therapy with”
  o “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.

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."

Review Date: May 2020

Review Summary:

- 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
  - Changed AML to extramedullary disease (previously lymphomatous involvement)
  - Changed Breast cancer stage IIb and above (previously III and IV)
  - Added Castleman’s disease
  - Added for Chronic Lymphocytic Leukemia to guide biopsy
  - Changed Mesothelioma to only prior to surgery for stage I-IIIA
  - Added “soft tissue” sarcoma in pediatric patient
  - Added Thymoma and thymic cancer
  - Added Langerhans Cell Histiocytosis-predominantly osseous disease (previously not included)
- Initial staging which is only indicated after prior inconclusive imaging (NCCN 2019/2020)
  - Added AIDS related Kaposi sarcoma
  - Added Anal carcinoma (previously indicated)
  - Added Ewing sarcoma-osseous
  - Added Gestational trophoblastic disease
  - Added Hepatocellular/Intrahepatic Cholangiocarcinoma (previously not included)
  - Added Fallopian tube and primary peritoneal cancer
  - Added Osteosarcoma-osseous
  - Changed Penile cancer (previously indicated with palpable nodes)
- Initial staging NOT indicated (NCCN 2019/2020)
  - Changed testicular (previously indicated)
  - Added Uveal Melanoma
  - Added Langerhans Cell Histiocytosis-predominantly non-osseous disease (previously not included)
Restaging indicated (NCCN 2019/2020)
- Added Castleman’s disease
- Added for accelerated Chronic Lymphocytic Leukemia and to guide biopsy
- Added Gastric Cancer post radiation treatment
- Changed Mesothelioma to only prior to surgery for stage I-IIIA
- Added “soft tissue” to sarcoma in pediatric patient
- Added Thymoma and thymic cancer
- Added Langerhans Cell Histiocytosis-predominantly osseous disease (previously not included)

Restaging which are only indicated after prior inconclusive imaging (NCCN 2019/2020)
- Removed for resectable disease in Colorectal cancer
- Removed for if candidate for surgery/locoregional therapy for endometrial cancer
- Specified Ewings sarcoma-osseous
- Added Extrahepatic Cholangiocarcinoma (previously not indicated)
- Added Gallbladder carcinoma (previously not indicated)
- Changed Gastric Cancer to prior inconclusive imaging or if radiation planning considered (previously indicated if no metastasis or early disease)
- Added Gestastional trophoblastic disease
- Added Hepatocellular/Intrahepatic Cholangiocarcinoma (previously not included)
- Changed Ovarian cancer (previously indicated for greater than Stage I)
- Added Fallopian tube and all stages of primary peritoneal cancer
- Added Osteosarcoma-osseous
- Added that for pheochromocytoma/paraganglioma, extrapulmonary large/small cell, restaging FDG PET/CT can be done after inconclusive CT
- Modified Seminoma with residual mass >3cm or 6 weeks post chemotherapy (previously indicated)
- Added Uveal melanoma

Restaging NOT indicated (NCCN 2019/2020)
- Added AIDS related Kaposi sarcoma
- Changed Testicular non seminoma (previously indicated)
- 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 ≥ 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 ≥ 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\textsuperscript{68} Dotatate - added restaging calcitonin levels $\geq 150$ pg/ml or CEA levels $>5$ ng/ml post-surgery
- F18 Fluciclovine (Axumin)
  - Initial staging changed to: With prior inconclusive bone scan with no CT/MRI correlate; or inconclusive bone SPECT/CT
  - 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
REFERENCES


Castroneves LA, Coura Filho G, de Freitas RMC, et al. Comparison of 68GaPET/CT to other Imaging Studies in Medullary Thyroid Cancer: Superiority in Detecting Bone Metastases. J Clin Endocrinol Metab. 2018 Sep 1; 103(9):3250-3259.


Møller AK, Loft A, Berthelsen AK, et. al. A prospective comparison of 18F-FDG PET/CT and CT as diagnostic tools to identify the primary tumor site in patients with extracervical carcinoma of unknown primary site. *Oncologist*. 2012; 17(9):1146-1154.


INDICATIONS FOR CEREBRAL PERFUSION CT:
(ACR, 2017)

In the following settings after initial CT and/or MRI has been performed or when MRI is contraindicated:

- For early detection of acute cerebral ischemia and infarct (Guerrero, 2012; Lui, 2010; Menon, 2015; Wintermark, 2013).
- Differentiating post ictal paralysis from acute stroke or seizure secondary to stroke after MRI has been completed or is contraindicated (Guerrero, 2012).
- For noninvasive evaluation of vasospasm after subarachnoid hemorrhage when transcranial Doppler cannot be done or is indeterminate (Mir, 2014).
- Pre-operative evaluation of cerebral blood flow in patients at high risk for developing cerebral hyperperfusion after carotid revascularization (Dapeng, 2016).
- For the assessment of cerebral blood flow after carotid revascularization in patients with severe carotid artery stenosis or signs/symptoms of cerebral hyperperfusion (Dapeng, 2016; Vasquez, 2012).
- For assessment of cerebrovascular reserve by using acetazolamide challenge in patients with intracranial vascular stenosis who are potential candidates for bypass surgery or neuroendovascular treatment (Galego, 2014; Sorteberg, 2014).
- For the assessment of microvascular permeability in patients with intracranial neoplasms (Jain, 2011).
- 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:
Cerebral perfusion computed tomography (CT) or CT perfusion (CTP) is an imaging technique that provides quantitative evaluation of cerebral perfusion by generating maps of cerebral blood flow, cerebral blood volume and mean transit time after passage of an IV contrast bolus through the region of interest. The technique is not widely used for any indication especially for outpatients. It is useful in specific scenarios after initial CT and/or MRI imaging has been obtained for assessment, not only of patients with acute stroke, but also a wide range of patients with other cerebrovascular diseases. It may provide the information needed to assess the most effective procedures or treatments for the conditions. In evaluating acute stroke, CTP is usually performed in specialized research centers and is not recommended for screening of these patients in the community setting (Huisa, 2014). It may assist
in differentiating the unsalvageable core infarct and salvageable ischemic regions of the brain that may benefit from thrombectomy or thrombolysis (Lui, 2010).

OVERVIEW:
Acute Cerebral Ischemia (Stroke) – Cerebral perfusion CT can quantitatively distinguish the extent of irreversibly infarcted brain tissue (infarct core) from the severely ischemic but salvageable tissue (penumbra), providing a basis for the selection of acute stroke patients that are most likely to benefit from thrombolytic treatment (ACR, 2016).

Cerebral Ischemia and Infarction and Evaluation of Vasospasm after Subarachnoid Hemorrhage – Cerebral perfusion CT measures cerebral blood flow, cerebral blood volume, and mean transit time which can be useful in identifying patients at risk for cerebral ischemia or infarction and for evaluation of vasospasm after subarachnoid hemorrhage. This information may be useful in identifying urgent medical or endovascular treatment. According to the ACR appropriateness criteria “definitive diagnosis of cerebral vasospasm after SAH is made with catheter angiography. Screening for vasospasm is performed with TCD US [transcranial doppler ultrasound]. CTA or MRA may be useful in the setting of indeterminate TCD” (ACR, 2016). CT or MR perfusion can help differentiate patients with vascular narrowing but normal perfusion due to the presence of collateral circulation from those without adequate collaterals.

Carotid Artery Stent Placement/Revascularization – Cerebral perfusion CT provides a quantitative evaluation of cerebral perfusion and helps in the assessment of the hemodynamic modifications in patients with severe carotid stenosis. Pre-operatively, CTP may help identify patients at high risk of developing hyperperfusion syndrome after carotid revascularization. The syndrome may result in fatal outcomes. Presenting symptoms include “…throbbing frontotemporal or periorbital headache, confusion, macular oedema [sic], visual disturbances, seizures, or focal neurological deficits” (Dapeng, 2016). “The presence of internal carotid artery (ICA) stenosis ≥90% is a main risk factor for the development of HPS. Other important risk factors include severe contralateral ICA disease, poor collateral flow, hypertension, and recent stroke or ischaemia [sic]” (Dapeng, 2016). Post-operatively CTP provides valuable information for a more thorough assessment in the follow-up of patients after they have undergone carotid revascularization, especially when there is concern for hyperperfusion syndrome (ACR, 2016).

Temporary Balloon Occlusion (BTO) – Balloon occlusion testing is utilized prior to a planned endovascular or surgical procedure that will disrupt blood supply to a part of the brain. Quantitative analysis of cerebral blood flow may be useful in identifying patient who may not tolerate permanent or prolonged occlusion. Due to the significant failure to predict strokes after sacrifice of the carotid artery there is a vast number of monitoring techniques and protocols during preoperative test occlusion. As CTP monitoring of BTO entails carotid occlusion times ranging from 15-30 minutes and the need to transfer the patient with a catheter in place to the angiography suite, other methods with 60-90 second occlusion times are generally preferred (Galego, 2014; Sorteberg, 2014).

Cerebrovascular Reserve - Cerebral perfusion CT, in conjunction with acetazolamide challenge in patients with intracranial vascular stenosis can evaluate cerebrovascular reserve capacity and help in
estimating the potential risk of stroke. It may help to identify candidates for bypass surgery and endovascular treatment to increase cerebral blood flow.

**Intracranial tumors** – Cerebral perfusion CT generates permeability measurements in images of brain tumors depicting areas of different blood flow within tumors and the surrounding tissues. This may allow for diagnosis and grading of tumors and may help to monitor treatment.

**POLICY HISTORY:**
**Review Date:** June 2019
**Review Summary:**
- Removed:
  - diagnosis of cerebral ischemia and infarction
  - evaluation of patients undergoing temporary balloon occlusion to assess collateral flow and cerebrovascular reserve
- Added:
  - Specified for vasospasm after subarachnoid hemorrhage ‘when transcranial Doppler cannot be performed or is indeterminate’
  - A f/u study may be needed to evaluate progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason indicating why additional imaging is needed.
- Updated background information and references

**Review Date:** May 2020
**Review Summary:**
- Updated background information references
- Reordered indications and background information
- Changed – “after carotid stent placement“ to “after carotid revascularization” in patients with severe carotid artery stenosis and added “or signs/symptoms of cerebral hyperperfusion”
REFERENCES:


G0219 – PET Imaging whole body, melanoma - noncovered

CPT Codes: G0219

IMPORTANT NOTE:

PET scan for whole body; melanoma for non-covered indications is considered to be not medically necessary and is therefore a non-covered study (Frary, 2016; Scheier, 2016).

POLICY HISTORY:
Review Date: April 2019
Review Summary:
• Added references

Review Date: May 2020
Review Summary: No changes
REFERENCES:


G0235 – PET imaging, any site, not otherwise specified

CPT Codes: G0235

IMPORTANT NOTE:

PET imaging, any site, not otherwise specified, is a non-covered CPT code.

POLICY HISTORY:
Review Date: April 2019
Review Summary: No changes

Review Date: May 2020
Review Summary: No changes
G0252 – PET imaging, initial diagnosis of breast cancer

CPT Codes: G0252

IMPORTANT NOTE

PET scan imaging, full and partial-ring pet scanners only, for initial diagnosis of breast cancer and/or surgical planning for breast cancer (e.g. initial staging of axillary lymph nodes) is considered to be not medically necessary and is therefore a non-covered study (Sasada, 2018).

POLICY HISTORY:
Review Date: April 2018
Review Summary:
• Updated reference

Review Date: May 2020
Review Summary: No changes
INDICATIONS FOR LOW DOSE CT FOR LUNG CANCER SCREENING (LDCT):

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 (Mazzone, 2018; NCCN, 2019):

Group 1:
- Individual is between 55-80 years of age; AND
- There is at least a 30 pack-year history of cigarette smoking; AND
- If the individual is a former smoker, that individual had quit smoking within the previous 15 years.

Group 2:
- Age ≥ 50 years old; AND
- ≥ 20 pack-year history of smoking; AND
- Additional risk factors (other than second-hand smoke)*

*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.

Nodule on initial LDCT (Follow-up low dose CT is approvable):
(Wood, 2018)
- Table 1 shows the follow-up interval at which LDCT can be approved to reduce radiation dose (ACR, 2019)
- If multiple nodules, the largest and type is used for decision
Table 2: Lung-RADS® Assessment Categories (ACR, 2019)

<table>
<thead>
<tr>
<th>Category Descriptor</th>
<th>Lung-RADS Score</th>
<th>Findings</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete</td>
<td>0</td>
<td>Prior chest CT examination(s) being located for comparison Part or all of lungs cannot be evaluated</td>
<td>Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>No lung nodules Nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules</td>
<td></td>
</tr>
</tbody>
</table>
| Benign Appearance or Behavior | 2 | Perifissural nodule(s) (See Footnote 11)  
< 10 mm (524 mm²)  
Solid nodule(s):  
< 6 mm (< 113 mm³)  
new < 4 mm (< 34 mm³)  
Part solid nodule(s):  
< 6 mm total diameter (< 113 mm³) on baseline screening  
Non solid nodule(s) (GGN):  
< 30 mm (<14137 mm³) OR  
≥ 30 mm (≥ 14137 mm³) and unchanged or slowly growing | Continue annual screening with LDCT in 12 months |
| Probably Benign      | 3               | Solid nodule(s):  
≥ 6 to < 8 mm (≥ 113 to < 268 mm³) at baseline OR new 4 mm to < 6 mm (34 to < 113 mm³)  
Part solid nodule(s):  
< 6 mm total diameter (≥ 113 mm³) with solid component < 6 mm (< 113 mm³) OR new < 6 mm total diameter (< 113 mm³)  
Non solid nodule(s) (GGN):  
≥ 30 mm (≥ 14137 mm³) on baseline CT or new | 6 month LDCT |
| Suspicious           | 4A              | Solid nodule(s):  
≥ 8 to < 15 mm (≥ 268 to < 1767 mm³) at baseline OR growing < 8 mm (< 268 mm³) OR new 6 to < 8 mm (113 to < 268 mm³)  
Part solid nodule(s):  
≥ 6 mm (≥ 113 mm³) with solid component ≥ 6 mm to < 8 mm (≥ 113 to < 268 mm³) OR with a new or growing < 4 mm (< 34 mm³) solid component | 3 month LDCT; PET/CT may be used when there is ≥ 8 mm (≥ 268 mm³) solid component |
| Endobronchial nodule |                 |          |            |
| Very Suspicious      | 4B              | Solid nodule(s):  
≥ 15 mm (≥ 1767 mm³) OR new or growing, and ≥ 8 mm (≥ 268 mm³)  
Part solid nodule(s) with:  
a solid component ≥ 8 mm (≥ 268 mm³) OR a new or growing ≥ 4 mm (≥ 34 mm³) 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 mm³) 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 |
| Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy | 4X | | |
| Other                | S               | Modifier - may add on to category 6-4 coding | As appropriate to the specific finding |
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 G0297) 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 (NCCN, 2019).

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:
Review Date: May 2019
Review Summary:
• 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

Review Date: May 2020
Review Summary:
• 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)*

*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
REFERENCES:


S8042 – Low Field MRI

CPT odes: S8042

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. 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 (Lee 2013, 2014).

POLICY HISTORY:

Review Date: April 2019
Review Summary: No changes

Review Date: May 2020
Review Summary: No changes

REFERENCES:

