



National Imaging Associates, Inc.		
Clinical guidelines HEART CATHETERIZATION	Original Date:	February 2010
	Page 1 of 4	
CPT Codes: 93452, 93453, 93454, 93455, 93456, 93457, 93458, 93459, 93460, 93461, +93462, +93463, +93464, +93565, +93566, +93567, +93568	Last Review Date:	September 2017
Guideline Number: NIA_CG_065	Last Revised Date:	July, 2018
Responsible Department: Clinical Operations	Implementation Date:	January 2019

INTRODUCTION

- Heart Catheterization is an invasive angiographic procedure used to evaluate the presence and extent of coronary artery disease (CAD).
- In addition to angiography, it can also include ventriculography, aortography, acquisition of hemodynamic data, measurement of cardiac output, detection and quantification of shunts and flows, intravascular ultrasound (IVUS), and fractional flow reserve (FFR)/ instantaneous wave free ratio (iFR) determination of a lesion’s hemodynamic severity.
- This guideline applies to patients with a stable clinical presentation, not to those with acute coronary syndromes or acute valvular scenarios, who frequently manifest imminent need for catheter-based or surgical intervention.
- In stable patients, prior to a recommendation for cardiac catheterization, preliminary evaluation with non-invasive cardiac testing is usually indicated.
- CAD stenosis $\geq 50\%$ is considered clinically significant or obstructive CAD (CAD and IHD [ischemic heart disease] mean the same thing. Hemodynamically or functionally significant CAD means the degree of stenosis is severe enough to cause ischemia. This is discussed in more detail in the Additional Information section) (Fihn 2012; Wolk 2013; Montalescot 2013; Gerber 2018; Tobis 2007).

INDICATIONS FOR INVASIVE CORONARY ARTERIOGRAPHY

(Patel 2012; Fihn 2012; Fihn 2014; Patel 2017; Wolk 2013)

Acute

- Reasonable documentation of acute coronary syndrome, which exempts it from this guideline.

Symptoms and Non-invasive Testing

- Based upon symptoms of ischemia, without known CAD, and with one of the following:

- A high pretest probability of clinically significant coronary artery disease (See Additional Information section) (Wolk 2013; Patel 2012)
 - Patients with suspected symptomatic CAD, who cannot undergo stress testing or coronary computed tomographic angiography (CCTA), when there is a high likelihood that the findings will affect therapy (Fihn 2012; Fihn 2014; Montalescot 2013)
- Noninvasive testing for CAD showing any of the following, which have not yet been addressed:
 - Exercise electrocardiogram (ECG) stress test with Duke Score \leq negative 11, ST segment elevation, hypotension, exercise induced ventricular tachycardia (VT), or several minutes of ST segment depression post exercise (Patel 2012)
 - Stress imaging with high risk findings (see Additional Information section)
 - Stress imaging with intermediate risk (see Additional Information section) in a patient with one of the following
 - Symptoms consistent with CAD (Patel 2012)
 - Ejection fraction $> 50\%$ and unsatisfactory quality of life due to angina (Fihn 2012)
 - Ejection fraction $< 50\%$ (Fihn 2012)
 - Discordant, equivocal, or inconclusive non-invasive evaluation in **symptomatic** patients, such as one of the following scenarios with appropriate stress imaging: (Wolk 2013; Montalescot 2013; Patel 2012)
 - Low risk stress imaging with ongoing symptoms of ischemia (Patel 2012)
 - Low risk stress imaging with high risk stress ECG response or stress induced typical angina (Patel 2012)
 - Equivocal/uninterpretable/inconclusive stress imaging due to issues of attenuation or other problems with interpretability (Patel 2012, Fihn 2012)
 - Otherwise appropriate noninvasive testing is inadequate or contraindicated
 - Moderate or greater sized area of infarction ($\geq 5\%$ myocardium), but limited or no ischemia ($<5\%$ myocardium), in a patient with symptoms of ischemia (Patel 2012)
 - CCTA findings, not yet addressed: (Patel 2012; Patel 2017; Fihn 2012)
 - In appropriately chosen symptomatic patient for CCTA, with one of:
 - One vessel CAD with $\geq 70\%$ stenosis
 - Moderate CAD stenosis (50% to 69% stenosis) in ≥ 2 arteries on CCTA
 - Stenosis $\geq 30\%$ with FFR-CT ≤ 0.8 . (Douglas 2016)

OR

- In any patient, with evidence of $\geq 50\%$ left main lesion

- Evaluation of patients with known major vessel CAD, with or without prior revascularization, who are amenable to, and candidates for, coronary revascularization or more aggressive coronary management of:
 - New, worsening, or limiting symptoms with non-invasive findings that are intermediate or high risk (Patel 2012)
 - New, worsening, or limiting symptoms, with reasonable suspicion of cardiac origin, despite optimal antianginal therapy (beta blocker and one additional antianginal medication, or necessary alternatives, as tolerated by side effects and vital signs), with non-invasive findings that are low risk (Fihn 2012; Fihn 2014; Patel 2012)
 - New, worsening, or limiting symptoms, with a history of prior unrevascularized significant or severe CAD, and the patient is eligible for coronary revascularization. (Fihn 2012; Fihn 2014)
 - Patients with suspected symptomatic CAD, who cannot undergo stress testing or CCTA, when there is a high likelihood that the findings will affect therapy (Fihn 2012; Fihn 2014; Montalescot 2013)
 - Asymptomatic or controlled symptoms, with unevaluated high risk non-invasive findings (Patel 2012)

Heart Failure and Left Ventricular Dysfunction/Abnormality

- New heart failure/ cardiomyopathy/wall motion abnormality, in patients who would be eligible for coronary revascularization or more aggressive coronary management: (Yancy 2013; Wolk 2013; Patel 2012; Patel 2013; Fihn 2012)
 - Newly recognized reduction in ejection fraction to $\leq 40\%$, with one of the following:
 - Any coronary risk factors, including age >45 in men, >55 in women
 - Symptoms or signs of ischemia
 - Evidence of ischemia (or hibernating myocardium) on non-invasive testing or ECG
 - Known history of significant CAD
 - Newly recognized reduction in ejection fraction to 41-49% and one of following:
 - Symptoms of or signs of ischemia
 - Evidence of ischemia on non-invasive testing or ECG
 - Known history of significant CAD
 - Symptomatic from HF and/or ischemia with new, unexplained, ($\geq 5\%$) significant wall motion abnormality and normal ejection fraction (Patel 2012, Fihn 2012)
 - Structural abnormality (severe secondary MR or a VSD) with reason to suspect ischemic origin
 - Deterioration in clinical status of heart failure or cardiomyopathy requiring invasive evaluation for guidance and/or alteration in therapy, with reasonable likelihood and candidacy for coronary revascularization
 - Clarification of the diagnosis of myocarditis versus acute/subacute coronary syndrome (Cooper 2018)
 - When non-invasive coronary evaluation has been nondiagnostic or has not been feasible, and reasonable likelihood of CAD has been provided (Colucci 2018)

- Diastolic heart failure, when symptoms, signs, or stress imaging provide evidence of contributory ischemia. (Borlaug 2018)

Ventricular Arrhythmias

- Ventricular Arrhythmias, without otherwise known explanatory diagnosis:
 - Following recovery from unexplained sudden cardiac arrest. (Al-Khatib 2017)
 - Significant ventricular arrhythmia such as sustained VT or VF (Patel 2012)
 - Exercise-induced nonsustained VT in a patient at significant risk for CAD, based upon signs or symptoms of ischemia (Patel 2012)

Prior to Non-Coronary Intervention and Cardiac Surgery

- Evaluation of coronary anatomy, with consideration of coronary revascularization, prior to cardiac surgical or transcatheter interventions (upon cardiac valves, great vessels/thoracic aorta, congenital disease, pericardial disease) in patients with any of the following:

(Nishimura 2014, Otto 2017, Doherty 2017, Ramee 2016, Svensson 2013)

- Symptoms of angina
- Objective evidence of ischemia
- Decreased LV systolic function (EF < 50%)
- History of CAD
- Coronary risk factors, including men > 40 and postmenopausal women
- Non-invasive data that is inconclusive or showing evidence of ischemia or clinically significant CAD ($\geq 50\%$ or $\text{FFR-CT} \leq 0.8$) (Douglas 2016)
- Chronic severe secondary mitral regurgitation
- Requirement for more detailed assessment of coronary anomalies prior to aortic valve homograft surgery
- Requirement for better assessment of the origin of the coronary arteries than non-invasive data could provide, when prior to a pulmonary autograft (Ross procedure) or root procedure

Indications Post Cardiac Transplantation

(Gustafsson 2018)

- Assessment for allograft vasculopathy on an annual basis for the first 5 years, followed by annual assessment in those with evidence of documented allograft vasculopathy, renal function permitting; estimated glomerular filtration rate (eGFR) ≥ 30 to 40 mL/min/1.73 square meter body surface area
- Assessment of change in clinical status, any one of the following:
 - Left ventricular dysfunction that has developed, but is not explained by graft dysfunction
 - Symptoms of angina/myocardial ischemia
 - Non-invasive findings of ischemia
- Annual assessment following diagnosis of allograft vasculopathy

Special Indications for Hemodynamic Assessment

- Indications for angiographic and/or hemodynamic assessment of valvular function (Doherty 2017; Patel 2012)
 - Assessment of bioprosthetic valve when transthoracic echocardiography (TTE) and transesophageal electrocardiography (TEE) were inadequate, and cardiac magnetic resonance (CMR) and cardiac computed tomography (CCT) are not available
 - Assessment of mechanical valve prostheses when TTE and TEE are inadequate, CCT is not available, and fluoroscopy is not sufficient
 - Discordance between non-invasive data and clinical impression of severity of valvular disease
 - Evaluation of indeterminate shunt anatomy or shunt flows/ratio
- Indications for Hemodynamic Assessment Only (Patel 2012)
 - Assessment of pericardial hemodynamics and distinction from restrictive physiology
 - Assessment of pulmonary hypertension and when non-invasive data provides inadequate information for its management
 - Assessment of pulmonary hypertension response to intravenous drug therapy.
 - Assessment of hemodynamics in heart failure, valvular disease, or cardiomyopathy, when
 - Non-invasive data is discordant or conflicts with the clinical presentation
 - Non-invasive data is inadequate for clinical management

ADDITIONAL INFORMATION

Angina Symptoms

Persistent symptoms indicative of CAD can include chest discomfort, arm or jaw symptoms thought to be ischemia related, and symptoms considered an anginal equivalent.

Anginal Equivalent

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, etc.), by presentation of clinical data such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT or CTA, and/or pulmonary function tests (PFTs) when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope by itself is not considered an anginal equivalent (Moya 2009; Shen 2017; Fihn 2012).

The Three Types of Chest Pain or Discomfort and Pretest Probability of CAD

- **Typical Angina (Definite)** is defined as including all 3 characteristics:
 - 1) Substernal chest pain or discomfort with characteristic quality and duration
 - 2) Provoked by exertion or emotional stress
 - 3) 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 (Wolk 2013; Fihn 2012).

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
<=39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40–49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50–59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
>=60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

- **Very low:** < 5% pretest probability of CAD, usually not requiring stress evaluation
- **Low:** 5-10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

(Fihn 2012)

Coronary Risk Categories Derived from Non-invasive Testing (Fihn 2012; Patel 2017)

High risk (>3% annual death or MI)

1. Severe resting left ventricular (LV) dysfunction (LVEF <35%) not readily explained by noncoronary causes
2. Resting perfusion abnormalities $\geq 10\%$ of the myocardium in patients without prior history or evidence of myocardial infarction (MI)
3. Stress ECG findings including ≥ 2 mm of ST-segment depression at low workload or persisting into recovery, exercise-induced ST-segment elevation, or exercise-induced ventricular tachycardia (VT)/ventricular fibrillation (VF)
4. Severe stress-induced left ventricular (LV) dysfunction (peak exercise LVEF <45% or drop in LVEF with stress $\geq 10\%$)
5. Stress-induced perfusion abnormalities encumbering $\geq 10\%$ myocardium or stress segmental scores indicating multiple vascular territories with abnormalities
6. Stress-induced LV dilation

7. Inducible wall motion abnormality (involving >2 segments or 2 coronary beds)
8. Wall motion abnormality developing at low dose of dobutamine (#10 mg/kg/min) or at a low heart rate (<120 beats/min)
9. Coronary artery calcium (CAC) score >400 Agatston units (only for use in primary prevention, not for heart cath decision making) (Patel 2012; Fihn 2012; Montalescot 2013; Goff 2014)
10. Multivessel obstructive CAD ($\geq 70\%$ stenosis) or left main stenosis ($\geq 50\%$ stenosis) on CCTA

Intermediate risk (1% to 3% annual death or MI)

1. Mild/moderate resting LV dysfunction (LVEF 35% to 49%) not readily explained by noncoronary causes
2. Resting perfusion abnormalities in 5% to 9.9% of the myocardium in patients without a history or prior evidence of MI
3. ≥ 1 mm of ST-segment depression occurring with exertional symptoms
4. Stress-induced perfusion abnormalities encumbering 5% to 9.9% of the myocardium or stress segmental scores (in multiple segments) indicating 1 vascular territory with abnormalities but without LV dilation
5. Small wall motion abnormality involving 1 to 2 segments and only 1 coronary bed
6. CAC score 100 to 399 Agatston units (only for use in primary prevention, not for heart cath decision making) (Patel 2012; Fihn 2012; Montalescot 2013; Goff 2014)
7. One vessel CAD with $\geq 70\%$ stenosis or moderate CAD stenosis (50% to 69% stenosis) in ≥ 2 arteries on CCTA

Low risk (<1% annual death or MI)

1. Low-risk treadmill score (score ≥ 5) or no new ST segment changes or exercise-induced chest pain symptoms; when achieving maximal levels of exercise
2. Normal or small myocardial perfusion defect at rest or with stress encumbering <5% of the myocardium (Note: Although the published data are limited, patients with these findings will probably not be at low risk in the presence of either a high-risk treadmill score or severe resting LV dysfunction (LVEF <35%))
3. Normal stress or no change of limited resting wall motion abnormalities during stress
4. CAC score <100 Agatston units (only for use in primary prevention, not for heart cath decision making) (Patel 2012; Fihn 2012; Montalescot 2013; Goff 2014)
5. No coronary stenosis >50% on CCTA

Abbreviations

CAC	coronary artery calcium
CAD	coronary artery disease
CCT	cardiac computed tomography
CCTA	coronary computed tomographic angiography
CMR	cardiac magnetic resonance
LV	left ventricular
LVEF	left ventricular ejection fraction
MI	myocardial infarction
MR	mitral regurgitation
TAVR	transcatheter aortic valve replacement
TTE	transthoracic echocardiography
TEE	transesophageal echocardiography
VT	ventricular tachycardia
VF	ventricular fibrillation

REFERENCES

- Al-Khatib SM, Stevenson WG, Ackerman MUJ, et al. 2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death. Accepted Manuscript in Press. *JACC*. Available at: http://www.onlinejacc.org/content/accj/early/2017/10/19/j.jacc.2017.10.054.full.pdf?_ga=2.14551095.1842511958.1523473576-1847200754.1521829021 Retrieved May 1, 2018
- Borlaug BA. Clinical manifestations and diagnosis of heart failure with preserved ejection fraction. UpToDate, Waltham MA; May, 2018. Available at: https://www.uptodate.com/contents/clinical-manifestations-and-diagnosis-of-heart-failure-with-preserved-ejection-fraction?search=hfpef§ionRank=3&usage_type=default&anchor=H8680985&source=machineLearning&selectedTitle=2~150&display_rank=2# Retrieved June 29, 2018
- Doherty JU, Kort S, Mehran R. et al. ACC/AATS/AHA/ASE/ASNC/HRS/SCAI/SCCT/SCMR/STS 2017 Appropriate Use Criteria for Multimodality Imaging in Valvular Heart Disease. A Report of the American College of Cardiology Appropriate Use Criteria Task Force, American Association for Thoracic Surgery, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. *JACC*. 2017; 70(13):1647-1672.
- Colucci WS. Determining the etiology and severity of heart failure or cardiomyopathy. UpToDate. Waltham MA; May, 2018. Available at: https://www.uptodate.com/contents/determining-the-etiology-and-severity-of-heart-failure-or-cardiomyopathy?search=nonischemic%20cardiomyopathy§ionRank=1&usage_type=default&anchor=H37909375&source=machineLearning&selectedTitle=2~150&display_rank=2# Retrieved June 28, 2018
- Cooper LT. Clinical manifestations and diagnosis of myocarditis in adults. UpToDate. Waltham, MA; May, 2018. Available at: https://www.uptodate.com/contents/clinical-manifestations-and-diagnosis-of-myocarditis-in-adults?search=myocarditis§ionRank=3&usage_type=default&anchor=H30&source=machineLearning&selectedTitle=1~150&display_rank=1# Retrieved June 28, 2018
- Douglas PS, De Bruyne B, Pontone G, et al. One-Year Outcomes of FFRCT-Guided Care in patients with suspected coronary disease: The PLATFORM Study. *JACC*. 2016;68(5):435-45. Available at: <https://www.sciencedirect.com/science/article/pii/S0735109716333952?via%3Dihub>
- Fihn SD, Gardin JM, Abrams J, et al. 2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the diagnosis and management of patients with stable ischemic heart disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, and the American College of Physicians, American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for

Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *Circulation*. 2012;126(25):e354-471.

Fihn SD, Blankenship JC, Alexander KP, et al. 2014 ACC/AHA/AATS/PCNA/SCAI/STS Focused Update of the Guideline for the Diagnosis and Management of Patients with Stable Ischemic Heart Disease, A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, and the American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *JACC*. 2014;64(18):1929-1948.

Gerber TC, Manning WJ. Non-invasive coronary imaging with cardiac computed tomography and cardiovascular magnetic resonance. UpToDate. Waltham, MA; May, 2019. Available at:

https://www.uptodate.com/contents/noninvasive-coronary-imaging-with-cardiac-computed-tomography-and-cardiovascular-magnetic-resonance?search=ccta§ionRank=2&usage_type=default&anchor=H395579878&source=machineLearning&selectedTitle=1~66&display_rank=1#H395579878 Retrieved June 22, 2018

Goff DC, Lloyd-Jones, DM, Bennett G, et al. 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk, A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines Endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation, American Society for Preventive Cardiology, American Society of Hypertension, Association of Black Cardiologists, National Lipid Association, Preventive Cardiovascular Nurses Association, and WomenHeart: The National Coalition for Women With Heart Disease. *JACC*. 2014;63(25):2935-2959.

Gustafsson F. Diagnosis and prognosis of cardiac allograft vasculopathy. UpToDate. Waltham, MA; March, 2018. Available at:

<http://www.uptodate.com/contents/diagnosis-and-prognosis-of-cardiac-allograft-vasculopathy?source=machineLearning&search=transplant+vasculopathy+follow+up&selectedTitle=1%7E150§ionRank=1&anchor=H12357202#H12357202> Retrieved May 1, 2018

Montalescot G, Sechtem U, Achenbach S, et al. 2013 ESC guidelines on the management of stable coronary artery disease: The Task Force on the management of stable coronary artery disease of the European Society of Cardiology. *European Heart Journal*. 2013;34(38):2949–3003. Available at: <https://academic.oup.com/eurheartj/article/34/38/2949/442952>

Moya A, Sutton, Ammirati F, et al. Guidelines for the diagnosis and management of syncope: Task Force for the Diagnosis and Management of Syncope. *Eur Heart J*. 2009;30:2631–71. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3295536/>

Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *JACC*.

2014;63(22):e57-e185.

Otto CM, Kumbhani DJ, Alexander KP, et al. 2017 ACC Expert Consensus Decision Pathway for Transcatheter Aortic Valve Replacement in the Management of Adults with Aortic Stenosis. A Report of the American College of Cardiology Task Force on Clinical Expert Consensus Documents. *JACC*. 2017;69(10):1313-1346.

Patel MR, Bailey SR, Bonow RO, et al. ACCF/SCAI/AATS/AHA/ASE/ASNC/HFSA/HRS/SCCM/SCCT/SCMR/STS 2012 appropriate use criteria for diagnostic catheterization: A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, American Association for Thoracic Surgery, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. *JACC*. 2012; 59(22):1995-2027.

Patel MR, White RD, Abbara S, et al. 2013 ACCF/ACR/ASE/ASNC/SCCT/SCMR Appropriate utilization of cardiovascular imaging in heart failure: A Joint Report of the American College of Radiology Appropriateness Criteria Committee and the American College of Cardiology Foundation Appropriate Use Criteria Task Force. *JACC*. 2013;61(21):2207-2231.

Patel MR, Calhoun JH, Dehmer GJ, et al. ACC/AATS/AHA/ASE/ASNC/SCAI/SCCT/STS 2017 Appropriate use criteria for coronary revascularization in patients with stable ischemic heart disease. *JACC*. 2017;69(17):2212-2241.

Ramee S, Anwaruddin S, Kumar G, et al. The rationale for performance of coronary angiography and stenting before transcatheter aortic valve replacement from the Interventional Section Leadership Council of the American College of Cardiology. *JACC Cardiovascular Interventions*. 2016;9(23): 2371-2375. Available at: <https://www.sciencedirect.com/science/article/pii/S1936879816315527>

Shen W, Sheldon RS, Benditt DG, et al. 2017 ACC/AHA/HRS Guideline for the evaluation and management of patients with syncope: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society, *JACC*. 2017;70(5): 620-663.

Svensson LG. Aortic valve and ascending aorta guidelines for management and quality measures. *Ann Thorac Surg*. 2013; 95:1-66. Available at: <http://www.sts.org/sites/default/files/documents/AorticValveandAscendingAortaGuidelinesforManagementandQualityMeasures.pdf>

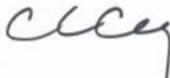
Tobis J, Azarbal B, Slavin L. Assessment of intermediate severity coronary lesions in the catheterization laboratory. *JACC*. 2007;49(8):839-848.

Wolk MJ, Bailey SR, Doherty JU, et al. ACCF/AHA/ASE/ASNC/HFSA/HRS/SCAI/SCCT/SCMR/STS 2013 Multimodality

Appropriate use criteria for the detection and risk assessment of stable ischemic heart disease: A report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. *JACC*. 2014;63(4):380-406. Available at: <http://content.onlinejacc.org/article.aspx?articleid=1789799>

Wunderlich NC, Beigel R, Ho SY, et al. Imaging for Mitral Interventions, Methods and Efficacy, *JACC Cardiovascular Imaging*. 2018;11(6): 872-901.

Yancy C, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA Guideline for the management of heart failure: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *JACC*. 2013;62(16): e147-237.

Reviewed / Approved by  Caroline Carney, MD, Chief Medical Officer