National Imaging Associates, Inc.*	
Clinical guidelines **HEART MRI**	**Original Date: March 26, 2008**
CPT Codes: 75557, 75559, 75561, 75563 +75565	**Last Revised Date: ~~March~~ February 2022~~1~~**
Guideline Number: NIA_CG_028	**Implementation Date: January 2023~~2~~**

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[1-3]

~~(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[4] ~~(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[5] ~~(Ommen, 2020)~~
  - When TTE is inadequate for diagnosis, management or operative planning, or when tissue characterization (degree of fibrosis) will impact indications for ICD
  - For patients with LVH when there is a suspicion of alternative diagnoses, including infiltrative or storage disease as well as athlete's heart
  - For patients who are not otherwise as high risk for SCD, in whom the decision to proceed with an ICD is uncertain after assessment (which includes personal/family

* National Imaging Associates, Inc. (NIA) is a subsidiary of Magellan Healthcare, Inc.

history, echocardiography), and CMR imaging is beneficial to assess for maximum LV wall thickness, ejection fraction (EF), LV apical aneurysm, and extent of myocardial fibrosis with LGE
    - For patients with obstructive HCM in whom the autonomic mechanism of obstruction is inconclusive on echocardiography, CMR is indicated for selection and planning of SRT (septal reduction therapy)
    - For patients with HCM, repeat imaging on a periodic basis (every 3-5 years) for the purpose of SCD risk stratification to evaluate changes in LGE, EF, development of apical aneurysm or LV wall thickness
- Arrhythmogenic right ventricular cardiomyopathy to aid in identification and diagnosis (assessment of myocardial fat, fibrosis, and RV tissue characteristics), based upon reason for suspicion, such as:
    - Nonsustained ventricular tachycardia (VT)
    - Unexplained syncope
    - ECG abnormalities
    - First-degree relatives with positive genotype for ARVD
- Noncompaction cardiomyopathy to aid in the diagnosis (measurement of compacted to noncompacted myocardium) when TTE is suggestive
- Clinical symptoms and signs consistent with a cardiac diagnosis known to cause presyncope/syncope (including, but not limited to, hypertrophic cardiomyopathy)
- Pulmonary hypertension in the absence of severe valvular disease

Valvular Heart Disease

- Evaluation of valvular stenosis, regurgitation, or valvular masses when transthoracic echocardiography (TTE) is inadequate[6] ~~(Doherty, 2017)~~
- Pre-TAVR assessment if the patient has not undergone cardiac CT[7] ~~(Otto, 2017)~~
- Prior to transcatheter mitral valve intervention, when TTE and TEE result in uncertain assessment of the severity of mitral regurgitation[8, 9] ~~(Bonow, 2020; Wunderlich, 2018)~~
- Suspected clinically significant bioprosthetic valvular dysfunction and inadequate images from TTE and TEE[6] ~~(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:
  - Device stability
  - Device leaks
  - To exclude device migration

Pre-Ablation Planning

- Evaluation of left atrium and pulmonary veins prior to radiofrequency ablation for atrial fibrillation, 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 condition~~s~~ that predispose to aortic aneurysm or dissection, such as Marfan's, Ehler's Danlos or Loeys-~~-~~Dietz syndrome (at the time of diagnosis and 6 months thereafter), followed by annual imaging (can be done more frequently if > 4.5 cm or rate of growth > 0.5 cm/year- up to twice per year)

Congenital Heart Disease (CHD)[10]

~~(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 (1~~3~~–2~~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**, and can be performed** ~~-i~~~~when a stress echocardiogram (SE) cannot be performed~~
  - ~~I~~f the ~~patient cannot walk and~~ **patient** would otherwise be a candidate for a pharmacologic MPI~~, a CMR can be performed~~**.**

- If the patient can walk and is having an MPI for another reason (LBBB, CABG, etc.), MPI is chosen over CMR
- Assessment of LV wall motion to identify patients with akinetic segments that would benefit from coronary revascularization
- To identify the extent and location of myocardial necrosis in patients with chronic or acute ischemic heart disease

---

BACKGROUND[11]
~~(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**[12-15] ~~(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[16] ~~(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[17] ~~(Hirshfeld, 2018)~~

OVERVIEW

CMR in CORONARY ARTERY DISEASE (CAD)[18-20]
~~(Fihn, 2012; Montalescot, 2013; Wolk, 2014)~~

Stable patients without known CAD fall into 2 categories[18-20] ~~(Fihn, 2012; Montalescot, 2013; Wolk, 2014)~~:

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant (≥ 50%) CAD (below):

The 3 Types of Chest Pain or Discomfort

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics

- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, The Pretest Probability of obstructive CAD is estimated from the ~~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[20] ~~(Wolk, 2014)~~:

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

- **Very low:** < 5% pretest probability of CAD, usually not requiring stress evaluation[18] ~~(Fihn 2012)~~
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CA

For additional information on stress imaging, please refer to NIA guideline CG 024 Myocardial Perfusion Imaging (aka Nuclear Cardiac Imaging Study).

Abbreviations

ARVD/C	Arrhythmogenic right ventricular dysplasia/cardiomyopathy
ASD	**Atrial septal defect**
CABG	Coronary artery bypass grafting surgery
CAD	Coronary artery disease
CMR	Cardiac magnetic resonance (imaging)
CT	Computed tomography
ECG	Electrocardiogram
EF	**Ejection fraction**
HCM	**Hypertrophic cardiomyopathy**
ICD	Implantable cardioverter-defibrillator
LAA	**Left atrial appendage**
LBBB	Left bundle-branch block
LGE	**Late gadolinium enhancement**
LV	Left ventricl**e**~~ular~~
LVH	**Left ventricular hypertrophy**
LVOT	**Left ventricular outflow**
MPI	Myocardial perfusion imaging
MR	Mitral regurgitation

MR(I)	Magnetic resonance (imaging)
PA	**Pulmonary artery**
PET	**Positron emission tomography**
PFO	**Patent foramen ovale**
PS	**Pulmonary stenosis**
RV	Right ventricle
SCD	**Sudden cardiac death**
SE	Stress echocardiography
SRT	**Septal reduction therapy**
TAVR	Transcatheter Aortic Valve Replacement
TTE	Transthoracic Echo
TEE	~~Transesophageal~~**Transesophageal** Echo
VT	Ventricular tachycardia

POLICY HISTORY

Date	Summary
February 2022	• ~~Took out~~**Deleted the statement of deferral toward a stress echo, leaving the equivalency statement toward MPI** • **C~~c~~larified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain." "** • **Changed postoperative routine surveillance for single-ventricle heart disease to 1 – 2 years in an asymptomatic patient**
March 2021	• Added expanded guidelines for HCM with new reference
March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review. • Added the following to the section Cardiomyopathy & Heart Failure: ○ 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 ○ 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 ○ 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:
	  ○ 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 indication for coronary anomalies
	• Updated and added new references

July 2019	• Removed table of comparison to Cardiac CT • Removed global risk calculator for asymptomatic patients • Removed scenarios for which approval of CMR is not approvable as well as follow-up indications • Removed section on MRI compatibility with Pacemakers • Format change: moved CAD section – clarification of indication of use of MRI in CAD and removed detailed indications • Expanded aortic screening section with removal of chart for "normal" sizes of aortic aneurysm • Expanded indication for prosthetic heart valves • Removed indication of screening with a strong family history of cardiomyopathy •

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. *J Am Coll Cardiol.* In press. 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 April 11, 2018.

Baumgartner H, Falk V, Bax JJ et al. 2017 ESC/EACTS guidelines for the management of valvular heart disease, The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). *Euro Heart J.* 2017; 38:2739–2791.

Bhave NM, Nienaber CA, Clough RE, et al. Multimodality imaging of thoracic aortic diseases in adults. *J Am Coll Cardiol Cardiovascular Imaging*. 2018; 1(6):903-919.

Birnie DH, Sauer WH, Bogun F, et al. HRS expert consensus statement on the diagnosis and management of arrhythmias associated with cardiac sarcoidosis. *Heart Rhythm*. 2014; 11:1305–1323.

Bonow RO, O'Gara PT, Adams DH, et al. 2020 Focused Update of the 2017 ACC Expert Consensus Decision Pathway on the Management of Mitral Regurgitation. *J Am Coll Cardiol*. 2020 Feb 14. Epub. DOI:10.1016/j.jacc.2020.02.005.

Brignole M, Auricchio A, Baron-Esquivias G, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: The Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC), developed in collaboration with the European Heart Rhythm Association (EHRA). *Eur Heart J.* 2013; 34:2281–2329.

Collier P, Phelan D, Klein A. A test in context: Myocardial strain measured by speckle-tracking echocardiography, *J Am Coll Cardiol.* 2017; 69:1043-1056.

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. *J Am Coll Cardiol.* 2017; 70(13):1647-1672.

Doherty JU, Kort S, Mehran R, et al. ACC/AATS/AHA/ASE/ASNC/HRS/SCAI/SCCT/SCMR/STS 2019 Appropriate Use Criteria for Multimodality Imaging in the Assessment of Cardiac Structure and Function in Nonvalvular Heart Disease. *J Am Coll Cardiol*. 2019 Feb; 73(4):488-516.

Douglas PS, Garcia MJ, Haines DE, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate use criteria for echocardiography: A report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance. *J Am Coll Cardiol.* 2011; 57(9):1126-66.

Erbel R. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases, European Heart Journal. *Eur Heart J.* 2014; 35(41):2873–2926. Available at: https://academic.oup.com/eurheartj/article/35/41/2873/407693.

Figtree GA, Lonborg J, Grieve SM, et al. Cardiac magnetic resonance imaging for the interventional cardiologist: State-Of-The-Art Paper. *J Am Coll Cardiol Interv.* 2011; 4(2):137– 48.

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.

Friedrich MG, Marcott F. How to use imaging, cardiac magnetic resonance assessment of myocarditis. *Circ Imaging*. 2013; 6(5):833-839.

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 Women Heart: The National Coalition for Women With Heart Disease. *J Am Coll Cardiol*. 2014; 63(25):2935-2959.

Grani C, Buechel RR, Kaufmann PA, et al. Multimodality imaging in individuals with anomalous coronary arteries. *J Am Coll Cardiol*. 2017; 10(4):471-581.

Halliday BP, Gulati A, Ali A, et al. Association between mid-wall late gadolinium enhancement and sudden cardiac death in patients with dilated cardiomyopathy and mild and moderate left ventricular systolic dysfunction. *Circulation.* 2017; 135(22):2106-2115. Retrieved June 6, 2018.

Hendel RC, Patel MR, Kramer CM, et al. ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SCAI/SIR 2006 Appropriateness criteria for cardiac computed tomography and cardiac magnetic resonance

imaging. A report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American College of Radiology, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, American Society of Nuclear Cardiology, North American Society for Cardiac Imaging, Society for Cardiovascular Angiography and Interventions, and Society of Interventional Radiology. *J Am Coll Cardiol*. 2006; 48(7):1475-1497. Available at: https://www.asnc.org/files/AUC%20for%20CCT%20and%20CMRI.pdf.

Henzlova MJ, Duvall WL, Einstein, AJ, et al. ASNC imaging guidelines for SPECT nuclear cardiology procedures: Stress, protocols, and tracers. *J Nucl Cardiol*. 2016; 23:606–39. Available at: https://link.springer.com/content/pdf/10.1007/s12350-015-0387-x.pdf.

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 American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. *Circulation*. 2010; 121(13):e266-369.

Hiratzka LF, Creager MA, Isselbacher EM, et al. Surgery for aortic dilatation in patients with bicuspid aortic valves. A statement of clarification from the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2016; 67(6):724-731.

Hirshfeld JW, Ferrari VA, Bengel FM, et al. 2018 ACC/HRS/NASCI/SCAI/SCCT Expert consensus document on optimal use of ionizing radiation in cardiovascular imaging: Best practices for safety and effectiveness: A report of the American College of Cardiology Task Force on Expert Consensus Decision Pathways developed in Collaboration with Mended Hearts. *Catheter Cardiovasc Interv*. 2018; 92(2):203-221.

Hundley WG, Bluemke DA, Finn JP, et al. ACCF/ACR/AHA/NASCI/SCMR 2010 Expert consensus document on cardiovascular magnetic resonance: A report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents. *J Am Coll Cardiol*. 2010; 55(23):2614-2662. Available at: https://www.sciencedirect.com/science/article/pii/S0735109709036985?via%3Dihub.

Hussain MA, Al0Omram M, Creager MA, et al. Antithrombotic therapy for peripheral artery disease: Recent Advances. *J Am Coll Cardiol*. 2018; 71(21): 2450-2467.

Indik JH, Gimbel JR, Abe H, et al. 2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with cardiovascular implantable electronic devices. *Heart Rhythm*. 2017; 14(7): pages e97-153. Available at:

https://www.hrsonline.org/Policy-Payment/Clinical-Guidelines-Documents/2017-HRS-Expert-Consensus-Statement-on-Magnetic-Resonance-Imaging-and-Radiation-Exposure-in-Patients-with-Cardiovascular-Implantable-Electronic-Devices

Kinderman I, Barth C, Mahfour F, et al. Update on Myocarditis. *J Am Coll Cardiol*.. 2012; 59(9):79–92.

Klein AL, Abbara S, Agler DA, et al. American Society of Echocardiography clinical recommendations for multimodality cardiovascular imaging of patients with pericardial disease: endorsed by the Society for Cardiovascular Magnetic Resonance and Society of Cardiovascular Computed Tomography. *J Am Soc Echocardiogr*. 2013; 26:965–1012.

Kuruvilla S, Adenaw N, Katwal AB, et al. Late gadolinium enhancement on cardiac magnetic resonance predicts adverse cardiovascular outcomes in nonischemic cardiomyopathy. *Circulation: Cardiovasc Imaging*. 2014; 7:250-258. Available at:

Lancellotti P, Knomo VT, Badano LP, et al. Expert consensus for multi-modality imaging evaluation of cardiovascular complications of radiotherapy in adults: A report from the European Association of Cardiovascular Imaging and the American Society of Echocardiography. *Eur Heart J Cardiovasc Imaging*. 2013; 14:721–740.

Marcus FI, McKenna WJ, Sherrill D, et al. Diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia: proposed modification of the task force criteria. *Circulation*. 2010; 121(13):1533-1541.

Maron M. Clinical utility of cardiovascular magnetic resonance in hypertrophic cardiomyopathy. *J Cardiovasc Magn Reson*. 2012; 14(13): 1-21.

Maron BJ, Ommen SR, Semsarian C, et al. Hypertrophic cardiomyopathy, present and future, with translation into contemporary cardiovascular medicine. *J Am Coll Cardiol*. 2014; 64(1): 83-99.

Maleszewski JJ, Bois MC, Bois JP, et al. State of the art review: Neoplasia and the heart, pathological review of effects with clinical and radiological correlation. *J Am Coll Cardiol*. 2018; 72(2): 202-227.

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. *Eur Heart J*. 2013; 34(38):2949–3003. Available at: https://academic.oup.com/eurheartj/article/34/38/2949/442952.

Nazarian S, Hansford R, Rahsepar AA, et al. Safety of magnetic resonance imaging in patients with cardiac devices. *N Engl J Med*. 2017; 377:2555-2564.

Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC Guideline for the management of patients with valvular heart disease. *J Am Coll Cardiol.* 2014; 63(22):e57-e185.

Ohana M, Bakouboula B, Labani A, et al. Imaging before and after catheter ablation of atrial fibrillation. *Diagn Interven Imaging.* 2015; 96:1113—1123. Available at: https://ac.els-cdn.com/S2211568415001734/1-s2.0-S2211568415001734-main.pdf?_tid=f89a367c-7c47-4066-9b2b-a55ec3dac7dd&acdnat=1525713586_4846a92586b60ba24ee857f33f7e5258

Ommen SR, Mital S, Burke MA, et al. 2020 AHA/ACC Guideline for the Diagnosis and Treatment of Patients with Hypertrophic Cardiomyopathy: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2020 Dec; 76(25):e159-240.

Otto CM, Kumbhani DJ, Alexander KP, et al. 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. *J Am Coll Cardiol*. 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. *J Am Coll Cardiol*. 2012; 59(22):1995-2027.

Patel MR, Calhoon 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. *J Am Coll Cardiol*. 2017; 69(17):2212-2241.

Patel MR, White RD, Abbara S, et al, 2013 ACCF/ACR/ASE/ASNC/SCCT/SCM 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. *J Am Coll Cardiol*. 2013; 61(21):2207-2231.

Pennell DJ. Contemporary reviews in cardiovascular medicine, cardiovascular magnetic resonance. *Circulation.* 2010; 121:692-705.

Pereira NL, Grogan M, Dec G. Spectrum of restrictive and infiltrative cardiomyopathies. *J Am Coll Cardiol*. 2018; 71(10):1149-1166.

Plana JC, Galderisi M, Bara, A, et al. Expert consensus for multimodality imaging evaluation of adult patients during and after cancer therapy: A report from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *J Am Soc Echocardiogr*. 2014; 27:911-39.

Russo RJ, Costa HS, Silva PD, et al. Assessing the risks associated with MRI in patients with a pacemaker or defibrillator. *N Engl J Med*. 2017; 376 (8):755-764.

Sachdeva R, Valente AM, Armstrong AK, et al. ACC/AHA/ASE/HRS/ISACHD/SCAI/SCCT/SCMR/SOPE 2020 Appropriate Use Criteria for Multimodality Imaging During the Follow-Up Care of Patients with Congenital Heart Disease. J Am Coll Cardiol. 2020 Jan 06. Epub. DOI:10.1016/j.jacc.2019.10.002.

Shah R, Heydari B, Coelho-Filho O, et al. Vasodilator stress perfusion CMR imaging is feasible and prognostic in obese patients. *JACC Cardiovasc Imaging*. 2014; 7(5):462-472.

Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2019; 73(12):1494-1563.

Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the management of adults with congenital heart disease. *J Am Coll Cardiol*. 2019; 73(18):2361-2362.

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.

te Riele ASJM, Tandri H, Saborn DM, et al. Non-invasive multimodality imaging in ARVD/C. *J Am Coll Cardiol*. 2015; 8(5):597-611.

Vita T, Okada DR, Veillet-Chowdhury M, et al. Complementary value of cardiac magnetic resonance imaging and positron emission tomography/computed tomography in the assessment of cardiac sarcoidosis. *Circ Cardiovasc Imaging*. 2018; 11(1):e007030. Available at: http://circimaging.ahajournals.org/content/11/1/e007030.

Wiant A, Nyberg E, Gilkeson RC. CT evaluation of congenital heart disease in adults. *Am J Roentgenol*. 2009; 193(2):388-96. Available at: http://www.ajronline.org/doi/abs/10.2214/AJR.08.2192

Wolak A, Gransar H, Thomson LE, et al. Aortic size assessment by noncontrast cardiac computed tomography: normal limits by age, gender, and body surface area. *J Am Coll Cardiol Cardiovasc Imaging*. 2008; 1(2):200–209.

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. *J Am Coll Cardiol.* 2014; 63(4):380-406.

Wunderlich NC, Beigel R, Ho SY, et al. Imaging for mitral interventions, methods and efficacy. *J Am Coll Cardiol 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. *J Am Coll Cardiol.* 2013; 62(16): e147-237.

Zamorano JL, Lancellotti P, Munoz DR, et al. 2016 ESC Position paper on cancer treatments and cardiovascular toxicity developed under the auspices of the ESC Committee for Practice Guidelines, The Task Force for cancer treatments and cardiovascular toxicity of the European Society of Cardiology (ESC). *Eur Heart J.* 2016; 37:2768–2801.

Reviewed / Approved by NIA Clinical Guideline Committee

1. Doherty JU, Kort S, Mehran R, et al. ACC/AATS/AHA/ASE/ASNC/HRS/SCAI/SCCT/SCMR/STS 2019 Appropriate Use Criteria for Multimodality Imaging in the Assessment of Cardiac Structure and Function in Nonvalvular 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 the Society of Thoracic Surgeons. *J Am Coll Cardiol*. Feb 5 2019;73(4):488-516. doi:10.1016/j.jacc.2018.10.038
2. 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. *J Am Coll Cardiol*. May 28 2013;61(21):2207-31. doi:10.1016/j.jacc.2013.02.005
3. Yancy CW, 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. *J Am Coll Cardiol*. Oct 15 2013;62(16):e147-239. doi:10.1016/j.jacc.2013.05.019
4. Birnie DH, Sauer WH, Bogun F, et al. HRS expert consensus statement on the diagnosis and management of arrhythmias associated with cardiac sarcoidosis. *Heart Rhythm*. Jul 2014;11(7):1305-23. doi:10.1016/j.hrthm.2014.03.043
5. Ommen SR, Mital S, Burke MA, et al. 2020 AHA/ACC Guideline for the Diagnosis and Treatment of Patients With Hypertrophic Cardiomyopathy: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. Dec 22 2020;76(25):e159-e240. doi:10.1016/j.jacc.2020.08.045
6. Doherty JU, Kort S, Mehran R, Schoenhagen P, Soman P. 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. *J Am Coll Cardiol*. Sep 26 2017;70(13):1647-1672. doi:10.1016/j.jacc.2017.07.732
7. 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. *J Am Coll Cardiol*. Mar 14 2017;69(10):1313-1346. doi:10.1016/j.jacc.2016.12.006
8. Bonow RO, O'Gara PT, Adams DH, et al. 2020 Focused Update of the 2017 ACC Expert Consensus Decision Pathway on the Management of Mitral Regurgitation: A Report of the American College of Cardiology Solution Set Oversight Committee. *J Am Coll Cardiol*. May 5 2020;75(17):2236-2270. doi:10.1016/j.jacc.2020.02.005
9. Wunderlich NC, Beigel R, Ho SY, et al. Imaging for Mitral Interventions: Methods and Efficacy. *JACC Cardiovasc Imaging*. Jun 2018;11(6):872-901. doi:10.1016/j.jcmg.2018.02.024
10. Sachdeva R, Valente AM, Armstrong AK, et al. ACC/AHA/ASE/HRS/ISACHD/SCAI/SCCT/SCMR/SOPE 2020 Appropriate Use Criteria for Multimodality Imaging During the Follow-Up Care of Patients With Congenital Heart Disease: A Report of the American College of Cardiology Solution Set Oversight Committee and Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Congenital Heart Disease, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Pediatric Echocardiography. *J Am Coll Cardiol*. Feb 18 2020;75(6):657-703. doi:10.1016/j.jacc.2019.10.002
11. Pennell DJ. Cardiovascular magnetic resonance. *Circulation*. Feb 9 2010;121(5):692-705. doi:10.1161/circulationaha.108.811547
12. Brignole M, Auricchio A, Baron-Esquivias G, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: the Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA). *Eur Heart J*. Aug 2013;34(29):2281-329. doi:10.1093/eurheartj/eht150
13. Indik JH, Gimbel JR, Abe H, et al. 2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with cardiovascular implantable electronic devices. *Heart Rhythm*. Jul 2017;14(7):e97-e153. doi:10.1016/j.hrthm.2017.04.025
14. Nazarian S, Hansford R, Rahsepar AA, et al. Safety of Magnetic Resonance Imaging in Patients with Cardiac Devices. *N Engl J Med*. Dec 28 2017;377(26):2555-2564. doi:10.1056/NEJMoa1604267
15. Russo RJ, Costa HS, Silva PD, et al. Assessing the Risks Associated with MRI in Patients with a Pacemaker or Defibrillator. *N Engl J Med*. Feb 23 2017;376(8):755-764. doi:10.1056/NEJMoa1603265

16. Shah RV, Heydari B, Coelho-Filho O, et al. Vasodilator stress perfusion CMR imaging is feasible and prognostic in obese patients. *JACC Cardiovasc Imaging*. May 2014;7(5):462-72. doi:10.1016/j.jcmg.2013.11.011
17. Hirshfeld JW, Jr., Ferrari VA, Bengel FM, et al. 2018 ACC/HRS/NASCI/SCAI/SCCT Expert Consensus Document on Optimal Use of Ionizing Radiation in Cardiovascular Imaging-Best Practices for Safety and Effectiveness, Part 1: Radiation Physics and Radiation Biology: A Report of the American College of Cardiology Task Force on Expert Consensus Decision Pathways Developed in Collaboration With Mended Hearts. *Catheter Cardiovasc Interv*. Aug 1 2018;92(2):203-221. doi:10.1002/ccd.27660
18. 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*. Dec 18 2012;126(25):e354-471. doi:10.1161/CIR.0b013e318277d6a0
19. 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. *Eur Heart J*. Oct 2013;34(38):2949-3003. doi:10.1093/eurheartj/eht296
20. 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. *J Am Coll Cardiol*. Feb 4 2014;63(4):380-406. doi:10.1016/j.jacc.2013.11.009

ADDITIONAL RESOURCES

1. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. *J Am Coll Cardiol*. Oct 2 2018;72(14):e91-e220. doi:10.1016/j.jacc.2017.10.054
2. Baumgartner H, Falk V, Bax JJ, et al. 2017 ESC/EACTS Guidelines for the management of valvular heart disease. *Eur Heart J*. Sep 21 2017;38(36):2739-2791. doi:10.1093/eurheartj/ehx391
3. Bhave NM, Nienaber CA, Clough RE, Eagle KA. Multimodality Imaging of Thoracic Aortic Diseases in Adults. *JACC Cardiovasc Imaging*. Jun 2018;11(6):902-919. doi:10.1016/j.jcmg.2018.03.009

4. Collier P, Phelan D, Klein A. A Test in Context: Myocardial Strain Measured by Speckle-Tracking Echocardiography. *J Am Coll Cardiol*. Feb 28 2017;69(8):1043-1056. doi:10.1016/j.jacc.2016.12.012
5. Douglas PS, Garcia MJ, Haines DE, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance Endorsed by the American College of Chest Physicians. *J Am Coll Cardiol*. Mar 1 2011;57(9):1126-66. doi:10.1016/j.jacc.2010.11.002
6. Erbel R, Aboyans V, Boileau C, et al. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). *Eur Heart J*. Nov 1 2014;35(41):2873-926. doi:10.1093/eurheartj/ehu281
7. Figtree GA, Lønborg J, Grieve SM, Ward MR, Bhindi R. Cardiac magnetic resonance imaging for the interventional cardiologist. *JACC Cardiovasc Interv*. Feb 2011;4(2):137-48. doi:10.1016/j.jcin.2010.09.026
8. Friedrich MG, Marcotte F. Cardiac magnetic resonance assessment of myocarditis. *Circ Cardiovasc Imaging*. Sep 2013;6(5):833-9. doi:10.1161/circimaging.113.000416
9. Goff DC, Jr., 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. *J Am Coll Cardiol*. Jul 1 2014;63(25 Pt B):2935-2959. doi:10.1016/j.jacc.2013.11.005
10. Gräni C, Buechel RR, Kaufmann PA, Kwong RY. Multimodality Imaging in Individuals With Anomalous Coronary Arteries. *JACC Cardiovasc Imaging*. Apr 2017;10(4):471-481. doi:10.1016/j.jcmg.2017.02.004
11. Halliday BP, Gulati A, Ali A, et al. Association Between Midwall Late Gadolinium Enhancement and Sudden Cardiac Death in Patients With Dilated Cardiomyopathy and Mild and Moderate Left Ventricular Systolic Dysfunction. *Circulation*. May 30 2017;135(22):2106-2115. doi:10.1161/circulationaha.116.026910
12. Hendel RC, Patel MR, Kramer CM, et al. ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SCAI/SIR 2006 appropriateness criteria for cardiac computed tomography and cardiac magnetic resonance imaging: a report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American College of Radiology, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, American Society of Nuclear Cardiology, North American Society for Cardiac Imaging, Society for Cardiovascular Angiography and Interventions, and Society of Interventional Radiology. *J Am Coll Cardiol*. Oct 3 2006;48(7):1475-97. doi:10.1016/j.jacc.2006.07.003

13. Fazel R, Dilsizian V, Einstein AJ, Ficaro EP, Henzlova M, Shaw LJ. Strategies for defining an optimal risk-benefit ratio for stress myocardial perfusion SPECT. *J Nucl Cardiol*. May 2011;18(3):385-92. doi:10.1007/s12350-011-9353-4
14. Hiratzka LF, Creager MA, Isselbacher EM, et al. Surgery for Aortic Dilatation in Patients With Bicuspid Aortic Valves: A Statement of Clarification From the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol.* Feb 16 2016;67(6):724-731. doi:10.1016/j.jacc.2015.11.006
15. 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 American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. *Circulation*. Apr 6 2010;121(13):e266-369. doi:10.1161/CIR.0b013e3181d4739e
16. Hundley WG, Bluemke DA, Finn JP, et al. ACCF/ACR/AHA/NASCI/SCMR 2010 expert consensus document on cardiovascular magnetic resonance: a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents. *J Am Coll Cardiol*. Jun 8 2010;55(23):2614-62. doi:10.1016/j.jacc.2009.11.011
17. Hussain MA, Al-Omran M, Creager MA, Anand SS, Verma S, Bhatt DL. Antithrombotic Therapy for Peripheral Artery Disease: Recent Advances. *J Am Coll Cardiol*. May 29 2018;71(21):2450-2467. doi:10.1016/j.jacc.2018.03.483
18. Kindermann I, Barth C, Mahfoud F, et al. Update on myocarditis. *J Am Coll Cardiol.* Feb 28 2012;59(9):779-92. doi:10.1016/j.jacc.2011.09.074
19. Klein AL, Abbara S, Agler DA, et al. American Society of Echocardiography clinical recommendations for multimodality cardiovascular imaging of patients with pericardial disease: endorsed by the Society for Cardiovascular Magnetic Resonance and Society of Cardiovascular Computed Tomography. *J Am Soc Echocardiogr*. Sep 2013;26(9):965-1012.e15. doi:10.1016/j.echo.2013.06.023
20. Kuruvilla S, Adenaw N, Katwal AB, Lipinski MJ, Kramer CM, Salerno M. Late gadolinium enhancement on cardiac magnetic resonance predicts adverse cardiovascular outcomes in nonischemic cardiomyopathy: a systematic review and meta-analysis. *Circ Cardiovasc Imaging*. Mar 2014;7(2):250-258. doi:10.1161/circimaging.113.001144
21. Lancellotti P, Nkomo VT, Badano LP, et al. Expert consensus for multi-modality imaging evaluation of cardiovascular complications of radiotherapy in adults: a report from the European Association of Cardiovascular Imaging and the American Society of Echocardiography. *Eur Heart J Cardiovasc Imaging*. Aug 2013;14(8):721-40. doi:10.1093/ehjci/jet123
22. Marcus FI, McKenna WJ, Sherrill D, et al. Diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia: proposed modification of the task force criteria. *Circulation*. Apr 6 2010;121(13):1533-41. doi:10.1161/circulationaha.108.840827

23. Maron BJ, Ommen SR, Semsarian C, Spirito P, Olivotto I, Maron MS. Hypertrophic cardiomyopathy: present and future, with translation into contemporary cardiovascular medicine. *J Am Coll Cardiol*. Jul 8 2014;64(1):83-99. doi:10.1016/j.jacc.2014.05.003
24. Maron MS. Clinical utility of cardiovascular magnetic resonance in hypertrophic cardiomyopathy. *J Cardiovasc Magn Reson*. Feb 1 2012;14(1):13. doi:10.1186/1532-429x-14-13
25. Maleszewski JJ, Bois MC, Bois JP, Young PM, Stulak JM, Klarich KW. Neoplasia and the Heart: Pathological Review of Effects With Clinical and Radiological Correlation. *J Am Coll Cardiol*. Jul 10 2018;72(2):202-227. doi:10.1016/j.jacc.2018.05.026
26. 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. *J Am Coll Cardiol*. Jun 10 2014;63(22):e57-185. doi:10.1016/j.jacc.2014.02.536
27. Ohana M, Bakouboula B, Labani A, et al. Imaging before and after catheter ablation of atrial fibrillation. *Diagn Interv Imaging*. Nov 2015;96(11):1113-23. doi:10.1016/j.diii.2014.12.011
28. 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. *J Am Coll Cardiol*. May 29 2012;59(22):1995-2027. doi:10.1016/j.jacc.2012.03.003
29. Patel MR, Calhoon 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: 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, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, and Society of Thoracic Surgeons. *J Am Coll Cardiol*. May 2 2017;69(17):2212-2241. doi:10.1016/j.jacc.2017.02.001
30. Pereira NL, Grogan M, Dec GW. Spectrum of Restrictive and Infiltrative Cardiomyopathies: Part 2 of a 2-Part Series. *J Am Coll Cardiol*. Mar 13 2018;71(10):1149-1166. doi:10.1016/j.jacc.2018.01.017
31. Plana JC, Galderisi M, Barac A, et al. Expert consensus for multimodality imaging evaluation of adult patients during and after cancer therapy: a report from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *J Am Soc Echocardiogr*. Sep 2014;27(9):911-39. doi:10.1016/j.echo.2014.07.012
32. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical

Practice Guidelines. *J Am Coll Cardiol*. Apr 2 2019;73(12):1494-1563. doi:10.1016/j.jacc.2018.08.1028
33. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. Apr 2 2019;73(12):e81-e192. doi:10.1016/j.jacc.2018.08.1029
34. Svensson LG, Adams DH, Bonow RO, et al. Aortic valve and ascending aorta guidelines for management and quality measures. *Ann Thorac Surg*. Jun 2013;95(6 Suppl):S1-66. doi:10.1016/j.athoracsur.2013.01.083
35. Te Riele A, Tandri H, Sanborn DM, Bluemke DA. Noninvasive Multimodality Imaging in ARVD/C. *JACC Cardiovasc Imaging*. May 2015;8(5):597-611. doi:10.1016/j.jcmg.2015.02.007
36. Vita T, Okada DR, Veillet-Chowdhury M, et al. Complementary Value of Cardiac Magnetic Resonance Imaging and Positron Emission Tomography/Computed Tomography in the Assessment of Cardiac Sarcoidosis. *Circ Cardiovasc Imaging*. Jan 2018;11(1):e007030. doi:10.1161/circimaging.117.007030
37. Wiant A, Nyberg E, Gilkeson RC. CT evaluation of congenital heart disease in adults. *AJR Am J Roentgenol.* Aug 2009;193(2):388-96. doi:10.2214/ajr.08.2192
38. Wolak A, Gransar H, Thomson LE, et al. Aortic size assessment by noncontrast cardiac computed tomography: normal limits by age, gender, and body surface area. *JACC Cardiovasc Imaging*. Mar 2008;1(2):200-9. doi:10.1016/j.jcmg.2007.11.005
39. Zamorano JL, Lancellotti P, Rodriguez Muñoz D, et al. 2016 ESC Position Paper on cancer treatments and cardiovascular toxicity developed under the auspices of the ESC Committee for Practice Guidelines: The Task Force for cancer treatments and cardiovascular toxicity of the European Society of Cardiology (ESC). *Eur Heart J*. Sep 21 2016;37(36):2768-2801. doi:10.1093/eurheartj/ehw211

Reviewed / Approved by NIA Clinical Guideline Committee

Disclaimer: Magellan Healthcare service authorization policies do not constitute medical advice and are not intended to govern or otherwise influence the practice of medicine. These policies are not meant to supplant your normal procedures, evaluation, diagnosis, treatment and/or care plans for your patients. Your professional judgement must be exercised and followed in all respects with regard to the treatment and care of your patients. These policies apply to all Magellan Healthcare subsidiaries including, but not limited to, National Imaging Associates ("Magellan"). The policies constitute only the reimbursement and coverage guidelines of Magellan. Coverage for services varies for individual members in accordance with the terms and conditions of applicable Certificates of Coverage, Summary Plan Descriptions, or contracts with governing regulatory agencies. Magellan reserves the right to review and update the guidelines at its sole discretion. Notice of such changes, if necessary, shall be provided in accordance with the terms and conditions of provider agreements and any applicable laws or regulations.