| National Imaging Associates, Inc.* | |
|---|---|
| **Clinical guidelines**<br>**HEART MRI** | **Original Date: March 26, 2008** |
| **CPT Codes: 75557, 75559, 75561, 75563 +75565, +0698T** | **Last Revised Date: March 2021** |
| **Guideline Number: NIA_CG_028** | **Implementation Date: January 2022** |

**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~~**cardiomyopathy (Ommen, 2020).**

- 
    - ~~,~~**W** ~~w~~hen 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**

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

**Valvular Heart Disease**

- Evaluation of valvular stenosis, regurgitation, or valvular masses when transthoracic echocardiography (TTE) is inadequate (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
  - **Device leaks**
  - 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~~**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~~**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)**

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

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**BACKGROUND**

(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, 2014)

**Stable patients without known CAD** fall into 2 categories (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

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, 201~~3~~4):

| Age (Years) | Gender | Typical/Definite Angina Pectoris | Atypical/Probable Angina Pectoris | Nonanginal Chest Pain |
|---|---|---|---|---|
| ≤ 39 | Men | Intermediate | Intermediate | Low |
| | Women | Intermediate | Very low | Very low |
| 40 – 49 | Men | High | Intermediate | Intermediate |
| | Women | Intermediate | Low | Very low |
| 50 – 59 | Men | High | Intermediate | Intermediate |
| | 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 (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 | Transesophogeal Echo |
| VT | Ventricular tachycardia |

**POLICY HISTORY**

| Date | Summary |
|---|---|
| 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.<br>• Added the following to the section Cardiomyopathy & Heart Failure:<br>○ Edited indication to assess systolic and diastolic function in the evaluation of a newly diagnosed cardiomyopathy<br>○ Added the following to suspected infiltrative disease such as amyloidosis, sarcoidosis, hemochromatosis, or endomyocardial fibrosis: if PET has not been performed<br>○ Added suspected inherited or acquired cardiomyopathy<br>○ 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<br>○ Added clinical symptoms and signs consistent with a cardiac diagnosis known to cause presyncope/syncope (including but not limited to hypertrophic cardiomyopathy)<br>• Added pulmonary hypertension in the absence of severe valvular disease<br>Added the following indications to the section Evaluation of Intra- and Extra-Cardiac Structures<br>○ Initial evaluation of cardiac mass, suspected tumor or thrombus or potential cardiac source of emboli<br>○ Re-evaluation of intracardiac mass when findings would change therapy<br>○ Added the following to identification and characteristics of coronary aneurysm: or anomalous coronary arteries<br>• Added section on Pre-Procedure Evaluation for Closure of ASD or PFO including the following indications:<br>○ For assessment of atrial septal anatomy and atrial septal aneurysm<br>○ For assessment of suitability for percutaneous device closure |

| | |
|---|---|
| | • Added section on Assessment Following LAA Occlusion including the following indications:<br>  ○ For surveillance at 45 days or FDA guidance, if TEE or Heart CT not done, to assess for:<br>  ▪ Device stability<br>  ▪ To exclude device migration<br>  ▪ To assess for device leaks<br>• 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<br>• Added the following to the section Aortic Pathology<br>  ○ 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:<br>  ▪ Aortic diameter >4.5 cm<br>  ▪ Rapid rate of change in aortic diameter<br>  ▪ Family history (first-degree relative) of aortic dissection<br>  ○ 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)<br>• Extensive update to the indications for Congenital Heart Disease to include the following:<br>  ○ For all indications noted, either CT or CMR can be done<br>  ○ All lesions: evaluation prior to planned repair and evaluation for change in clinical status and/or new concerning signs or symptoms<br>  ○ Specific indications based on lesion were added with interval and criteria for repeat imaging included<br>  ○ Added indication for coronary anomalies<br>• Updated and added new references |
| July 2019 | • Removed table of comparison to Cardiac CT<br>• Removed global risk calculator for asymptomatic patients<br>• Removed scenarios for which approval of CMR is not approvable as well as follow-up indications<br>• Removed section on MRI compatibility with Pacemakers<br>• 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<br>• Expanded indication for prosthetic heart valves<br>• Removed indication of screening with a strong family history of cardiomyopathy<br>• |

~~July 2019~~

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- 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:
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  - Added indication for coronary anomalies
- Updated and added new references

3/2021

Added expanded guidelines for HCM with new reference

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**Reviewed / Approved by NIA Clinical Guideline Committee**

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