*National Imaging Associates, Inc.	
Clinical guidelines **MYOCARDIAL PERFUSION IMAGING** **(aka NUCLEAR CARDIAC IMAGING STUDY)**	**Original Date: October 2009**
CPT Codes: 78451, 78452, 78453, 78454, 78466, 78468, 78469, 78481, 78483, 78499, +0742T	**Last Revised Date: May 2023**
Guideline Number: NIA_CG_024	**Implementation Date: January 2024**

GENERAL INFORMATION

- *It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.*
- *Where a specific clinical indication is not directly addressed in this guideline, medical necessity determination will be made based on widely accepted standard of care criteria. These criteria are supported by evidence-based or peer-reviewed sources such as medical literature, societal guidelines and state/national recommendations.*

This guideline is for stress imaging, specifically myocardial perfusion imaging (MPI), with appropriate preference for suitable alternatives, such as stress echocardiography (SE), when more suitable, unless otherwise stated (refer to Overview).

INDICATIONS for MPI[1-4]

SUSPECTED CORONARY ARTERY DISEASE (CAD)

- **Symptomatic patients without known CAD (use Diamond Forrester Table)**
  - Low or intermediate pretest probability and unable to exercise *(SE diversion not required)*
  - High pretest probability *(SE diversion not required)*
  - Repeat testing in a patient with new or worsening symptoms and negative result at least one year prior AND meets one of the criteria above
- **Asymptomatic patients without known CAD** *(SE diversion not required)*
  - Previously unevaluated ECG evidence of possible myocardial ischemia including ischemic ST segment or T wave abnormalities (see Overview section)
  - Previously unevaluated pathologic Q waves (see Overview section)

- Previously unevaluated complete left bundle branch block

ABNORMAL CALCIUM SCORES (CAC)[4-8]

- ASYMPTOMATIC patient with a calcium score > 400, not previously evaluated
- SYMPTOMATIC patient with prior CAC ≥ 100

INCONCLUSIVE CAD EVALUATION AND OBSTRUCTIVE CAD REMAINS A CONCERN

- Exercise stress ECG with low-risk Duke treadmill score (≥5), (see section in Overview) but patient's current symptoms indicate an intermediate or high pretest probability *(SE diversion not required* for high pretest probability)
- Exercise stress ECG with an intermediate Duke treadmill score *(SE diversion not required* for symptoms consistent with high pretest probability)
- Intermediate coronary computed tomography angiography (CCTA) (e.g., 40 - 70% lesions)
- Non-diagnostic exercise stress test with inability to achieve target heart rate (THR) *(SE diversion not required)*
- An indeterminate (equivocal, borderline, or discordant) evaluation by prior stress imaging (SE or CMR) *(SE diversion not required)*
- Coronary stenosis of unclear significance on previous coronary angiography[4]

FOLLOW-UP OF PATIENT'S POST CORONARY REVASCULARIZATION (PCI or CABG)[4]

- **Asymptomatic follow-up stress imaging** at a minimum of 2 years post coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI) (whichever is later) is appropriate for patients with a history of silent ischemia or a history of a prior left main stent.[4] *(SE diversion not required for CABG)*

  OR

  For patients with high occupational risk, associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers and firefighters *(SE diversion not required)*
- **New, recurrent, or worsening symptoms post coronary revascularization** is an indication for stress imaging, if it will alter management (SE diversion not required for typical anginal symptoms or symptoms documented to be similar to those prior to revascularization).

FOLLOW-UP OF KNOWN CAD

- **Follow-up of asymptomatic or stable symptoms** when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR ≤ 0.80 or significant stenosis in a major vessel (≥ 50% left main coronary artery or ≥ 70 % LAD, LCX, RCA)), over two years ago, without intervening coronary revascularization is an appropriate indication for stress imaging in patients if it will alter management

SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION

- Prior acute coronary syndrome (with documentation in MD notes), without invasive or non-invasive coronary evaluation *(SE diversion not required)*
- Newly diagnosed systolic heart failure or diastolic heart failure, *with reasonable suspicion of cardiac ischemia (prior events, risk factors*), unless invasive coronary angiography is immediately planned *(SE diversion not required)*[1, 9-11]
- LVEF requiring myocardial viability assessment to assist with decisions regarding coronary revascularization[9, 12]
- Ventricular arrhythmias
    - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise-induced VT, when invasive coronary arteriography is not immediately planned[13] *(SE diversion not required)*
    - Nonsustained VT, multiple episodes, each ≥ 3 beats at ≥ 100 bpm, or frequent PVCs (defined as greater than or equal to 30/hour on remote monitoring) without known cause or associated cardiac pathology, when an exercise ECG cannot be performed[14]
- Prior to initiation of Class IC antiarrhythmic drug initiation (Propafenone or Flecainide), as well as annually in intermediate and high global risk patients *(SE diversion not required)* [15]
- Assessment of hemodynamic significance of one of the following documented conditions:
    - Anomalous coronary arteries[16]
    - Myocardial bridging of coronary artery
- Coronary aneurysms in Kawasaki's disease[17] or due to atherosclerosis
- Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter[18]
- Cardiac sarcoidosis: as a combination study with Heart PET for the evaluation and treatment of cardiac sarcoidosis.[19]
- Cardiac amyloidosis: for the diagnosis of cardiac transthyretin amyloidosis (ATTR). **Not** to be used for the diagnosis of cardiac light chain amyloidosis (AL)[20]

PRIOR TO ELECTIVE NON-CARDIAC SURGERY IN ASYMPTOMATIC PATIENT

- An intermediate or high risk surgery with of one or more risk factors (see below), AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year[21-23]
    - **Risk factors:** history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dL.
    - **Surgical Risk:**
        - **High risk surgery:** Aortic and other major vascular surgery, peripheral vascular surgery, anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss
        - **Intermediate risk surgery:** Carotid endarterectomy, head and neck surgery, intraperitoneal and intrathoracic surgery, orthopedic surgery, prostate surgery

    - **Low risk surgery**: Endoscopic procedures, superficial procedure, cataract surgery, breast surgery
- Planning for any organ or stem cell transplantation is an indication for preoperative MPI, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, at the discretion of the transplant service. [3, 24]

POST CARDIAC TRANSPLANT *(SE diversion not required)*

- Annually, for the first five years post cardiac transplantation, in a patient not undergoing invasive coronary arteriography
- After the first five years post cardiac transplantation, patients with documented transplant coronary vasculopathy can be screened annually unless invasive coronary arteriography is planned

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BACKGROUND

This guideline is for stress imaging, specifically myocardial perfusion imaging (MPI), with appropriate preference for alternatives, such as stress echocardiography (SE) or stress ECG alone when more suitable (see section below).

Radionuclide myocardial perfusion imaging (MPI) allows for evaluation of cardiac perfusion at rest and at exercise, as well as using pharmacologic agents for the diagnosis and management of coronary artery disease. With radionuclide MPI, pharmacologic stress may be performed with an inotropic agent or vasodilator. These agents are indicated for patients who cannot reach an adequate endpoint with physical exercise stress testing.[25]

Stable patients without known CAD fall into 2 categories[1, 3, 4]:

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see Websites for Global Cardiovascular Risk Calculators section).
- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant CAD (below):

The 3 Types of Chest Pain or Discomfort

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
    - Substernal chest pain or discomfort with characteristic quality and duration
    - Provoked by exertion or emotional stress
    - Relieved by rest and/or nitroglycerine
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics

The medical record should provide enough detail to establish the type of chest pain. From those details, The Pretest Probability of obstructive CAD is estimated from the Diamond Forrester Table below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability[1, 4]:

Diamond Forrester Table

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

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

OVERVIEW

MPI may be performed without diversion to a SE in any of the following[4, 26]:

- Inability to Exercise
    - Physical limitations precluding ability to exercise for at least 3 full minutes of Bruce protocol
    - Limited functional capacity (< 4 METS) **such as one** of the following:
        - Unable to take care of their ADLs or ambulate
        - Unable to walk 2 blocks on level ground
        - Unable to climb 1 flight of stairs
- Other Comorbidities
    - Severe chronic obstructive pulmonary disease (COPD) with pulmonary function test (PFT) documentation, severe shortness of breath on minimal exertion, or requirement of home oxygen during the day
    - Poorly controlled hypertension, with systolic BP > 180 or diastolic BP > 120 (and clinical urgency not to delay MPI)
- ECG and Echo-Related Baseline Findings

    - Prior cardiac surgery (coronary artery bypass graft or valvular)
    - Documented poor acoustic imaging window
    - Left ventricular ejection fraction ≤ 40%
    - Pacemaker or ICD
    - Persistent atrial fibrillation
    - Resting wall motion abnormalities that would make SE interpretation difficult
    - Complete left bundle branch block (LBBB)
- Risk-Related scenarios
    - High pretest probability in suspected CAD
    - Intermediate or high global risk in patients requiring type IC antiarrhythmic drugs (prior to initiation of therapy and annually)
    - Arrhythmia risk with exercise
- Previously unevaluated pathologic Q waves (in two contiguous leads) defined as the following:
    - > 40 ms (1 mm) wide
    - > 2 mm deep
    - > 25% of depth of QRS complex

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) require that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate **AND** has an interpretable ECG for ischemia during exercise[4]:

- The (symptomatic) low or intermediate pretest probability patient who can exercise and has an interpretable ECG[4]
- The patient who is under evaluation for exercise-induced arrhythmia
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription
- For the evaluation of syncope or presyncope during exertion[27]

Duke Exercise ECG Treadmill Score[28]

Calculates risk from ECG treadmill alone**:**

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤ - 11) categories

An uninterpretable baseline ECG includes[1]:

- ST segment depression 1 mm or more; (not for non-specific ST- T wave changes)
- Ischemic looking T waves; at least 2.5 mm inversions (excluding V1 and V2)

- LVH with repolarization abnormalities, pre-excitation pattern such as WPW, ventricular paced rhythm, or LBBB
- Digitalis use with associated ST segment abnormalities
- Resting HR under 50 bpm on a medication, such as beta-blockers or calcium channel blockers, that is required for patient's treatment and cannot be stopped, with an anticipated suboptimal workload

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years. **High global risk by itself generally lacks scientific support as an indication for stress imaging.** There are rare exceptions, such as patients requiring IC antiarrhythmic drugs who might require coronary risk stratification prior to initiation of the drug.

- **CAD Risk—Low**
  10-year absolute coronary or cardiovascular risk less than 10%.
- **CAD Risk—Moderate**
  10-year absolute coronary or cardiovascular risk between 10% and 20%.
- **CAD Risk—High**
  10-year absolute coronary or cardiovascular risk of greater than 20%.

Websites for Global Cardiovascular Risk Calculators*[29-33]

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.

Definitions of Coronary Artery Disease[1, 3, 6, 34]

Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).

- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; intermediate lesions are 50 – 69%[35]
    - For a left main artery, suggested by a percentage stenosis ≥ 50% [1, 36, 37]
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel[36, 37]
    - Demonstrable ischemic findings on stress testing (ECG or stress imaging), that are at least mild in degree
- FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion. Less than or equal to 0.80 is considered a significant reduction in coronary flow.

Anginal Equivalent[1, 27]

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia). This may include respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope per se is not an anginal equivalent.

Abbreviations

ADLs	Activities of daily living
BSA	Body surface area in square meters
CABG	Coronary artery bypass grafting
CAD	Coronary artery disease
CMR	Cardiac magnetic resonance imaging
CTA	Computed tomography angiography
ECG	Electrocardiogram
FFR	Fractional flow reserve
IVUS	Intravascular ultrasound
LBBB	Left bundle-branch block
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
MI	Myocardial infarction
MET	Estimated metabolic equivalent of exercise
MPI	Myocardial perfusion imaging
PCI	Percutaneous coronary intervention
PFT	Pulmonary function test
PVCs	Premature ventricular contractions
SE	Stress echocardiography
THR	Target heart rate
VT	Ventricular tachycardia
VF	Ventricular fibrillation
WPW	Wolf Parkinson White

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POLICY HISTORY

Date	Summary
May 2023	• Removed time limitation "within past two years" for further evaluation inconclusive prior CAD evaluation • Added coronary stenosis of unclear significance on coronary angiography • Clarified indication for combination PET/MPI in evaluation of cardiac sarcoidosis • Added indication for diagnosis of ATTR amyloidosis • Added statement on clinical indications not addressed in this guideline
February 2022	• Moved the sentence regarding utilization of suitable alternatives such as Stress Echocardiography to the General Information section • Placed Link to Overview Section in General Information • Clarified evaluation of possible ischemia in newly diagnosed heart failure by stating "with reasonable suspicion of cardiac ischemia (prior events, risk factors, or symptoms and signs)" • Clarified "intermediate lesions are 50-69%" for ischemia-producing disease • Added stress imaging approval for calcium score > 100 with low to intermediate probability symptoms • Deleted the requirement for diabetes when calcium score > 400 for stress imaging • Deleted "≤50%" from "LVEF ≤50% requiring myocardial viability assessment to assist with decisions regarding coronary revascularization" • Added Calcium score section: ○ Added stress imaging approval for calcium score > 100 with symptoms consistent with low to intermediate pretest probability • Added reminder *(SE diversion not required for CABG)* • Changed preoperative guideline to include intermediate risk surgery with one or more risk factors AND documentation of an inability to walk (or <4 METs) AND there has not been an imaging stress test within 1 year • Changed solid organ transplant guideline to include stem cell transplant and "any" organ transplant • Added definition of surgical risk to preop guidelines • In Background section clarified the requirement for description of chest pain by adding sentence "The medical record should provide enough detail to establish the type of chest pain." • Added definition of Q waves

	• Deleted sentence regarding calcium scoring within the Global Risk Section • Deleted sentence regarding using calcium score solely for risk stratification • Deleted IFR references

Reviewed / Approved by NIA Clinical Guideline Committee

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