National Imaging Associates, Inc.*	
Clinical Guidelines **STRESS ECHOCARDIOGRAPHY**	**Original Date: February 2010**
CPT Codes: 93350, 93351, +93320, +93321, +93325, +93352, +93356	**Last Revised Date: March 2021**
Guideline Number: NIA_CG_026	**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 STRESS ECHO

SUSPECTED CORONARY ARTERY DISEASE (CAD)

Symptomatic patients without known CAD (use Diamond Forrester table)

- Low or intermediate pretest probability, and electrocardiogram (ECG) is uninterpretable
- High pretest probability
- Repeat testing in patient with new or worsening symptoms and negative result at least one year ago AND meets one of the criteria above

Asymptomatic patients without known CAD

- **Previously unevaluated ECG evidence of possible myocardial ischemia including ischemic ST segment or T wave abnormalities (See Overview section)**
- **Previously unevaluated pathologic Q waves**
- **Previously unevaluated complete left bundle branch block**
- **History of diabetes mellitus, > 40 years old, with calcium score >400 (Budoff, 2016)**
- ~~Evidence of possible myocardial ischemia which was not seen on prior EKG including but not limited to:~~
  - ~~Ischemic ST segment or T wave abnormalities (See Overview Section)~~
  - ~~Q waves~~

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- ~~Complete left bundle branch block~~

INCONCLUSIVE CAD EVALUATION WITHIN THE PAST 2 YEARS AND OBSTRUCTIVE CAD REMAINS A CONCERN

- Exercise stress ECG with low risk Duke treadmill score ≥5, but patient's current symptoms indicate an intermediate or high pretest probability
- Exercise stress ECG with an intermediate Duke treadmill score
- Intermediate coronary computed tomography angiography (CCTA) defined as:
  - 30 -70% lesion

FOLLOW-UP OF PATIENTS POST CORONARY REVASCULARIZATION (PCI or CABG)
(Doherty, 2019)

- Asymptomatic follow-up stress imaging (MPI or SE), at a minimum of 2 years post coronary artery bypass grafting (CABG), or percutaneous coronary intervention (PCI), whichever is later, is appropriate for patients with a history of silent ischemia or a history of a prior left main stent (Wolk, 2014)
  OR
- For patients with high occupational risk including any of the following:
  - Associated with public safety
  - Airline and boat pilots
  - Bus and train drivers
  - Bridge and tunnel workers/toll collectors
  - Police officers and firefighters
- New, recurrent, or worsening symptoms post coronary revascularization is an indication for stress imaging

FOLLOW-UP OF KNOWN CAD

- **Routine follow-up of asymptomatic or stable symptoms** when last invasive or non-invasive assessment of coronary disease showed hemodynamically significant CAD (ischemia on stress test or FFR ≤ 0.80 or stenosis greater than or equal to 70% of a major vessel), over two years ago without intervening coronary revascularization, is an appropriate indication for stress imaging (MPI or SE)

SPECIAL DIAGNOSTIC CONDITIONS REQUIRING CORONARY EVALUATION

- Prior acute coronary syndrome (with documentation in MD notes), within last three months, without a prior stress test or coronary angiography performed since that time
- Newly diagnosed systolic heart failure (EF < 50%), when invasive coronary angiography has not been performed, especially when symptoms or signs of ischemia are present or suspected such as:
  - Chest pain
  - EKG changes such as new ST segment depression or T wave inversions
  - New wall motion abnormalities

- Ventricular arrhythmias:
    - Sustained ventricular tachycardia (VT) > 100 bpm, ventricular fibrillation (VF), or exercise-induced VT, when invasive coronary arteriography has not been performed (Al-Khatib, 2018)
    - Nonsustained VT, multiple episodes, each ≥ 3 beats at ≥ 100 bpm, frequent VPC's (defined as greater than or equal to 30/hour on remote monitoring), when an exercise ECG cannot be performed (Zimetbaum, 2018)
- Prior to **initiation of** Class IC antiarrhythmic drug initiation (Propafenone or Flecanide), **as well as annually** in intermediate and high global risk patients (Reiffel, 2015)
- Hemodynamic **a**~~A~~ssessment of ischemia in one of the following documented conditions:
    - Anomalous coronary arteries in an asymptomatic individual without prior stress echocardiography (Grani, 2017);
    - Myocardial bridging of a coronary artery (perform with exercise stress) (Tang, 2011);
- Coronary aneurysms in Kawasaki's disease (McCrindle, 2017)
- Following radiation therapy to the anterior or left chest, at 5 years post initiation and every 5 years thereafter (Lancellotti, 2013)

CHRONIC VALVULAR DISEASE

Evaluation with Inclusion of Doppler
(Baumgartner, 2017; Bonow, 2020; Nishimura, 2014; Steiner, 2017)

- Dobutamine SE for the evaluation of aortic stenosis and flow (contractile) reserve in symptomatic patients with severe aortic stenosis by calculated valve area, low flow / low gradient, and ejection fraction < 50%
- Exercise echo Doppler evaluation for mitral stenosis (MS) if there is:
    - Exertional shortness of breath which suggests the amount of MS is worse than is seen on the resting echocardiogram
- Exercise echo Doppler evaluation for mitral regurgitation (MR) if there is:
    - Exertional shortness of breath which suggests the amount of MR is worse than is seen on the resting echocardiogram; **OR**
    - The echocardiogram is not able to distinguish whether the MR is moderate or severe in a patient that is asymptomati~~c~~c
- **For symptomatic patients with HCM, who do not have resting or provocable outflow tract gradient ≥50 mm Hg on TTE, for detection and quantification of dynamic LVOT obstruction (Ommen, 2020)**
- **For asymptomatic patients with HCM who do not have a resting or provocable outflow tract gradient ≥ 50 mm Hg on TTE (Class 2A)**

PRIOR TO ELECTIVE NON-CARDIAC SURGERY
(Fleischer, 2014; Patel, 2015)

- Patients who would otherwise not be planned for a non-invasive coronary evaluation, but are referred for preoperative cardiac evaluation, are eligible for SE if **ALL 4** criteria are met:
    - Surgery is supra-inguinal vascular, intrathoracic, or intra-abdominal; **AND**
    - The patient has **at least one** of these additional cardiac complication risk factors:
        - Ischemic Heart Disease
        - History of stroke or transient ischemic attack (TIA)
        - History of congestive heart failure (CHF) or ejection fraction ≤ 35%
        - Insulin-requiring diabetes mellitus
        - Creatinine ≥ 2.0 mg/dl

    AND
    - The patient has limited functional capacity (< 4 metabolic equivalents) such as one of the following (would likely be requested as MPI):
        - Cannot take care of their ADLs which include but not limited to:
            - Independently eating, bathing or ambulating
            - Cannot walk 2 blocks on level ground
            - Cannot climb 1 flight of stairs

    AND
    - There has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year, and the results would be likely to preclude proceeding with the intended surgery

- Planning for solid organ transplantation (liver or kidney), is an indication for preoperative dobutamine SE, if there has not been a conclusive stress evaluation, CTA, or heart catheterization within the past year and **with ≥ 3** of the following risk factors (Lentine, 2012):
    - Age > 60
    - Smoking
    - Hypertension
    - Dyslipidemia
    - Left ventricular hypertrophy
    - > 1 year on dialysis (for renal transplant patients)
    - Diabetes mellitus
    - Prior ischemic heart disease

POST CARDIAC TRANSPLANTATION

- 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 transplant coronary vasculopathy can be screened annually with **ONE** of the following:
    - MPI
    - SE

- Left heart catheterization

BACKGROUND
Stress echocardiography (SE) refers to ultrasound imaging of the heart during exercise electrocardiography (ECG) testing, during which visualized wall motion abnormalities can provide evidence of potential significant coronary artery disease (CAD).

While drug-induced stress with dobutamine can be an alternative to exercise stress testing in patients who are unable to exercise, this guideline does not require use of this modality. Hence, reference in this document to SE predominantly refers to exercise stress echocardiography.

Although SE provides comparable accuracy without radiation risk, relative to myocardial perfusion imaging (MPI), scenarios which do not permit effective use of SE might be better suited for stress imaging with MPI, cardiovascular magnetic resonance imaging (CMR) or positron emission tomography (PET), or coronary computed tomography angiography (CCTA).

Stable patients without known CAD fall into 2 categories:
(Fihn, 2012; Montalescot, 2013; Wolk, 2014~~3~~)

- **Asymptomatic patients**, 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 patients,** for whom we estimate the Pretest Probability that their chest-related symptoms are due to clinically significant CAD (see below):

The 3 Types of Chest Pain or Discomfort:

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

Once the type of chest pain has been established from the medical record, the Pretest Probability of obstructive CAD is estimated from the **Diamond Forrester Table** below, recognizing that in some cases multiple additional coronary risk factors could increase pretest probability (Fihn, 2012; Wolk, 2014~~3~~):

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 (Fihn, 2012)
- **Low:** 5 - 10% pretest probability of CAD
- **Intermediate:** 10% - 90% pretest probability of CAD
- **High:** > 90% pretest probability of CAD

OVERVIEW

MPI may be performed without diversion to SE in any of the following (Henzlova, 2016; Wolk, 2014~~3~~):

- Inability to exercise
    - Physical limitations precluding ability to exercise for at least 3 full minutes of Bruce protocol
    - Limited functional capacity (< 4 metabolic equivalents) **such as one** of the following:
        - Cannot take care of their activities of daily living (ADLs) or ambulate
        - Cannot walk 2 blocks on level ground
        - Cannot climb 1 flight of stairs
        - Cannot vacuum, dust, do dishes, sweep, or carry a small grocery bag
- Other Comorbidities
    - Severe chronic obstructive pulmonary disease with pulmonary function test (PFT) documentation, severe shortness of breath on minimal exertion, or requirement of home oxygen during the day
    - Poorly controlled hypertension, with systolic BP > 180 or Diastolic BP > 120 (and clinical urgency not to delay MPI)
        - ECG and Echo Related Baseline Findings
    - Prior cardiac surgery (coronary artery bypass graft or valvular)
    - ~~Obesity with body mass index (BMI) over 40 kg/m2 or~~ D~~d~~ocumented 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 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

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) are inferred from the guidelines presented above, often requiring that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate **AND** has an interpretable ECG for ischemia during exercise (Wolk, 2014~~3~~):

- The (symptomatic) low or intermediate pretest probability patient who is able to exercise and has an interpretable ECG
- The (asymptomatic) high global risk patient who can exercise and has an interpretable ECG
- The patient who is under evaluation for exercise-induced arrhythmia (Al-Khatib, 2017)
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription.

Duke Exercise ECG Treadmill Score (Mark, 1987)

Calculates risk from ECG treadmill alone**:**

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

An uninterpretable baseline ECG includes (Fihn, 2012):

- ST segment depression 1 mm or more; (not for non-specific ST- T wave changes)
- Ischemic looking T wave -- at least 2.5 mm inversions (excluding V1 and V2)
- LVH, pre excitation pattern such as WPW, a ventricular paced rhythm, or left bundle branch block
- Digitalis use

- 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 exemptions, such as patients requiring IC antiarrhythmic drugs, who might require coronary risk stratification prior to initiation of the drug, or patients with a CAC score > 400 Agatston units, when global risk is moderate or high.

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

Websites for Global Cardiovascular Risk Calculators*
*Patients who have known CAD are already at high global risk and are not applicable to the calculators (Arnet, 2019; D'Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007).

Risk Calculator	Link to 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	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

Calcium Score, for CAD-only risk	

Definitions of Coronary Artery Disease
(Fihn, 2012; Mintz, 2016; Montalescot, 2013; Patel, 2017; Tobis, 2007)

- Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and refers to cross-sectional narrowing when IVUS (intravascular ultrasound) is the method of determination
- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. It is not a diagnostic tool so much as it is a **risk stratification** tool. Its incorporation into Global Risk can be achieved by using the MESA risk calculator.
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate), generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; borderline lesions are 40 - 70% (Fihn, 2012; Tobis, 2007)
    - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum lumen cross-sectional area on IVUS ≤ 6 square mm (Fihn, 2012; Lofti, 2018; Mintz, 2016)
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel (Lofti, 2018; Mintz, 2016)
    - iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel (Davies, 2017; Gotberg, 2017; Lofti, 2018)
- A major vessel would be a coronary vessel that would be amenable to revascularization, if indicated. This assessment is made based on the diameter of the vessel and/or the extent of myocardial territory served by the vessel
- FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow.
- iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel (Davies, 2017; Gotberg, 2017)

Anginal Equivalent
(Fihn, 2012; Moya, 2009; Shen, 2017)

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons 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

AAD	Antiarrhythmic drug
ADLs	Activities of daily living
BSA	Body surface area in square meters
CAD	Coronary artery disease
ECG	Electrocardiogram
FFR	Fractional flow reserve
LBBB	Left bundle-branch block
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
MI	Myocardial infarction
MET	Estimated metabolic equivalent of exercise
MPI	Myocardial perfusion imaging
PFT	Pulmonary function test
PVCs	Premature ventricular contractions
SE	Stress echocardiography
VT	Ventricular tachycardia
VF	Ventricular fibrillation
WPW	Wolf Parkinson White

POLICY HISTORY

Date	Summary
March 2021	• **Wording changes to align with MPI** • **Added annual studies for patients on Flecainide** • **Added indication for Ca score in diabetic > 40 and calcium score > 400 with reference added** • **Added indicatios and reference for hypertrophic cardiomyopathy** • **Removed BMI > 40 as indication to allow MPI over SE**
August 2020	• **For asymptomatic patients without a history of CAD, the wording for previously unevaluated was changed for Q waves and complete BBB** • **For newly diagnosed systolic heart failure (EF < 50%), when invasive coronary angiography has not been performed, especially when symptoms or signs of ischemia are present or suspected were further defined to state such as:** ○ **Chest pain** ○ **EKG changes such as new ST segment depression or T wave inversions**

	○ New wall motion abnormalities • Stress echo with Doppler indication further defined as exertional shortness of breath which suggests the amount of MS is worse than is seen on the resting echocardiogram • After the first five years post cardiac transplantation, patients with transplant coronary vasculopathy can be screened annually with ONE of the following: ○ MPI ○ SE ○ Left heart catheterization •
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 clarification of repeat testing in a patient with new or worsening symptoms and negative result at least one year prior to include the statement "AND meets one of the criteria above" • Added clarification of frequent PVCs under ventricular arrhythmias which states defined as greater than or equal to 30/hour to include "on remote monitoring" • Edited indication of planning for solid organ transplantation to remove the requirement of limited functional capacity but maintaining requirement of ≥ 3 listed risk factors • Added edits to the Coronary Artery Disease definition section • Updated and added new references
November 2019	• Added CPT code +93356
July 2019	• Stress echo for suspected CAD deleted the following indication: Repeat testing in patient with recurrent symptomatic presentation and negative result over 2 years ago • Added indications: 'For assessment of hemodynamic significance due to atherosclerosis or following radiation therapy to the anterior or left chest, at 5 years post initiation inception of radiation and every 5 years thereafter'; and 'Following radiation therapy to the anterior or left chest, at 5 years post initiation inception of radiation and every 5 years thereafter' • Removed secondary mitral regurgitation indication under doppler evaluation section • Clarified indication as follows: Routine follow-up of asymptomatic or stable symptoms when last invasive or non-invasive assessment of coronary disease showed

	hemodynamically significant CAD (ischemia on stress test or FFR less than or equal to 0.80 or stenosis greater than or equal to 70% of a major vessel) over two years ago without intervening coronary revascularization is an appropriate indication for stress imaging (MPI or SE) in patients if it will alter management

~~July 23, 2019~~

- ~~Stress echo for suspected CAD deleted the following indication: Repeat testing in patient with recurrent symptomatic presentation and negative result over 2 years ago~~
- ~~Added indications: 'For assessment of hemodynamic significance due to atherosclerosis or following radiation therapy to the anterior or left chest, at 5 years post initiation inception of radiation and every 5 years thereafter'; and 'Following radiation therapy to the anterior or left chest, at 5 years post initiation inception of radiation and every 5 years thereafter'~~
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March 2021

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Reviewed / Approved by NIA Clinical Guideline Committee

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