Home

Patient Care Pathways

Evaluating At-Risk Patients

Cardiac Testing Options

Patient-Centered Test Selection

Appropriate Use Criteria

Resources

Patient Care Pathways and Noninvasive Modalities

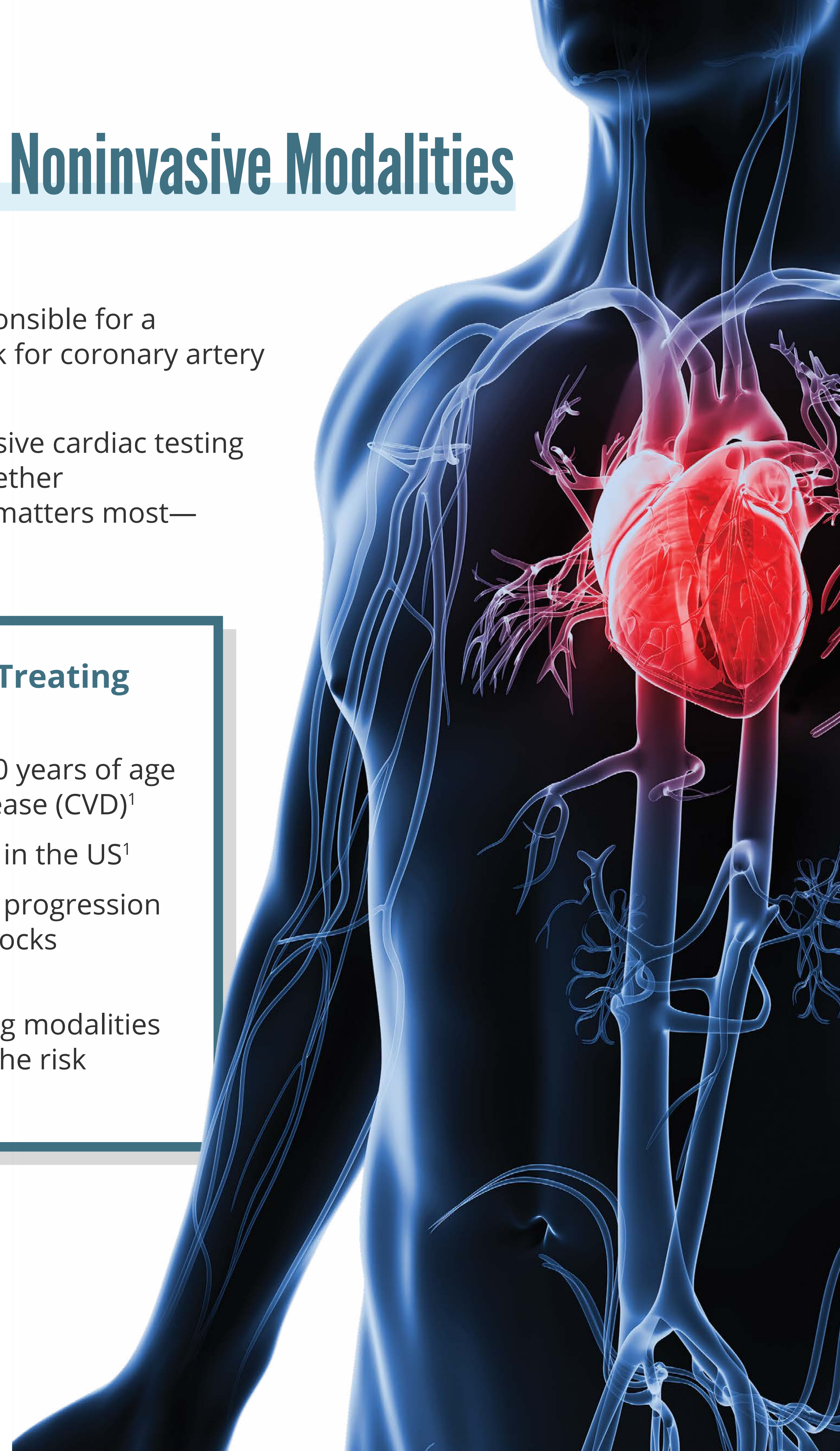
for the Evaluation of Coronary Artery Disease

Primary care providers are increasingly responsible for a growing, aging population that may be at risk for coronary artery disease (CAD).

The more we understand about the noninvasive cardiac testing options available, the more we can work together to help improve the quality of care for what matters most—the patient.

The Importance of Detecting and Treating CAD Early

- An estimated 126 million US adults ≥20 years of age have some form of cardiovascular disease (CVD)[1]
- CAD is the leading cause of CVD death in the US[1]
- Risk of CAD increases over time as the progression of atherosclerosis partially or totally blocks myocardial perfusion to the heart[2,3]
- Appropriate noninvasive cardiac testing modalities can provide essential information for the risk assessment and evaluation of CAD[4]



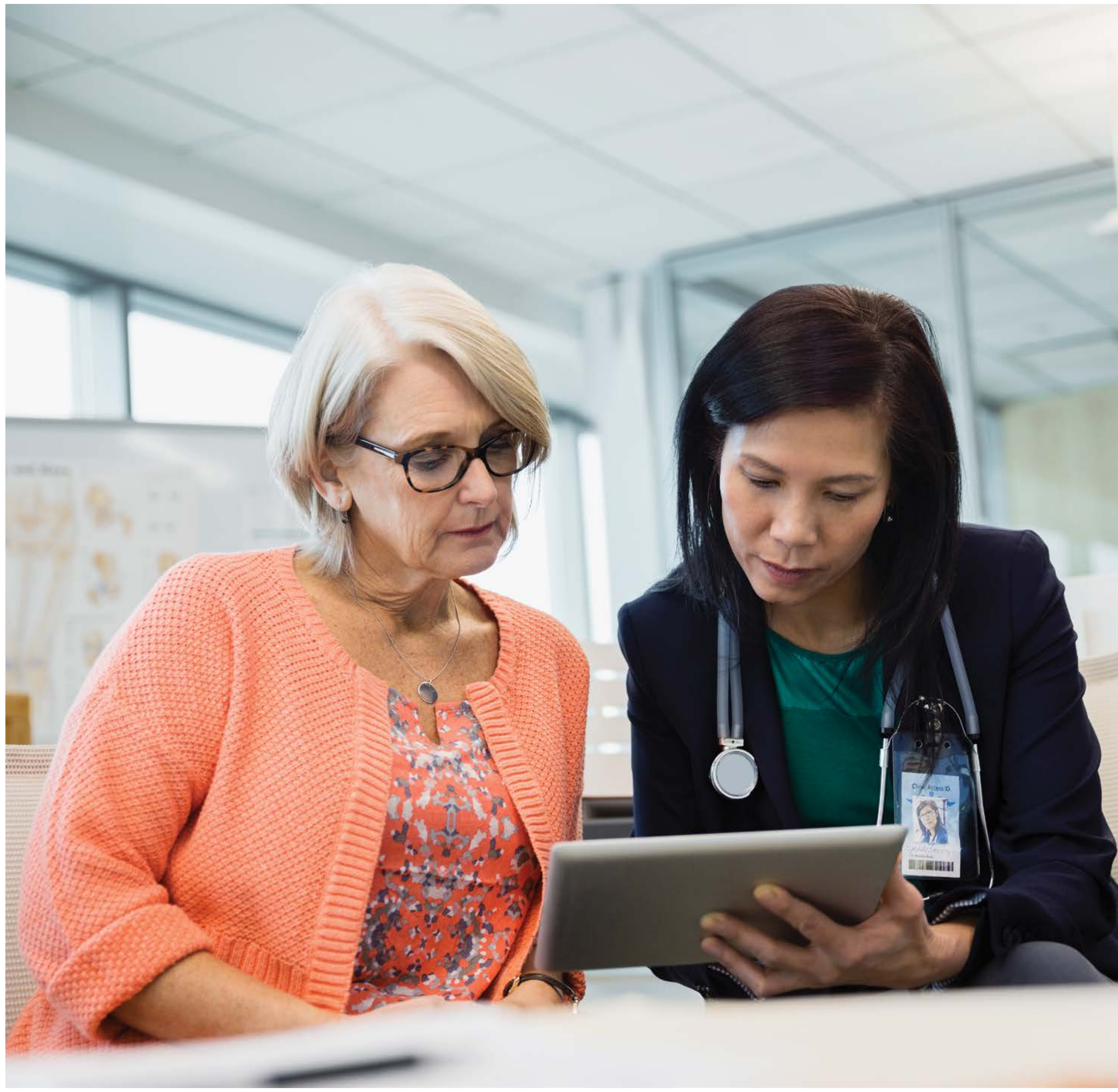
Patient Care Pathways

Considering Pathways for Patient Care

Patient evaluation pathways can help determine whether cardiac testing or treatment may be appropriate.

There are several patient care pathways for the evaluation of CAD. Although the pathways include considerations for testing and treatment, they are not intended to replace clinical judgment and should not be used for patient risk assessment or diagnosis.

Whether you're a primary care provider[a] or a cardiology specialist, following appropriate evaluation pathways can help ensure that your patients get the right tests or treatment at the right time.



[a]Primary care providers are the first to see patients at risk for CAD and may include primary care physicians (PCPs), obstetricians/gynecologists (OB/GYNs), internists, hospitalists, nurse practitioners (NPs), physician assistants (PAs), or other referring or ordering providers.

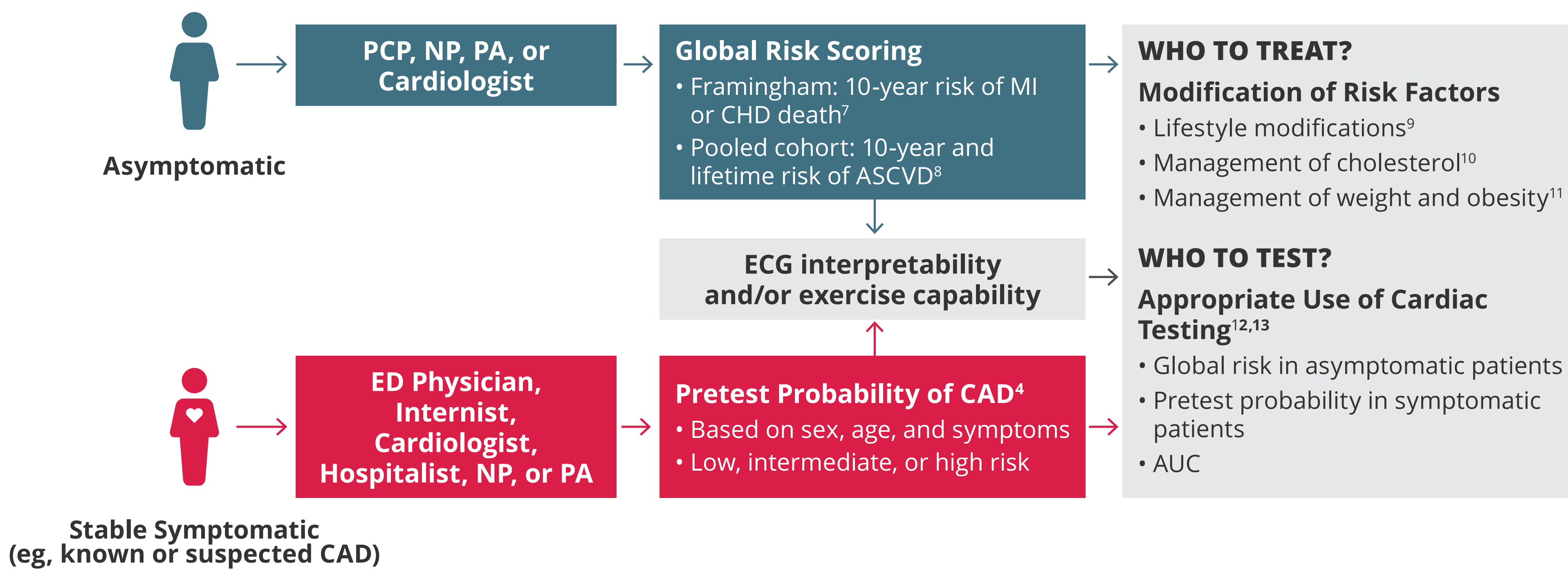
Patient Care Pathways

Patient Evaluation Pathways

Guideline-based pathways may help support clinical decisions for patient-centered care. According to guidelines from the American Heart Association (AHA) and other leading professional organizations, the evaluation of stable patients for suspected CAD follows 2 distinct pathways: one for patients who are asymptomatic, and another for those with symptoms (Figure 1).[4]

Following these guideline-recommended pathways may help identify which patients require management of risk factors for CAD, and which patients would benefit from further testing to diagnose CAD or assess the risk of a cardiac event.[4] Of note, patients who have acute coronary syndrome (ACS), including myocardial infarction (MI), enter a separate evaluation and management pathway.[5,6]

Figure 1. Patient-Centered Pathways for Evaluating CAD[4,7-13]



ASCVD = atherosclerotic cardiovascular disease; AUC = appropriate use criteria; CHD = coronary heart disease; ECG = electrocardiogram; ED = emergency department.

Patient Care Pathways

Who, When, and How to Treat

Although every scenario is different and patients are managed on a case-by-case basis, current published guidelines and clinical studies can help referring and ordering providers make more informed decisions about whether an individual patient requires advanced diagnostic imaging tests or whether they can be treated with optimal medical management. It is important to establish the right test for the right patient at the right time.

To learn more about **who to treat**, **when to treat**, and **how to treat**, click on the links below (Figure 2).

Figure 2. CAD Treatment Guidelines and Clinical Evidence

WHO TO TREAT? → 2013 Guideline on the Assessment of Cardiovascular Risk,[8] 2012 SIHD Guideline[4]

WHEN TO TREAT? → Guideline for Percutaneous Coronary Intervention,[14] 2013 Guideline on the Treatment of Blood Cholesterol[10]

HOW TO TREAT? → 2013 Guideline on Lifestyle Management,[9] 2013 Guideline on the Treatment of Blood Cholesterol,[10] COURAGE,[15] BARI 2D,[16] FAME 2,[17] FREEDOM,[18] ISCHEMIA,[19] 2012 SIHD Guideline[4]

SIHD = stable ischemic heart disease.

Patient Care Pathways

Who, When, and How to Test

To help determine individual patient test selection, the questions of who, when, and how to test for known or suspected CAD are supported by guidelines and clinical studies. To access these resources, click on the links below (Figure 3).

Figure 3. CAD Testing Guidelines and Information

WHO TO TEST?

WHEN TO TEST?

HOW TO TEST?

- ACCF/AHA Multimodality Appropriate Use Criteria for SIHD[12]
- AHA/ACC 2021 Guideline for the Evaluation and Diagnosis of Chest Pain[20]
- ACR/ACC Appropriate Utilization of Cardiovascular Imaging in ED Patients With Chest Pain[13]
- ACR Appropriateness Criteria® for Chronic Chest Pain With a High Probability of CAD[21]
- ASNC Model Coverage Policy for SPECT MPI[22]
- PROMISE Trial[23]

ACC = American College of Cardiology; ACCF = American College of Cardiology Foundation; ACR = American College of Radiology; ASNC = American Society of Nuclear Cardiology; SPECT MPI = single-photon emission computed tomography myocardial perfusion imaging.

Patient Care Pathways

References

1. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart disease and stroke statistics-2022 update: a report from the American Heart Association. Circulation (Epub) 02-22-2022.
2. National Heart, Lung, and Blood Institute. What is coronary heart disease? (03-24-2022). https://www.nhlbi.nih.gov/health/coronary-heart-disease. Accessed 05-12-2022.
3. American Heart Association. Atherosclerosis (11-06-2020). https://www.heart.org/en/health-topics/cholesterol/about-cholesterol/atherosclerosis. Accessed 01-26-2022.
4. 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. J Am Coll Cardiol 2012;60(24):e44-164. Erratum in: J Am Coll Cardiol 2014;63(15):1588-90.
5. Amsterdam EA, Wenger NK, Brindis RG, et al. 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes. Circulation 2014;130(25):e344-426. Erratum in: Circulation 2014;130(25):e433-4.
6. O’Gara PT, Kushner FG, Ascheim DD, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation 2013;127(4):e362-425. Erratum in: Circulation 2013;128(25):e481.
7. D’Agostino RB Sr, Vasan RS, Pencina MJ, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. Circulation 2008;117(6):743-53. Erratum in: Circulation 2008;118:e86.
8. Goff DC, Lloyd-Jones DM, Bennett G, et al. 2013 ACC/AHA guideline on the assessment of cardiovascular risk. Circulation 2014;129(25 Suppl 2):S49-73. Erratum in: Circulation 2014;129(25 Suppl 2):S74-5.
9. Eckel RH, Jakicic JM, Ard JD, et al. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2014;63(25 Pt B):2960-84. Erratum in: J Am Coll Cardiol 2014;63(25 Pt B):3027-28.
10. Stone NJ, Robinson JG, Lichtenstein AH, et al. 2013 ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014;129(25 Suppl 2):S1-45. Errata in: Circulation 2014;129(25 Suppl 2):S46-8. Circulation 2015;132(25):e396.
11. Jensen MD, Ryan DH, Apovian CM, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults. Circulation 2014;129(25 Suppl 2):S102-38. Erratum in: Circulation 2014;129(25 Suppl 2):S139-40.
12. 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. J Am Coll Cardiol 2014;63(4):380-406.

Patient Care Pathways

References *continued*

13. Rybicki FJ, Udelson JE, Peacock WF, et al. 2015 ACR/ACC/AHA/AATS/ACEP/ASNC/NASCI/SAEM/SCCT/SCMR/SCPC/SNMMI/STR/STS appropriate utilization of cardiovascular imaging in emergency department patients with chest pain. J Am Coll Cardiol 2016;67(7):853-79.

14. Levine GN, Bates ER, Blankenship JC, et al. 2011 ACCF/AHA/SCAI guideline for percutaneous coronary intervention. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions. J Am Coll Cardiol 2011;58(24):e44-122.

15. Shaw LJ, Berman DS, Maron DJ, et al. Optimal medical therapy with or without percutaneous coronary intervention to reduce ischemic burden: results from the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial nuclear substudy. Circulation 2008;117(10):1283-91.

16. Frye RL, August P, Brooks MM, et al. A randomized trial of therapies for type 2 diabetes and coronary artery disease. N Engl J Med 2009;360(24):2503-15.

17. De Bruyne B, Pijls NH, Kalesan B, et al. Fractional flow reserve–guided PCI versus medical therapy in stable coronary disease. N Engl J Med 2012;367(11):991-1001. Erratum in: N Engl J Med 2012;367(18):1768.

18. Abdallah MS, Wang K, Magnuson EA, et al. Quality of life after PCI vs CABG among patients with diabetes and multivessel coronary artery disease: a randomized clinical trial. JAMA 2013;310(15):1581-90.

19. Maron DJ, Hochman JS, Reynolds HR, et al. Initial invasive or conservative strategy for stable coronary disease. N Engl J Med 2020;382(15):1395-407.

20. Gulati M, Levy PD, Mukherjee D, et al. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR guideline for the evaluation and diagnosis of chest pain: executive summary: a report of the American College of Cardiology/American Heart Association Joint Committee on clinical practice guidelines. Circulation 2021;144(22):e336-67.

21. Akers SR, Panchal V, Ho VB, et al. ACR Appropriateness Criteria® chronic chest pain—high probability of coronary artery disease. J Am Coll Radiol 2017;14(5S):S71-80.

22. Wolinsky DG, Calnon DA, Hansen CL, et al. ASNC model coverage policy: single photon myocardial perfusion imaging. J Nucl Cardiol 2011;18(5):811-29.

23. Douglas PS, Hoffman U, Lee KL, et al. PROspective Multicenter Imaging Study for Evaluation of chest pain: rationale and design of the PROMISE trial. Am Heart J 2014;167(6):796-803.e1.

Evaluating At-Risk Patients

Evaluating At-Risk Patients | Initial Patient Evaluation | Risk Assessment | Risk Score Calculators | Initial Noninvasive Testing | References

Evaluating At-Risk Patients

The initial evaluation of patients with known or suspected CAD can help give primary care providers a better understanding of each patient's risk.

As the US population ≥65 years of age continues to grow, understanding risk assessment and evaluation options for CAD may become increasingly important in determining whether patients can be managed with optimal medical therapy or whether further noninvasive cardiac testing is needed.

The first step for all patients is a thorough initial evaluation of medical history, cardiac risk factors, symptoms, stability, and any prior cardiac test results.[1,2] For symptomatic patients, the initial evaluation may also include a resting ECG.[1]

Heart Disease Is a Major Threat to Public Health

It is estimated that nearly half of adults ≥20 years of age in the United States (126.9 million) have some form of CVD.[3]

Approximately 1 of every 3 deaths in the United States is attributed to CVD.[3]

CAD is the leading cause of CVD death in the United States.[3]

The prevalence of CAD is higher in those ≥60 years of age.[3]

+26M — **The number of adults ≥65 years of age is projected to increase by more than 26 million by 2040.[4]**

Evaluating At-Risk Patients

Initial Patient Evaluation

A variety of methods are available to assess patient risk for a future cardiac event based on the following[1]:

- Clinical classification of chest pain
- Risk factors
- Physical examination results
- Age
- Sex
- ECG results
- History of MI
- Presence of typical angina

Asymptomatic Patients

For patients who are asymptomatic, global risk scores can be used to estimate 10-year and lifetime risk of a cardiac event, including MI, fatal or nonfatal stroke, or CHD death.[5,6] The global risk score, along with exercise capacity and interpretability of ECG results, can help inform decisions about further testing or initiating lifestyle modifications and/or treatment to manage CAD risk factors.[7-10]

Symptomatic Patients

For patients who have symptoms suggestive of CAD, the probability of CAD can be estimated based on the patient's sex, age, and type of symptoms.[1,10,11] Pretest probability of CAD, exercise capacity, and ECG interpretability are factors that help determine if a patient should undergo further cardiac testing.[10]

Evaluating At-Risk Patients

Initial Patient Evaluation *continued*

Chest Pain

In patients presenting with chest pain, the first goal is to determine if the patient has ACS, which would require immediate intervention. Patient history may help classify the chest pain as typical, atypical, or noncardiac (Figure 4).[1]

Figure 4. Clinical Classifications of Chest Pain[1]

TYPICAL ANGINA (DEFINITE)	ATYPICAL ANGINA (PROBABLE)	NONCARDIAC CHEST PAIN
1 Substernal chest discomfort with a characteristic quality and duration that is 2 provoked by exertion or emotional stress and 3 relieved by rest or nitroglycerin	← Meets 2 of the typical angina characteristics	← Meets 1 or none of the typical angina characteristics

Adapted from Fihn SD, et al. J Am Coll Cardiol 2012;60(24):e44-164. Erratum in: J Am Coll Cardiol 2014;63(15):1588-90.

Evaluating At-Risk Patients

Risk Assessment

Once ACS has been ruled out, and after thorough characterization of any chest pain, patient risk factors for CAD can be evaluated.[1]

Patient Risk Factors[1]

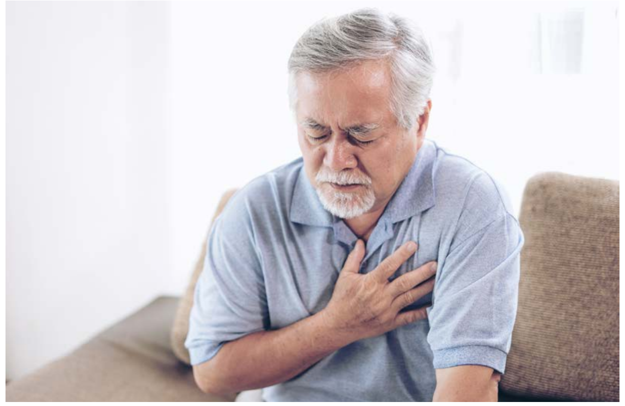
- Smoking
- Physical inactivity
- Hypertension
- Hyperlipidemia
- Dyslipidemia
- Diabetes mellitus
- Frequency of angina
- Chronic kidney disease (CKD)
- Obesity or metabolic syndrome
- Chronic pulmonary disease or heart failure
- History of cerebrovascular or peripheral artery disease (PAD)
- Sociodemographic characteristics, including age, sex, and socioeconomic status
- Family history of premature CAD (onset before age 55 years in a male relative or 65 years in a female relative)

Evaluating At-Risk Patients

Risk Assessment *continued*

< Page 2 of 2 >

Risk Estimates for Patients With Stable Chest Pain



Stable chest pain is characterized by stress-induced chest pain, which is a symptom of myocardial ischemia.

Figure 5 shows estimates of risk according to the 2021 AHA/ACC Guideline for the Evaluation and Diagnosis of Chest Pain.[12]

Figure 5. Pretest Probabilities of Obstructive CAD in Symptomatic Patients[12]

(A) Based on age, sex, and symptoms;
(B) Based on age, sex, symptoms, and CAC

Age, y	Chest Pain		Dyspnea	
	Men	Women	Men	Women
30-39	≤4	≤5	0	3
40-49	≤22	≤10	12	3
50-59	≤32	≤13	20	9
60-69	≤44	≤16	27	14
70+	≤52	≤27	32	12

A: Pretest probability based on age, sex, and symptoms

Low ≤15%	Intermediate–High >15%

B: Pretest probability based on age, sex, symptoms, and CAC score

≤15%	>15%–50%	>50%
CAC 1–99	CAC ≥100–999	CAC ≥1000

CAC = coronary artery calcium.

Evaluating At-Risk Patients

Risk Score Calculators

< Page 1 of 3 >

As part of an initial evaluation, global risk scores can be used to estimate the risk of a future cardiac event[6] and identify patients who would benefit from treatments aimed at management of risk.[7-9]

There are several helpful risk score calculators you can access online to evaluate your patients.

Access the ASCVD Risk Estimator Plus

Evaluating At-Risk Patients

Risk Score Calculators *continued*

ASCVD Risk Estimator Plus

The ACC/AHA Task Force on Practice Guidelines developed a risk score based on data from large community-based cohorts that are representative of the US population of Whites and African Americans.[6] The updated version of this calculator, the ASCVD Risk Estimator Plus (also referred to as the Pooled Cohort Equations), provides sex- and race-specific estimates of the 10-year risk and lifetime risk for ASCVD for men and women aged 20 to 79 years, taking into account[13,14]:

- Age
- Race (White, African American, or other)
- Total and high-density lipoprotein (HDL) cholesterol levels
- Systolic and diastolic blood pressure (including treated or untreated status)
- Diabetes
- Smoking history
- Current statin and aspirin therapy statuses

The ASCVD Risk Estimator Plus also includes capabilities to estimate and track change in risk over time, forecast the potential benefit of specific risk-lowering interventions, and calculate initial 10-year ASCVD risk for patients who have already initiated therapy.[13,14]

Evaluating At-Risk Patients

Risk Score Calculators *continued*

Framingham Risk Score

The Framingham Risk Score takes into account age, sex, cholesterol levels, blood pressure, treatment for hypertension, and whether the patient is a smoker.[5] The Framingham Risk Score was derived using data from Whites exclusively and only assesses the 10-year risk of experiencing an MI or CHD death. It cannot be used to estimate the risk of ASCVD or the lifetime risk of a cardiac event.[5,6]

Reynolds Risk Score

The Reynolds Risk Score was initially developed to improve the assessment of cardiovascular event risk in women by taking into account additional factors, such as family history of MI and high-sensitivity C-reactive protein (hsCRP).[15] The Reynolds Risk Score was subsequently found to improve risk assessment for men.[16]

Evaluating At-Risk Patients

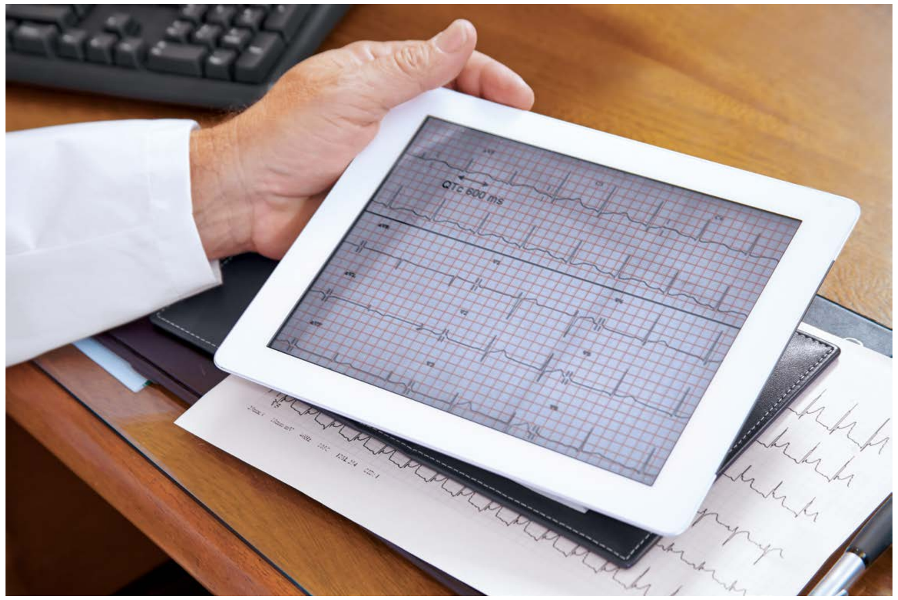
Initial Noninvasive Testing

For patients with suspected CAD, the initial evaluation may also include noninvasive tests that provide additional information about overall risk of cardiac events and the likelihood of a CAD diagnosis.

Resting ECG

A resting ECG can be used as part of the initial risk assessment in patients with known or suspected CAD. Patients with CAD who have the following abnormalities on a resting ECG have a worse prognosis than those with normal results[1]:

- Evidence of prior MI
- Left bundle-branch block (LBBB)
- Bifascicular block
- Second- or third-degree atrioventricular block
- Ventricular tachyarrhythmia
- Left ventricular (LV) hypertrophy
- Persistent ST-T-wave inversions



Evaluating At-Risk Patients

Initial Noninvasive Testing *continued*

Exercise Stress Testing

Exercise stress testing is the preferred method of stress testing to assess cardiac ischemia and determine the likelihood of CAD and risk for future events.[1,17]

This noninvasive method not only provides information about exercise-induced chest pain but also measures exercise capacity, hemodynamic response to exercise, and the presence of cardiovascular abnormalities,[1] all of which can be used to predict the risk of a cardiac event. Calculating the Duke Treadmill Score (Figure 6) can help evaluate patient cardiovascular risk.[17]

Figure 6. Duke Treadmill Score[17]

This score is a composite index that provides an estimate of cardiovascular risk based on results from the exercise stress test, including ST-segment depression, chest pain, and exercise duration.

Exercise time in minutes

– (5 x ST deviation)

– (4 x exercise angina[a])

= Duke Treadmill Score (–25 to +15)

Low Risk	≥+5
Moderate Risk	–10 to +4
High Risk	≤–11

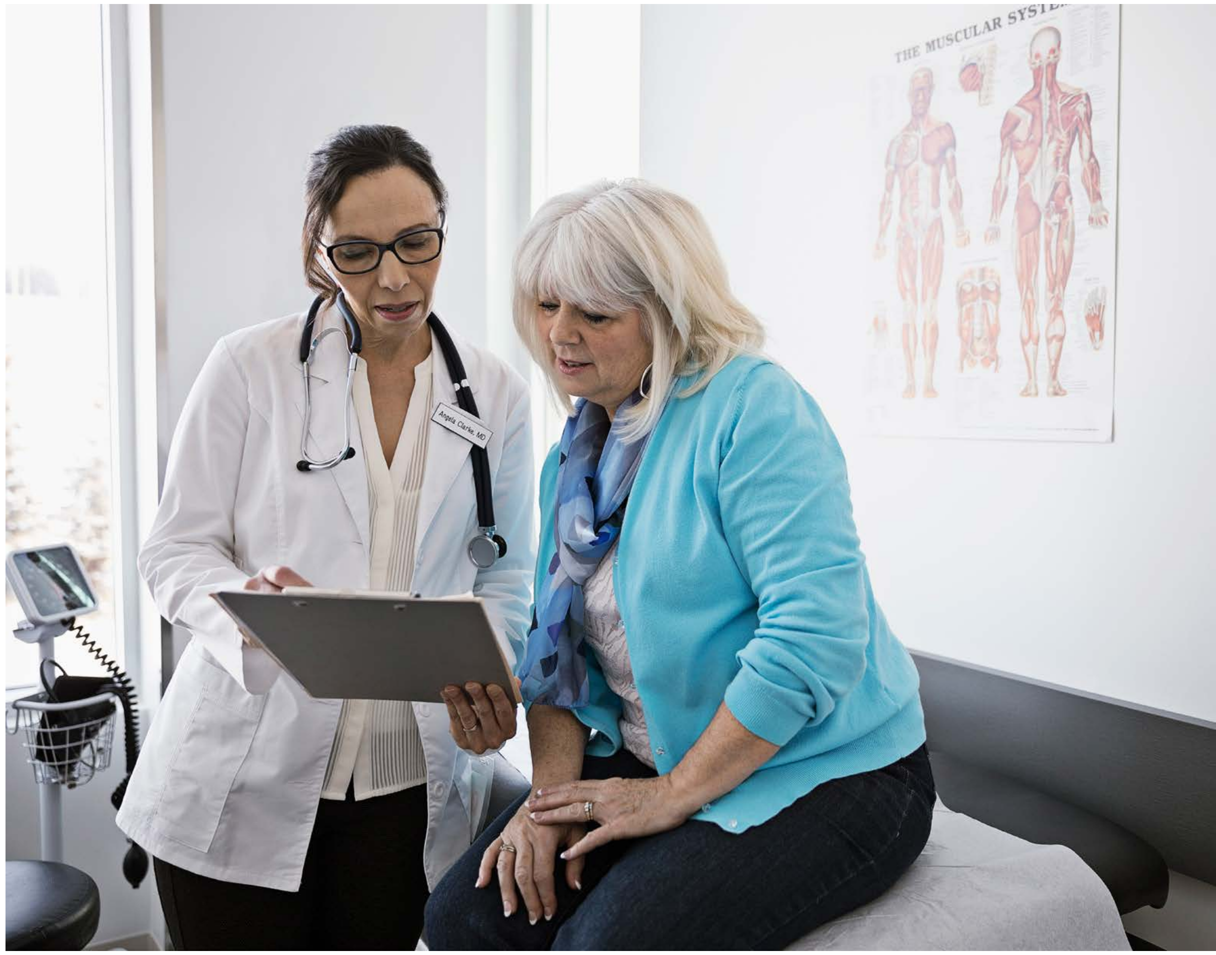
[a]0 = No angina
1 = Nonlimiting angina
2 = Exercise-limiting angina

Evaluating At-Risk Patients

Initial Noninvasive Testing *continued*

Further Testing

For patients with known or suspected CAD, further testing beyond the initial evaluation may be necessary. Once it is determined that more information is needed, the next step is choosing the most appropriate diagnostic and therapeutic strategies to optimize patient care.



Evaluating At-Risk Patients

References

1. 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. J Am Coll Cardiol 2012;60(24):e44-164. Erratum in: J Am Coll Cardiol 2014;63(15):1588-90.
2. Fang JC, O'Gara PT. History and physical examination: an evidence-based approach. In: Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD, eds. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 12th ed. Philadelphia, PA: Elsevier, 2021:159-78.
3. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart disease and stroke statistics-2022 update: a report from the American Heart Association. Circulation (Epub) 02-22-2022.
4. U.S. Department of Health and Human Services. Administration for Community Living. Administration on Aging. 2020 Profile of Older Americans (05-2021). https://acl.gov/sites/default/files/Profile%20of%20OA/2020Profile OlderAmericans_RevisedFinal.pdf. Accessed 04-25-2022.
5. D'Agostino RB Sr, Vasan RS, Pencina MJ, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. Circulation 2008;117(6):743-53. Erratum in: Circulation 2008;118:e86.
6. Goff DC, Lloyd-Jones DM, Bennett G, et al. 2013 ACC/AHA guideline on the assessment of cardiovascular risk. Circulation 2014;129(25 Suppl 2):S49-73. Erratum in: J Am Coll Cardiol 2014;129(25 Suppl 2):S74-5.
7. Eckel RH, Jakicic JM, Ard JD, et al. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2014;63(25 Pt B):2960-84. Erratum in: J Am Coll Cardiol 2014;63(25 Pt B):3027-28.
8. Stone NJ, Robinson JG, Lichtenstein AH, et al. 2013 ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014;129(25 Suppl 2):S1-45. Errata in: Circulation 2014;129(25 Suppl 2):S46-8. Circulation 2015;132(25):e396.
9. Jensen MD, Ryan DH, Apovian CM, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults. Circulation 2014;129(25 Suppl 2):S102-38. Erratum in: Circulation 2014;129(25 Suppl 2):S139-40.
10. 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. J Am Coll Cardiol 2014;63(4):380-406.
11. Gibbons RJ, Balady GJ, Bricker JT, et al. ACC/AHA 2002 guideline update for exercise testing: summary article. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (committee to update the 1997 exercise testing guidelines). J Am Coll Cardiol 2002;40(8):1531-40. Erratum in: J Am Coll Cardiol 2006;48(8):1731.

Evaluating At-Risk Patients

References *continued*

12. Gulati M, Levy PD, Mukherjee D, et al. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR guideline for the evaluation and diagnosis of chest pain: executive summary: a report of the American College of Cardiology/American Heart Association Joint Committee on clinical practice guidelines. Circulation 2021;144(22):e336-67.

13. American College of Cardiology. ASCVD risk estimator plus: about the app (10-2021). https://tools.acc.org/ascvd-risk-estimator-plus/#!/content/about. Accessed 01-26-2022.

14. American College of Cardiology. Welcome to the ASCVD Risk Estimator Plus. https://tools.acc.org/ascvd-risk-estimator-plus/#!/calculate/estimate. Accessed 03-18-2022.

15. Ridker PM, Buring JE, Rifai N, Cook NR. Development and validation of improved algorithms for the assessment of global cardiovascular risk in women. JAMA 2007;297(6):611-9. Erratum in: JAMA 2007;297(13):1433.

16. Ridker PM, Paynter NP, Rifai N, Gaziano JM, Cook NR. C-reactive protein and parental history improve global cardiovascular risk prediction: the Reynolds Risk Score for men. Circulation 2008;118(22):2243-51.

17. Shaw LJ, Peterson ED, Shaw LK, et al. Use of a prognostic treadmill score in identifying diagnostic coronary disease subgroups. Circulation 1998;98(16):1622-30.

Cardiac Testing Options

Assessing Cardiac Testing Options | Exercise ECG | SPECT MPI | PET MPI | Echo | CMR | CCTA | CAC | Hybrid | References

Assessing Cardiac Testing Options

Noninvasive cardiac tests are used for 2 distinct purposes: diagnosis and prognostic risk assessment. The choice of which test(s) to use may be influenced by several factors, including patient profile, results of prior testing, local availability of equipment, expertise in performing and interpreting the test, and patient preference.[1]

Noninvasive Cardiac Tests[1]

- Exercise ECG (electrocardiogram)
- SPECT MPI (single-photon emission computed tomography myocardial perfusion imaging)
- PET (positron emission tomography) MPI
- Echo (echocardiography)
- CMR (cardiovascular magnetic resonance) imaging—angiography and perfusion
- CCTA (coronary computed tomography angiography)
- CAC (coronary artery calcium) scoring
- Hybrid imaging

Assessing Cardiac Testing Options

Exercise ECG

Exercise ECG has served as the cornerstone of cardiovascular testing for several decades.[1]

It can be performed in the outpatient office setting and is a relatively low-cost and accessible test.[2,3]

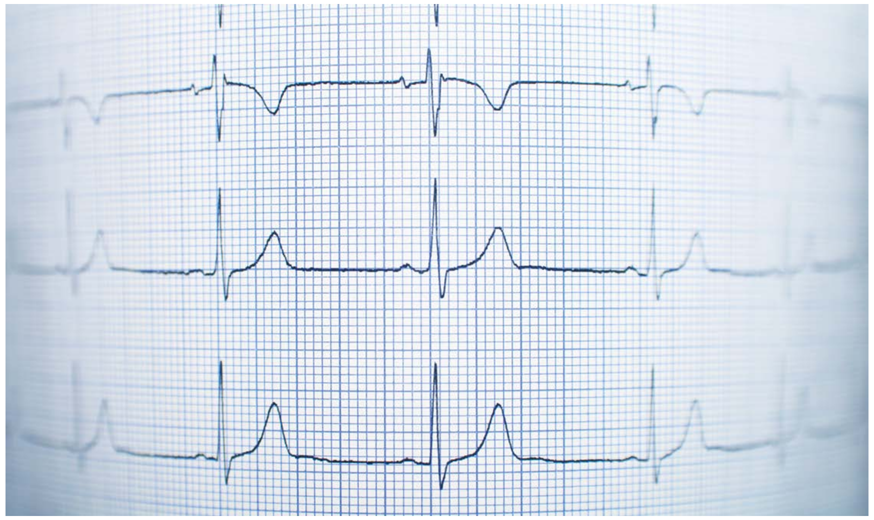
What Does Exercise ECG Reveal?

In both men and women with known or suspected CAD, exercise ECG provides information about exercise-induced chest pain and measures exercise capacity, hemodynamic response to exercise, and the presence of cardiovascular abnormalities, all of which can be used to predict the risk for a cardiac event.[1,2]

The goal of exercise testing is to either exclude the presence of obstructive CAD or predict the likelihood of obstructive CAD based on the extent and severity of ECG changes and angina during exercise-induced ischemia.[1]

Attributes of Exercise ECG

- The cornerstone of cardiac testing[1,2]
- Assesses exercise capacity[2]
- No ionizing radiation involved



Candidates for Exercise ECG

Patients capable of performing at least moderate physical functioning (eg, most activities of daily living) and who have no disabling comorbidity (including frailty, advanced age, marked obesity, peripheral artery disease, chronic obstructive pulmonary disease, or orthopedic limitations) are optimal candidates for exercise testing. However, detecting ischemia may be suboptimal in patients who cannot achieve at least moderate physical function. Pharmacologic stress testing should be considered for these patients.[1]

Assessing Cardiac Testing Options

Exercise ECG *continued*

Exercise ECG for Diagnosis, Prognosis, and Risk Stratification

To utilize an exercise ECG test for diagnosis and CAD risk assessment, patients must be able to exercise and have an interpretable resting ECG. Abnormalities on the resting ECG, such as resting ST-segment abnormalities related to LV hypertrophy, LBBB, or ventricular-paced rhythm, will interfere with the interpretation of any exercise-induced ECG changes. It may also be difficult to interpret ST-segment changes in patients with right bundle-branch block (RBBB) and in patients taking certain medications, such as digitalis. The effect of anti-ischemic therapies on heart rate and myocardial workload can lead to false-negative exercise ECG results.[1]

Beyond ECG changes, the following factors measured during the exercise test may be helpful in CAD diagnosis[1]:

- Exercise duration
- Chronotropic incompetence
- Chest pain
- Ventricular arrhythmias
- Heart rate recovery
- Hemodynamic changes

It should be noted that for ECG, the diagnostic accuracy of exertional ST-segment changes is lower in women than in men, although marked ST-segment changes (≥1 mm of horizontal or downsloping ST-segment depression or elevation for ≥60 to 80 ms after the end of the QRS complex) are diagnostic for all patients.[1]

Scoring Systems

Several scoring systems have also been developed that combine multiple endpoints to improve the diagnostic accuracy of exercise ECG, such as the Duke Treadmill Score and the Lauer score.[1] Calculating the Duke Treadmill Score (Figure 7) can help evaluate patient cardiovascular risk.[4]

Assessing Cardiac Testing Options

SPECT MPI

< Page 1 of 4 >

For more than 40 years, noninvasive radionuclide imaging (RNI) has been used to evaluate myocardial perfusion.[5]

As the most commonly used imaging modality in nuclear cardiology, SPECT MPI plays an essential role in the risk assessment and evaluation of CAD.[5,6]

Attributes of SPECT MPI

- The most commonly used imaging modality in nuclear cardiology[5,6]
- As a functional imaging test, SPECT can help detect perfusion defects[1,7]
- Can be used with exercise or pharmacologic stress[1,7]
- Can quantify coronary blood flow (with contemporary SPECT cameras) to detect microvascular disease[5]

A Modality by Many Names

You may have heard SPECT MPI referred to as one of the following terms:

- Nuclear stress test
- Noninvasive cardiac imaging
- Cardiac nuclear scan
- RNI

Assessing Cardiac Testing Options

SPECT MPI *continued*

What Does SPECT Reveal?

SPECT scans are taken using a gamma camera, which captures images of photons emitted by radiotracers as they are taken up by viable myocytes. Imaging can be done at stress and at rest.[5,7]

The standard MPI procedure uses ECG data as the heart beats to guide image acquisition (also known as ECG-gated SPECT).[5]

The radiotracers used in SPECT include technetium-99m (Tc-99m) and thallium-201 (Tl-201), although Tl-201 is associated with a higher radiation dose and is not currently recommended for MPI.[5]

A series of images (sections of the heart) shows radiotracer distribution throughout the myocardium. The images are then reassembled by the computer to produce a 3-dimensional (3D) image of the heart, providing information about the extent, severity, and location of perfusion defects.[5]

Image Quality

Image quality and diagnostic accuracy of SPECT MPI may be affected by attenuation artifacts, which can be seen in obese patients or those with a large amount of breast tissue. However, these attenuation artifacts may be reduced with the following techniques[1]:

- Using Tc-99m radiotracers
- Imaging patients in the prone position
- Applying attenuation correction algorithms in image-processing software

Assessing Cardiac Testing Options

SPECT MPI *continued*

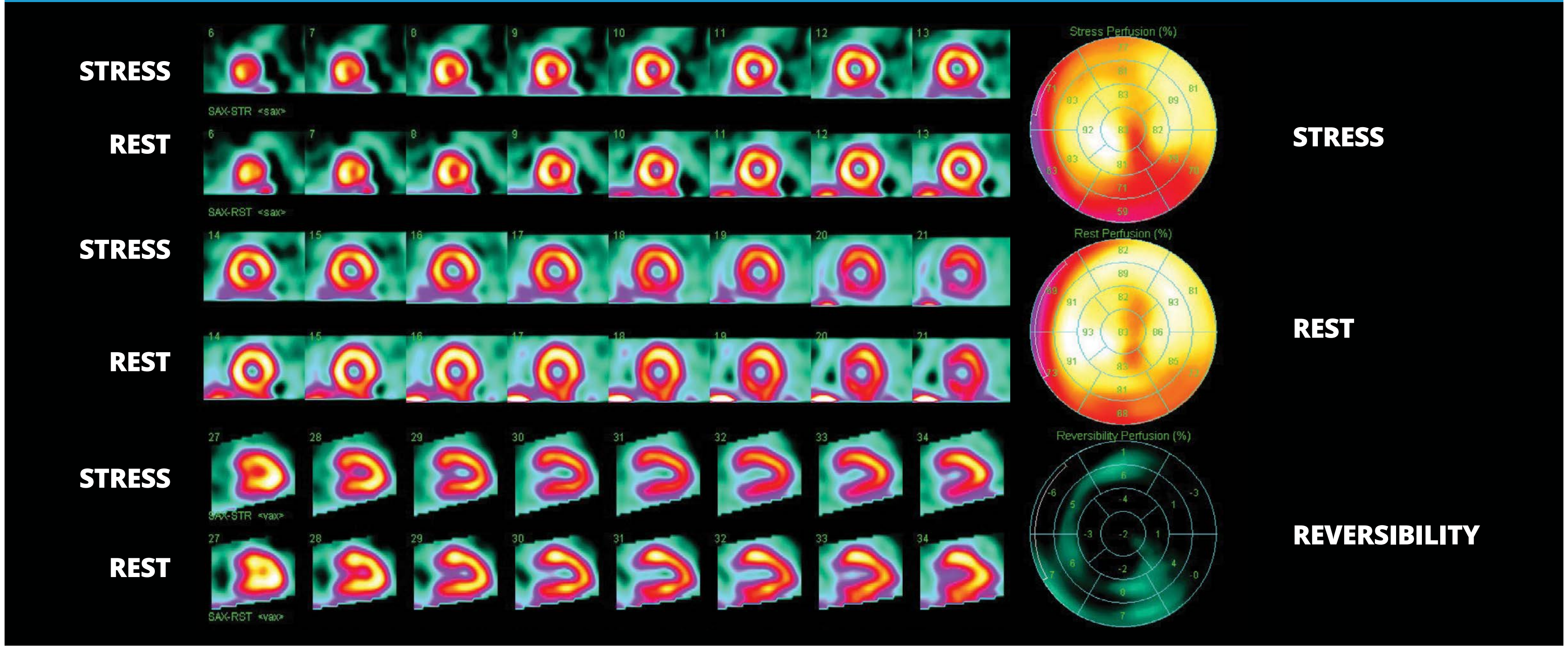
< Page 3 of 4 >

SPECT for Diagnosis, Prognosis, and Risk Stratification

SPECT MPI scans show vital clinical information about a patient's heart health (Figure 7) and can help detect perfusion defects.[1] Perfusion defects may be reversible, with perfusion abnormalities at stress and normal perfusion at rest, or irreversible, with perfusion defects visible on both stress and rest images. Irreversible perfusion defects may indicate prior MI.[5]

Multiple perfusion defects in different coronary territories may indicate severe CAD. Of note, SPECT images may underestimate ischemia in patients with left-main or 3-vessel CAD who may have global, balanced reduction in myocardial blood flow rather than regional hypoperfusion.[1]

Figure 7. SPECT MPI Scans



Images courtesy of Kim Allan Williams, MD.

Assessing Cardiac Testing Options

SPECT MPI *continued*

The extent and severity of stress-induced perfusion abnormalities are directly correlated with the degree of risk for ischemic events, namely, cardiovascular death and MI (Figure 8).[1]

- Normal test results are associated with a very low annual risk for cardiovascular death or MI (<1%)
- Moderate to severe abnormalities are associated with an annual risk for cardiovascular death or MI of ≥5%

Figure 8. Assessment of SPECT MPI Bull's-eye Scans

Image data are combined into a single display, showing extent and severity of perfusion abnormalities.

Images courtesy of D Jain, MD.

Contemporary SPECT cameras have expanded the range of cardiac SPECT applications to include the quantification of myocardial blood flow, which can detect microvascular disease. Coronary microvascular disease is common in symptomatic patients who have risk factors and is more prevalent in women than men.[5]

Assessing Cardiac Testing Options

PET MPI

Similar to SPECT, PET MPI can be used for the evaluation and risk stratification of CAD and can help in making decisions for medical therapy or revascularization. PET has a high diagnostic sensitivity and specificity, with high spatial resolution and attenuation correction. It also has the potential to quantify regional perfusion.[1,5]

Attributes of PET MPI

- High sensitivity and specificity for the diagnosis of CAD[1,5]
- Can be used to detect perfusion defects[5]
- Limited to pharmacologic stress[5]
- Able to quantify coronary blood flow[5]

PET can calculate coronary flow reserve, which can provide useful information to estimate the risk for future events. PET can also be used to measure the viability of myocardial tissue, helping to distinguish between scar tissue and tissue that is “stunned” but still viable (Figure 9).[5]

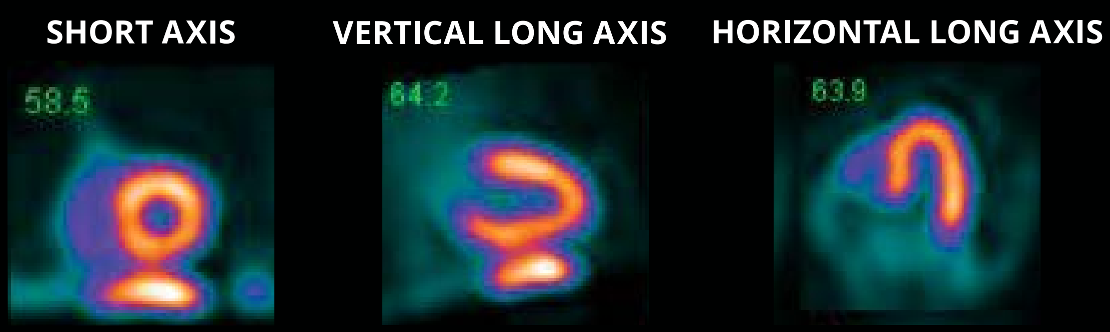
However, PET may require an onsite cyclotron or generator for the radiotracers used in imaging. The high cost of PET equipment and imaging may continue to limit its more widespread use. Furthermore, the short half-lives of some PET radiotracers may limit stress procedures to pharmacologic stress tests only.[5]

Assessing Cardiac Testing Options

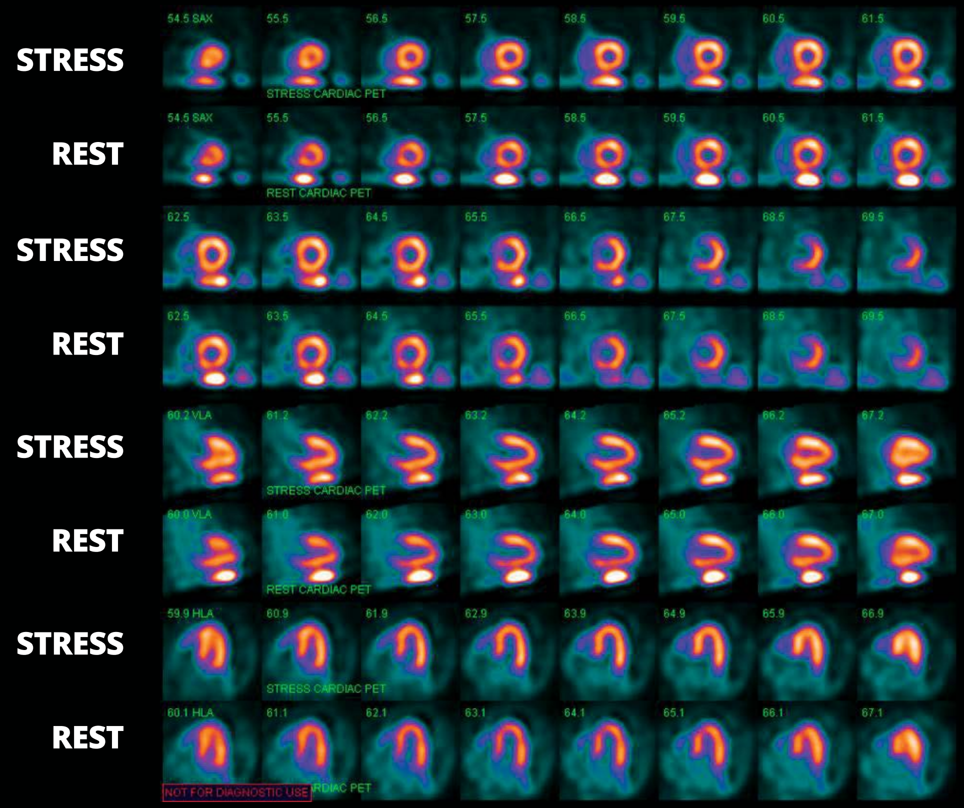
PET MPI *continued*

Figure 9. PET MPI Scans

Sections of the myocardium are imaged in 3 axes to view perfusion defects at different orientations.[19]



Stress images demonstrate an extensive moderate perfusion defect involving the inferior wall and inferolateral wall. Rest images demonstrate normal perfusion throughout the myocardium.



Images courtesy of WA Jaber, MD.

Assessing Cardiac Testing Options

Echo

Echo images are taken at rest and after either exercise or pharmacologic stress, using reflected ultrasound beams to visualize cardiac anatomic features in real time. Echo may be performed with intravenous contrast agents that help define the endocardial border and improve diagnostic accuracy.[1,8,9]

Attributes of Echo

- Rapid assessment provides immediate data on cardiac structure and function[8]
- Relatively low cost and widely available[8]
- No ionizing radiation involved[9]

Baseline ECG performed during stress echo includes an assessment of[9]:

- Ventricular function
- Chamber size
- Wall motion thickness
- Aortic root
- Valve function

Diagnosing CAD

Diagnosis of CAD with stress echo is based on the presence of new or worsening wall motion abnormalities and LV function during or immediately after stress. Stress echo results can also be compared with resting echo results to assess changes in ventricular function that may be caused by demand ischemia.[1]

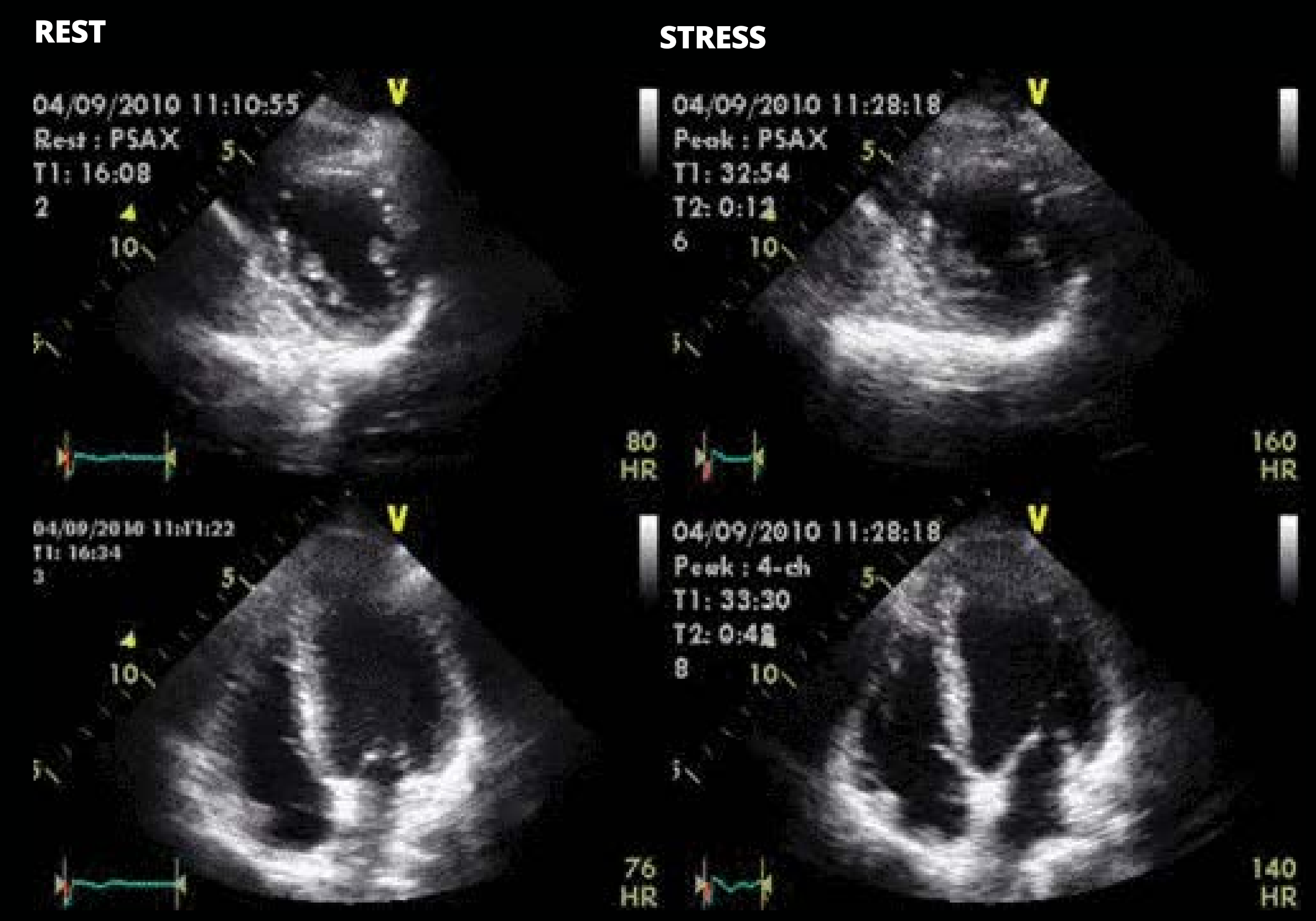
A normal exercise echo result is associated with a very low risk for MI or cardiovascular death (see Figure 10 for a normal rest/stress echo result).[1]

Assessing Cardiac Testing Options

Echo *continued*

< Page 2 of 3 >

Figure 10. Echo Images



Normal echo, with rest images on the left and stress images on the right.

Assessing Cardiac Testing Options

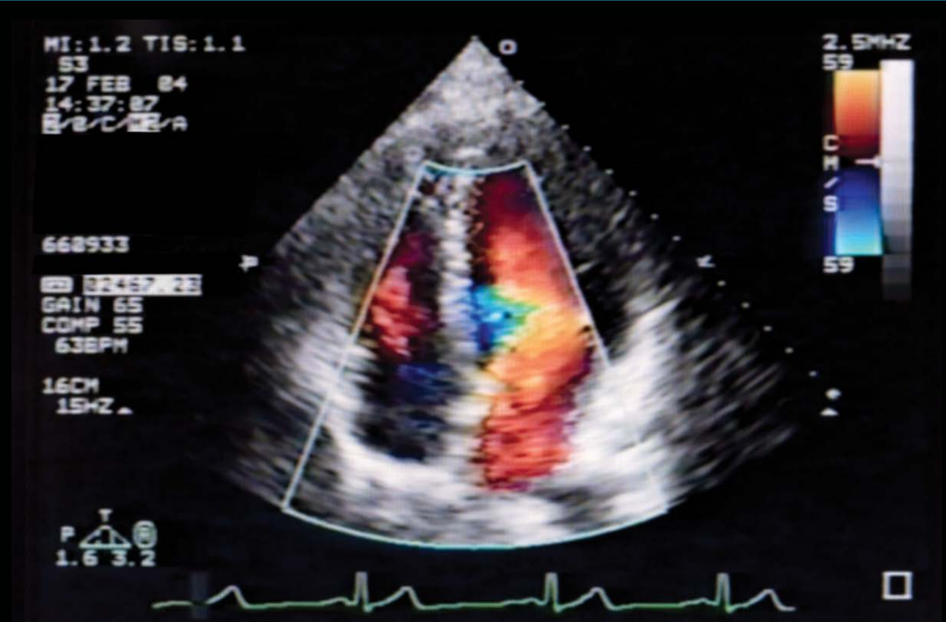
Echo *continued*

The extent and severity of exercise-induced wall motion abnormalities are directly correlated with disease risk. Patients with stress echo results showing wall motion abnormalities in multiple LV segments or in more than 1 coronary territory and evidence of transient ischemic dilation have a high likelihood of severe CAD.[1]

Resting 2-dimensional (2D) echo (Figure 11) is recommended for the assessment of LV function and abnormalities of the myocardium, heart valves, or pericardium, specifically in patients with known or suspected CAD and a prior MI, pathological Q waves, symptoms or signs suggestive of heart failure, complex ventricular arrhythmias, or an undiagnosed heart murmur.[1]

Three-dimensional echo provides 3D images of the heart, which can improve assessment of cardiac size and function.[1,8]

Figure 11. Resting 2D Echo Images



Resting echo is useful for assessing cardiac structure and function, including identifying the mechanism of heart failure and differentiating systolic LV from diastolic dysfunction.

Images courtesy of HC Lewin, MD.

Assessing Cardiac Testing Options

CMR

CMR imaging allows physicians to evaluate CAD in several ways. It can assess cardiac structure and function, valvular and great vessel flow hemodynamics, and 3D angiography.[10]

With pharmacologic stress, CMR imaging can be used to study wall motion abnormalities and LV function. No ionizing radiation exposure is involved.[1,10]

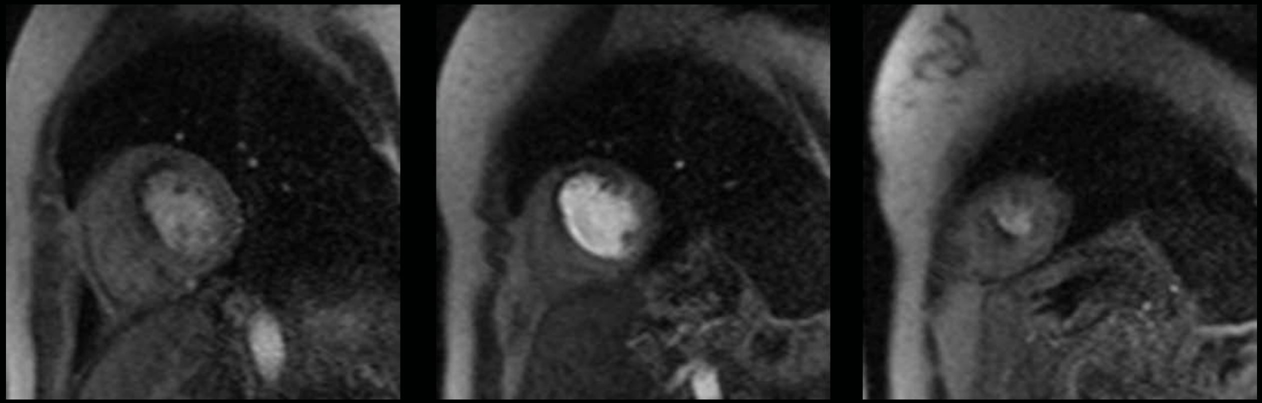
Attributes of CMR

- No iodine-containing dyes are used[10]
- No ionizing radiation involved[10]
- Can be used with pharmacologic stress[1]

MPI can be used with a contrast agent (eg, gadolinium) to differentiate between the reversible ischemia that is characteristic of CAD and areas of scar tissue that are associated with acute MI (Figure 12).[1]

Figure 12. CMR Perfusion Images

CMR images of perfusion defects in the anterior and anteroseptal walls.



Images courtesy of DH Kwon, MD.

Assessing Cardiac Testing Options

CMR *continued*

CMR angiography can be used to assess the extent and severity of obstructive CAD (Figure 13).[1]

Due to the generation of strong magnetic fields in CMR, it is not recommended for certain patients with cochlear implants, metal-containing ocular implants, or other implants that could be hazardous.[11]

CMR testing is limited by the number of centers experienced in CMR protocols, differences in the imaging techniques and equipment, and changing interpretative standards.[1]

Figure 13. CMR Angiography Images

CMR angiography images of a patient with a suspected coronary artery anomaly—images are of excellent image quality, demonstrating normal coronary arteries.

Images courtesy of DH Kwon, MD.

Assessing Cardiac Testing Options

CCTA

< Page 1 of 2 >

Multisection CCTA produces high-resolution images of the coronary anatomy and identifies areas of obstructive CAD (Figure 14). Noninvasive CCTA and invasive angiography are both anatomic tests and show a high degree of correlation.

CCTA is more sensitive than nuclear MPI in detecting obstructive CAD at ≤70% stenosis, when perfusion defects may not yet be evident. CCTA can also visualize arterial remodeling and nonobstructive plaque, including calcified, noncalcified, or mixed plaque.[1]

Attributes of CCTA

- High-resolution images of coronary anatomy[1]
- High specificity to rule out CAD in low-risk patients[1]
- Can show stenotic lesions, arterial remodeling, and plaque[1,11]

Predictive Value

CCTA has a high negative predictive value (specificity) to rule out obstructive CAD.[11] However, several studies have demonstrated that there is a poor correlation between the presence of obstructive CAD on anatomic imaging with CCTA and evidence of myocardial ischemia on functional imaging with nuclear MPI or echo. Ischemia can occur as a consequence of stenoses in smaller epicardial vessels that are not as easily detected by CCTA, and some obstructive lesions may not lead to myocardial ischemia.[1]

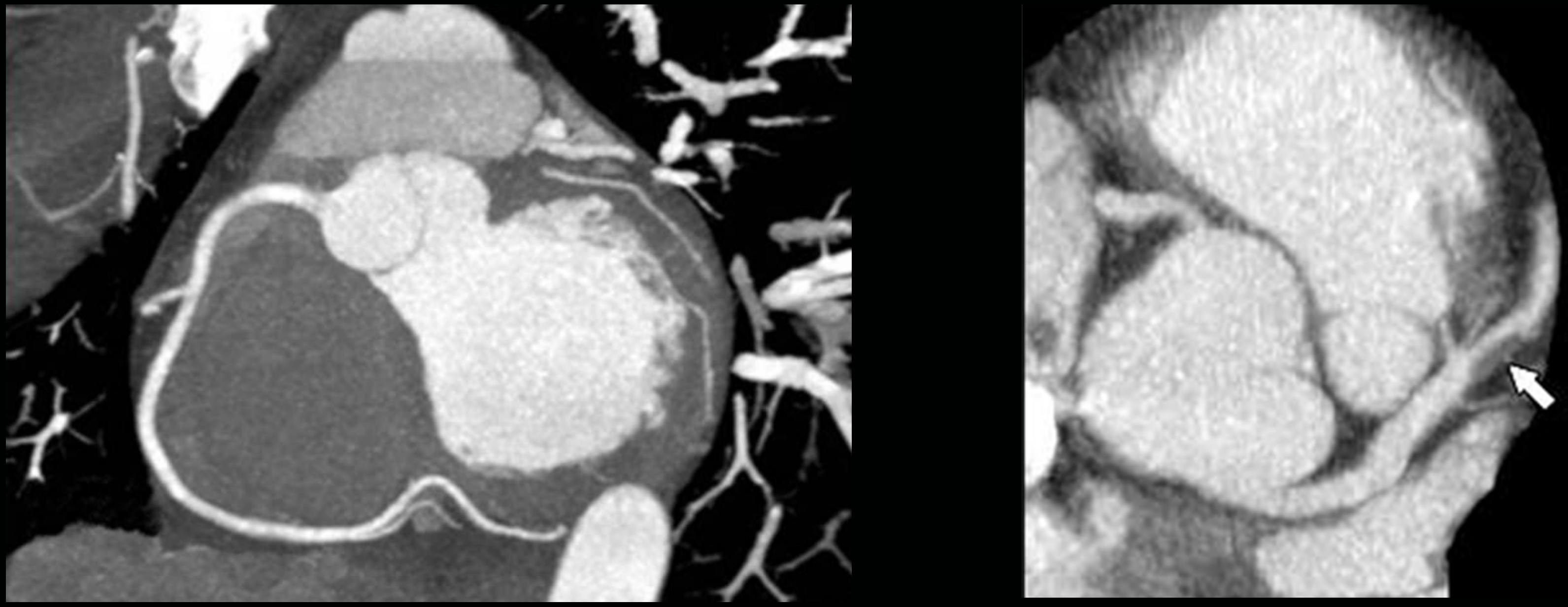
False-positive results may occur when calcification of coronary artery plaques (part of the atherosclerotic process) interferes with accurate CCTA imaging of lesion severity. Patients who have extensive calcification or who are considered to be at high risk for CAD based on clinical assessment or previous test results may not be appropriate candidates for CCTA.[1]

Assessing Cardiac Testing Options

CCTA *continued*

< Page 2 of 2 >

Figure 14. CCTA Images



CCTA image of a normal right coronary artery.

CCTA image of the left coronary system with a >50% stenosis (blockage) of the left anterior coronary artery (*arrow*).

Images courtesy of HC Lewin, MD.

Assessing Cardiac Testing Options

CAC Scoring

Computed tomography (CT) scans can also be used to measure calcium levels in coronary arteries (Figure 15), producing a CAC score. This score has been shown to have prognostic value in assessing CAD risk in asymptomatic patients, and in predicting the presence of coronary stenosis in symptomatic patients (on coronary angiography).[1]

The CAC score has high diagnostic sensitivity to detect obstructive CAD, but it is not clear how well the CAC score correlates to functional measures of CAD, eg, myocardial perfusion abnormalities in symptomatic patients.[1]

Patients with a CAC score of 0 may still have perfusion defects on nuclear MPI. Obstructive CAD may be present in younger patients despite lower CAC scores, because calcification of atherosclerotic plaques occurs later in the disease progression.[1]

Attributes of CAC Scoring

- Measures calcium levels in coronary arteries[1]
- High sensitivity but low specificity for detecting CAD[1]

Figure 15. CT Scan for CAC Scoring

This CT scan obtained for CAC scoring shows calcification of the left anterior descending coronary artery.

Image courtesy of HC Lewin, MD.

Assessing Cardiac Testing Options

Hybrid Imaging

Combination or "hybrid" cardiac imaging protocols use complementary datasets from anatomic and functional tests to provide comprehensive information about the heart.[1]

Attributes of Hybrid Imaging

- Functional and anatomic information can be gathered in a single imaging session[5]
- Combined dataset may improve diagnostic accuracy and attenuation correction[5]

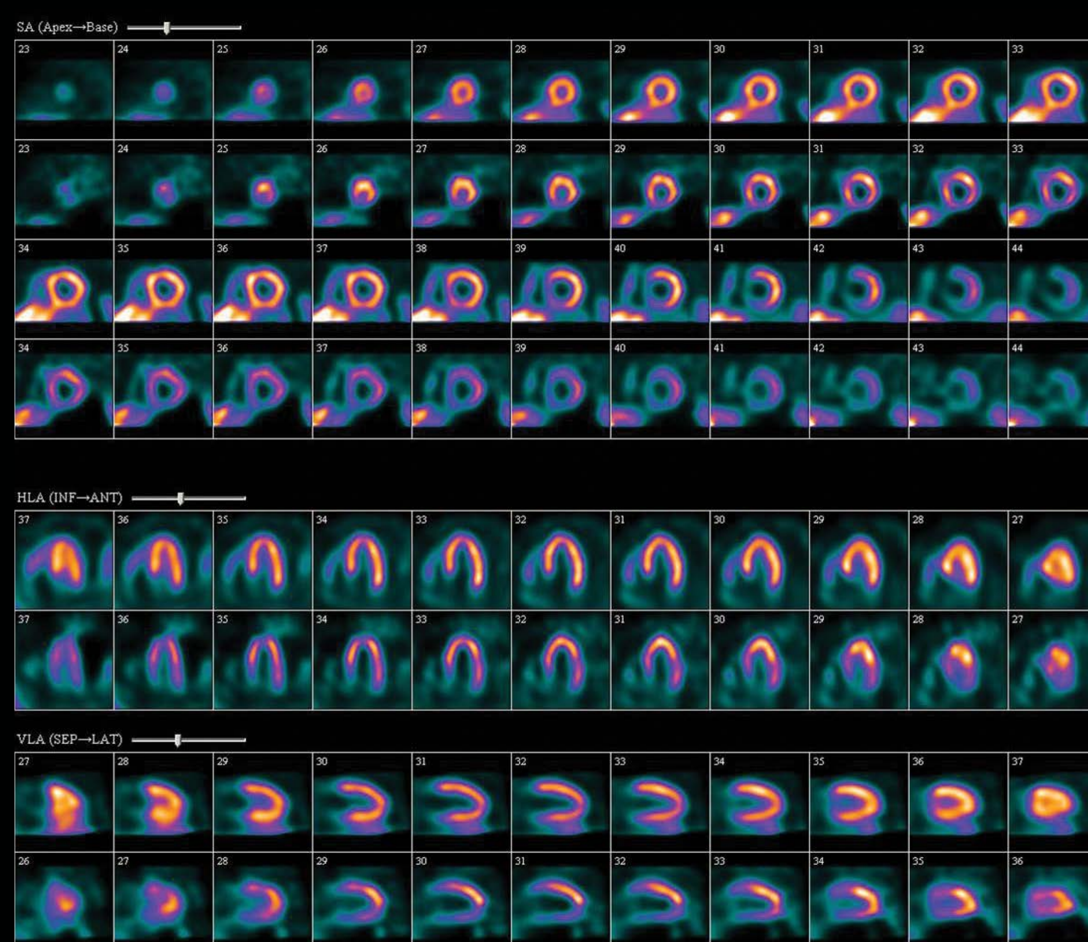
PET or SPECT MPI combined with CT scanning allows concurrent assessment of arterial remodeling, plaque composition, extent and severity of coronary stenoses, and functional consequences during a single imaging session. The combined dataset can provide comprehensive information about both functional and anatomic endpoints. This information may improve diagnostic accuracy and assessment of patient risk to better inform clinical decisions.[1]

Cardiac CT scanning has also been used to improve attenuation correction of SPECT MPI images (Figure 16).[5] Adding the CAC score to MPI plays an important role, particularly for patients without prior CAD and normal MPI.[5] Despite the potential benefits, hybrid imaging may increase the radiation dose to which patients are exposed, as it involves more than 1 test procedure.[1]

Assessing Cardiac Testing Options

Hybrid Imaging *continued*

Figure 16. Hybrid Imaging



Stress images display CT-based attenuation-corrected stress imaging, and show homogenous and normal tracer uptake in the entire inferior wall. Rest images at the bottom show a persistent and fixed severe perfusion defect in the basal inferior wall.

Images courtesy of WA Jaber, MD.

Assessing Cardiac Testing Options

References

1. 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. J Am Coll Cardiol 2012;60(24):e44-164. Erratum in: J Am Coll Cardiol 2014;63(15):1588-90.
2. Fletcher GF, Ades PA, Kligfield P, et al. Exercise standards for testing and training: a scientific statement from the American Heart Association. Circulation 2013;128(8):873-934.
3. Balady GJ, Ades PA. Exercise physiology and exercise electrocardiographic testing. In: Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD, eds. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 12th ed. Philadelphia, PA: Elsevier Inc, 2022.
4. Shaw LJ, Peterson ED, Shaw LK, et al. Use of a prognostic treadmill score in identifying diagnostic coronary disease subgroups. Circulation 1998;98(16):1622-30.
5. Dorbala S, DiCarli MF. Nuclear cardiology. In: Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD, eds. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 12th ed. Philadelphia, PA: Elsevier Inc, 2022.
6. Abbott BG, Case JA, Dorbala S, et al. Contemporary cardiac SPECT imaging—innovations and best practices: an information statement from the American Society of Nuclear Cardiology. J Nucl Cardiol 2018;25(5):1847-60.
7. American Heart Association. Single photon emission computed tomography (SPECT) (07-31-2015). https://www.heart.org/en/health-topics/heart-attack/diagnosing-a-heart-attack/single-photon-emission-computed-tomography-spect#.WXdxYI6QyS4. Accessed 12-06-2021.
8. Wu JC, Gillam LD, Solomon SD. Echocardiography. In: Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD, eds. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 12th ed. Philadelphia, PA: Elsevier Inc, 2022.
9. Pellikka PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. J Am Soc Echocardiogr 2007;20(9):1021-41.
10. Kwong RY. Cardiovascular magnetic resonance imaging. In: Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD, eds. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 12th ed. Philadelphia, PA: Elsevier Inc, 2022.
11. Blankstein R. Cardiac computed tomography. In: Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD, eds. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 12th ed. Philadelphia, PA: Elsevier Inc, 2022.

Patient-Centered Test Selection

Patient-Centered Test Selection

When determining noninvasive test options for your patients, considerations may include several factors.

According to the ASNC PatientFirst initiative, no test should be considered a first-line test. Rather, optimal test selection should be based on appropriate use and centered on the patient's unique characteristics and risk to obtain the best clinical information.[1]

Specific Considerations for Test Selection Include:

- Risk vs benefit[2]
- Functional vs anatomic testing[2]
- Other considerations
  - Local expertise and availability[1]
  - Cost-effectiveness[2]
  - AUC[3]

Patient-Centered Test Selection

Risk vs Benefit

The potential risks of a particular cardiac test should be weighed against the potential benefit of acquiring information regarding disease extent and severity. Noninvasive cardiac testing may be most useful in patients with an intermediate likelihood of CAD.[2]

The ACCF and the AHA discourage the use of cardiac assessments as routine screening tests in asymptomatic individuals.[2]

- Further testing is not warranted in patients with a low likelihood of CAD (<5%) because testing of these patients may lead to a false-positive test result (a positive result in the absence of obstructive CAD)
- For patients with a high likelihood of CAD based on personal history, primary care providers should be aware that a subsequent negative exercise test result would likely be a false negative

Safety Considerations

When weighing risks vs benefits, it's important to understand radiation and allergy risks.

Nuclear perfusion imaging and CCTA use ionizing radiation to obtain images of the heart. Although no studies have directly linked this type of low-level radiation exposure to an increased cancer risk, there is general agreement that the overriding principle of "As Low As Reasonably Achievable" (ALARA) should be applied in all cardiac CT and MPI procedures to reduce radiation exposure as much as possible without compromising image quality.[2]

The contrast agents that are used in CMR and CCTA tests may cause allergic reactions and affect renal function, and should therefore be avoided in patients with CKD.[2]

Patient-Centered Test Selection

Functional vs Anatomic Testing

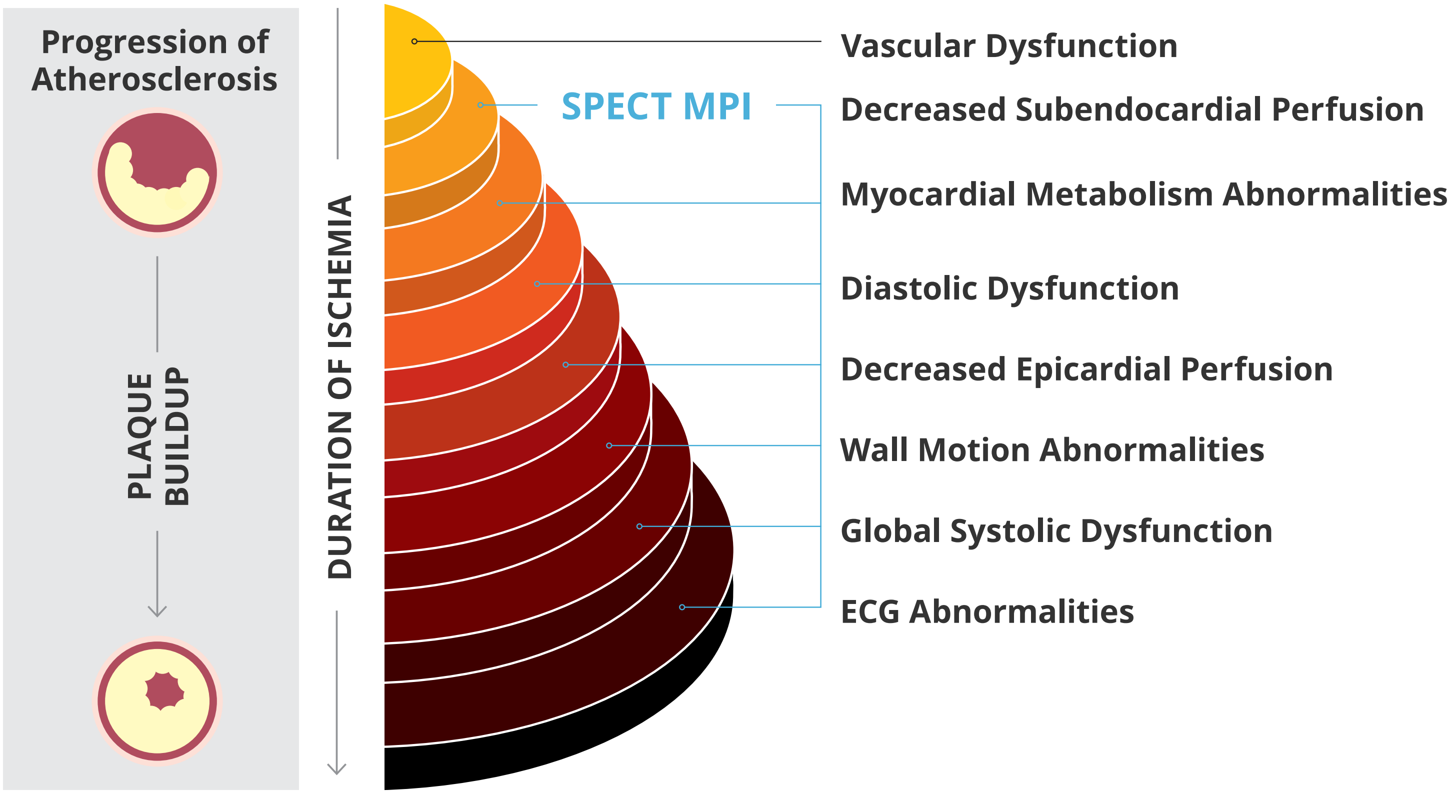
Cardiac imaging modalities can be divided into those that provide anatomic data on coronary stenosis and plaque composition, such as CCTA and CMR angiography, and those that provide functional information about ischemia, such as echo, SPECT MPI, PET MPI, and CMR perfusion. Functional imaging relies on the principles embodied within the ischemic cascade (Figure 17).[2,4]

Functional imaging modalities are able to provide information about the changes that occur in cardiac function during the ischemic cascade. Various types of imaging tests provide different but complementary information. The choice of test depends on the type of information needed to assess the presence and severity of CAD in individual patients.[2,4]

Figure 17. SPECT Scan Analysis[2]

As ischemia becomes progressively worse in severity and duration, it produces a cascading sequence of functional changes (abnormalities) in:

- Perfusion
- Relaxation and contraction
- Wall motion
- Repolarization



Patient-Centered Test Selection

Other Considerations

Local Expertise and Availability

According to ASNC PatientFirst imaging, when multiple testing modalities are considered appropriate, choosing a cardiac test may depend on local expertise and availability.[1] Not all modalities are widely available, and some are more dependent on local expertise to achieve high quality.

Cost-Effectiveness

The cost-effectiveness of a diagnostic test involves not only the cost of the test but also the cost of any further testing, procedures, or treatment that might be required based on the test results. In addition, the potential expenses associated with a misdiagnosis (false-positive test results) or undiagnosed CAD (false-negative test results) must be considered.[2]

Appropriate Use Criteria

The Multimodality AUC provide recommendations for choosing the right test for the right patients at the right time. The ultimate objective is to improve patient care and health outcomes in a cost-effective manner.[3] See the section on Appropriate Use Criteria for more information.

Patient-Centered Test Selection

References

1. Thompson RC, Calnon DA, Polk DM, et al. ASNC statement of principles on the issue of multimodality imaging. J Nucl Cardiol 2021;28(5):2456-7.
2. 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. J Am Coll Cardiol 2012;60(24):e44-164. Erratum in: J Am Coll Cardiol 2014;63(15):1588-90.
3. 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. J Am Coll Cardiol 2014;63(4):380-406.
4. Neglia D, Rovai D, Caselli C, et al. Detection of significant coronary artery disease by noninvasive anatomical and functional imaging. Circ Cardiovasc Imaging 2015;8(3):1-10.

Appropriate Use Criteria

Appropriate Use Criteria

AUC are not intended to replace sound clinical judgment and practice experience, but are designed to help support clinical decision-making in the evaluation of advanced cardiac imaging tests.[1]

Multiple AUC were established for cardiac testing—from the ACCF/AHA,[1] the ACR,[2] and several other key specialty and subspecialty societies.

The ACCF/AHA Multimodality AUC cover appropriateness ratings for 7 testing modalities for the detection of SIHD and risk assessment across 80 common patient presentations.[1]

> ***An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequences[a] by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.***
>
> From the ACCF/AHA Multimodality Appropriate Use Criteria.[1]

[a]Negative consequences of cardiovascular imaging include the risks of the procedure (ie, radiation or contrast exposure) and the downstream impact of poor test performance, such as delay in diagnosis (false negatives) or inappropriate diagnosis (false positives).[1]

Appropriate Use Criteria

Appropriate Use Criteria | Appropriateness Ratings | References

Appropriateness Ratings

Each imaging test is rated by appropriateness for each indication, based on technical capabilities, evidence, and clinical experience (see Figure 18 for appropriateness ratings).[1]

Figure 18. AUC Ratings for Cardiac Imaging Tests Based on the ACCF/AHA Multimodality AUC[1]

APPROPRIATE

- Benefits generally outweigh risks
- Generally an effective option
- Dependent on physician judgment and patient-specific preferences

MAY BE APPROPRIATE

- Variable evidence regarding the risk-benefit ratio
- Potentially an effective option
- Dependent on clinical variables, physician judgment, and patient preferences

RARELY APPROPRIATE

- Lack of evidence that benefits clearly outweigh risks
- Rarely an effective option
- Exceptions should have documentation of clinical reasons

Appropriate Use Criteria

References

1. 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. J Am Coll Cardiol 2014;63(4):380-406.
2. Rybicki FJ, Udelson JE, Peacock WF, et al. 2015 ACR/ACC/AHA/AATS/ACEP/ASNC/NASCI/SAEM/SCCT/SCMR/SCPC/SNMMI/STR/STS appropriate utilization of cardiovascular imaging in emergency department patients with chest pain. J Am Coll Cardiol 2016;67(7):853-79.

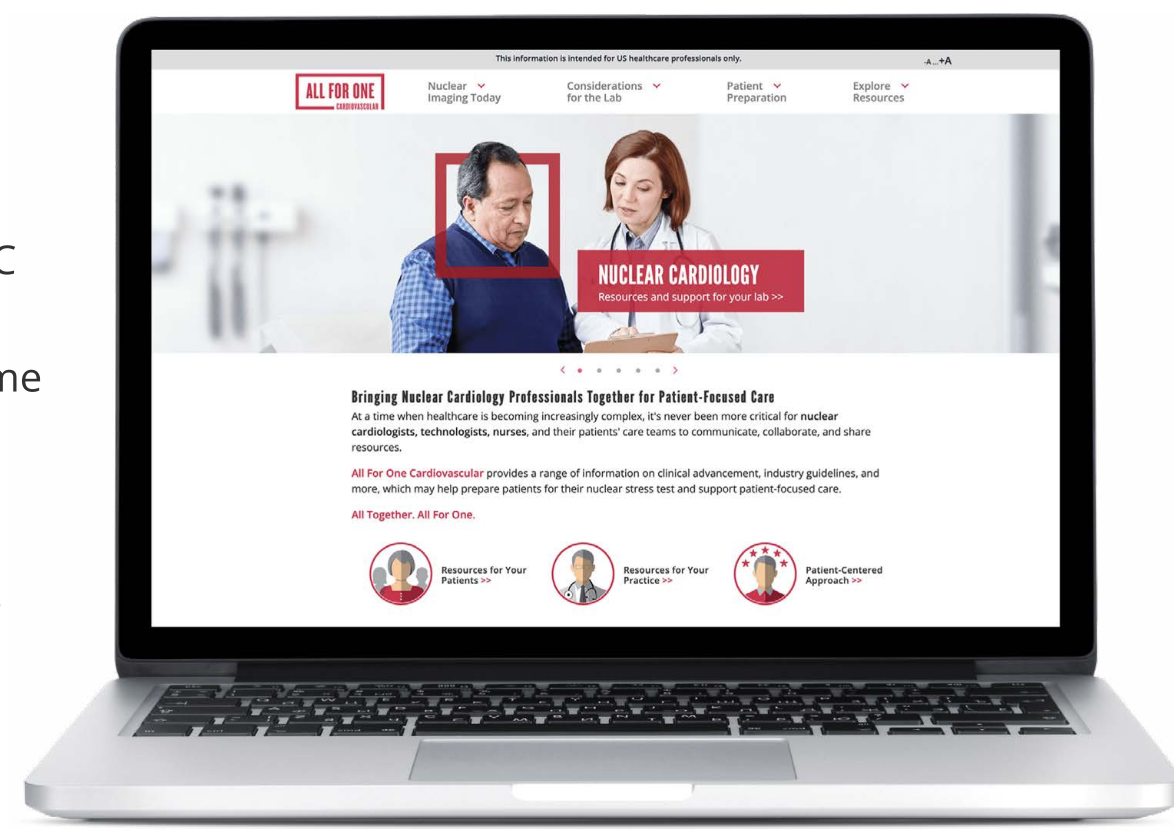
Resources About Cardiac Testing

Resources About Cardiac Testing

For more than 25 years, Astellas has offered practical resources to help providers make decisions focused on patient-centered care. The educational materials are designed to help increase understanding of cardiac testing and encourage communication between providers—all to help each patient get the right cardiac test at the right time.

For the latest information about cardiovascular care, go to AllForOneCardiovascular.com. There you can:

- Read about risk assessment and AUC
- Learn about potential nuclear lab challenges and ways to help overcome them
- Download and review hypothetical patient scenarios
- Download educational resources for your patients and practice



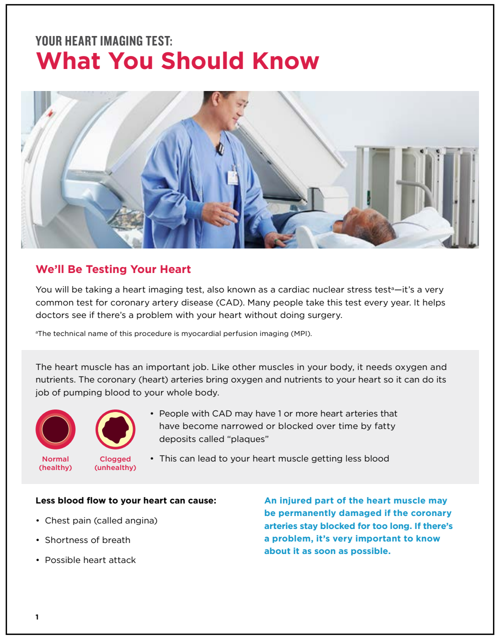
This image may not reflect the most current version of the website.

Resources About Cardiac Testing

Resources About Cardiac Testing | Patient Resources | Practice Resources

Patient Resources

Download these educational resources to help your patients prepare for a stress test, which can help avoid delays and improve the patient experience.



YOUR HEART IMAGING TEST:
What You Should Know

We'll Be Testing Your Heart

You will be taking a heart imaging test, also known as a cardiac nuclear stress test[a]—it's a very common test for coronary artery disease (CAD). Many people take this test every year. It helps doctors see if there's a problem with your heart without doing surgery.

[a]The technical name of this procedure is myocardial perfusion imaging (MPI).

The heart muscle has an important job. Like other muscles in your body, it needs oxygen and nutrients. The coronary (heart) arteries bring oxygen and nutrients to your heart so it can do its job of pumping blood to your whole body.

Normal (healthy) | Clogged (unhealthy)

- People with CAD may have 1 or more heart arteries that have become narrowed or blocked over time by fatty deposits called "plaques"
- This can lead to your heart muscle getting less blood

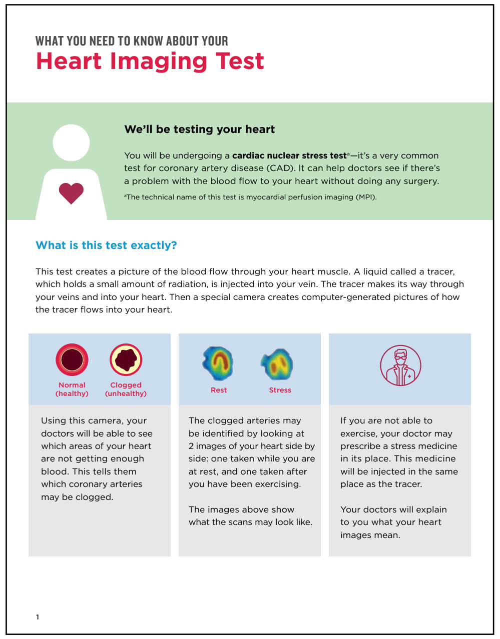
Less blood flow to your heart can cause:

- Chest pain (called angina)
- Shortness of breath
- Possible heart attack

An injured part of the heart muscle may be permanently damaged if the coronary arteries stay blocked for too long. If there's a problem, it's very important to know about it as soon as possible.

1

Patient Heart Imaging Test Guide



WHAT YOU NEED TO KNOW ABOUT YOUR
Heart Imaging Test

We'll be testing your heart

You will be undergoing a **cardiac nuclear stress test**[a]—it's a very common test for coronary artery disease (CAD). It can help doctors see if there's a problem with the blood flow to your heart without doing any surgery.

[a]The technical name of this test is myocardial perfusion imaging (MPI).

What is this test exactly?

This test creates a picture of the blood flow through your heart muscle. A liquid called a tracer, which holds a small amount of radiation, is injected into your vein. The tracer makes its way through your veins and into your heart. Then a special camera creates computer-generated pictures of how the tracer flows into your heart.

Normal (healthy) | Clogged (unhealthy)

Using this camera, your doctors will be able to see which areas of your heart are not getting enough blood. This tells them which coronary arteries may be clogged.

Rest | Stress

The clogged arteries may be identified by looking at 2 images of your heart side by side: one taken while you are at rest, and one taken after you have been exercising.

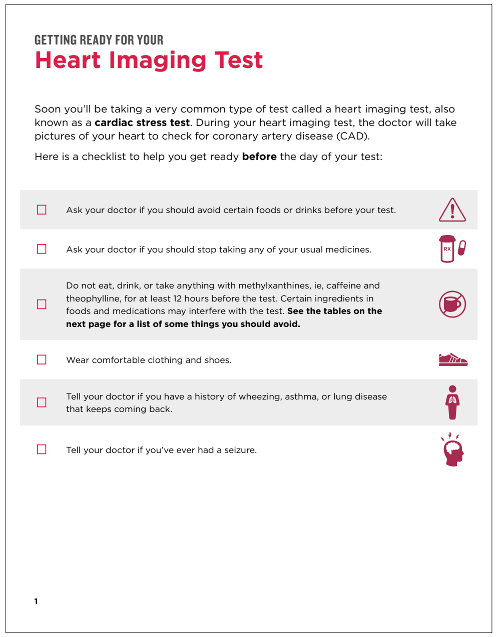
The images above show what the scans may look like.

If you are not able to exercise, your doctor may prescribe a stress medicine in its place. This medicine will be injected in the same place as the tracer.

Your doctors will explain to you what your heart images mean.

1

Getting Ready Patient Handout



GETTING READY FOR YOUR
Heart Imaging Test

Soon you'll be taking a very common type of test called a heart imaging test, also known as a **cardiac stress test**. During your heart imaging test, the doctor will take pictures of your heart to check for coronary artery disease (CAD).

Here is a checklist to help you get ready **before** the day of your test:

- ☐ Ask your doctor if you should avoid certain foods or drinks before your test.
- ☐ Ask your doctor if you should stop taking any of your usual medicines.
- ☐ Do not eat, drink, or take anything with methylxanthines, ie, caffeine and theophylline, for at least 12 hours before the test. Certain ingredients in foods and medications may interfere with the test. **See the tables on the next page for a list of some things you should avoid.**
- ☐ Wear comfortable clothing and shoes.
- ☐ Tell your doctor if you have a history of wheezing, asthma, or lung disease that keeps coming back.
- ☐ Tell your doctor if you've ever had a seizure.

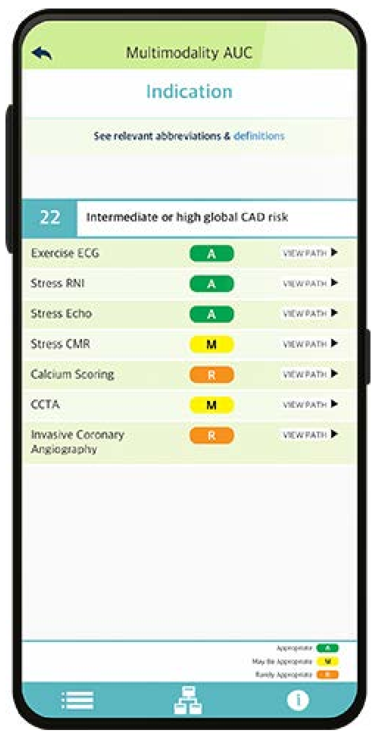
1

Patient Prep Test Checklist

These images may not reflect the most current versions of the educational resources.

Resources About Cardiac Testing

Practice Resources



Download the Multimodality AUC App. Based on the ACCF/AHA Multimodality AUC, this app allows providers to review the appropriateness of 7 cardiac testing modalities for the detection and risk assessment of stable ischemic heart disease.

The Multimodality AUC App is not intended to diagnose, treat, or prevent any disease or condition. It is also not a qualified Clinical Decision Support Mechanism (CDSM). Thus, the Multimodality AUC App must not be used to try and comply with the Centers for Medicare & Medicaid Services (CMS) AUC program requirements. The Multimodality AUC App is for informational purposes only.

Download on the App Store

GET IN ON Google Play

astellas

ASTELLAS IS PROUD TO SUPPORT THE PATIENT ALL FOR ONE