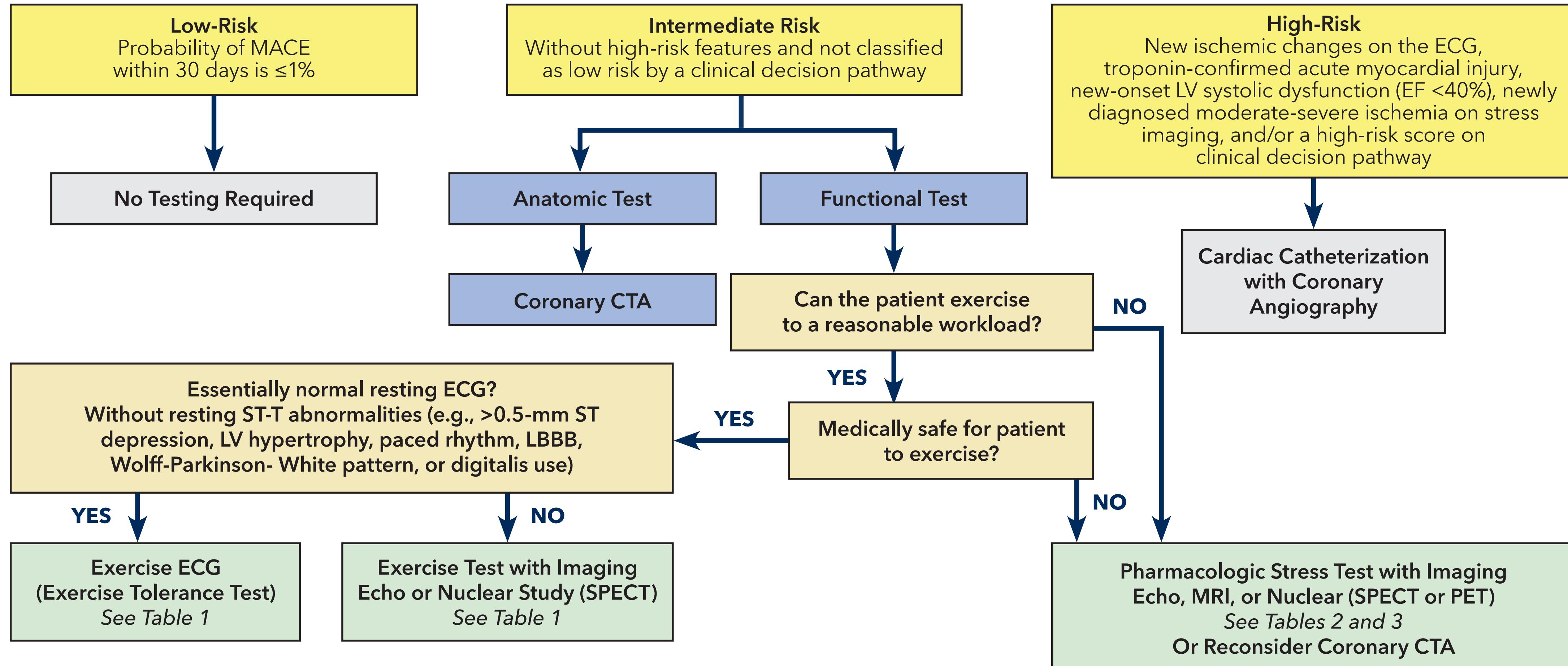


## ED Presentation of Acute Chest Pain

### For Patients with Acute Chest Pain and Suspected ACS, Excluding STEMI

**Step 1:** Focused history, physical exam, and diagnostic testing with ECG to evaluate potentially serious causes of chest pain and to identify complications.

**Step 2:** If suspected ACS, obtain troponin and use clinical decision pathway (e.g., HEART pathway, EDACS) to risk stratify.



Abbreviations: CTA, computed tomography angiography; ECG, electrocardiogram; EDACS, Emergency Department Acute Coronary Syndrome; EF, ejection fraction; HEART, History, ECG, Age, Risk Factors, Troponin; LV, left ventricle; MRI, magnetic resonance imaging; PET, positron emission tomography; SPECT, single photon emission computed tomography.

## Exercise Stress Test<sup>a</sup>

**Table 1**

	<b>Exercise ECG</b>	<b>Exercise Stress Echo</b>	<b>Exercise Nuclear Stress Test (SPECT)</b>
<b>Technique</b>	<b>ECG</b>	<b>Ultrasound</b>	<b>Nuclear</b>
<b>Imaging</b>	None	Visualizes myocardium, cardiac chambers, valves, and wall motion abnormalities. Enables assessment of cardiac hemodynamics.	Assesses blood flow to the heart, left ventricular function, and can assess high-risk findings such as transient ischemic dilation.
<b>Contraindications to Exercise<sup>b,c,d</sup></b>	Acute MI (<2 days) High-risk unstable angina, or active ACS Significant cardiac arrhythmias (e.g., ventricular tachycardia, high-grade AV block) or high risk for arrhythmias attributable to QT prolongation Uncontrolled heart failure Severe systemic arterial hypertension ( $\geq 200/110$ ) Acute pulmonary embolism		Severe pulmonary hypertension Respiratory failure Symptomatic severe aortic stenosis Acute myocarditis/pericarditis Acute aortic dissection Acute symptomatic medical illness
<b>Relative Contraindications to Exercise</b>	Significant left main coronary artery stenosis, asymptomatic severe aortic stenosis, hypertrophic obstructive cardiomyopathy or other forms of severe LVOT obstruction, significant bradyarrhythmias, electrolyte abnormalities, and mental or physical impairment leading to inability to exercise adequately. <sup>c</sup> If combined with imaging, patients with complete LBBB, permanent pacemakers, and ventricular pre-excitation (Wolff-Parkinson-White syndrome) should preferentially undergo pharmacologic vasodilator stress test. <sup>c</sup>		
<b>Additional Contraindications</b>	Significant abnormalities on resting ECG Inability to achieve $\geq 5$ METs	Limited acoustic windows (e.g., in COPD patients) Inability to reach target heart rate	
<b>Comments</b>	For all modalities, inability to reach target heart rate will likely result in a non-diagnostic study.		
	Exercise ECG will be uninterpretable if resting ST-T abnormalities (e.g., $>0.5$ mm ST depression, left ventricular hypertrophy, paced rhythm, LBBB, Wolff-Parkinson-White pattern, or digitalis use).	A patient unable to reach the desired target heart rate should be considered for dobutamine stress echo test.  Due to lack of radiation exposure, stress echo is an attractive technique for young patients, considering cumulative lifetime exposure, and women because of the radiation sensitivity of breast tissue. <sup>d</sup>	Patients with left bundle branch block or ventricular paced rhythm should undergo pharmacologic test with a perfusion agent (due to a high rate of false positive exercise nuclear tests).  A patient unable to reach the desired target heart rate should be considered for perfusion study.
<b>IV injection</b>	None	Microbubble contrast is optional. <sup>e</sup>	Radioactive tracer (technetium) <sup>f</sup>
<b>Radiation Exposure</b>	None	None	$\sim 10$ mSv <sup>g</sup>
<b>Estimated Time</b>	30-40 minutes	1 hour	2-4 hours
<b>Cost</b>	\$ - least expensive	\$\$ - less expensive	\$\$\$\$ - more expensive

Abbreviations: ACS, acute coronary syndrome; AV, atrioventricular; COPD, chronic obstructive pulmonary disease.; ECG, electrocardiogram; LBBB, left bundle branch block; METs, metabolic equivalents; MI, myocardial infarction; mSv, millisievert; SPECT, single photon emission computed tomography.

<sup>a</sup>All modalities incorporate ECG. <sup>b</sup>Gulati M, et al. Circulation 2021;144(22):e368-e454. <sup>c</sup>Henzlova MJ, et al. J Nucl Cardiol 2016;23(3):606-639. <sup>d</sup>Pellikka PA, et al. J Am Soc Echocardiogr 2020;33(1):1-41.e8. <sup>e</sup>Microbubble contrast with Definity or Optison is contraindicated in patients with known or suspected right-to-left, bi-directional, or transient right-to-left cardiac shunts, or hypersensitivity to perflutren. It should not be administered by intra-arterial injection. Optison is also contraindicated in patients with known hypersensitivity to blood, blood products or albumin. <sup>f</sup>Thallium is no longer recommended. <sup>g</sup>In comparison, a chest x-ray has 0.1 mSv of radiation exposure.

## Pharmacologic Stress Tests<sup>a</sup>

**Table 2**

	<b>Dobutamine Stress Echo</b>	<b>Perfusion Stress MRI</b>	<b>Perfusion Nuclear Stress Test (SPECT)<sup>b</sup></b>	<b>Perfusion Nuclear Stress Test (PET)<sup>b</sup></b>
<b>Pharmacologic Agent</b>	Dobutamine; Atropine if needed to boost heart rate	Adenosine, Dipyridamole, or Regadenoson	Adenosine, Dipyridamole, or Regadenoson	Adenosine, Dipyridamole, or Regadenoson
<b>Imaging Agent</b>	Microbubble contrast is optional <sup>c</sup>	Gadolinium (usually)	Radioactive tracer (technetium) <sup>d</sup>	Radioactive tracer (rubidium or N13 are common)
<b>Technique</b>	Ultrasound	Magnetic Resonance	Nuclear (SPECT)	Nuclear (PET)
<b>Imaging</b>	Visualizes myocardium, cardiac chambers, valves, and wall motion abnormalities. Enables assessment of cardiac hemodynamics.	Accurately assesses global and regional left and right ventricular function, myocardial ischemia and infarction, and myocardial viability. Detects myocardial edema and microvascular obstruction, which can help differentiate acute versus chronic MI, as well as other causes of acute chest pain, including myocarditis.	Assesses blood flow to the heart, left ventricular function, and can assess high-risk findings such as transient ischemic dilation.	Assesses blood flow to the heart, left ventricular function, and can assess high-risk findings, such as transient ischemic dilation. With PET, calculation of myocardial blood flow reserve adds diagnostic and prognostic information.
<b>Contraindications<sup>e</sup></b>	Limited acoustic windows (eg, in COPD patients)  Contraindications to dobutamine stress testing (see Table 3 below)	Implanted metal or devices not safe for CMR or producing artifact limiting scan quality  Significant claustrophobia  Reduced GFR (<30 mL/min/1.73 m <sup>2</sup> )  Allergy to gadolinium  Contraindications to adenosine, dipyridamole, or regadenoson (see Table 3 below)	Contraindications to adenosine, dipyridamole, or regadenoson (see Table 3 below)	Contraindications to adenosine, dipyridamole, or regadenoson (see Table 3 below)
<b>Radiation Exposure</b>	None	None	~10 mSv <sup>f</sup>	~3 mSv <sup>f</sup>
<b>Estimated Time</b>	1 hour	3 hours	2-4 hours	2-3 hours
<b>Cost</b>	\$\$ - less expensive	\$\$\$ - moderately expensive	\$\$\$\$ - more expensive	\$\$\$\$\$ - most expensive

Abbreviations: CMR, cardiac magnetic resonance imaging; COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate; MI, myocardial infarction; mSv, millisievert; PET, positron emission tomography; SPECT, single photon emission computed tomography.

<sup>a</sup>All modalities incorporate ECG. <sup>b</sup>Screening screening for potential pregnancy by history and/or pregnancy testing should be performed according to the local imaging facilities policies for undertaking radiological examinations that involve ionizing radiation in women of child-bearing age. <sup>c</sup>Microbubble contrast with Definity or Optison is contraindicated in patients with known or suspected right-to-left, bi-directional, or transient right-to-left cardiac shunts, or hypersensitivity to perflutren. It should not be administered by intra-arterial injection. Optison is also contraindicated in patients with known hypersensitivity to blood, blood products or albumin. <sup>d</sup>Thallium is no longer recommended. <sup>e</sup>Gulati M, et al. Circulation 2021;144(22):e368-e454. <sup>f</sup>In comparison, a chest x-ray has 0.1 mSv of radiation exposure.

# Contraindications to Pharmacologic Stress Testing<sup>a</sup>

**Table 3**

Dobutamine <sup>b</sup>	Perfusion Study <sup>g</sup>
<p><b>Contraindications:</b></p> <ul style="list-style-type: none"> <li>• Acute MI (&lt;2 days)</li> <li>• High-risk unstable angina or active ACS</li> <li>• Serious ventricular arrhythmia or high risk for arrhythmias attributable to QT prolongation; prior history of ventricular tachycardia<sup>c</sup></li> <li>• Uncontrolled heart failure</li> <li>• Hemodynamically significant left ventricular outflow tract obstruction</li> <li>• Severe systemic arterial hypertension (systolic BP &gt;200 mmHg or diastolic BP &gt;110 mm Hg)<sup>d</sup></li> <li>• Atrioventricular block</li> <li>• Critical aortic stenosis<sup>e</sup></li> <li>• Acute illness (e.g., acute pulmonary embolus, acute myocarditis/pericarditis, acute aortic dissection)</li> <li>• Respiratory failure</li> <li>• Severe COPD, acute pulmonary emboli, severe pulmonary hypertension</li> <li>• Known hypersensitivity to dobutamine</li> </ul> <p><b>Relative contraindications<sup>f</sup>:</b></p> <ul style="list-style-type: none"> <li>• Patients on beta-blockers where the heart rate and inotropic responses to dobutamine will be attenuated</li> <li>• Severe aortic stenosis</li> <li>• Patients with symptomatic or large aortic aneurysm</li> </ul>	<p><b>Contraindications:</b></p> <ul style="list-style-type: none"> <li>• Acute MI (&lt;2 days)</li> <li>• High-risk unstable angina or complicated ACS</li> <li>• Known or suspected bronchoconstrictive or bronchospastic disease<sup>h</sup></li> <li>• Significant arrhythmias: <ul style="list-style-type: none"> <li>◦ Second or third-degree AV block without a functioning pacemaker</li> <li>◦ Sinus node disease, eg, sick sinus syndrome or symptomatic bradycardia without a functioning pacemaker</li> <li>◦ Sinus bradycardia &lt;45</li> <li>◦ Other significant cardiac arrhythmias, such as ventricular tachycardia</li> </ul> </li> <li>• Significant hypotension (SBP &lt;90 mm Hg)</li> <li>• Uncontrolled hypertension (SBP &gt;200 mmHg or DBP &gt;110 mmHg)</li> <li>• Recent use of dipyridamole or dipyridamole-containing medications (e.g., Aggrenox)</li> <li>• Use of methylxanthines (caffeine, aminophylline) within 12 hours</li> <li>• Known hypersensitivity to adenosine,<sup>i</sup> regadenoson,<sup>j</sup> or dipyridamole<sup>k</sup></li> </ul> <p><b>Relative contraindications<sup>c</sup>:</b></p> <ul style="list-style-type: none"> <li>• Severe aortic stenosis</li> <li>• Seizure disorder</li> <li>• Mobitz Type 1 second-degree AV block (Wenckebach)<sup>j</sup></li> </ul>

Abbreviations: ACS, acute coronary syndrome; AV, atrioventricular; BP, blood pressure; COPD, chronic obstructive pulmonary disease; DBP, diastolic blood pressure; MI, myocardial infarction; SBP, systolic blood pressure; SSS, sick sinus syndrome.

<sup>a</sup>Gulati M, et al. Circulation 2021;144(22):e368-e454. <sup>b</sup>Atropine, an anticholinergic agent, is sometimes used to augment heart rate (if needed) during a dobutamine stress test. <sup>c</sup>Henzlova MJ, et al. J Nucl Cardiol 2016;23(3):606-639.

<sup>d</sup>Blood pressure limit of 180/100 is utilized by some practices. <sup>e</sup>Low-dose dobutamine may be useful for assessing for low-gradient AS. <sup>f</sup>Left bundle branch block and paced ventricular rhythm are listed as relative contraindications to dobutamine nuclear imaging stress tests in the 2016 ASNC guidelines (see footnote a). <sup>g</sup>Perfusion studies include adenosine (Adenoscan), regadenoson (Lexiscan), or dipyridamole (Persantine) studies. <sup>h</sup>Per ASNC guidelines (footnote a), patients "with bronchospastic lung disease with ongoing wheezing or a history of significant reactive airway disease" should not undergo vasodilator stress testing with adenosine, regadenoson, or dipyridamole.

<sup>i</sup>Adenosine study; <sup>j</sup>Adenosine or regadenoson study; <sup>k</sup>Dipyridamole study