

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: **Chest Pain, Suggestive of Acute Coronary Syndrome**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
SPECT MPI rest and stress	8	Intermediate-to-high likelihood for coronary artery disease. There is abundant literature available on clinical utility.	☼ ☼ ☼ ☼
Arteriography coronary	8	Gold standard, invasive.	☼ ☼ ☼
SPECT MPI rest only	7	In the setting of ongoing chest pain, high negative predictive value. Tc-99m is the most commonly used radionuclide agent for this test. RRL may be higher if Thallium (Tl-201) used.	☼ ☼ ☼
US echocardiography transthoracic stress	7	When resting echo and cardiac enzymes are normal.	O
US echocardiography transthoracic resting	6	Primarily for evaluating wall motion abnormalities and aortic dissection.	O
CTA coronary arteries with contrast	6	For those with low to intermediate likelihood for coronary artery disease, in the absence of cardiac enzyme elevation and ischemic ST changes.	☼ ☼ ☼ ☼
X-ray chest	5	Primarily a survey for noncardiac etiologies of chest pain.	☼
CT chest with contrast	5	Primarily for noncardiac etiologies such as pulmonary embolism and aortic dissection.	☼ ☼ ☼
MRI heart with stress without and with contrast	5	Limited experience in the clinical setting and lack of availability. See statement regarding contrast in text under “Anticipated Exceptions.”	O
MRI heart with stress without contrast	4	Limited experience in the clinical setting and lack of availability.	O
Rb-82 PET heart stress	4	Lack of widespread use and availability.	☼ ☼ ☼
MRI heart function and morphology without and with contrast	4	Primarily for the possibility of aortic dissection. See statement regarding contrast in text under “Anticipated Exceptions.”	O
CT chest without and with contrast	3		☼ ☼ ☼
MRI heart function and morphology without contrast	3	Primarily for the possibility of aortic dissection.	O
US echocardiography transesophageal	3	Relative contraindication for acute coronary syndrome.	O
CT coronary calcium	2	Not validated in the acute setting.	☼ ☼ ☼
MRA coronary arteries without contrast	2	Technically challenging and lack of widespread use and protocol availability.	O
MRA coronary arteries without and with contrast	2	Technically challenging and lack of widespread use and protocol availability.	O
CT chest without contrast	2		☼ ☼ ☼
CTA coronary arteries with contrast with advanced low dose techniques	No Consensus	Lack of data in the acute setting.	☼ ☼ ☼
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

CHEST PAIN, SUGGESTIVE OF ACUTE CORONARY SYNDROME

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Summary of Literature Review

Acute chest pain is a frequent presentation in emergency departments. Along with other important disease entities (eg, aortic dissection, pulmonary embolus), clinical symptoms may raise the possibility of acute myocardial ischemia. Acute coronary syndromes (ACS) include ST-segment elevation myocardial infarction (STEMI), non-STEMI (NSTEMI), and unstable angina (UA) [1]. Being able to establish the diagnosis rapidly and accurately may be lifesaving. The immediate cardiac workup consists of an electrocardiogram (ECG) and cardiac biomarkers. In the acute setting, even if there are no ischemic changes on ECG, a cardiac workup is indicated. Because research has demonstrated that patients having a STEMI have improved outcomes if percutaneous intervention (PCI) is performed within 90 minutes of arrival to a hospital, if ECG changes and clinical examination suggest that the patient is suspected of having a STEMI, the patient will be urgently transferred to a cardiac catheterization laboratory for invasive angiography and coronary revascularization [2-4].

In stable patients without ST elevation, an initially conservative approach may be considered [5]. In patients with active chest pain, an ECG with no ischemic changes, and an initial negative troponin, rest single photon emission computed tomography (SPECT) has been demonstrated to be useful [6-9]. However, it has been shown to be less sensitive than stress SPECT imaging if the chest pain has subsided [6]. Stress echocardiography may be equally considered in acute chest pain patients as

well [10-11]. Noninvasive imaging may be indicated for risk stratification before discharge in both low- and intermediate-risk patients who have been free of ischemia for a minimum of 12-24 hours. This approach also serves to identify patients with latent ischemia who could benefit from more aggressive revascularization [5,12-15].

In clinically stable UA/NSTEMI patients, cardiac catheterization in a nonemergent setting has advantages which may outweigh the benefits of performing urgent intervention. This select group of patients with UA/NSTEMI may be selected for “early but nonurgent angiography/intervention,” also referred to as “upstream therapy.” In the interval prior to angiography, these patients may benefit from aggressive antiplatelet therapy. In this group of patients selected for nonurgent invasive angiography, noninvasive imaging may be the intermediate step between the emergency department and discharge, hopefully improving confidence regarding the safety of the discharge [5].

Noncoronary etiologies for chest pain may also be established with imaging, the results of which may alter the patient’s post-discharge care altogether. It is not uncommon for a patient to have acute chest pain occurring from either other cardiovascular causes or noncardiac etiologies. Patients may have predisposing cardiac risk factors and pain characteristics that place them in the triage category of intermediate probability for coronary artery disease (CAD). Further cardiac risk stratification of this subgroup of patients is recommended before discharge, and noninvasive imaging is necessary to exclude ischemia as an etiology [16-22].

The available noninvasive cardiac imaging modalities include chest radiography (CXR), rest SPECT myocardial perfusion imaging (MPI), stress SPECT MPI, echocardiography (transthoracic and transesophageal), multidetector computed tomography (MDCT), positron emission tomography (PET) (metabolic and perfusion), and magnetic resonance imaging (MRI).

Chest Radiography

The utility of the CXR is primarily for ruling out conditions that may masquerade as an acute myocardial ischemia as well as defining secondary findings that may accompany acute myocardial infarction. Acute pulmonary edema can be seen on the chest radiograph without enlargement of the cardiac silhouette in patients with acute myocardial infarction and no prior history of ischemic damage or associated mitral valve disease. However, CXR is insufficient to confirm or exclude the presence of significant coronary artery disease. Other cardiovascular entities, such as aortic aneurysms, aortic dissections, and pulmonary embolism may be suggested from the CXR but with lower sensitivity than other imaging modalities such as MDCT [23-25]. Noncardiac findings associated with chest pain that can be identified on the CXR include pneumothorax, fractured ribs, pleural effusions, and pneumonia.

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Single Photon Emission Computed Tomography/Myocardial Perfusion Imaging

SPECT perfusion scintigraphy is an important test in the assessment for myocardial ischemia. In patients with active chest pain, an ECG with no ischemic changes, and an initial negative troponin, rest SPECT has been demonstrated to be the test of choice [6-9,26-27]. It has been shown to be less sensitive than stress SPECT imaging, however, if performed after the chest pain has subsided [28-29]. The commonly used radionuclide agents are Tl-201 (Thallium) chloride and (Technetium) Tc-99m-labeled agents (eg, sestamibi, tetrofosmin). There is abundant literature describing the use of SPECT in ACS. The absence of a perfusion defect on an acute rest study is associated with a very high negative predictive value for ACS evaluation. A perfusion defect which becomes apparent or becomes larger during exercise stress or pharmacologic stress defines ischemic myocardium.

Recently new software algorithms such as iterative reconstruction, maximum a posteriori noise regularization, and resolution-recovery, and new hardware and detector materials have become available, allowing for image acquisitions at significantly shorter acquisition times (one fifth to one half of previous acquisition times), or alternatively at lower doses compared to conventional algorithms [30-31].

Echocardiography

Stress echocardiography has been shown to be a modality equivalent to stress SPECT MPI in the acute setting in low to intermediate risk patients, with a stress pharmacologic agent such as dobutamine, inducing focal wall motion abnormalities in the region(s) of ischemia [10-11,28-34]. Overall left ventricular function can also be assessed. The presence of left ventricular aneurysms, pseudoaneurysms, effusions, and valvular dysfunction can be determined as well.

The primary utility of transesophageal echocardiography (TEE) in the setting of acute chest pain is in ruling out aortic dissection in unstable patients. TEE is also used to further define valvular dysfunction or intracardiac thrombus, which can be sequelae of ischemic events in the subacute setting. Because of the invasive nature of TEE and because there is limited information that can be added in the setting of acute chest pain, this modality is generally not indicated in the workup of acute chest-pain patients [35-36].

Multidetector Computed Tomography

In stable patients with suggested ACS with a low or intermediate probability of CAD, in whom follow-up ECG and cardiac biomarker measurements are normal, performance of a noninvasive coronary imaging test (ie, coronary CT angiography [CCTA]) is reasonable as an alternative to stress testing or selective coronary angiography [5,37]. CCTA has a high negative predictive value for the detection of coronary atherosclerosis with or without significant stenosis and may be a potential alternative to stress imaging in the emergency department

setting in patients at low to intermediate risk for CAD [37-46]. In addition, CT has a well established role in identifying aortic aneurysms, aortic dissections, pulmonary embolism, pericardial disease, and lung parenchymal disease, all of which can also present with acute chest pain [20,47].

Of note, CCTA results may be limited in patients with high heart rates (>65 beats/min) uncontrolled by beta blocker or other rate-limiting agents, and in patients who have intractable arrhythmias, or calcium scores greater than 400-600 Agatston Units.

Recent advances in cardiac CT imaging technology allow for further reduction of the radiation dose from CCTA [48]; available new dose-reducing techniques include prospective triggering [49-51], adaptive statistical iterative reconstruction [52], and high-pitch spiral acquisition [53]. However, these newer low-dose techniques may not be the appropriate choice in all patients due to their dependency on a combination of factors, including heart rate, rhythm, and clinical indication. Thus, while these techniques are promising in terms of reducing patient radiation dose, their overall accuracy and utility as compared to standard CCTA techniques are not yet completely defined.

Positron Emission Tomography

A stress PET examination can reliably demonstrate myocardial blood flow using Rubidium-82 (Rb-82) or Nitrogen-13 (N-13) ammonia. Limited data are available for PET perfusion studies in the setting of acute chest pain, although there is growing evidence for diagnostic and prognostic applications in chronic coronary disease. PET can also document anaerobic metabolism using F (Fluorine)-18 fluorodeoxyglucose and other metabolic tracers. This technology is not universally available and, therefore, is probably not indicated in the workup of the acute chest pain patient [27,33,54].

Magnetic Resonance Imaging

MRI has modest utility in patients with suspected ischemia in the acute setting. Limitations to this technique are principally equipment availability and the high level of expertise required of technologists and interpreting physicians. Access to the patient may be more difficult in the magnetic environment if the patient's stability should deteriorate.

However, cardiac MRI delayed post contrast imaging and edema-weighted imaging provides definitive assessment of the size, distribution, and mural extent of acute or remote myocardial infarction. Cine MRI has utility in demonstrating wall motion abnormalities which may accompany acute or chronic ischemic heart disease, and dynamic contrast-enhanced perfusion cardiac MRI can demonstrate myocardial perfusion abnormalities [55-56]. MRI, like CT, can also identify noncardiac findings of chest pain, such as aortic dissection. Although MR coronary angiography has not been established in general practice, both angiographic and phase-contrast flow continue to be developed for coronary artery assessment in research centers [57].

Summary

- A number of imaging modalities may be utilized in evaluating stable patients with chest pain suggestive of acute coronary syndrome and who are not selected for urgent cardiac catheterization.
- Although cardiac catheterization is the mainstay for evaluation of patients in whom acute coronary syndrome is being considered, in the clinically stable patient with UA/NSTEMI, alternative noninvasive imaging modalities may be appropriate.
- Noninvasive imaging in this setting includes myocardial perfusion scanning, coronary CT angiography, and echocardiography. These tests may be performed as an intermediate step and may improve confidence regarding the safety of discharge from the emergency department.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m²), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m². For more information, please see the [ACR Manual on Contrast Media](#) [58].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria[®] [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼ ☼	0.1-1 mSv	0.03-0.3 mSv
☼ ☼ ☼	1-10 mSv	0.3- 3 mSv
☼ ☼ ☼ ☼	10-30 mSv	3-10 mSv
☼ ☼ ☼ ☼ ☼	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).		

Supporting Document(s)

- [ACR Appropriateness Criteria[®] Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.