Chest Pain Suggestive of Acute Coronary Syndrome
EVIDENCE TABLE

	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1.	Cannon CP, Battler A, Brindis RG, et al. American College of Cardiology key data elements and definitions for measuring the clinical management and outcomes of patients with acute coronary syndromes. A report of the American College of Cardiology Task Force on Clinical Data Standards (Acute Coronary Syndromes Writing Committee). *J Am Coll Cardiol.* 2001; 38(7):2114-2130.	Review/Other-Tx	N/A	ACC key data elements and definitions for measuring the clinical management and outcomes of patients with ACSs.	N/A	4
2.	Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction; A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of patients with acute myocardial infarction). *J Am Coll Cardiol.* 2004; 44(3):E1-E211.	Review/Other-Tx	N/A	ACC/AHA guidelines for the management of patients with ST-elevation MI.	N/A	4
3.	Antman EM, Hand M, Armstrong PW, et al. 2007 Focused Update of the ACC/AHA 2004 Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines: developed in collaboration With the Canadian Cardiovascular Society endorsed by the American Academy of Family Physicians: 2007 Writing Group to Review New Evidence and Update the ACC/AHA 2004 Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction, Writing on Behalf of the 2004 Writing Committee. *Circulation.* 2008; 117(2):296-329.	Review/Other-Tx	N/A	Focused update of the ACC/AHA 2004 guidelines for the management of patients with ST-elevation MI.	N/A	4

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	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
4.	Nallamothu BK, Bates ER, Herrin J, Wang Y, Bradley EH, Krumholz HM. Times to treatment in transfer patients undergoing primary percutaneous coronary intervention in the United States: National Registry of Myocardial Infarction (NRMI)-3/4 analysis. *Circulation.* 2005; 111(6):761-767.	Review/Other-Tx	4,278 patients	To describe patterns of times to treatment in patients undergoing interhospital transfer for primary percutaneous coronary intervention in the United States.	Among 4,278 patients transferred for primary percutaneous coronary intervention at 419 hospitals, the median total door-to-balloon time was 180 minutes, with only 4.2% of patients treated within 90 minutes, the benchmark recommended by national quality guidelines. Comorbid conditions, absence of chest pain, delayed presentation after symptom onset, less specific ECG findings, and hospital presentation during off-hours were associated with longer total door-to-balloon times. Patients at teaching hospitals in rural areas also had significantly longer times to treatment. Total door-to-balloon times for transfer patients undergoing primary percutaneous coronary intervention in the United States rarely achieve guideline-recommended benchmarks, and current decision making should take these times into account. For the full benefits of primary percutaneous coronary intervention to be realized in transfer patients, improved systems are urgently needed to minimize total door-to-balloon times.	4

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	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
5.	Anderson JL, Adams CD, Antman EM, et al. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-Elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction) developed in collaboration with the American College of Emergency Physicians, the Society for Cardiovascular Angiography and Interventions, and the Society of Thoracic Surgeons endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation and the Society for Academic Emergency Medicine. *J Am Coll Cardiol.* 2007; 50(7):e1-e157.	Review/Other-Tx	N/A	ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-Elevation MI.	N/A	4
6.	Kontos MC, Fratkin MJ, Jesse RL, Anderson FP, Ornato JP, Tatum JL. Sensitivity of acute rest myocardial perfusion imaging for identifying patients with myocardial infarction based on a troponin definition. *J Nucl Cardiol.* 2004; 11(1):12-19.	Observational-Dx	319 patients	To determine sensitivity of acute rest MPI for identifying patients with MI based on a troponin definition.	Of the 319 patients who had MPI and cTnI elevations, 78 had negative MPI results (sensitivity, 75%). Patients with negative MPI results had lower peak CK-MB values (15 +/- 25 ng/mL vs 45 +/- 78 ng/mL, P<.0001) and higher ejection fractions (56% +/- 15% vs 47% +/- 13%, P<.0001) and were less likely to have significant disease (55% vs 72%, P=.04) than those with positive MPI results. Increasing summed rest score was associated with larger MIs as estimated by peak CK and CK-MB values.	3

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7.	Udelson JE, Beshansky JR, Ballin DS, et al. Myocardial perfusion imaging for evaluation and triage of patients with suspected acute cardiac ischemia: a randomized controlled trial. *JAMA.* 2002; 288(21):2693-2700.	Experimental-Dx	2,475 patients	Prospective randomized controlled trial to assess whether incorporating acute resting perfusion imaging into an ED evaluation strategy for patients with symptoms suggestive of acute cardiac ischemia would improve clinical decision making.	Among patients with acute cardiac ischemia (ie, acute MI or unstable angina; n=329), there were no differences in ED triage decisions between those receiving standard evaluation and those whose evaluation was supplemented by a sestamibi scan. Among patients with acute MI (n=56), 97% vs 96% were hospitalized (RR, 1.00; 95% CI, 0.89-1.12), and among those with unstable angina (n=273), 83% vs 81% were hospitalized (RR, 0.98; 95% CI, 0.87-1.10). However, among patients without acute cardiac ischemia (n=2,146), hospitalization was 52% with usual care vs 42% with sestamibi imaging (RR, 0.84; 95% CI, 0.77-0.92).	2
8.	Cantor WJ, Goodman SG, Cannon CP, et al. Early cardiac catheterization is associated with lower mortality only among high-risk patients with ST- and non-ST-elevation acute coronary syndromes: observations from the OPUS-TIMI 16 trial. *Am Heart J.* 2005; 149(2):275-283.	Observational-Tx	8,286 patients	To determine whether early cardiac catheterization was associated with a differential effect on mortality based on risk profile.	Inhospital cardiac catheterization was performed in 44% of patients. Mortality rates at 10 months were 1.3%, 2.2%, and 11.3% in the low-, intermediate-, and high-risk groups, respectively. Inhospital cardiac catheterization was associated with a trend to lower mortality among the high-risk patients with ST-elevation MI (HR 0.57, 95% CI, 0.33-1.01, P=.052) and non-ST-elevation MI (HR 0.65, 95% CI, 0.39-1.07, P=.088) but not in those with unstable angina (HR 0.95, 95% CI, 0.63-1.43, P=.82). Catheterization was not associated with any significant difference in mortality in the low-risk or intermediate-risk group. The differences among high-risk patients persisted after adjusting for baseline characteristics; inhospital catheterization was associated with significantly lower mortality in high-risk patients with ST and non-ST MI (HR 0.65, 95% CI, 0.45-0.95, P=.03).	2

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	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
9.	de Winter RJ, Windhausen F, Cornel JH, et al. Early invasive versus selectively invasive management for acute coronary syndromes. *N Engl J Med.* 2005; 353(11):1095-1104.	Experimental-Tx	1,200 patients	To test the hypothesis that an early invasive strategy is superior to a selectively invasive strategy for patients who have ACSs without ST-segment elevation and with an elevated cardiac troponin T level.	The estimated cumulative rate of the primary end point was 22.7% in the group assigned to early invasive management and 21.2% in the group assigned to selectively invasive management (RR, 1.07; 95% CI, 0.87 to 1.33; P=0.33). The mortality rate was the same in the two groups (2.5%). MI was significantly more frequent in the group assigned to early invasive management (15.0% vs 10.0%, P=0.005), but rehospitalization was less frequent in that group (7.4% vs 10.9%, P=0.04).	1
10.	Fox KA, Poole-Wilson P, Clayton TC, et al. 5-year outcome of an interventional strategy in non-ST-elevation acute coronary syndrome: the British Heart Foundation RITA 3 randomised trial. *Lancet.* 2005; 366(9489):914-920.	Experimental-Tx	1,810 patients	To determine whether an interventional strategy (routine angiography followed by revascularization) was better than a conservative strategy (ischaemia-driven or symptom-driven angiography) over 5 years' follow-up.	At 1-year follow-up, rates of death or non-fatal MI were similar. However, at a median of 5 years' follow-up (IQR 4.6–5.0), 142 (16.6%) patients with intervention treatment and 178 (20.0%) with conservative treatment died or had non-fatal MI (OR 0.78, 95% CI, 0.61–0.99, P=0.044), with a similar benefit for cardiovascular death or MI (0.74, 0.56–0.97, P=0.030). 234 (102 [12%] intervention, 132 [15%] conservative) patients died during follow-up (0.76, 0.58–1.00, P=0.054). The benefits of an intervention strategy were mainly seen in patients at high risk of death or MI (P=0.004), and for the highest risk group, the OR of death or non-fatal MI was 0.44 (0.25–0.76).	1

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
11. Mehta SR, Cannon CP, Fox KA, et al. Routine vs selective invasive strategies in patients with acute coronary syndromes: a collaborative meta-analysis of randomized trials. *JAMA*. 2005; 293(23):2908-2917.	Review/Other-Tx	7 trials (n=9,212 patients)	To conduct a meta-analysis that compares benefits and risks of routine invasive vs selective invasive strategies.	Overall, death or MI was reduced from 663 (14.4%) of 4,604 patients in the selective invasive group to 561 (12.2%) of 4,608 patients in the routine invasive group (OR, 0.82; 95% CI, 0.72-0.93; P=.001). There was a nonsignificant trend toward fewer deaths (6.0% vs 5.5%; OR, 0.92; 95% CI, 0.77-1.09; P=.33) and a significant reduction in MI alone (9.4% vs 7.3%; OR, 0.75; 95% CI, 0.65-0.88; P<.001). Higher-risk patients with elevated cardiac biomarker levels at baseline benefited more from routine intervention, with no significant benefit observed in lower-risk patients with negative baseline marker levels. During the initial hospitalization, a routine invasive strategy was associated with a significantly higher early mortality (1.1% vs 1.8% for selective vs routine, respectively; OR, 1.60; 95% CI, 1.14-2.25; P=.007) and the composite of death or MI (3.8% vs 5.2%; OR, 1.36; 95% CI, 1.12-1.66; P=.002). But after discharge, the routine invasive strategy was associated with fewer subsequent deaths (4.9% vs 3.8%; OR, 0.76; 95% CI, 0.62-0.94; P=.01) and the composite of death or MI (11.0% vs 7.4%; OR, 0.64; 95% CI, 0.56-0.75; P<.001). At the end of follow-up, there was a 33% reduction in severe angina (14.0% vs 11.2%; OR, 0.77; 95% CI, 0.68-0.87; P<.001) and a 34% reduction in rehospitalization (41.3% vs 32.5%; OR, 0.66; 95% CI, 0.60-0.72; P<.001) with a routine invasive strategy.	4
12. Pryor DB, Shaw L, Harrell FE, Jr., et al. Estimating the likelihood of severe coronary artery disease. *Am J Med*. 1991; 90(5):553-562.	Review/Other-Dx	6,435 consecutive symptomatic patients	To determine which clinical characteristics obtained by a physician during an initial clinical examination are important for estimating the likelihood of severe CAD, and to determine whether estimates based on these characteristics remain valid when applied prospectively and in different patient groups.	11 of 23 characteristics were important for estimating the likelihood of severe CAD. A model using these characteristics accurately estimated the likelihood of severe disease in an independent sample of 2,342 patients referred since 1983. The model also accurately estimated the prevalence of severe disease in large series of patients reported in the literature.	4

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13. Rubinshtein R, Halon DA, Gaspar T, et al. Impact of 64-slice cardiac computed tomographic angiography on clinical decision-making in emergency department patients with chest pain of possible myocardial ischemic origin. *Am J Cardiol.* 2007; 100(10):1522-1526.	Observational-Dx	58 consecutive patients	To examine the impact of contrast enhanced MDCT on clinical decision-making in patients who present to the ED with chest pain of possible ischemic origin.	Patients underwent 64-slice contrast agent-enhanced MDCT with image reconstruction in multiple formats using retrospective electrocardiographic gating, which revealed normal (no or trivial atheroma) coronary vasculature in 15 patients, nonobstructive atheroma in 20 patients, and obstructive coronary disease ($\geq$1 luminal narrowing of $\geq$50%) in 23 patients. After MDCT, the diagnosis of ACS was revised in 18/41 patients (44%; 16 normal MDCT/widely patent stents, 2 alternative diagnoses), planned hospitalization canceled in 21/47 patients (45%; 13 normal MDCT/patent stent, 8 minor branch vessel disease), and planned early invasive strategy altered in 25/58 patients (43%; unnecessary in 20/32, advisable in 5/26 others). Effect of MDCT on clinical decisions was greater in the 36 patients without known preceding coronary disease. In 32 patients discharged from the ED (11 after initial triage, 21 patients after MDCT), there were no major adverse cardiac events (eg, death, MI, unplanned revascularization) during a 12-month follow-up period.	3
14. Solinas L, Raucci R, Terrazzino S, et al. Prevalence, clinical characteristics, resource utilization and outcome of patients with acute chest pain in the emergency department. A multicenter, prospective, observational study in north-eastern Italy. *Ital Heart J.* 2003; 4(5):318-324.	Observational-Dx	495 patients	To evaluate the diagnostic accuracy and costs of the actual ED triage modalities of patients with acute chest pain.	The diagnosis of ACS was confirmed in 79% of hospitalized patients. Among the patients discharged directly from the ED 68% were immediately sent back home (69 +/- 60 min from admission) and 32% required a brief clinical observation lasting 10 +/- 6 hours and including serial electrocardiographic and myocardial injury marker assessment. The average cost of the ED triage was 189 +/- 237 €/patient. The 1-month follow-up of the patients directly discharged from the ED revealed a 2.5% incidence of ACSs (3 acute MIs), but no deaths.	3

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15. Amsterdam EA, Kirk JD, Bluemke DA, et al. Testing of low-risk patients presenting to the emergency department with chest pain: a scientific statement from the American Heart Association. *Circulation.* 2010; 122(17):1756-1776.	Review/Other-Dx	N/A	A scientific statement from the AHA on testing of low-risk patients presenting to the ED with chest pain.	Rest MPI has assumed an important role in the ED. CCTA has also shown promise. A negative accelerated diagnostic protocol evaluation allows discharge, whereas patients with positive findings are admitted. This approach has been found to be safe, accurate, and cost-effective in low-risk patients presenting with chest pain.	4
16. Buenger RE. Five thousand acute care/emergency department chest radiographs: comparison of requisitions with radiographic findings. *J Emerg Med.* 1988; 6(3):197-202.	Review/Other-Dx	5,000 radiographs	To interpret 5,000 portable or posterior-anterior-lateral radiographs of acute care ED patients. The study was directed at two specific groups of acute care ED patients; those with cardiorespiratory symptoms, and those with other symptoms. The symptoms of the group were compared with the radiographic findings.	The radiographs revealed serious disease in 35% of patients with chest symptoms, in 27% of all patients examined, and in 18% of patients with noncardiorespiratory symptoms. The highest incidence of abnormal radiographs (42%-79%) occurred in patients with symptoms of congestive heart failure, dyspnea, hemoptysis, dysrhythmia, and hypertension. Asthma (14%) and trauma (5%) presented the lowest incidence of significant findings. Radiographs of patients suspected of having pneumonia were abnormal in 25% of cases, and in those patients with either cough or fever alone, the incidences of pneumonia were 13% and 18%. Whereas 24% of patients with dyspnea alone had radiographic findings of congestive heart failure, 52% of those with congestive heart failure diagnosed on clinical grounds had abnormal radiographs.	4
17. Butcher BL, Nichol KL, Parenti CM. High yield of chest radiography in walk-in clinic patients with chest symptoms. *J Gen Intern Med.* 1993; 8(3):115-119.	Observational-Dx	221 patients	To assess the yield of chest radiography among a group of symptomatic adults presenting to a walk-in clinic.	New clinically important radiographic abnormalities, defined as those necessitating acute intervention and/or follow-up evaluation, were identified for 77 (34.8%) of the 221 patients studied. Abnormalities included 39 (17.6%) cases of infiltrates, 23 (10.4%) cases of nodules or mass lesions, and 19 (8.6%) cases of cardiomegaly or congestive heart failure. Evaluation of clinical data obtained during the triage interview revealed no statistically significant difference between those patients with and those without new radiographic abnormalities on their chest x-rays.	2

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18.	Templeton PA, McCallion WA, McKinney LA, Wilson HK. Chest pain in the accident and emergency department: is chest radiography worthwhile? *Arch Emerg Med.* 1991; 8(2):97-101.	Review/Other-Dx	297 patients	To assess the value of chest radiography.	Overall, 23% of chest radiographs had an abnormality which influenced management of the patient, rising to 40% in those patients admitted to Coronary Care. 29% of chest radiographs were misinterpreted by Casualty Officers but resulted in the mismanagement of only 6 patients (3.3%). Potentially serious errors were averted by early chest radiographs audit by a Radiologist.	4
19.	Varetto T, Cantalupi D, Altieri A, Orlandi C. Emergency room technetium-99m sestamibi imaging to rule out acute myocardial ischemic events in patients with nondiagnostic electrocardiograms. *J Am Coll Cardiol.* 1993; 22(7):1804-1808.	Observational-Dx	64 patients	To determine the role of nuclear imaging in patients with chest pain.	30 patients showed a perfusion defect on admission. Of these, 13 developed MI within 12 hours. CAD was diagnosed in 14 patients and the remaining 3 patients were classified as having false positive findings. Normal perfusion scans were seen in 34 patients, none of whom were ultimately diagnosed as having CAD. A 100% sensitivity was demonstrated vs the final diagnosis of acute cardiac ischemia (kappa 0.91, 95% CI, 0.8 to 1.0). A follow-up period of up to 18 months (mean 11 +/- 3) was also carried out for major cardiac events (death, MI, coronary angioplasty and coronary artery bypass grafting). Six events (2 coronary bypass procedures, 3 angioplasty procedures and one death) were observed at follow-up in the group of patients with a technetium-99m sestamibi perfusion defect. Patients with normal perfusion scans on admission had no major cardiac events at follow-up study.	2

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20. Di Pasquale P, Cannizzaro S, Scalzo S, et al. Sensitivity, specificity and predictive value of the echocardiography and troponin-T test combination in patients with non-ST elevation acute coronary syndromes. *Int J Cardiovasc Imaging.* 2004; 20(1):37-46.	Observational-Dx	280 patients	To determine the clinical utility, sensitivity and specificity of the combination of troponin-T test levels and echocardiography in patients presenting with chest pain, ST-depression, T-wave negative and no diagnostic ECG.	The combination of positive troponin-T test and wall motion alterations showed a higher sensitivity, specificity and predictive values in comparison with alone troponin-T test or echocardiography. Patients, with the concordance between troponin-T test and echocardiography, were at higher risk. Patients with negative combination in all groups (94), showed a low incidence of coronary stenosis (10.6%), as well as negative echocardiography alone (102 patients) (12.7%), while patients with negative troponin-T test (128) showed higher incidence of coronary stenosis (39%), P<0.0001.	2
21. Lim SH, Sayre MR, Gibler WB. 2-D echocardiography prediction of adverse events in ED patients with chest pain. *Am J Emerg Med.* 2003; 21(2):106-110.	Review/Other-Dx	1,112 patients received echo	To establish the efficacy of 2D echocardiography in predicting adverse cardiac events in patients presenting to the ED with possible ACS.	Of the 1,112 patients receiving echocardiography, 18 had positive studies. None had adverse events on follow-up. Of the 1,094 patients with a negative 2-D echocardiography, 15 had adverse events (2 acute MIs, 2 coronary artery bypass graftings, and 11 percutaneous transluminal coronary angioplasties). Resting 2-D echocardiography did not predict cardiac adverse events in patients with possible ACS and non-diagnostic serial 12-lead ECG and normal serial CK-MB at the end of a 9-hour evaluation.	4
22. Tong KL, Kaul S, Wang XQ, et al. Myocardial contrast echocardiography versus Thrombolysis In Myocardial Infarction score in patients presenting to the emergency department with chest pain and a nondiagnostic electrocardiogram. *J Am Coll Cardiol.* 2005; 46(5):920-927.	Review/Other-Dx	957 patients	To hypothesize that regional function and myocardial perfusion are superior to the Thrombolysis In Myocardial Infarction (TIMI) score for diagnosis and prognostication in patients presenting to the ED with chest pain and a nondiagnostic ECG.	The modified TIMI score was unable to discriminate between intermediate- compared to high-risk patients at any follow-up time point, whereas only 2/523 patients with normal regional function had an early primary event. Regional function provided incremental prognostic value over modified TIMI scores for predicting intermediate and late events. In patients with abnormal regional function, myocardial perfusion further classified patients into intermediate- and high-risk groups. The full TIMI score could not improve upon these results at any follow-up time point.	4

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23. Kuhl HP, Hanrath P. The impact of transesophageal echocardiography on daily clinical practice. *Eur J Echocardiogr.* 2004; 5(6):455-468.	Review/Other-Dx	N/A	To review the impact of TEE in daily clinical practice and on possible future applications of the technique.	TEE has opened a new window to the heart. Its success rate is impressive. In less than two decades it has become an integral part of pediatric and adult cardiology as well as cardiac surgery and anesthesiology.	4
24. Peres M, Pitta Mda L, Alcaravela J, et al. Transesophageal echocardiography in an emergency setting. A district general hospital experience. *Rev Port Cardiol.* 2005; 24(7-8):971-979.	Review/Other-Dx	97 patients	To evaluate the benefits obtained by the use of TEE in an emergency setting.	The indications to perform TEE were: possible massive or submassive pulmonary thromboembolism in 32 patients (33.0%); suspected aortic dissection in 19 (19.6%); shock with inconclusive transthoracic echocardiogram in 10 (10.3%); possible endocarditis in 8 (8.2%); possible prosthetic valve dysfunction in 7 (7.2%); intracardiac mass in 6 (6.2%); search for cardiac source of embolism in 5 (5.2%); possible mechanical complication of acute MI in 4 (4.1%); pre-electrical cardioversion study in 4 patients with atrial fibrillation (4.1%); and suspected congenital heart disease in 2 (2.1%). TEE examination yielded additional information and helped in the therapeutic decision in 88 patients (90.7%), leading to a diagnosis in 49 (50.6%), which was different from the initial diagnostic hypothesis in 4, and exclusion of the suspected diagnosis in 39 (40.1%). There was only one minor complication (1.0%) and no TEE-related mortality.	4

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25. Hendel RC, Patel MR, Kramer CM, et al. ACCF/ACR/SCCT/SCMR/ASNC/NASCI /SCAI/SIR 2006 appropriateness criteria for cardiac computed tomography and cardiac magnetic resonance imaging: a report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American College of Radiology, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, American Society of Nuclear Cardiology, North American Society for Cardiac Imaging, Society for Cardiovascular Angiography and Interventions, and Society of Interventional Radiology. *J Am Coll Cardiol.* 2006; 48(7):1475-1497.	Review/Other-Dx	N/A	ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SC AI/SIR 2006 appropriateness criteria for cardiac CT and cardiac MRI. The reviews assessed the risks and benefits of the imaging tests for several indications or clinical scenarios.	N/A	4
26. Hoffmann U, Bamberg F, Chae CU, et al. Coronary computed tomography angiography for early triage of patients with acute chest pain: the ROMICAT (Rule Out Myocardial Infarction using Computer Assisted Tomography) trial. *J Am Coll Cardiol.* 2009; 53(18):1642-1650.	Observational-Dx	368 patients	To determine the usefulness of CCTA in patients with acute chest pain.	Among 368 patients (mean age 53 +/- 12 years, 61% men), 31 had ACS (8%). By CCTA, 50% of these patients were free of CAD, 31% had nonobstructive disease, and 19% had inconclusive or positive CT for significant stenosis. Sensitivity and NPV for ACS were 100% (n=183/368; 95% CI: 98% to 100%) and 100% (95% CI: 89% to 100%), respectively, with the absence of CAD 77% (95% CI: 59% to 90%) and 98% (n=300/368, 95% CI: 95% to 99%), respectively, with significant stenosis by CCTA. Specificity of presence of plaque and stenosis for ACS were 54% (95% CI: 49% to 60%) and 87% (95% CI: 83% to 90%), respectively. Only 1 ACS occurred in the absence of calcified plaque. Both the extent of coronary plaque and presence of stenosis predicted ACS independently and incrementally to Thrombolysis In Myocardial Infarction risk score (area under curve: 0.88, 0.82, vs 0.63, respectively; all P<0.0001).	2

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27. Gallagher MJ, Ross MA, Raff GL, Goldstein JA, O'Neill WW, O'Neil B. The diagnostic accuracy of 64-slice computed tomography coronary angiography compared with stress nuclear imaging in emergency department low-risk chest pain patients. *Ann Emerg Med.* 2007; 49(2):125-136.	Observational-Dx	92 patients	Prospective study to compare the accuracy of MD CCTA with stress nuclear imaging for the detection of an ACS or 30-day major adverse cardiac events in low-risk chest pain patients.	Of the 92 patients, 7 (8%) were excluded because of uninterpretable MDCT scans. Of the remaining 85 study patients (49+/-11 years, 53% men), 7 (8%) were found to have the target condition, with all having significant coronary stenosis (88%+/-9%) and none having MI or major adverse cardiac events during 30 days. Stress nuclear imaging results were negative in 72 (85%) patients, and MDCT results were negative in 73 (86%) patients. The sensitivity of stress nuclear imaging was 71% (95% CI 36% to 92%), and MDCT was 86% (95% CI 49% to 97%), and the specificity was 90% (95% CI 81% to 95%) and 92% (95% CI 84% to 96%), respectively. The NPV of stress nuclear imaging and MDCT was 97% (95% CI 90% to 99%) and 99% (95% CI 93% to 100%), respectively, and the PPV was 38% (95% CI 18% to 64%) and 50% (95% CI 25% to 75%), respectively.	2
28. Goldstein JA, Gallagher MJ, O'Neill WW, Ross MA, O'Neil BJ, Raff GL. A randomized controlled trial of multi-slice coronary computed tomography for evaluation of acute chest pain. *J Am Coll Cardiol.* 2007; 49(8):863-871.	Experimental-Dx	197 patients randomized to MSCT (n=99) vs standard of care (n=98)	To compare the safety, diagnostic efficacy, and efficiency of MSCT with standard diagnostic evaluation of low-risk acute chest pain patients.	Both approaches were completely (100%) safe. The MSCT alone immediately excluded or identified coronary disease as the source of chest pain in 75% of patients, including 67 with normal coronary arteries and 8 with severe disease referred for invasive evaluation. The remaining 25% of patients required stress testing, owing to intermediate severity lesions or nondiagnostic scans. During the index visit, MSCT evaluation reduced diagnostic time compared with standard of care (3.4 hours vs 15.0 hours, P<0.001) and lowered costs (1,586 dollars vs 1,872 dollars, P<0.001). Importantly, MSCT patients required fewer repeat evaluations for recurrent chest pain (MSCT, 2/99 (2.0%) patients vs standard of care, 7/99 (7%) patients; P=0.10).	2

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29. Hoffmann U, Nagurney JT, Moselewski F, et al. Coronary multidetector computed tomography in the assessment of patients with acute chest pain. *Circulation.* 2006; 114(21):2251-2260.	Observational-Dx	103 patients	Prospective study was performed in patients presenting with acute chest pain to the ED between May and July 2005 who were admitted to the hospital to rule out ACS with no ischemic ECG changes and negative initial biomarkers.	Among 103 consecutive patients (40% female; mean age, 54+/-12 years), 14 patients had ACS. Both the absence of significant coronary artery stenosis (73/103 patients) and nonsignificant coronary atherosclerotic plaque (41/103 patients) accurately predicted the absence of ACS (NPVs, 100%). Multivariate logistic regression analyses demonstrated that adding the extent of plaque significantly improved the initial models containing only traditional risk factors or clinical estimates of the probability of ACS (c statistic, 0.73 to 0.89 and 0.61 to 0.86, respectively). Noninvasive assessment of CAD by MDCT has good performance characteristics for ruling out ACS in subjects presenting with possible myocardial ischemia to the ED and may be useful for improving early triage.	2
30. Hoffmann U, Pena AJ, Cury RC, et al. Cardiac CT in emergency department patients with acute chest pain. *Radiographics.* 2006; 26(4):963-978; discussion 979-980.	Review/Other-Dx	N/A	Review cardiac CT protocols of patients with acute chest pain in the ED.	While 64-section MDCT has the potential to image the coronary arteries, aorta, and pulmonary arteries in a single scan, further studies are necessary to test the accuracy of this protocol.	4
31. Kuettner A, Trabold T, Schroeder S, et al. Noninvasive detection of coronary lesions using 16-detector multislice spiral computed tomography technology: initial clinical results. *J Am Coll Cardiol.* 2004; 44(6):1230-1237.	Observational-Dx	60 patients	To evaluate the feasibility of detecting coronary artery lesions using a new CT scanner with 16 detectors and faster gantry rotation.	Calcium scoring was successful in all patients; 58/60 patients had a diagnostic contrast-enhanced scan. Mean calcium score was 506 +/- 743 Agatston score equivalent; 13/58 (22%) patients had an ASE ≥1,000, 46/58 (78%) patients <1,000. In 763 coronary segments, CCTA detected a total of 75 lesions ≥50%. The MSCT correctly assessed 54 of these. 21 lesions were missed or incorrectly underestimated. Sensitivity was 72%, specificity 97%. When restricting analysis to patients with an Agatston score equivalent <1,000, 40 significant lesions ≥50% were seen on CCTA, and MSCT correctly detected 39 lesions (sensitivity 98%, specificity 98%). Regardless of any threshold, the correct clinical diagnosis could be obtained in 58/60 (97%) of all patients.	3

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	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
32.	Mochizuki T, Hosoi S, Higashino H, Koyama Y, Mima T, Murase K. Assessment of coronary artery and cardiac function using multidetector CT. *Semin Ultrasound CT MR.* 2004; 25(2):99-112.	Review/Other-Dx	N/A	To review the potential benefits of the cardiac application of MDCT in the assessment of coronary artery and cardiac function, such as wall motion and systolic thickening.	By applying retrospective ECG-gating, 10 phases throughout 1 cardiac cycle are extracted for functional analysis. Animated movies are generated by paging through these 2D and 3D images in cardiac phase order. LV end-diastolic volume, end-systolic volume, and ejection fraction can also be generated. Using the data acquired during a single breath hold, coronary artery and cardiac function can be assessed by MDCT.	4
33.	Rubinshtein R, Halon DA, Gaspar T, et al. Usefulness of 64-slice multidetector computed tomography in diagnostic triage of patients with chest pain and negative or nondiagnostic exercise treadmill test result. *Am J Cardiol.* 2007; 99(7):925-929.	Observational-Dx	100 patients	To examine the usefulness of 64-slice MDCT in a diagnostic triage of 100 consecutive patients (age 55.8+/-11.6 years; 57% men) with chest pain suspected to be ischemic in origin and a negative or nondiagnostic exercise treadmill test.	MDCT showed obstructive (≥50%) CAD in 29 patients; 13/59 patients (22%) with a negative and 16/41 patients (39%) with a nondiagnostic exercise treadmill test result. High-risk (left main and/or 3-vessel) CAD was present in 3.3% of patients with a negative and 4.9% with a nondiagnostic exercise treadmill test result. The 29 patients with obstructive CAD on MDCT had a higher mean Agatston calcium score (221+/-402 vs 40+/-77 U, P<0.001). Invasive coronary angiography confirmed MDCT findings in 26/29 patients (PPV 90%) and 45/54 stenotic segments (83%) in a per-segment analysis. For the 71 patients without obstructive CAD on MDCT, clinically driven invasive angiography detected CAD in 1/15 patients (1 false-negative MDCT result) and 2 of another 5 patients who were referred for invasive angiography later during a 12-month follow-up period. In the remaining 51 patients, MDCT findings effectively allowed exclusion of obstructive CAD, and there were no major adverse clinical events during follow-up.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
34. Stanford W, Thompson BH, Weiss RM. Coronary artery calcification: clinical significance and current methods of detection. *AJR Am J Roentgenol.* 1993; 161(6):1139-1146.	Review/Other-Dx	N/A	Review clinical significance and current methods of detection of coronary artery calcification.	Many imaging techniques can be used to detect calcification of coronary arteries. The most promising are fluoroscopy, ultrafast CT, and intravascular sonography. Detection of calcification is most valuable in persons less than 40 years old in whom modification of risk factors may be important. In addition, the progression and possible regression of calcification can be used as an indicator of the atherosclerotic process. The absence of calcification in coronary arteries may diminish the need for further testing.	4
35. Stillman AE, Oudkerk M, Ackerman M, et al. Use of multidetector computed tomography for the assessment of acute chest pain: a consensus statement of the North American Society of Cardiac Imaging and the European Society of Cardiac Radiology. *Eur Radiol.* 2007; 17(8):2196-2207.	Review/Other-Dx	N/A	A consensus statement on the use of MDCT for the assessment of acute chest pain.	In patients with chest pain whose history, clinical findings and/or predisposing conditions suggest other life-threatening diseases, specifically acute aortic syndrome or pulmonary embolism, MDCT is proven to be the diagnostic study of choice.	4
36. Goldstein JA, Chinnaiyan KM, Abidov A, et al. The CT-STAT (Coronary Computed Tomographic Angiography for Systematic Triage of Acute Chest Pain Patients to Treatment) trial. *J Am Coll Cardiol.* 2011; 58(14):1414-1422.	Experimental-Dx	699 patients randomized to CCTA (n=361) or MPI (n=338)	To compare the efficiency, cost, and safety of a diagnostic strategy employing early CCTA to a strategy employing rest-stress MPI in the evaluation of acute low-risk chest pain.	The CCTA resulted in a 54% reduction in time to diagnosis compared with MPI (median 2.9 h [25th to 75th percentile: 2.1 to 4.0 h] vs 6.3 h [25th to 75th percentile: 4.2 to 19.0 h], P<0.0001). Costs of care were 38% lower compared with standard (median $2,137 [25th to 75th percentile: $1,660 to $3,077] vs $3,458 [25th to 75th percentile: $2,900 to $4,297], P<0.0001). The diagnostic strategies had no difference in major adverse cardiac events after normal index testing (0.8% in the CCTA arm vs 0.4% in the MPI arm, P=0.29).	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Hoffmann U, Truong QA, Schoenfeld DA, et al. Coronary CT angiography versus standard evaluation in acute chest pain. *N Engl J Med.* 2012; 367(4):299-308.	Experimental-Dx	1,000 patients randomized to CCTA (n=501) and standard evaluation (n=499)	To compare the effectiveness of a CCTA-based evaluation strategy with that of standard evaluation in the ED for patients with symptoms suggestive of an ACS and to evaluate the downstream testing, cost, and radiation exposure associated with CCTA.	The rate of ACSs among 1,000 patients with a mean (± standard deviation) age of 54 ± 8 years (47% women) was 8%. After early CCTA, as compared with standard evaluation, the mean length of stay in the hospital was reduced by 7.6 hours (P<0.001) and more patients were discharged directly from the ED (47% vs 12%, P<0.001). There were no undetected ACSs and no significant differences in major adverse cardiovascular events at 28 days. After CCTA, there was more downstream testing and higher radiation exposure. The cumulative mean cost of care was similar in the CCTA group and the standard evaluation group ($4,289 and $4,060, respectively; P=0.65).	3
38. Litt HI, Gatsonis C, Snyder B, et al. CT angiography for safe discharge of patients with possible acute coronary syndromes. *N Engl J Med.* 2012; 366(15):1393-1403.	Experimental-Dx	1,370 patients: 908 in the CCTA group and 462 in the group receiving traditional care	To determine the safety and efficiency of a CCTA-based strategy. The study compared a CCTA-based strategy with traditional "rule out" approaches for low-to-intermediate-risk patients presenting to the ED with chest pain and possible ACS.	Of 640 patients with a negative CCTA examination, none died or had a MI within 30 days (0%; 95% CI, 0 to 0.57). As compared with patients receiving traditional care, patients in the CCTA group had a higher rate of discharge from the ED (49.6% vs 22.7%; difference, 26.8 percentage points; 95% CI, 21.4 to 32.2), a shorter length of stay (median, 18.0 hours vs 24.8 hours; P<0.001), and a higher rate of detection of coronary disease (9.0% vs 3.5%; difference, 5.6 percentage points; 95% CI, 0 to 11.2). There was one serious adverse event in each group.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
39. Marwan M, Pflederer T, Schepis T, et al. Accuracy of dual-source CT to identify significant coronary artery disease in patients with uncontrolled hypertension presenting with chest pain: comparison with coronary angiography. *Int J Cardiovasc Imaging.* 2012; 28(5):1173-1180.	Observational-Dx	260 consecutive patients	To investigate the sensitivity and specificity of dual-source CT to detect and rule out significant CAD in patients presenting with uncontrolled hypertension accompanied by chest pain.	On a per patient basis, the sensitivity and specificity for dual-source CT to detect significant CAD in vessels >1.5 mm diameter was 100% (36/36, 95% CI, 90-100) and 90% (47/52, 95% CI, 79-97), respectively with a NPV of 100% (47/47, 95% CI, 92-100) and a PPV of 88% (36/41, 95% CI, 74-96). On a per artery basis, 352 vessels were evaluated (left main, left anterior descending, left circumflex and right coronary artery in 88 patients, 12 vessels could not be assessed due to either motion artifacts or heavy calcification and were considered positive for stenoses) with a sensitivity of 84% (54/64, 95% CI, 72-95) and specificity of 94% (272/288, 95% CI, 88-100); NPV was 96% (272/282, 95% CI, 90-100) and PPV was 77% (54/70, 95% CI, 62-91).	3
40. Takakuwa KM, Keith SW, Estepa AT, Shofer FS. A meta-analysis of 64-section coronary CT angiography findings for predicting 30-day major adverse cardiac events in patients presenting with symptoms suggestive of acute coronary syndrome. *Acad Radiol.* 2011; 18(12):1522-1528.	Review/Other-Dx	9 studies (1,559 patients)	To determine the accuracy of 64-section CCTA in predicting 30 day major adverse cardiac events for patients presenting with symptoms concerning for ACS.	Patients ranged from low to intermediate risk for ACS. All had initial inconclusive ECGs and negative cardiac biomarker results. A total of 14.8% of patients had a positive CCTA result. The pooled sensitivity was 93.3% (95% CI, 88.3%-96.6%), specificity was 89.9% (95% CI, 88.3%-91.3%), PPV was 48.1% (95% CI, 42.5%-53.8%), and NPV was 99.3% (95% CI, 98.7%-99.6%). 64-section CCTA had a 99.3% NPV in excluding major adverse cardiac events for 30 days after initial symptom presentation in 85.2% of our study population. Although the value of 64-section CCTA is best for identifying patients who can safely be discharged home, it is less useful for patients who have positive results.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
41. van Velzen JE, de Graaf FR, Kroft LJ, et al. Performance and efficacy of 320-row computed tomography coronary angiography in patients presenting with acute chest pain: results from a clinical registry. *Int J Cardiovasc Imaging.* 2012; 28(4):865-876.	Observational-Dx	106 patients	To evaluate the performance of 320-row CTA in the identification of significant CAD in patients presenting with acute chest pain and to examine the relation to outcome during follow-up.	Among the 106 patients, 23 patients (22%) had a normal CTA, 19 patients (18%) had nonsignificant CAD on CTA, 59 patients (55%) had significant CAD on CTA, and 5 patients (5%) had nondiagnostic image quality. In total, 16 patients (15%) were immediately discharged after normal CTA and 90 patients (85%) underwent invasive coronary angiography. Sensitivity, specificity, and PPV and NPV to detect significant CAD on CTA were 100%, 87%, 93%, and 100%, respectively. During mean follow-up of 13.7 months, no cardiovascular events occurred in patients with a normal CTA examination. In patients with nonsignificant CAD on CTA, no cardiac death or MIs occurred and only 1 patient underwent revascularization due to unstable angina. In patients presenting with acute chest pain, an excellent clinical performance for the noninvasive assessment of significant CAD was demonstrated using CTA. Importantly, normal or nonsignificant CAD on CTA predicted a low rate of adverse cardiovascular events and favorable outcome during follow-up.	3
42. White CS, Kuo D, Kelemen M, et al. Chest pain evaluation in the emergency department: can MDCT provide a comprehensive evaluation? *AJR Am J Roentgenol.* 2005; 185(2):533-540.	Observational-Dx	69 patients	To determine whether MDCT can provide a comprehensive assessment of cardiac and noncardiac causes of chest pain in stable ED patients.	69 patients met all criteria for enrollment in the study, of whom 45 (65%) would not otherwise have undergone CT. 52 patients (75%) had no significant CT findings and a final diagnosis of clinically insignificant chest pain. 13 patients (19%) had significant CT findings (cardiac, 10; noncardiac, 3) concordant with the final diagnosis. CT failed to suggest a diagnosis in 2 patients (3%), both of whom proved to have clinically significant coronary artery stenoses. In 2 patients (3%), CT overdiagnosed a coronary stenosis. Sensitivity and specificity for the establishment of a cardiac cause of chest pain were 83% and 96%, respectively. Overall sensitivity and specificity for all other cardiac and noncardiac causes were 87% and 96%, respectively.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
43. Urbania TH, Hope MD, Huffaker SD, Reddy GP. Role of computed tomography in the evaluation of acute chest pain. *J Cardiovasc Comput Tomogr.* 2009; 3(1 Suppl):S13-22.	Review/Other-Dx	N/A	To explore the role of CT in the evaluation of acute chest pain. The discussion focuses on 3 life-threatening causes of chest pain: aortic dissection, pulmonary embolism, and ACS.	CT is an effective tool for the assessment of chest pain in the acute setting. It is fast, available, and safe.	4
44. Chang AM, Le J, Matsuura AC, Litt HI, Hollander JE. Does coronary artery calcium scoring add to the predictive value of coronary computed tomography angiography for adverse cardiovascular events in low-risk chest pain patients? *Acad Emerg Med.* 2011; 18(10):1065-1071.	Observational-Dx	1,049 patients	To assess if CAC score = 0 determines freedom from CAD and whether the addition of coronary angiography calcium score to coronary CTA provides additional risk stratification information or helps predict 30-day cardiovascular outcomes.	Of 1,049 total patients, 17/795 (2.1%) with coronary angiography calcium score of 0 had CAD, 16/169 patients (9.5%) with CAC score of 0.1 to 99 had CAD, 53.3% (32/60) with CAC score between 100 and 399 had CAD, and 10/23 (43.5%) with coronary angiography calcium score ≥400 had CAD. There was a higher likelihood of significant CAD with increased coronary angiography calcium score. Patients who had a calcium score of 0 but still had CAD were more likely to be young (50 years old or less; RR = 1.73, 95% CI, 1.01 to 2.96). For the secondary outcome, there were 15 cardiovascular events within 30 days: one patient with CAC score =0 and no CAD (1/733; 0.1%), one patient with CAC score >0 and no CAD (1/182; 0.5%), 4 patients with coronary angiography calcium score =0 and CAD (4/17; 23.5%), and 9 patients with coronary angiography calcium score >0 and CAD (9/58; 15.5%), with a net reclassification index of -0.001 (P=0.32).	3
45. Laudon DA, Behrenbeck TR, Wood CM, et al. Computed tomographic coronary artery calcium assessment for evaluating chest pain in the emergency department: long-term outcome of a prospective blind study. *Mayo Clin Proc.* 2010; 85(4):314-322.	Observational-Dx	263 patients	To determine the long-term outcome of CT quantification of CAC used as a triage tool for patients presenting with chest pain to an ED.	Of the 263 study patients, 133 (51%) had a CAC score of zero. This absence of CAC correlated strongly with the likelihood of noncardiac chest pain. Among 133 patients with a CAC score of zero, only 1 (<1%) had cardiac chest pain. Conversely, of the 31 patients shown to have cardiac chest pain, 30 (97%) had evidence of CAC on CT. When a CAC cutoff score of 36 was used, as suggested by receiver operating characteristic analysis, sensitivity was 90%; specificity, 85%; PPV, 44%; and NPV, 99%. During long-term follow-up, patients without CAC experienced no cardiac events at 30 days, 1 year, and 5 years.	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Gerber TC, Kantor B, McCollough CH. Radiation dose and safety in cardiac computed tomography. *Cardiol Clin.* 2009; 27(4):665-677.	Review/Other-Dx	N/A	To review the existing data regarding biologic hazards of radiation exposure associated with medical diagnostic testing, the methodologies used to estimate radiation exposure and dose, and the measures that can be taken to effectively reduce that exposure.	The risk of causing a malignancy at the radiation dose levels used in cardiac imaging is hypothetical, not proven, and estimates of radiation dose have a wide margin of error. However, in the absence of certainty, the consensus opinions of influential expert panels advocate adopting a conservative estimate of radiation risks.	4
47. Earls JP, Berman EL, Urban BA, et al. Prospectively gated transverse coronary CT angiography versus retrospectively gated helical technique: improved image quality and reduced radiation dose. *Radiology.* 2008; 246(3):742-753.	Observational-Dx	203 patients	To retrospectively compare image quality, radiation dose, and blood vessel assessability for CCTA obtained with a prospectively gated transverse CT technique and a retrospectively gated helical CT technique.	The mean effective dose for the group with the prospectively gated transverse technique was 2.8 mSv; this represents an 83% reduction as compared with that for the group with the retrospectively gated helical technique (mean, 18.4 mSv; P<.001). The image quality score for each of the arteries, as well as the overall combined score, was significantly greater for images obtained with prospectively gated transverse technique than for images obtained with retrospectively gated helical technique. The combined mean image quality score was 4.791 for images obtained with prospectively gated transverse technique vs 4.514 for images obtained with retrospectively gated helical technique (proportional odds model OR, 2.8; 95% CI: 1.7, 4.8). The percentage of assessable coronary artery segments was 98.6% (1,196/1,213) for images obtained with prospectively gated transverse technique vs 97.9% (1,741/1,778) for images obtained with retrospectively gated helical technique (P=.83).	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
48. Husmann L, Valenta I, Gaemperli O, et al. Feasibility of low-dose coronary CT angiography: first experience with prospective ECG-gating. *Eur Heart J.* 2008; 29(2):191-197.	Observational-Dx	41 consecutive patients	To determine the feasibility of prospective ECG-gating to achieve low-dose CCTA.	Mean effective radiation dose was 2.1 +/- 0.6 mSv (range, 1.1-3.0 mSv). Image quality was inversely related to heart rate (57.3 +/- 6.2, range 39-66 b.p.m.; r = 0.58, P<0.001), vessel attenuation (346 +/- 104, range 110-780 HU; r = 0.56, P<0.001), and body mass index (26.1 +/- 4.0, range 19.1-36.3 kg/m(2); r = 0.45, P<0.001), but not to heart rate variability (1.5 +/- 1.0, range 0.2-5.1 b.p.m.; r = 0.28, P=0.069). Non-diagnostic CCTA image quality was found in 5.0% of coronary segments. However, below a heart rate of 63 b.p.m. (n=28), as determined by receiver-operator characteristic, only 1.1% of coronary segments were non-diagnostic compared with 14.8% with heart rate of >63 b.p.m. (P<0.001).	3
49. Stolzmann P, Leschka S, Scheffel H, et al. Dual-source CT in step-and-shoot mode: noninvasive coronary angiography with low radiation dose. *Radiology.* 2008; 249(1):71-80.	Observational-Dx	40 patients	To prospectively investigate CT image quality parameters by using different protocols and to calculate radiation dose estimates for noninvasive coronary angiography performed with dual-source CT in the step-and-shoot mode.	Mean image noise was similar with protocols A and B. Mean attenuation in the aorta and coronary arteries with protocol A (444 HU) was significantly (P<.001) higher than that with protocol B (358 HU). The reduced contrast material dose in protocol C yielded attenuation similar to that with protocol B. Diagnostic image quality was achieved with all protocols in 1,237 (97.9%) of 1,264 coronary segments. No significant differences in image quality between the 100- and 120-kV protocols were found. Mean heart rate had a significant effect on motion artifacts (AUC = 0.818; 95% CI: 0.723, 0.892; P<.001), whereas heart rate variability had a significant effect on stair-step artifacts (AUC = 0.79; 95% CI: 0.687, 0.865; P<.001). The mean estimated effective dose was 1.2 mSv +/- 0.2 for protocols A and C and 2.6 mSv +/- 0.5 for protocol B.	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
50. Leipsic J, Labounty TM, Heilbron B, et al. Estimated radiation dose reduction using adaptive statistical iterative reconstruction in coronary CT angiography: the ERASIR study. *AJR Am J Roentgenol.* 2010;195(3):655-660.	Observational-Dx	574 consecutive patients	Prospectively evaluate patients undergoing CCTA at 3 centers to assess the impact of Adaptive Statistical Iterative Reconstruction (ASIR) on radiation dose and study quality for CCTA. Comparisons were performed between consecutive groups initially using filtered back projection (n = 331) and subsequently ASIR (n = 243) with regard to patient and scan characteristics, radiation dose, and diagnostic study quality.	There was no difference between groups in the use of prospective gating, tube voltage, or scan length. The examinations performed using ASIR had a lower median tube current than those obtained using filtered back projection (median [interquartile range], 450 mA [350–600] vs 650 mA [531–750], respectively; P<0.001). There was a 44% reduction in the median radiation dose between the filtered back projection and ASIR cohorts (4.1 mSv [2.3–5.2] vs 2.3 mSv [1.9–3.5]; P<0.001). After adjustment for scan settings, ASIR was associated with a 27% reduction in radiation dose compared with filtered back projection (95% CI, 21%–32%; P<0.001). Despite the reduced current, ASIR was not associated with a difference in adjusted signal, noise, or signal-to-noise ratio (P=not significant). No differences existed between filtered back projection and ASIR for interpretability per coronary artery (98.5% vs 99.3%, respectively; P=0.12) or per patient (96.1% vs 97.1%, P=0.65). ASIR enabled reduced tube current and lower radiation dose in comparison with filtered back projection, with preserved signal, noise, and study interpretability, in a large multicenter cohort. ASIR represents a new technique to reduce radiation dose in CCTA studies.	3
51. Achenbach S, Marwan M, Ropers D, et al. Coronary computed tomography angiography with a consistent dose below 1 mSv using prospectively electrocardiogram-triggered high-pitch spiral acquisition. *Eur Heart J.* 2010; 31(3):340-346.	Observational-Dx	50 consecutive patients	To evaluate the feasibility and image quality of a new scan mode for CCTA with an effective dose of <1 mSv.	In all 50 patients, imaging was successful. Mean duration of data acquisition was 258 +/- 20 ms. Mean dose-length product was 62 +/- 5 mGy cm, the effective dose was 0.87 +/- 0.07 mSv (0.78-0.99 mSv). Of the 742 coronary artery segments, 94% had an image quality score of 1, 5.0% a score of 2, 0.9% a score of 3, and 4 segments (0.5%) were 'uninterpretable'. In non-obese patients with a low and stable heart rate, prospectively ECG-triggered high-pitch spiral CCTA provides excellent image quality at a consistent dose below 1.0 mSv.	3

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	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
52.	Osborne AD, Moore B, Ross MA, Pitts SR. The feasibility of Rubidium-82 positron emission tomography stress testing in low-risk chest pain protocol patients. *Crit Pathw Cardiol.* 2011; 10(1):41-43.	Review/Other-Dx	1,177 patients received PET imaging	To evaluate the feasibility of dipyridamole-induced reversible ischemia on myocardial perfusion PET imaging using Rubidium-82 to predict the presence of ACS in ED chest pain patients at low risk who were admitted to an observation unit.	There were 7,691 ED visits for chest pain. Among these patients, 1,177 had a Rubidium-82 PET. 54 (4.6%) of these patients had an abnormal or probably abnormal scan. Of these, 28 had catheter-proven significant coronary disease, requiring either revascularization or intensive medical management; 22 patients had ACS by clinical assessment but did not undergo catheterization. Four had no CAD on catheterization.	4
53.	Gropler RJ. Imaging to distinguish between viable and nonviable myocardium: pathophysiologic basis and importance of positron emission tomography. *AJR Am J Roentgenol.*1993; 161(3):497-500.	Review/Other-Dx	N/A	To review the pathophysiologic characteristics of viable and nonviable myocardium and discuss the diagnostic methods that exploit these characteristics for the purposes of detecting viable myocardium.	Thallium-201 myocardial scintigraphy is probably the current routine clinical method of choice for detecting viable myocardium because of its widespread availability and extensive clinical experience.	4
54.	Steel K, Broderick R, Gandla V, et al. Complementary prognostic values of stress myocardial perfusion and late gadolinium enhancement imaging by cardiac magnetic resonance in patients with known or suspected coronary artery disease. *Circulation.* 2009; 120(14):1390-1400.	Observational-Dx	254 patients	To hypothesize that because CMR MPI and late gadolinium enhancement describe different aspects of CAD, combining the diagnostic information of CMR MPI and late gadolinium enhancement can provide incremental prognostic association with adverse cardiac events during follow-up.	At a median follow-up of 17 months, 49 cardiac events occurred, including 12 cardiac deaths, 16 acute MIs, and 21 cardiac hospitalizations. Reversible perfusion defect and late gadolinium enhancement both maintained a 3-fold association with cardiac death or acute MI (death/MI) when adjusted for each other and for the effects of patient age and gender (adjusted HR, 3.31; P=0.02; and HR, 3.43; P=0.01, respectively). In patients without a history of MI who had negative reversible perfusion defect, late gadolinium enhancement presence was associated with a 11-fold hazards increase in death/MI. Patients with neither reversible perfusion defect nor late gadolinium enhancement had a 98.1% negative annual event rate for death/MI. For association with major adverse cardiac events, reversible perfusion defect was the strongest multivariable variable in the best overall model (HR, 10.92; P=0.0001).	3

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	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
55.	Vogel-Claussen J, Skrok J, Dombroski D, et al. Comprehensive adenosine stress perfusion MRI defines the etiology of chest pain in the emergency room: Comparison with nuclear stress test. *J Magn Reson Imaging.* 2009; 30(4):753-762.	Observational-Dx	31 patients	To compare standard of care nuclear SPECT imaging with CMR for ED patients with chest pain and intermediate probability for CAD.	Of 27 patients, 8 (30%) showed subendocardial hypoperfusion on CMR that was not detected on SPECT. These patients had a higher rate of diabetes (P=0.01) and hypertension (P=0.01) and a lower global myocardial perfusion reserve (P=0.01) compared with patients with a normal CMR (n=10). Patients with subendocardial hypoperfusion had more risk factors for cardiovascular disease (mean 4.4) compared with patients with a normal CMR (mean 2.5; P=0.005). During the follow-up period, patients with subendocardial hypoperfusion on stress MRI were more likely to return to the ED with chest pain compared with patients who had a normal CMR (P=0.02). Four patients did not finish the MRI examination due to claustrophobia.	2
56.	Lerakis S, McLean DS, Anadiotis AV, et al. Prognostic value of adenosine stress cardiovascular magnetic resonance in patients with low-risk chest pain. *J Cardiovasc Magn Reson.* 2009; 11:37.	Observational-Dx	103 patients	To evaluate the negative prognostic value of adenosine stress-CMR among low-risk acute chest pain patients.	In 14 patients (13.6%), adenosine stress-CMR was positive. The remaining 89 patients (86.4%), who had negative adenosine stress-CMR, were discharged. No patient with negative adenosine stress-CMR reached the primary end-point during follow-up. The NPV of adenosine stress-CMR was 100%.	4
57.	Miller CD, Hoekstra JW, Lefebvre C, et al. Provider-directed imaging stress testing reduces health care expenditures in lower-risk chest pain patients presenting to the emergency department. *Circ Cardiovasc Imaging.* 2012; 5(1):111-118.	Experimental-Dx	120 patients randomized to CMR stress imaging test (n=60) or a provider-selected stress test (n=60)	To compare 2 observation unit strategies to determine among lower-risk patients if a mandatory CMR stress test strategy was more effective than a physicians' ability to select a stress test modality.	On ED arrival and referral to the observation unit for management of low- to intermediate-risk chest pain, 120 individuals were randomly assigned to receive (1) a CMR stress imaging test (n=60) or (2) a provider-selected stress test (n=60: stress echo [62%], CMR [32%], cardiac catheterization [3%], nuclear [2%], and coronary CT [2%]). No differences were detected in length of stay (median CMR=24.2 hours vs 23.8 hours, P=0.75), catheterization without revascularization (CMR=0% vs 3%), appropriateness of admission decisions (CMR 87% vs 93%, P=0.36), or 30-day ACS (both 3%). Median cost was higher among those randomly assigned to the CMR-mandated group ($2005 vs $1686, P<0.001).	2

Chest Pain Suggestive of Acute Coronary Syndrome
EVIDENCE TABLE

	Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
58.	Cury RC, Shash K, Nagurney JT, et al. Cardiac magnetic resonance with T2-weighted imaging improves detection of patients with acute coronary syndrome in the emergency department. *Circulation.* 2008;118(8):837-844.	Observational-Dx	62 patients	To evaluate a CMR protocol that includes T2-weighted imaging and assessment of left ventricular wall thickness in detecting patients with ACS in the emergency department.	Among 62 patients, 13 developed ACS during the index hospitalization. The mean CMR time was 32 +/- 8 minutes. The new CMR protocol (with the addition of T2-weighted and left ventricular wall thickness) increased the specificity, PPV, and overall accuracy from 84% to 96%, 55% to 85%, and 84% to 93%, respectively, compared with the conventional CMR protocol (cine, perfusion, and delayed-enhancement MRI). Moreover, in a logistic regression analysis that contained information on clinical risk assessment (c-statistic=0.695) and traditional cardiac risk factors (c-statistic=0.771), the new CMR protocol significantly improved the c-statistic to 0.958 (P<0.0001).	2
59.	Miller CD, Case LD, Little WC, et al. Stress CMR reduces revascularization, hospital readmission, and recurrent cardiac testing in intermediate-risk patients with acute chest pain. *JACC Cardiovasc Imaging.* 2013;6(7):785-794.	Experimental-Dx	105 patients	To determine the effect of stress CMR imaging in an observation unit on revascularization, hospital readmission, and recurrent cardiac testing in intermediate-risk patients with possible ACS.	Index hospital admission was avoided in 85% of the observation unit CMR participants. The primary outcome occurred in 20 usual care participants (38%) vs 7 observation unit CMR participants (13%) (HR: 3.4; 95% CI: 1.4 to 8.0, P=0.006). The observation unit CMR group experienced significant reductions in all components: revascularizations (15% vs 2%, P=0.03), hospital readmissions (23% vs 8%, P=0.03), and recurrent cardiac testing (17% vs 4%, P=0.03). Median length of stay was 26 hours (interquartile range: 23 to 45 hours) in the usual care group and 21 hours (interquartile range: 15 to 25 hours) in the observation unit CMR group (P<0.001). ACS after discharge occurred in 3 usual care participants (6%) and no observation unit CMR participants.	2

Chest Pain Suggestive of Acute Coronary Syndrome
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
60. Miller CD, Hwang W, Case D, et al. Stress CMR imaging observation unit in the emergency department reduces 1-year medical care costs in patients with acute chest pain: a randomized study for comparison with inpatient care. *JACC Cardiovasc Imaging.* 2011;4(8):862-870.	Experimental-Dx	109 patients	To compare the direct cost of medical care and clinical events during the first year after patients with intermediate risk acute chest pain were randomized to stress CMR observation unit testing vs inpatient care.	At 1 year, 6% of observation unit-CMR and 9% of inpatient care participants experienced a major cardiac event (P=0.72) with 1 patient in each group experiencing a cardiac event after discharge. First-year cardiac-related costs were significantly lower for participants randomized to observation unit-CMR than for participants receiving inpatient care (geometric mean $3,101 vs $4,742 including the index visit [P=0.004] and $29 vs $152 following discharge [P=0.012]). During the year following randomization, 6% of observation unit-CMR and 9% of inpatient care participants experienced a major cardiac event (P=0.72).	3
61. Bluemke DA, Achenbach S, Budoff M, et al. Noninvasive coronary artery imaging: magnetic resonance angiography and multidetector computed tomography angiography: a scientific statement from the american heart association committee on cardiovascular imaging and intervention of the council on cardiovascular radiology and intervention, and the councils on clinical cardiology and cardiovascular disease in the young. *Circulation.* 2008; 118(5):586-606.	Review/Other-Dx	N/A	Discuss and summarize two noninvasive modalities, MRA and CTA, which may be used for coronary artery evaluation.	Noninvasive coronary CTA and MRA represent substantial advances that may ultimately be valuable for diagnosis of significant CAD. The chief advantages of coronary CTA compared with MRA are wider availability, higher spatial resolution, and more consistent, shorter examinations with better patient adherence. Advantages associated with coronary MRA are a lack of ionizing radiation and a lack of administration of iodinated contrast material. Both tests are presently suboptimal for patients with atrial fibrillation and other arrhythmias, and image quality may be further reduced by high body mass.	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1*   The study is well-designed and accounts for common biases.

- *Category 2*   The study is moderately well-designed and accounts for most common biases.

- *Category 3*   There are important study design limitations.

- *Category 4*   The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:

  a)   the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  b)   the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  c)   the study is an expert opinion or consensus document.

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

ACS = Acute coronary syndrome

AUC = Area under receiver operating characteristic curve

CAC = Coronary artery calcium

CAD = Coronary artery disease

CCTA = Coronary computed tomography angiography

CI = Confidence interval

CK = Creatine kinase

CMR = Cardiovascular magnetic resonance

CT = Computed tomography

CTA = Computed tomography angiography

ECG = Electrocardiogram

ED = Emergency department

HR = Hazard ratio

LV = Left ventricular

MDCT = Multidetector computed tomography

MI = Myocardial infarction

MPI = Myocardial perfusion imaging

MRI = Magnetic resonance imaging

MSCT = Multi-slice computed tomography

NPV = Negative predictive value

OR = Odds ratio

PET = Positron emission tomography

PPV = Positive predictive value

RR = Relative risk

SPECT = Single-photon emission tomography

TEE = Transesophageal echocardiography