

Chronic Chest Pain-Noncardiac Etiology Unlikely: Low to Intermediate Probability of Coronary Artery Disease

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Ferencik M, Schlett CL, Bamberg F, et al. Comparison of traditional cardiovascular risk models and coronary atherosclerotic plaque as detected by computed tomography for prediction of acute coronary syndrome in patients with acute chest pain. Acad Emerg Med. 2012;19(8):934-942.	Observational-Dx	368 patients	To determine the association of four clinical risk scores and coronary plaque burden as detected by computed tomography (CT) with the outcome of acute coronary syndrome (ACS) in patients with acute chest pain. The hypothesis was that the combination of risk scores and plaque burden improved the discriminatory capacity for the diagnosis of ACS	Among 368 subjects, 31 (8%) subjects were diagnosed with ACS. Goldman (AUC = 0.61), Sanchis (AUC = 0.71), and TIMI (AUC = 0.63) had modest discriminatory capacity for the diagnosis of ACS. Plaque burden was the strongest predictor of ACS (AUC = 0.86; $p < 0.05$ for all comparisons with individual risk scores). The combination of plaque burden and risk scores improved prediction of ACS (plaque + Goldman AUC = 0.88, plaque + Sanchis AUC = 0.90, plaque + TIMI AUC = 0.88; $p < 0.01$ for all comparisons with coronary plaque burden alone).	2
2. Fernandez-Friera L, Garcia-Alvarez A, Guzman G, Garcia MJ. Coronary CT and the coronary calcium score, the future of ED risk stratification?. [Review]. Curr Cardiol Rev. 8(2):86-97, 2012 May.	Review/Other-Tx	N/A	To review the role of coronary artery calcium score and the coronary computed tomography in the assessment of individual coronary risk and their usefulness in the emergency department in facilitating appropriate disposition decision and discusses the evidence base and clinical applications for both techniques, together with cost-effectiveness and radiation exposure considerations.	No results stated in the abstract	4
3. Bom MJ, Van der Zee PM, Van der Zant FM, Knol RJ, Cornel JH. Independent prognostic value of coronary artery calcium score and coronary computed tomography angiography in an outpatient cohort of low to intermediate risk chest pain patients. Neth Heart J. 2016;24(5):332-342.	Observational-Dx	1551 patients	To evaluate the prognostic value of coronary computed tomography angiography (CCTA) and the coronary artery calcium score (CACs).	MACE occurred in 23 patients (1.5%): death (3, 0.2%), myocardial infarction (4, 0.3%) and late revascularisation (16, 1.3%). Multivariate analysis showed an independent prognostic value of CCTA ($p < 0.001$), CACS of 100-400 ($p = 0.035$) and CACS of > 400 ($p = 0.021$). CCTA showed obstructive CAD in 3.1% of patients with CACS ≥ 0 . No events occurred in patients with CACS ≥ 0 without obstructive CAD at CCTA, whereas 2/23 patients (9%) with CACS ≥ 0 with obstructive CAD had a MACE.	2

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4. Gerber TC, Kantor B, McCollough CH. Radiation dose and safety in cardiac computed tomography. <i>Cardiol Clin.</i> 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
5. 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. <i>Radiology.</i> 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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6. Husmann L, Valenta I, Gaemperli O, et al. Feasibility of low-dose coronary CT angiography: first experience with prospective ECG-gating. <i>Eur Heart J</i> . 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). Nondiagnostic CCTA image quality was found in 5.0% of coronary segments. However, below a HR of 63 b.p.m. (n=28), as determined by receiver operator characteristic curve, only 1.1% of coronary segments were nondiagnostic compared with 14.8% with heart rate of >63 b.p.m. (P<0.001).	3
7. Stolzmann P, Leschka S, Scheffel H, et al. Dual-source CT in step-and-shoot mode: noninvasive coronary angiography with low radiation dose. <i>Radiology</i> . 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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<p>8. Leipsic J, Labounty TM, Heilbron B, et al. Estimated radiation dose reduction using adaptive statistical iterative reconstruction in coronary CT angiography: the ERASIR study. <i>AJR Am J Roentgenol.</i> 2010;195(3):655-660.</p>	<p>Experiment al-Dx</p>	<p>574 consecutive patients</p>	<p>To 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.</p>	<p>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.</p>	<p>2</p>

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9. 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. <i>Eur Heart J</i> . 2010;31(3):340-346.	Observational-Dx	50 patients	To evaluate the feasibility and image quality of a new scan mode for coronary computed tomography angiography (CTA) with an effective dose of less than 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 coronary CTA provides excellent image quality at a consistent dose below 1.0 mSv.	3
10. Desai MY, Schoenhagen P. Noninvasive testing strategies in symptomatic, intermediate-risk CAD patients: a perspective on the "PROMISE" trial and its potential implementation in clinical practice. <i>Cardiovasc Diagn Ther</i> . 2015;5(2):166-168.	Review/Other-Dx	10,003 patients	To provide insights into clinical management of patients presenting with chest pain.	The results reinforce that while diagnostic testing is an important component of modern management, its choice should be directed by a clinician in a clinical context and with subsequent management in mind. Based on presentation and pre-test probability, the clinician will decide if any additional testing necessary is necessary and if that is the case chose the most appropriate test according to current guidelines, applied to the individual patient and clinical scenario.	4
11. Doris M, Newby DE. Coronary CT Angiography as a Diagnostic and Prognostic Tool: Perspectives from the SCOT-HEART Trial. <i>Curr Cardiol Rep</i> . 2016;18(2):18.	Review/Other-Dx	N/A	To provide perspectives on the SCOT-Heart Trial: Coronary CT Angiography as a Diagnostic and Prognostic Tool:	In this trial, CCTA clarified the diagnosis of angina due to coronary heart disease in a quarter of patients and this led to major alterations in treatment and management that appeared to reduce the risk of subsequent coronary heart disease death or non-fatal myocardial infarction. The SCOT-Heart trial has established that CCTA is a valuable diagnostic test in patients with suspected angina pectoris due to coronary heart disease and leads to greater clarity, more focused appropriate treatments and better coronary heart disease outcomes.	4

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12. Genders TS, Petersen SE, Pugliese F, et al. The optimal imaging strategy for patients with stable chest pain: a cost-effectiveness analysis. <i>Ann Intern Med.</i> 162(7):474-84, 2015 Apr 07.	Review/Other-Dx	N/A	To determine the cost-effectiveness of different imaging strategies for patients with stable chest pain	The strategy that maximized QALYs and was cost-effective in the United States and the Netherlands began with coronary CT angiography, continued with cardiac stress imaging if angiography found at least 50% stenosis in at least 1 coronary artery, and ended with catheter-based coronary angiography if stress imaging induced ischemia of any severity. For U.K. men, the preferred strategy was optimal medical therapy without catheter-based coronary angiography if coronary CT angiography found only moderate CAD or stress imaging induced only mild ischemia. In these strategies, stress echocardiography was consistently more effective and less expensive than other stress imaging tests. For U.K. women, the optimal strategy was stress echocardiography followed by catheter-based coronary angiography if echocardiography induced mild or moderate ischemia. Results were sensitive to changes in the probability of CAD and assumptions about false-positive results.	4
13. Marwick TH, Cho I, O'Hartaigh B, Min JK. Finding the Gatekeeper to the Cardiac Catheterization Laboratory: Coronary CT Angiography or Stress Testing?. [Review]. <i>Journal of the American College of Cardiology.</i> 65(25):2747-56, 2015 Jun 30.	Review/Other-Dx	N/A	To discuss the review of finding the Gatekeeper to the Cardiac Catheterization Laboratory Coronary CT Angiography or Stress Testing	The potential of CCTA to serve as an effective gatekeeper to invasive coronary angiography will depend, in part, on the adoption of these new developments, as well as definition of the benefit of detecting high-risk plaque for guiding the management of selected patients.	4

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<p>14. Poon M, Cortegiano M, Abramowicz AJ, et al. Associations between routine coronary computed tomographic angiography and reduced unnecessary hospital admissions, length of stay, recidivism rates, and invasive coronary angiography in the emergency department triage of chest pain. <i>J Am Coll Cardiol.</i> 62(6):543-52, 2013 Aug 06.</p>	<p>Observational-Dx</p>	<p>894 patients</p>	<p>To assess the effects on resource utilization of routine coronary computed tomographic angiography (CCTA) in triaging chest pain patients in the emergency department (ED).</p>	<p>The overall admission rate was lower with CCTA (14% vs. 40%; $p < 0.001$). Standard evaluation was associated with a 5.5-fold greater risk for admission (odds ratio [OR]: 5.53; $p < 0.001$). Expected ED length of stay with standard evaluation was about 1.6 times longer (OR: 1.55; $p < 0.001$). There were no differences in the rates of death and acute myocardial infarction within 30 days of the index visit between the two groups. The likelihood of returning to the ED within 30 days for recurrent chest pain was 5 times greater with standard evaluation (OR: 5.06; $p = 0.022$). Standard evaluation was associated with a 7-fold greater likelihood of invasive coronary angiography without revascularization (OR: 7.17; $p < 0.001$), while neither group was significantly more likely to receive revascularization (OR: 2.06; $p = 0.193$). The median radiation dose with CCTA was 5.88 mSv ($n = 1039$; confidence interval: 5.2 to 6.4).</p>	<p>3</p>

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<p>15. Williams MC, Hunter A, Shah AS, et al. Use of Coronary Computed Tomographic Angiography to Guide Management of Patients With Coronary Disease. <i>J Am Coll Cardiol.</i> 2016;67(15):1759-1768.</p>	<p>Observational-Dx</p>	<p>4,146 patients</p>	<p>To explore the consequences of CCTA-assisted diagnosis on invasive coronary</p>	<p>Despite similar overall rates (409 vs. 401; $p = 0.451$), invasive angiography was less likely to demonstrate normal coronary arteries (20 vs. 56; hazard ratios [HRs]: 0.39 [95% confidence interval (CI): 0.23 to 0.68]; $p < 0.001$) but more likely to show obstructive coronary artery disease (283 vs. 230; HR: 1.29 [95% CI: 1.08 to 1.55]; $p = 0.005$) in those allocated to CCTA. More preventive therapies (283 vs. 74; HR: 4.03 [95% CI: 3.12 to 5.20]; $p < 0.001$) were initiated after CCTA, with each drug commencing at a median of 48 to 52 days after clinic attendance. From the median time for preventive therapy initiation (50 days), fatal and nonfatal myocardial infarction was halved in patients allocated to CCTA compared with those assigned to standard care (17 vs. 34; HR: 0.50 [95% CI: 0.28 to 0.88]; $p = 0.020$). Cumulative 6-month costs were slightly higher with CCTA: difference \$462 (95% CI: \$303 to \$621).</p>	<p>3</p>

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<p>16. Foy AJ, Dhruva SS, Peterson B, Mandrola JM, Morgan DJ, Redberg RF. Coronary Computed Tomography Angiography vs Functional Stress Testing for Patients With Suspected Coronary Artery Disease: A Systematic Review and Meta-analysis. JAMA Intern Med. 2017;177(11):1623-1631.</p>	<p>Meta-analysis</p>	<p>13 studies</p>	<p>To compare the clinical effectiveness of Coronary computed tomography angiography (CCTA) with that of functional stress testing for patients with suspected coronary artery disease (CAD).</p>	<p>Thirteen trials were included, with 10315 patients in the CCTA arm and 9777 patients in the functional stress testing arm who were followed up for a mean duration of 18 months. There were no statistically significant differences between CCTA and functional stress testing in death (1.0% vs 1.1%; risk ratio [RR], 0.93; 95% CI, 0.71-1.21) or cardiac hospitalization (2.7% vs 2.7%; RR, 0.98; 95% CI, 0.79-1.21), but CCTA was associated with a reduction in the incidence of myocardial infarction (0.7% vs 1.1%; RR, 0.71; 95% CI, 0.53-0.96). Patients undergoing CCTA were significantly more likely to undergo invasive coronary angiography (11.7% vs 9.1%; RR, 1.33; 95% CI, 1.12-1.59) and revascularization (7.2% vs 4.5%; RR, 1.86; 95% CI, 1.43-2.43). They were also more likely to receive a diagnosis of new CAD and to have initiated aspirin or statin therapy.</p>	<p>Good</p>

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<p>17. Schulman-Marcus J, Lin FY, Gransar H, et al. Coronary revascularization vs. medical therapy following coronary-computed tomographic angiography in patients with low-, intermediate- and high-risk coronary artery disease: results from the CONFIRM long-term registry. <i>Eur Heart J Cardiovasc Imaging</i>. 2017;18(8):841-848.</p>	<p>Observational-Dx</p>	<p>5544 patients</p>	<p>To identify the effect of early revascularization on 5-year survival in patients with coronary artery disease (CAD) diagnosed by coronary-computed tomographic angiography (CCTA).</p>	<p>We examined 5544 stable patients with suspected CAD undergoing CCTA who were followed a median of 5.5 years in a large international registry. Patients were categorized as having low-, intermediate-, or high-risk CAD based on CCTA findings. Two treatment groups were defined: early revascularization within 90 days of CCTA (n = 1171) and medical therapy (n = 4373). To account for the non-randomized referral to revascularization, we developed a propensity score by logistic regression. This score was incorporated into Cox proportional hazard models to calculate the effect of revascularization on all-cause mortality. Death occurred in 363 (6.6%) patients and was more frequent in medical therapy. In multivariable models, when compared with medical therapy, the mortality benefit of revascularization varied significantly over time and by CAD risk (P for interaction 0.04). In high-risk CAD, revascularization was significantly associated with lower mortality at 1 year (hazard ratio [HR] 0.22, 95% confidence interval [CI] 0.11-0.47) and 5 years (HR 0.31, 95% CI 0.18-0.54). For intermediate-risk CAD, revascularization was associated with reduced mortality at 1 year (HR 0.45, 95% CI 0.22-0.93) but not 5 years (HR 0.63, 95% CI 0.33-1.20). For low-risk CAD, there was no survival benefit at either time point.</p>	<p>2</p>

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18. Fordyce CB, Newby DE, Douglas PS. Diagnostic Strategies for the Evaluation of Chest Pain: Clinical Implications From SCOT-HEART and PROMISE. [Review]. J Am Coll Cardiol. 67(7):843-52, 2016 Feb 23.	Review/Other-Dx	N/A	To discuss the data generated from these 2 pivotal trials to better inform the practicing clinician in the selection of noninvasive testing for stable chest pain. Similarities and differences between SCOT-HEART and PROMISE are highlighted, and clinical and practical implications are discussed. Both trials show that coronary computed tomography angiography should have a greater role in the diagnostic pathway of patients with stable chest pain.	No results stated in abstract	4
19. Thomas DM, Branch KR, Cury RC. PROMISE of Coronary CT Angiography: Precise and Accurate Diagnosis and Prognosis in Coronary Artery Disease. [Review]. South Med J. 109(4):242-7, 2016 Apr.	Review/Other-Tx	N/A	To discuss the review of the interval knowledge obtained from newer data on CCTA in patients with stable ischemic heart disease, primarily focusing on the contributions of the Prospective Multicenter Imaging Study for Evaluation of Chest Pain and the Scottish Computed Tomography of the Heart Trial.	No results stated in abstract	4

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20. Lubbers M, Dedic A, Coenen A, et al. Calcium imaging and selective computed tomography angiography in comparison to functional testing for suspected coronary artery disease: the multicentre, randomized CRESCENT trial. <i>Eur Heart J.</i> 2016;37(15):1232-1243.	Observational-Dx	350 patients	To compare the effectiveness and safety of a cardiac computed tomography (CT) algorithm with functional testing in patients with symptoms suggestive of coronary artery disease (CAD).	Between April 2011 and July 2013, 350 patients with stable angina, referred to the outpatient clinic of four Dutch hospitals, were prospectively randomized between cardiac CT and functional testing (2 : 1 ratio). The tiered cardiac CT protocol included a calcium scan followed by CT angiography if the Agatston calcium score was between 1 and 400. Patients with test-specific contraindications were not excluded from study participation. By 1 year, fewer patients randomized to cardiac CT reported anginal complaints (P = 0.012). The cumulative radiation dose was slightly higher in the CT group (6.6 +/- 8.7 vs. 6.1 +/- 9.3 mSv; P < 0.0001). After 1.2 years, event-free survival was 96.7% for patients randomized to CT and 89.8% for patients randomized to functional testing (P = 0.011). After CT, the final diagnosis was established sooner (P < 0.0001), and additional downstream testing was required less frequently (25 vs. 53%, P < 0.0001), resulting in lower cumulative diagnostic costs (euro369 vs. euro440; P < 0.0001).	1
21. Galperin-Aizenberg M, Cook TS, Hollander JE, Litt HI. Cardiac CT angiography in the emergency department. [Review]. <i>AJR. American Journal of Roentgenology.</i> 204(3):463-74, 2015 Mar.	Review/Other-Dx	N/A	To discuss the role of cardiac CT angiography (CTA) as a safe, efficient, and cost-effective tool in this setting and review state-of-the-art technology, protocols, advantages, and limitations from the perspective of our institution's 10-year experience.	Early utilization of cardiac CTA in patients presenting to the ED with chest pain and a low to intermediate risk of ACS quickly identifies a group of particularly low-risk patients (< 1% risk of adverse events within 30 days) and allows safe and expedited discharge. By preventing unnecessary admissions and prolonged lengths of stay, a strategy based on early cardiac CTA has been shown to be efficient, although potential overutilization and other issues require long-term study.	4

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22. Hoffmann U, Truong QA, Schoenfeld DA, et al. Coronary CT angiography versus standard evaluation in acute chest pain. <i>N Engl J Med.</i> 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 (\pm 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; $P = 0.65$).	1
23. Mahler SA, Hiestand BC, Nwanji-Enwerem J, et al. Reduction in observation unit length of stay with coronary computed tomography angiography depends on time of emergency department presentation. <i>Acad Emerg Med.</i> 20(3):231-9, 2013 Mar.	Observational-Dx	841 patients	To determine whether low-risk chest pain patients receiving stress testing or CCTA have differences in ED plus observation unit (OU) LOS and if there are disparities in testing modality use, based on the time of patient presentation to the ED.	Over the study period, 841 subjects presented Monday through Friday. Median LOS was 18.0 hours (interquartile range [IQR] = 11.7 to 22.9 hours). Objective cardiac testing was completed in 788 of 841 (94%) patients, with 496 (63%) receiving stress testing and 292 (37%) receiving CCTA. After age, race, and sex were adjusted for, patients presenting between 08:00 and 11:59 hours not only had a shorter LOS associated with CCTA ($p < 0.0001$), but also had a greater likelihood of being tested by CCTA ($p = 0.001$). None of the other time periods had significant differences in LOS or testing modality choice for CCTA relative to stress testing.	2

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<p>24. SCOT-HEART investigators.. CT coronary angiography in patients with suspected angina due to coronary heart disease (SCOT-HEART): an open-label, parallel-group, multicentre trial.[Erratum appears in Lancet. 2015 Jun 13;385(9985):2354; PMID: 26088642]. Lancet. 385(9985):2383-91, 2015 Jun 13.</p>	<p>Observational-Dx</p>	<p>9,849 patients</p>	<p>To assess the effect of computed tomography (CT) coronary angiography on the diagnosis, management and outcome of patients with suspected angina due to coronary heart disease.</p>	<p>Between Nov 18, 2010, and Sept 24, 2014, we randomly assigned 4146 (42%) of 9849 patients who had been referred for assessment of suspected angina due to coronary heart disease. 47% of participants had a baseline clinic diagnosis of coronary heart disease and 36% had angina due to coronary heart disease. At 6 weeks, CTCA reclassified the diagnosis of coronary heart disease in 558 (27%) patients and the diagnosis of angina due to coronary heart disease in 481 (23%) patients (standard care 22 [1%] and 23 [1%]; p<0.0001). Although both the certainty (relative risk [RR] 2.56, 95% CI 2.33–2.79; p<0.0001) and frequency of coronary heart disease increased (1.09, 1.02–1.17; p=0.0172), the certainty increased (1.79, 1.62–1.96; p<0.0001) and frequency seemed to decrease (0.93, 0.85–1.02; p=0.1289) for the diagnosis of angina due to coronary heart disease. This changed planned investigations (15% vs 1%; p<0.0001) and treatments (23% vs 5%; p<0.0001) but did not affect 6-week symptom severity or subsequent admittances to hospital for chest pain. After 1.7 years, CTCA was associated with a 38% reduction in fatal and nonfatal myocardial infarction (26 vs 42, HR 0.62, 95% CI 0.38–1.01; p=0.0527), but this was not significant.</p>	<p>1</p>

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<p>25. Douglas PS, Hoffmann U, Patel MR, et al. Outcomes of anatomical versus functional testing for coronary artery disease. N Engl J Med. 372(14):1291-300, 2015 Apr 02.</p>	<p>Experimental-Dx</p>	<p>10,003 patients</p>	<p>The objective of the Prospective Multicenter Imaging Study for Evaluation of Chest Pain (PROMISE) was to compare health outcomes in patients who presented with new symptoms suggestive of CAD that required further evaluation and who were randomly assigned to an initial strategy of anatomical testing with the use of CTA or to functional testing.</p>	<p>The mean age of the patients was 60.8+/-8.3 years, 52.7% were women, and 87.7% had chest pain or dyspnea on exertion. The mean pretest likelihood of obstructive CAD was 53.3+/-21.4%. Over a median follow-up period of 25 months, a primary end-point event occurred in 164 of 4996 patients in the CTA group (3.3%) and in 151 of 5007 (3.0%) in the functional-testing group (adjusted hazard ratio, 1.04; 95% confidence interval, 0.83 to 1.29; P=0.75). CTA was associated with fewer catheterizations showing no obstructive CAD than was functional testing (3.4% vs. 4.3%, P=0.02), although more patients in the CTA group underwent catheterization within 90 days after randomization (12.2% vs. 8.1%). The median cumulative radiation exposure per patient was lower in the CTA group than in the functional-testing group (10.0 mSv vs. 11.3 mSv), but 32.6% of the patients in the functional-testing group had no exposure, so the overall exposure was higher in the CTA group (mean, 12.0 mSv vs. 10.1 mSv; P<0.001).</p>	<p>1</p>

Chronic Chest Pain-Noncardiac Etiology Unlikely: Low to Intermediate Probability of Coronary Artery Disease

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
26. Hoffmann U, Ferencik M, Udelson JE, et al. Prognostic Value of Noninvasive Cardiovascular Testing in Patients With Stable Chest Pain: Insights From the PROMISE Trial (Prospective Multicenter Imaging Study for Evaluation of Chest Pain). <i>Circulation</i> . 135(24):2320-2332, 2017 Jun 13.	Experimental-Dx	10,003 patients	To perform a prespecified secondary analysis of the Prospective Multicenter Imaging Study for Evaluation of Chest Pain (PROMISE) trial, comparing the prognostic value of an anatomic versus a functional testing strategy in stable symptomatic patients with suspected coronary artery disease (CAD).	Both the prevalence of normal test results and incidence rate of events in these patients were significantly lower among 4500 patients randomly assigned to CTA in comparison with 4602 patients randomly assigned to functional testing (33.4% versus 78.0%, and 0.9% versus 2.1%, respectively; both $P < 0.001$). In CTA, 54.0% of events ($n=74/137$) occurred in patients with nonobstructive CAD (1%-69% stenosis). Prevalence of obstructive CAD and myocardial ischemia was low (11.9% versus 12.7%, respectively), with both findings having similar prognostic value (hazard ratio, 3.74; 95% confidence interval [CI], 2.60-5.39; and 3.47; 95% CI, 2.42-4.99). When test findings were stratified as mildly, moderately, or severely abnormal, hazard ratios for events in comparison with normal tests increased proportionally for computed tomography angiography (CTA) (2.94, 7.67, 10.13; all $P < 0.001$) but not for corresponding functional testing categories (0.94 [$P=0.87$], 2.65 [$P=0.001$], 3.88 [$P < 0.001$]). The discriminatory ability of CTA in predicting events was significantly better than functional testing (c-index, 0.72; 95% CI, 0.68-0.76 versus 0.64; 95% CI, 0.59-0.69; $P=0.04$). If 2714 patients with at least an intermediate Framingham Risk Score ($>10\%$) who had a normal functional test were reclassified as being mildly abnormal, the discriminatory capacity improved to 0.69 (95% CI, 0.64-0.74).	2

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
27. Schlett CL, Banerji D, Siegel E, et al. Prognostic value of CT angiography for major adverse cardiac events in patients with acute chest pain from the emergency department: 2-year outcomes of the ROMICAT trial. JACC Cardiovasc Imaging. 2011;4(5):481-491.	Observational-Dx	368 patients	To determine the 2-year prognostic value of cardiac computed tomography (CT) for predicting major adverse cardiac events (MACE) in patients presenting to the emergency department (ED) with acute chest pain.	Follow-up was completed in 333 patients (90.5%) with a median follow-up period of 23 months. At the end of the follow-up period, 25 patients (6.8%) experienced 35 MACE (no cardiac deaths, 12 myocardial infarctions, and 23 revascularizations). Cumulative probability of 2-year MACE increased across CT strata for coronary artery disease (CAD) (no CAD 0%; nonobstructive CAD 4.6%; obstructive CAD 30.3%; log-rank $p < 0.0001$) and across combined CT strata for CAD and RWMA (no stenosis or RWMA 0.9%; 1 feature-either RWMA [15.0%] or stenosis [10.1%], both stenosis and RWMA 62.4%; log-rank $p < 0.0001$). The c statistic for predicting MACE was 0.61 for clinical Thrombolysis In Myocardial Infarction risk score and improved to 0.84 by adding CT CAD data and improved further to 0.91 by adding RWMA (both $p < 0.0001$).	3

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>28. McKavanagh P, Lusk L, Ball PA, et al. A comparison of cardiac computerized tomography and exercise stress electrocardiogram test for the investigation of stable chest pain: the clinical results of the CAPP randomized prospective trial. Eur Heart J Cardiovasc Imaging. 16(4):441-8, 2015 Apr.</p>	<p>Observational-Dx</p>	<p>574 patients</p>	<p>To determine the symptomatic and prognostic differences resulting from a novel diagnostic pathway based on cardiac computerized tomography (CT) compared with the traditional exercise stress electrocardiography test (EST) in stable chest pain patients.</p>	<p>A prospective randomized controlled trial compared selected patient outcomes in EST and cardiac CT coronary angiography groups. Five hundred patients with troponin-negative stable chest pain and without known coronary artery disease were recruited. Patients completed the Seattle Angina Questionnaires (SAQ) at baseline, 3, and 12 months to assess angina symptoms. Patients were also followed for management strategies and clinical events. Over the year 12 patients withdrew, resulting in 245 in the EST cohort and 243 in the CT cohort. There was no significant difference in baseline demographics. The CT arm had a statistical difference in angina stability and quality-of-life domains of the SAQ at 3 and 12 months, suggesting less angina compared with the EST arm. In the CT arm, there was more significant disease identified and more revascularizations. Significantly, more inconclusive results were seen in the EST arm with a higher number of additional investigations ordered. There was also a longer mean time to management. There were no differences in major adverse cardiac events between the cohorts. At 1 year in the EST arm, there were more Accident and Emergency (A&E) attendances and cardiac admission.</p>	<p>1</p>

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
29. Hadamitzky M, Achenbach S, Al-Mallah M, et al. Optimized prognostic score for coronary computed tomographic angiography: results from the CONFIRM registry (COronary CT Angiography Evaluation For Clinical Outcomes: An InteRnational Multicenter Registry). J Am Coll Cardiol. 2013;62(5):468-476.	Observational-Dx	27,125 patients	To analyze the predictive value of coronary computed tomography angiography (CCTA) and to model and validate an optimized score for prognosis of 2-year survival on the basis of a patient population with suspected coronary artery disease (CAD).	During a median follow-up of 2.3 years, 347 patients died. The best CCTA parameter for prediction of mortality was the number of proximal segments with mixed or calcified plaques (C-index 0.64, $p < 0.0001$) and the number of proximal segments with a stenosis $>50\%$ (C-index 0.56, $p = 0.002$). In an optimized score including both parameters, CCTA significantly improved overall risk prediction beyond National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) score as best clinical score. According to this score, a proximal segment with either a mixed or calcified plaque or a stenosis $>50\%$ is equivalent to a 5-year increase in age or the risk of smoking.	3
30. Puchner SB, Liu T, Mayrhofer T, et al. High-risk plaque detected on coronary CT angiography predicts acute coronary syndromes independent of significant stenosis in acute chest pain: results from the ROMICAT-II trial. J Am Coll Cardiol. 64(7):684-92, 2014 Aug 19.	Observational-Dx	472 patients	To determine whether high-risk plaque features, as detected by CTA in the emergency department (ED), may improve diagnostic certainty of ACS independently and incrementally to the presence of significant CAD and clinical risk assessment in patients with acute chest pain but without objective evidence of myocardial ischemia or myocardial infarction (MI).	Overall, 37 of 472 patients who underwent coronary CTA with diagnostic image quality (mean age 53.9 ± 8.0 years; 52.8% men) had ACS (7.8%; MI $n = 5$; unstable angina pectoris $n = 32$). CAD was present in 262 patients (55.5%; nonobstructive CAD in 217 patients [46.0%] and significant CAD with $\geq 50\%$ stenosis in 45 patients [9.5%]). High-risk plaques were more frequent in patients with ACS and remained a significant predictor of ACS (odds ratio [OR]: 8.9; 95% CI: 1.8 to 43.3; $p = 0.006$) after adjustment for $\geq 50\%$ stenosis (OR: 38.6; 95% CI: 14.2 to 104.7; $p < 0.001$) and clinical risk assessment (age, sex, number of cardiovascular risk factors). Similar results were observed after adjustment for $\geq 70\%$ stenosis.	2

ACR Appropriateness Criteria®

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
31. Cury RC, Abbara S, Achenbach S, et al. CAD-RADS(TM) Coronary Artery Disease - Reporting and Data System. An expert consensus document of the Society of Cardiovascular Computed Tomography (SCCT), the American College of Radiology (ACR) and the North American Society for Cardiovascular Imaging (NASCI). Endorsed by the American College of Cardiology. Journal of cardiovascular computed tomography. 10(4):269-81, 2016 Jul-Aug.	Review/Other-Dx	N/A	To communicate findings of coronary CT angiography (coronary CTA) in order to facilitate decision-making regarding further patient management	No results stated in the abstract	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>32. Feuchtner G, Kerber J, Burghard P, et al. The high-risk criteria low-attenuation plaque <60 HU and the napkin-ring sign are the most powerful predictors of MACE: a long-term follow-up study. <i>Eur Heart J Cardiovasc Imaging</i>. 2017;18(7):772-779.</p>	<p>Observational-Dx</p>	<p>1469 patients</p>	<p>To assess the prognostic value of coronary Computed Tomography angiography (CTA) for prediction of major adverse cardiac events (MACE) over a long-term follow-up period.</p>	<p>A total of 1469 low-to-intermediate-risk patients (65.9 years; 44.2% females) were included in our prospective cohort study. CTA was evaluated for (i) stenosis severity (minimal <10%; mild <50%; moderate 50-70%; severe >70%), (ii) plaque types (calcified, mixed dominantly calcified, mixed dominantly non-calcified, non-calcified), and (iii) high-risk plaque criteria [low-attenuation plaque (LAP) quantified by HU, napkin-ring (NR) sign, spotty calcification <3 mm, and remodelling index (RI)]. Over a follow-up of mean 7.8 years, MACE rate was 41 (2.8%) and 0% in patients with negative CTA. MACE rate increased along with stenosis severity by CTA (from 1.3 to 7.8%) (P < 0.001) and was higher in T3/T4 plaques than in T2/T1 (7.8 vs. 1.9%; P < 0.0001). LAP density was lower (35.2 HU +/- 32 vs. 108.8 HU +/- 53) (P < 0.001) and both NR-sign prevalence with n = 26 (63.4%) vs. n = 40 (28%) and LAP <30, <60, and <90 HU prevalence with 46.3-78% vs. 2.4-7% were higher in the MACE group (P < 0.001). On univariate and unadjusted multivariable proportional Hazards model, LAP <60 HU and NR were the strongest MACE predictors (HR 4.96; 95% CI: 2.0-12.2 and HR 3.85; 95% CI: 1.7-8.6) (P < 0.0001), while spotty calcification (HR 2.2; 95% CI: 1.1-4.3, P < 0.001), stenosis severity, and plaque type (HR 1.5; 95% CI: 1.1-2.3 and HR 1.7; 95% CI: 1.1-2.6) (P < 0.001) were less powerful. After adjusting for risk factors, CTA stenosis severity, and plaque type, LAP <60 HU and the NR sign remained significant (P < 0.001), while the effect of NR sign was even enhancing. HRP criteria were independent predictors from other risk factors.</p>	<p>3</p>

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
33. Koo BK, Erglis A, Doh JH, et al. Diagnosis of ischemia-causing coronary stenoses by noninvasive fractional flow reserve computed from coronary computed tomographic angiograms. Results from the prospective multicenter DISCOVER-FLOW (Diagnosis of Ischemia-Causing Stenoses Obtained Via Noninvasive Fractional Flow Reserve) study. <i>J Am Coll Cardiol</i> . 2011;58(19):1989-1997.	Experimental-Dx	103 patients	To determine the diagnostic performance of a new method for quantifying fractional flow reserve (FFR) with computational fluid dynamics (CFD) applied to coronary computed tomography angiography (CCTA) data in patients with suspected or known coronary artery disease (CAD).	Fifty-six percent of patients had ≥ 1 vessel with $\text{FFR} \leq 0.80$. On a per-vessel basis, the accuracy, sensitivity, specificity, positive predictive value, and negative predictive value were 84.3%, 87.9%, 82.2%, 73.9%, 92.2%, respectively, for FFR(CT) and were 58.5%, 91.4%, 39.6%, 46.5%, 88.9%, respectively, for CCTA stenosis. The area under the receiver-operator characteristics curve was 0.90 for FFR(CT) and 0.75 for CCTA ($p = 0.001$). The FFR(CT) and FFR were well correlated ($r = 0.717$, $p < 0.001$) with a slight underestimation by FFR(CT) (0.022 ± 0.116 , $p = 0.016$).	2
34. Min JK, Leipsic J, Pencina MJ, et al. Diagnostic accuracy of fractional flow reserve from anatomic CT angiography. <i>JAMA</i> . 2012;308(12):1237-1245.	Observational-Dx	252 stable patients	To assess the diagnostic performance of FFR(CT) plus CT for diagnosis of hemodynamically significant coronary stenosis.	Among study participants, 137 (54.4%) had an abnormal FFR determined by ICA. On a per-patient basis, diagnostic accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of FFR(CT) plus CT were 73% (95% CI, 67%-78%), 90% (95% CI, 84%-95%), 54% (95% CI, 46%-83%), 67% (95% CI, 60%-74%), and 84% (95% CI, 74%-90%), respectively. Compared with obstructive CAD diagnosed by CT alone (area under the receiver operating characteristic curve [AUC], 0.68; 95% CI, 0.62-0.74), FFR(CT) was associated with improved discrimination (AUC, 0.81; 95% CI, 0.75-0.86; $P < .001$).	1
35. Taylor CA, Fonte TA, Min JK. Computational fluid dynamics applied to cardiac computed tomography for noninvasive quantification of fractional flow reserve: scientific basis. <i>J Am Coll Cardiol</i> . 2013;61(22):2233-2241.	Review/Other-Dx	N/A	To discuss the review on the scientific principles that underlie computational fluid dynamics applied to cardiac computed tomography for noninvasive quantification of fractional flow reserve.	No results stated in the abstract	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
36. Zarins CK, Taylor CA, Min JK. Computed fractional flow reserve (FFRCT) derived from coronary CT angiography. J Cardiovasc Transl Res. 2013;6(5):708-714.	Review/Other-Dx	N/A	To discuss the review of computed fractional flow reserve (FFRCT) derived from coronary CT angiography	No results stated in abstract	4
37. Zhang JM, Luo T, Huo Y, et al. Area stenosis associated with non-invasive fractional flow reserve obtained from coronary CT images. Conf Proc IEEE Eng Med Biol Soc. 2013;2013:3865-3868.	Observational-Dx	6 models of patient-specific left coronary artery trees(12 stenosis)	To assess the severity of coronary artery disease (CAD). FFRCT can be obtained non-invasively by combining computed tomography (CT) images and Computational Fluid Dynamics (CFD) method	In this study, FFRCT was computed for 6 models of patient-specific left coronary artery trees reconstructed from CT images. A total of 12 stenoses were observed. FFR values obtained for 7 of the 12 stenoses during invasive angiography were used as the gold standard for comparison. On a per-stenosis basis, the sensitivity, specificity, positive predictive value and negative predictive value were 50%, 100%, 100% and 83.3% respectively for FFRCT. A weak correlation was found between percent lumen diameter stenosis and FFRCT ($r=0.431$; $p>0.05$). However, the correlation between percent lumen area stenosis and FFRCT was significant ($r=0.853$; $p<0.05$). Therefore, non-invasive FFRCT appears to be a promising index to assess the severity of CAD and lumen area has distinct advantages over diameter measurement in terms of anatomy assessment.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>38. Jensen JM, Botker HE, Mathiassen ON, et al. Computed tomography derived fractional flow reserve testing in stable patients with typical angina pectoris: influence on downstream rate of invasive coronary angiography. Eur Heart J Cardiovasc Imaging. 2017:[E-pub ahead of print].</p>	<p>Observational-Dx</p>	<p>774 patients</p>	<p>To assess the use of downstream coronary angiography (ICA) and short-term safety of frontline coronary computed tomography (CT) angiography (CTA) with selective CT-derived fractional flow reserve (FFRCT) testing in stable patients with typical angina pectoris.</p>	<p>Between 1 January 2016 and 30 June 2016 all patients (N = 774) referred to non-emergent ICA or coronary CTA at Aarhus University Hospital on a suspicion of coronary artery disease (CAD) had frontline CTA performed. Downstream testing and treatment within 3 months and adverse events ≥ 90 days were registered. Patients were divided into two groups according to the presence of typical angina pectoris, which according to local practice would have resulted in referral to ICA, (low-intermediate-risk, n = 593 [76%]; high-risk, n = 181 [24%]) with mean pre-test probability of CAD of 31 +/- 16% and 67 +/- 16%, respectively. Coronary CTA was performed in 745 (96%) patients in whom FFRCT was prescribed in 212 (28%) patients. In the high- vs. low-intermediate-risk group, ICA was cancelled in 75% vs. 91%. Coronary revascularization was performed more frequently in high-risk than in low-intermediate-risk patients, 76% vs. 52% (P = 0.03). Mean follow-up time was 157 +/- 50 days. Serious clinical events occurred in four patients, but not in any patients with cancelled ICA by coronary CTA with selective FFRCT testing.</p>	<p>3</p>

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>39. Douglas PS, Pontone G, Hlatky MA, et al. Clinical outcomes of fractional flow reserve by computed tomographic angiography-guided diagnostic strategies vs. usual care in patients with suspected coronary artery disease: the prospective longitudinal trial of FFR(CT): outcome and resource impacts study. Eur Heart J. 2015;36(47):3359-3367.</p>	<p>Experiment al-Dx</p>	<p>584 patients</p>	<p>To test the hypotheses that patients with suspected CAD evaluated using a CTA/FFRCT-guided strategy would have fewer invasive angiograms that showed no obstructive CAD than would patients who were evaluated based on standard practice, and would have similar and low rates of major cardiac events.</p>	<p>Subjects averaged 61 +/- 11 years of age, 40% were female, and the mean pre-test probability of obstructive CAD was 49 +/- 17%. Among those with intended ICA (FFR(CT)-guided = 193; usual care = 187), no obstructive CAD was found at ICA in 24 (12%) in the CTA/FFR(CT) arm and 137 (73%) in the usual care arm (risk difference 61%, 95% confidence interval 53-69, P< 0.0001), with similar mean cumulative radiation exposure (9.9 vs. 9.4 mSv, P = 0.20). Invasive coronary angiography was cancelled in 61% after receiving CTA/FFR(CT) results. Among those with intended non-invasive testing, the rates of finding no obstructive CAD at ICA were 13% (CTA/FFR(CT)) and 6% (usual care; P = 0.95). Clinical event rates within 90 days were low in usual care and CTA/FFR(CT) arms.</p>	<p>1</p>

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
40. Douglas PS, De Bruyne B, Pontone G, et al. 1-Year Outcomes of FFRCT-Guided Care in Patients With Suspected Coronary Disease: The PLATFORM Study. <i>J Am Coll Cardiol.</i> 68(5):435-45, 2016 Aug 02.	Observational-Dx	584 patients	To determine the 1-year clinical, economic, and quality-of-life (QOL) outcomes of using fractional flow reserve using computed tomographic angiography (CTA)(FFRCT) instead of usual care.	Patients averaged 61 years of age with a mean 49% pre-test probability of coronary artery disease. At 1 year, major adverse cardiac events (MACE) events were infrequent, with 2 in each arm of the planned invasive group and 1 in the planned noninvasive cohort (usual care strategy). In the planned invasive stratum, mean costs were 33% lower with CTA and selective FFRCT (\$8,127 vs. \$12,145 usual care; $p < 0.0001$); in the planned noninvasive stratum, mean costs did not differ when using an FFRCT cost weight of zero (\$3,049 FFRCT vs. \$2,579; $p = 0.82$), but were higher when using an FFRCT cost weight equal to CTA. QOL scores improved overall at 1 year ($p < 0.001$), with similar improvements in both groups, apart from the 5-item EuroQOL scale scores in the noninvasive stratum (mean change of 0.12 for FFRCT vs. 0.07 for usual care; $p = 0.02$).	2
41. Abbott BG, Abdel-Aziz I, Nagula S, Monico EP, Schriver JA, Wackers FJ. Selective use of single-photon emission computed tomography myocardial perfusion imaging in a chest pain center. <i>Am J Cardiol.</i> 2001;87(12):1351-1355.	Observational-Dx	2,601 patients	Prospective evaluation of the use of SPECT imaging in patients with chest pain and nonischemic ECG in an emergency department chest pain center.	906 patients required SPECT imaging to complete the evaluation. Had SPECT not been performed and all 906 patients been admitted, 29% (762) would have been admitted to the hospital unnecessarily. Sending all 906 patients home would have meant that, 6% (144) of patients would have been discharged inappropriately as they had CAD.	3

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Einstein AJ, Johnson LL, DeLuca AJ, et al. Radiation dose and prognosis of ultra-low-dose stress-first myocardial perfusion SPECT in patients with chest pain using a high-efficiency camera. <i>J Nucl Med.</i> 2015;56(4):545-551	Observational-Dx	100 patients	To assess outcomes and radiation doses of patients undergoing myocardial perfusion imaging (MPI) on an high-efficiency single-photon emission computerized tomography (HE-SPECT) camera using an ultra-low-dose stress-first protocol.	Stress-only imaging was performed in 69 patients, for whom radiation effective dose averaged 0.99 mSv and study duration, 117 min. Radiation dose averaged 2.22 mSv over all patients. At 3 mo, 96 patients were free of major adverse cardiac events, repeat hospital chest pain evaluation, and repeat imaging or stress testing. One year after MPI and hospital discharge, all patients were living and without acute coronary syndrome.	2
43. Levsky JM, Spevack DM, Travin MI, et al. Coronary Computed Tomography Angiography Versus Radionuclide Myocardial Perfusion Imaging in Patients With Chest Pain Admitted to Telemetry: A Randomized Trial. <i>Annals of Internal Medicine.</i> 163(3):174-83, 2015 Aug 04.	Observational-Dx	400 patients	To compare CCTA with conventional noninvasive testing.	Thirty (15%) patients who had CCTA and 32 (16%) who had MPI underwent cardiac catheterization within 1 year. Fifteen (7.5%) and 20 (10%) of these patients, respectively, did not undergo revascularization (difference, -2.5 percentage points [95% CI, -8.6 to 3.5 percentage points]; hazard ratio, 0.77 [CI, 0.40 to 1.49]; P = 0.44). Median length of stay was 28.9 hours for the CCTA group and 30.4 hours for the MPI group (P = 0.057). Median follow-up was 40.4 months. For the CCTA and MPI groups, the incidence of death (0.5% versus 3%; P = 0.12), nonfatal cardiovascular events (4.5% versus 4.5%), rehospitalization (43% versus 49%), emergency department visit (63% versus 58%), and outpatient cardiology visit (23% versus 21%) did not differ. Long-term, all-cause radiation exposure was lower for the CCTA group (24 versus 29 mSv; P < 0.001). More patients in the CCTA group graded their experience favorably (P = 0.001) and would undergo the examination again (P = 0.003).	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
44. Lim SH, Anantharaman V, Sundram F, et al. Stress myocardial perfusion imaging for the evaluation and triage of chest pain in the emergency department: a randomized controlled trial. <i>J Nucl Cardiol.</i> 20(6):1002-12, 2013 Dec.	Experimental-Dx	1504 patients	To assess whether adding stress myocardial perfusion imaging (SMPI) to an evaluation strategy for emergency department (ED) patients presenting with chest pain more effectively identifies patients with ACS.	SMPI participants had a significantly lower admission rate than clinical assessment participants (10.16% vs 18.45%), with no significant between-group differences in risk of cardiac events (CEs) after 30 days (0.40% vs 0.79%) or 1 year (0.70% vs 0.99%).	3
45. Tota-Maharaj R, McEvoy JW, Blaha MJ, Silverman MG, Nasir K, Blumenthal RS. Utility of coronary artery calcium scoring in the evaluation of patients with chest pain. [Review]. <i>Crit. pathw. cardiol.</i> 11(3):99-106, 2012 Sep.	Review/Other-Dx	N/A	To discuss the review of articles investigating the utility of: (1) CAC scoring in elective patients with indeterminate chest pain symptoms, (2) CAC as a "gatekeeper" in the triage of patients presenting to the emergency department (ED) with chest pain, and (3) the cost-effectiveness of the use of CAC scoring in the ED	In our pooled analysis, the presence of any CAC resulted in a high sensitivity (range 70%-100%) for predicting the presence of obstructive coronary disease among symptomatic patients subsequently referred for coronary angiography. More importantly, a CAC score of 0 in low- and intermediate-risk ED populations with chest pain had a high negative predictive value (99.4%) for CHD events over an average follow-up of 21 months. CAC scoring also seems cost-effective in this population. Although further research is needed, carefully selected ED patients with a normal electrocardiogram, normal cardiac biomarkers, and CAC = 0 may be considered for early discharge without further testing.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. McKavanagh P, Lusk L, Ball PA, et al. A comparison of Diamond Forrester and coronary calcium scores as gatekeepers for investigations of stable chest pain. <i>Int J Cardiovasc Imaging</i> . 29(7):1547-55, 2013 Oct.	Observational-Dx	250 patients	To determine if calcium scores (CS) could act as a more effective gatekeeper than Diamond Forrester (DF) in the assessment of patients with suspected coronary artery disease (CAD).	The mean DF was 47.8 and mean CS 172.5. Of the 144 patients with non-anginal pain 19.4 % had significant disease (>50 % stenosis). In general the DF over estimated the presence of CAD whereas the CS reclassified patients to lower risk groups, with 91 in the high risk DF category compared to 26 in the CS. Both receiver operating curve and McNemar Bowker test analysis suggested the DF was less accurate in the prediction of CAD compared to CS [Formula: see text] Projected downstream investigations were also calculated, with the cost per number of significant stenoses identified cheaper with the CS criteria.	3
47. Nasir K, Clouse M. Role of nonenhanced multidetector CT coronary artery calcium testing in asymptomatic and symptomatic individuals. [Review]. <i>Radiology</i> . 264(3):637-49, 2012 Sep.	Review/Other-Dx	N/A	To examine in detail the methods, value, and potential role of non-contrast-enhanced, or noncontrast, CT assessment of CAD for risk stratification in asymptomatic and symptomatic individuals.	No results stated in abstract.	4
48. Kim YJ, Hur J, Lee HJ, et al. Meaning of zero coronary calcium score in symptomatic patients referred for coronary computed tomographic angiography. <i>Eur Heart J Cardiovasc Imaging</i> . 2012;13(9):776-785.	Observational-Dx	2088 patients. Of these a CCS of zero was detected in 1114 patients.	To determine the meaning of a CCS of zero in a large sample of symptomatic patients referred for coronary computed tomographic (CT) angiography.	A CCS of zero was detected in 1114 patients (471 men and 643 women). Of these 1114 patients, obstructive coronary artery disease (CAD) was found in a total of 48 patients (4.3%); 35 men (7.4%) and 13 women (2.0%). Among the zero CCS patients with obstructive CAD, men had a higher prevalence of both premature CAD (49 vs. 0%) and multivessel disease (20 vs. 8%) than women. During the follow-up period (1033 +/- 136 days), early revascularization was done in 25 patients (2.2%, 18 men and 7 women) and there were 14 major adverse cardiac events (1.3%, 8 men and 7 women) among the zero CCS patients. CAD severity was a strong prognostic indicator in the zero CCS patients.	2

Chronic Chest Pain-Noncardiac Etiology Unlikely: Low to Intermediate Probability of Coronary Artery Disease

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>49. Staniak HL, Bittencourt MS, Sharovsky R, Bensenor I, Olmos RD, Lotufo PA. Calcium score to evaluate chest pain in the emergency room. <i>Arq Bras Cardiol.</i> 2013;100(1):90-93.</p>	<p>Observational-Dx</p>	<p>135 symptomatic patients with no previous coronary heart disease</p>	<p>To evaluate the diagnostic accuracy of a zero CAC when compared to the coronary computed tomography angiography (CCTA) at the emergency department. 135 symptomatic patients with no previous coronary heart disease (CHD) who presented to the emergency department were submitted to CAC and CCTA to rule out CHD.</p>	<p>All patients had normal electrocardiogram and cardiac biomarkers and were TIMI risk score 0 to 2. The CCTA was considered positive if any obstructive lesion (> 50%) was identified. The mean age was 51.7 ± 13.6 years with 50.6% of men. Seventy-three (54.1%) patients had a calcium score of zero. Of them, 3 (4.1%) had an obstruction > 50% and underwent invasive coronary angiography. Calcium score showed a sensitivity of 92.9%, specificity of 75.3%, positive and negative predictive values of, respectively, 62.9% and 95.9%. Positive and negative likelihood ratios were respectively of 3.7 and 0.09 to detect lesions greater than 50% in the CCTA. A negative likelihood ratio of 0.09 is very good to rule out most cases of significant coronary obstruction in epidemiologic studies. However, it is important to understand that in a clinical scenario, all evidence including history, clinical examination, data from electrocardiogram and myocardial biomarkers have to be interpreted together. In our study, three cases with a zero CAC score had coronary obstruction higher than 50% at the CCTA.</p>	<p>3</p>

Chronic Chest Pain-Noncardiac Etiology Unlikely: Low to Intermediate Probability of Coronary Artery Disease

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
50. Villines TC, Carbonaro S, Hulten E. Calcium scoring and chest pain: is it dead on arrival? J Cardiovasc Comput Tomogr. 2011;5(1):30-34.	Review/Other-Tx	N/A	To discuss several considerations and potential limitations to the widespread use of Coronary artery calcium(CAC) to exclude obstructive coronary artery disease (CAD) in symptomatic patients which include (1) the effect of pretest disease prevalence on test accuracy, (2) limited clinical efficiency due to low specificity for obstructive CAD and myocardial ischemia and high background prevalence of CAC in adults, (3) occurrence of CAC relatively late in the atherosclerotic process, (4) lack of association of CAC with vulnerable and culprit coronary artery lesions, and (5) interindividual and racial heterogeneity in the process of atherosclerosis calcificatio	No results stated in abstract	4
51. Kaul S, Senior R, Firschke C, et al. Incremental value of cardiac imaging in patients presenting to the emergency department with chest pain and without ST-segment elevation: a multicenter study. Am Heart J. 2004;148(1):129-136.	Observational-Dx	203 patients	To compare contrast echocardiography with SPECT to determine incremental value of cardiac imaging in patients presenting to the emergency department with chest pain and without ST-segment elevation on the ECG. Both contrast echocardiography and SPECT readings included separate and composite assessments of both regional myocardial function and perfusion.	Concordance between contrast-enhanced and SPECT was 77% (73%-82%) for all territories, with a higher concordance for the anterior wall of 84% (78%-89%). Regional myocardial function and composite evaluation was better on SPECT compared with contrast echocardiography, while perfusion alone was not.	2

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
52. Metz LD, Beattie M, Hom R, Redberg RF, Grady D, Fleischmann KE. The prognostic value of normal exercise myocardial perfusion imaging and exercise echocardiography: a meta-analysis. <i>J Am Coll Cardiol</i> . 2007;49(2):227-237.	Meta-analysis	17 studies; 8,008 patients	To determine the prognostic value of normal exercise myocardial perfusion imaging (MPI) tests and echocardiography (ECG) tests.	The negative predictive value (NPV) for MI and cardiac death was 98.8% (95% confidence interval [CI] 98.5 to 99.0) over 36 months of follow-up for MPI, and 98.4% (95% CI 97.9 to 98.9) over 33 months for echocardiography. The corresponding annualized event rates were 0.45% per year for MPI and 0.54% per year for echocardiography. In subgroup analyses, annualized event rates were <1% for each MPI isotope, and were similar for women and men. For secondary events, MPI and echocardiography had annualized event rates of 1.25% and 0.95%, respectively.	Good
53. Ciampi Q, Rigo F, Grolla E, Picano E, Cortigiani L. Dual imaging stress echocardiography versus computed tomography coronary angiography for risk stratification of patients with chest pain of unknown origin. <i>Cardiovasc ultrasound</i> . 13:21, 2015 Apr 21.	Observational-Dx	131 patients	To compare the prognostic value of the two methods in a cohort of patients with chest pain having suspected coronary artery disease (CAD).	Of 131 patients, 34 (26%) had ischemia at stress echo (new wall motion abnormalities), and 56 (43%) had reduced CFR on LAD. Significant coronary stenosis at CTCA was found in 69 (53%) patients. Forty-six patients (84%) with abnormal CFR on LAD showed significant CAD at CTCA ($p < 0.001$). Calcium score was higher in patients with reduced than in those with normal CFR (265 ± 404 vs 131 ± 336 , $p = 0.04$). During a median follow-up of 7 months (1st to 3rd quartile: 5–13 months), there were 45 major cardiac events (4 deaths, 11 nonfatal myocardial infarctions, and 30 late [=6 months] coronary revascularizations). At Cox analysis, independent prognostic indicators were calcium score > 100 (HR 2.84, 95% CI 1.33-6.07, $p = 0.007$), significant CAD at CTCA (HR 2.68, 95% CI 1.23-5.82, $p = 0.013$), and inducible ischemia or CFR $< 1.9R$ on LAD on dual imaging stress echo (HR 2.25, 95% CI 1.05-4.84, $p = 0.038$).	3

Chronic Chest Pain-Noncardiac Etiology Unlikely: Low to Intermediate Probability of Coronary Artery Disease

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
54. Gibbons RJ, Carryer D, Liu H, et al. Use of Echocardiography in Olmsted County Outpatients With Chest Pain and Normal Resting Electrocardiograms Seen at Mayo Clinic Rochester. Mayo Clin Proc. 90(11):1492-8, 2015 Nov.	Review/Other-Dx	8280 outpatients	To determine how often unnecessary resting echocardiograms that are "not recommended" by clinical practice guidelines are performed in patients with stable chest pain and normal resting electrocardiograms (ECGs).	Of the 8280 outpatients from Olmsted County who were evaluated at Mayo Clinic Rochester with chest pain, 590 (7.1%) had resting echocardiograms. Ninety-two of these 590 patients (15.6%) had normal resting ECGs. Thirty-three of these 92 patients (35.9%) had other indications for echocardiography. The remaining 59 patients (10.0% of all echocardiograms and 0.7% of all patients) had normal resting ECGs and no other indication for echocardiography. Fifty-seven of these 59 patients (96.6%) had normal echocardiograms. Thirteen of these 59 echocardiograms (22.0%) were "preordered" before the provider (physicians, nurses, physician assistants) visit.	4
55. Hundley WG, Morgan TM, Neagle CM, Hamilton CA, Rerkpattanapit P, Link KM. Magnetic resonance imaging determination of cardiac prognosis. Circulation. 2002;106(18):2328-2333.	Observational-Dx	279 patients	To determine if the presence of inducible ischemia identified during MRI stress tests could be used to identify those at risk of sustaining a future cardiac event.	279 patients referred (because of poor left ventricular endocardial visualization with echocardiography) for dobutamine/atropine MRI for the detection of inducible ischemia were followed for an average of 20 months. After MRI stress testing, the occurrence of MI, cardiac death, death attributable to any cause, coronary arterial revascularization, and unstable angina or congestive heart failure requiring hospitalization was determined. In a multivariate analysis, the presence of inducible ischemia (HR 3.3, CI 1.1 to 9.7) or an left ventricular ejection fraction <40% (HR 4.2, CI 1.3 to 13.9) was associated with future MI or cardiac death independent of the presence of risk factors for coronary arteriosclerosis.	3

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
56. Paetsch I, Jahnke C, Wahl A, et al. Comparison of dobutamine stress magnetic resonance, adenosine stress magnetic resonance, and adenosine stress magnetic resonance perfusion. <i>Circulation</i> . 2004;110(7):835-842.	Observational-Dx	79 consecutive patients	Prospective study to evaluate the diagnostic value of inducible wall motion abnormalities during dobutamine and adenosine stress MR and adenosine MR perfusion compared with invasive coronary angiography.	Sensitivity and specificity for detection by dobutamine and adenosine stress and adenosine perfusion were 89% and 80%, 40% and 96%, and 91% and 62%, respectively. Dobutamine stress is recommended for current state-of-the-art treatment regimens to detect ischemia in patients with suspected or known CAD but no history of prior MI.	2
57. Macwar RR, Williams BA, Shirani J. Prognostic value of adenosine cardiac magnetic resonance imaging in patients presenting with chest pain. <i>Am J Cardiol</i> . 112(1):46-50, 2013 Jul 01.	Review/Other-Dx	626 patients	To discuss the review of the clinical characteristics of Adenosine cardiac magnetic resonance imaging (AS-CMR) findings	The AS-CMR findings were normal in 264, ischemic in 201, and scar in 240 patients. No cardiac death occurred in the normal AS-CMR group. Among the ischemic and scar groups, 7.2% and 8.3% experienced an event, respectively. On univariate analysis, ischemia (hazard ratio 5.3, 95% confidence interval 2.5 to 11.5, $p < 0.001$) and the presence of scar (hazard ratio 5.7, 95% confidence interval 2.6 to 12.4, $p < 0.001$) were independent predictors of all cardiac events. Multivariate Cox regression analysis for MACE identified the presence of ischemia (hazard ratio 2.8, 95% confidence interval 1.2 to 6.2, $p [0.01$) and scarring (hazard ratio 2.9, 95% confidence interval 1.3 to 6.6, $p [0.01$) as the strongest independent factors. The annual event rate for hard events was 0% in the normal, 1.7% in the scar, and 1.5% in the ischemia group. For the MACE end points, the rate was 0.5% in the normal, 2.4% in the scar, and 2.6% in the ischemia group. In conclusion, in the present, single-center cohort with chest pain, normal AS-CMR findings conferred very low risk (<1% annually) of MACE. However, the findings of ischemia or scar were a significant and independent predictor of hard events and MACE.	4

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
58. Greenwood JP, Maredia N, Younger JF, et al. Cardiovascular magnetic resonance and single-photon emission computed tomography for diagnosis of coronary heart disease (CE-MARC): a prospective trial. <i>Lancet</i> . 2012;379(9814):453-460.	Observational-Dx	752 patients	Prospective study to establish the diagnostic accuracy of a multiparametric cardiovascular MR protocol with x-ray coronary angiography as the reference standard and to compare cardiovascular MR with SPECT, in patients with suspected coronary heart disease.	Of the 752 patients, 39% had significant CHD as identified by x-ray angiography. For multiparametric cardiovascular MR the sensitivity was 86.5% (95% CI, 81.8%-90.1%), specificity 83.4% (79.5%-86.7%), PPV 77.2%, (72.1%-81.6%) and NPV 90.5% (87.1%-93.0%). The sensitivity of SPECT was 66.5% (95% CI, 60.4%-72.1%), specificity 82.6% (78.5%-86.1%), PPV 71.4% (65.3%-76.9%), and NPV 79.1% (74.8%-82.8%). The sensitivity and NPV of cardiovascular MR and SPECT differed significantly ($P<0.0001$ for both) but specificity and PPV did not ($P=0.916$ and $P=0.061$, respectively). Cardiovascular MR had high diagnostic accuracy in coronary heart disease and superiority over SPECT. It should be adopted more widely than at present for the investigation of coronary heart disease.	3
59. Ingkanisorn WP, Kwong RY, Bohme NS, et al. Prognosis of negative adenosine stress magnetic resonance in patients presenting to an emergency department with chest pain. <i>J Am Coll Cardiol</i> . 2006;47(7):1427-1432.	Observational-Dx	135 patients	To determine the diagnostic value of adenosine cardiac MR in troponin-negative patients with chest pain. Hypothesis that adenosine cardiac MR could determine which troponin-negative patients with chest pain in an emergency department have CAD or future adverse cardiac.	Adenosine perfusion abnormalities had 100% sensitivity, 93% specificity for detection of CAD and were the single most accurate component of the cardiac MRI.	3

Chronic Chest Pain-Noncardiac Etiology Unlikely: Low to Intermediate Probability of Coronary Artery Disease

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>60. Bodi V, Husser O, Sanchis J, et al. Prognostic implications of dipyridamole cardiac MR imaging: a prospective multicenter registry. <i>Radiology</i>. 2012;262(1):91-100.</p>	<p>Observational-Dx</p>	<p>1722 patients</p>	<p>To evaluate dipyridamole cardiac magnetic resonance (MR) imaging in the prediction of major events (MEs) in patients with ischemic chest pain in a large multicenter registry.</p>	<p>During a median follow-up period of 308 days, 61 MEs (4%) occurred (36 cardiac deaths, 25 nonfatal myocardial infarctions). MEs were associated with a greater extent of WMA, PD, LGE, and inducible WMA (P = .001 for all analyses). In multivariable analyses, PD (P = .002) and inducible WMA (P = .0001) were the only cardiac MR predictors. ME rate in categories 1, 2, 3, and 4 was 2% (14 of 901 patients), 3% (six of 219 patients), 4% (15 of 409 patients), and 14% (26 of 193 patients), respectively (category 4 vs category 1, adjusted P < .001). Cardiac MR-directed revascularization was performed in 242 patients (14%) and reduced the risk of ME in only category 4 (7% [six of 92 patients] vs 26% [26 of 101 patients], P = .0004).</p>	<p>1</p>

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>61. Kim WY, Danias PG, Stuber M, et al. Coronary magnetic resonance angiography for the detection of coronary stenoses. N Engl J Med. 2001;345(26):1863-1869.</p>	<p>Observational-Dx</p>	<p>109 patients</p>	<p>To investigate the accuracy of coronary magnetic resonance angiography among patients with suspected coronary disease in a prospective, multicenter study.</p>	<p>A total of 636 of 759 proximal and middle segments of coronary arteries (84 percent) were interpretable on magnetic resonance angiography. In these segments, 78 (83 percent) of 94 clinically significant lesions (those with a > or = 50 percent reduction in diameter on x-ray angiography) were also detected by magnetic resonance angiography. Overall, coronary magnetic resonance angiography had an accuracy of 72 percent (95 percent confidence interval, 63 to 81 percent) in diagnosing coronary artery disease. The sensitivity, specificity, and accuracy for patients with disease of the left main coronary artery or three-vessel disease were 100 percent (95 percent confidence interval, 97 to 100 percent), 85 percent (95 percent confidence interval, 78 to 92 percent), and 87 percent (95 percent confidence interval, 81 to 93 percent), respectively. The negative predictive values for any coronary artery disease and for left main artery or three-vessel disease were 81 percent (95 percent confidence interval, 73 to 89 percent) and 100 percent (95 percent confidence interval, 97 to 100 percent), respectively.</p>	<p>1</p>

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
62. Watanuki A, Yoshino H, Udagawa H, et al. Quantitative evaluation of coronary stenosis by coronary magnetic resonance angiography. <i>Heart Vessels</i> . 2000;15(4):159-166.	Observational-Dx	137 patients	To determine whether coronary MRA can assess the degree of stenosis using the two-dimensional segmented turbo-FLASH method (2D method).	The right coronary artery was evaluated in 64 patients and the left coronary artery in 73 patients. When a marked or moderate decrease in coronary MRA blood flow signal intensity was defined as indicating stenosis, the sensitivity and specificity of coronary MRA for detecting angiographically severe stenosis were 85% and 80%, respectively. A moderate decrease in coronary MRA blood flow signal intensity detected angiographically moderate stenoses with a sensitivity of 38% and a specificity of 83%. Coronary MRA can detect a high proportion of severe stenoses but only a low proportion of moderate stenoses. Technical improvements are required before coronary MRA can be used clinically.	1
63. Dhawan S, Dharmashankar KC, Tak T. Role of magnetic resonance imaging in visualizing coronary arteries. <i>Clin Med Res</i> . 2004;2(3):173-179.	Review/Other-Dx	N/A	To discuss summarizes results from several studies comparing coronary MRA with conventional coronary angiography	No results stated in abstract	4
64. Hwang IC, Kim YJ, Kim KH, et al. Diagnostic yield of coronary angiography in patients with acute chest pain: role of noninvasive test. <i>Am J Emerg Med</i> . 32(1):1-6, 2014 Jan.	Observational-Dx	375 patients	To investigate the diagnostic yield of invasive coronary angiography (CAG) and the impact of noninvasive test (NIV) in patients presented to emergency department (ED) with acute chest pain.	Among the total 375 consecutive patients, significant CAD was observed in 244 (65.1%). Diagnostic yields of CAG were higher in patients who underwent NIV before CAG, but the discriminative effect was modest (59.7% vs 70.7% [P = .026] for detection of CAD; 45.0% vs 50.5% [P = .285] for revascularization). Positive results of NIV were significantly associated with the presence of CAD and the need for revascularization, when compared with patients without NIV or patients with negative results (P < .001, respectively).	2

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>65. Blankstein R, Ahmed W, Bamberg F, et al. Comparison of exercise treadmill testing with cardiac computed tomography angiography among patients presenting to the emergency room with chest pain: the Rule Out Myocardial Infarction Using Computer-Assisted Tomography (ROMICAT) study. <i>Circ Cardiovasc Imaging</i>. 2012;5(2):233-242.</p>	<p>Observational-Dx</p>	<p>220 patients</p>	<p>To (1) examine how data from exercise treadmill testing (ETT) can identify patients who have coronary plaque or stenosis, using CT angiography (CTA) as the reference standard, and (2) identify patient characteristics that may be used in selecting ETT versus CTA.</p>	<p>The Rule Out Myocardial Infarction Using Computer-Assisted Tomography (ROMICAT) trial was an observational cohort study of acute chest pain patients presenting to the emergency department with normal initial troponin and a nonischemic ECG. Univariate and multivariable analyses were performed to assess the relationship of baseline clinical data and ETT parameters with coronary plaque and stenosis on CTA. Of the 220 patients who had ETT (mean age, 51 years; 63% men), 21 (10%) had positive results. A positive ETT had a sensitivity of 30% and specificity of 93% to detect >50% stenosis. The sensitivity increased to 83% after excluding uninterpretable segments and evaluating the ability to detect a >70% stenosis. Predictors of plaque included older age, male sex, diabetes, hypertension, hyperlipidemia, lower functional capacity, and a lower Duke Treadmill Score. Both a positive ETT and a low Duke Treadmill Score were significant univariate and multivariable predictors of stenosis >50% on CTA. Whereas the prevalence of stenosis by CTA was greater among patients with more risk factors, coronary stenosis was not present among men <40 years old or women <50 years old or individuals who achieved at least 13 metabolic equivalents on ETT.</p>	<p>1</p>

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
66. Yoshinaga K, Chow BJ, Williams K, et al. What is the prognostic value of myocardial perfusion imaging using rubidium-82 positron emission tomography? J Am Coll Cardiol. 2006;48(5):1029-1039.	Observational-Dx	367 patients	To determine the prognostic value of rubidium-82 PET MPI, specifically in diagnosing CAD. In addition, the study evaluated the prognostic value of rubidium-82 PET MPI in a subset of patients with obesity.	There were significant differences among patients in the 3 summed stress score groups for hard events (cardiac death and MI) (P<0.001) and total cardiac events (hard events, revascularization and hospitalization) (P<0.001). The annual hard events rates were 0.4%, 2.3%, and 7.0% in the normal, mild, and moderate-severe groups, respectively. In adjusted survival models, rubidium-82 PET summed stress score was the strongest predictor of total cardiac events and a significant predictor of hard events. Among patients referred for PET after 99mTc SPECT, the annual total event rate was higher with abnormal vs normal summed stress score on PET (15.2% vs 1.3%, P<0.001). In patients with obesity, the annual total event rate was 11.1% with an abnormal scan and 1.5% with a normal scan (P<0.001). Rubidium-82 PET MPI has significant prognostic value for predicting cardiac events, including death and MI.	2
67. Schindler TH, Schelbert HR, Quercioli A, Dilsizian V. Cardiac PET imaging for the detection and monitoring of coronary artery disease and microvascular health. JACC Cardiovasc Imaging. 2010;3(6):623-640.	Review/Other-Dx	N/A	To discuss the review of cardiac PET imaging for the detection and monitoring of coronary artery disease and microvascular health.	No results stated in abstract	4
68. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf .	Review/Other-Dx	N/A	Guidance document on exposure of patients to ionizing radiation.	No results stated in abstract.	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.
- Meta-analysis
 - a. *Good quality* – the study design, methods, analysis, and results are valid and the conclusion is supported.
 - b. *Inadequate quality* – the study design, analysis, and results lack the methodological rigor to be considered a good meta-analysis study.

Abbreviations Key

Dx = Diagnostic

Tx = Treatment