Title: Computed Tomography (CT) to Detect Coronary Artery Calcification

See also:
- Cardiac Computed Tomography
- Contrast-Enhanced CTA for Coronary Artery Evaluation
- CTA and MRA of the Head, Neck, Abdomen, Pelvis, and Extremities

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**DESCRIPTION**

Several types of fast computed tomography (CT) imaging, including electron beam computed tomography and spiral CT, allow the quantification of calcium in coronary arteries. Coronary artery calcium (CAC) is associated with coronary artery disease (CAD). The use of CAC scores has been studied in the prediction of future risk of CAD and in the diagnosis of CAD in symptomatic patients.

Coronary artery calcium (CAC) is associated with coronary artery disease (CAD) based anatomic studies. The development of fast computed tomography (CT) scanners has allowed the measurement of CAC in clinical practice. CAC has been evaluated in several clinical settings. The most widely studied indication is for the use of CAC in the prediction of future risk for CAD in patients with subclinical disease, with the goal of instituting appropriate risk-reducing therapy (eg, statin treatment; lifestyle modifications) to improve outcomes. In addition, CAC has been evaluated in patients with symptoms potentially consistent with CAD, but in whom a diagnosis is unclear.

Electron beam computed tomography (EBCT, also known as ultrafast CT) and spiral CT (or helical CT) may be used as an alternative to conventional CT scanning due to their faster throughput. Their speed of image acquisition gives them unique value for imaging a moving heart. The rapid image acquisition time virtually eliminates motion artifact related to cardiac contraction, permitting visualization of the calcium in the epicardial coronary arteries. EBCT software permits quantification of calcium area and density, which are translated into calcium scores. Calcium scores have been investigated as a technique for detecting CAC, both as a diagnostic technique in symptomatic patients to rule out an atherosclerotic etiology of symptoms or, in asymptomatic patients, as an adjunctive method for risk stratification for CAD.

EBCT and multidetector computed tomography were initially the primary fast CT methods for measurement of CAC. A fast CT study for CAC measurement generally takes 10 to 15 minutes and requires only a few seconds of scanning time. More recently, computed tomography angiography (CTA) has been used to assess coronary calcium. Because of the basic similarity between EBCT and CTA in measuring coronary calcium, it is expected that CTA provides similar information on coronary calcium that is similar to EBCT.
CT scan–derived coronary calcium measures have been used to evaluate coronary atherosclerosis. Coronary calcium is present in coronary atherosclerosis, but the atherosclerosis detected may or may not be causing ischemia or symptoms. Coronary calcium measures may be correlated with the presence of critical coronary stenoses or serve as a measure of the patient’s proclivity toward atherosclerosis and future coronary disease. Thus, it could serve as a variable to be used in a risk assessment calculation for the purposes of determining appropriate preventive treatment in asymptomatic patients. Alternatively, in other clinical scenarios, it might help determine whether there is atherosclerotic etiology or component to the presenting clinical problem in symptomatic patients, thus helping to direct further workup for the clinical problem. In this second scenario, a calcium score of 0 usually indicates that the patient’s clinical problem is unlikely to be due to atherosclerosis and that other etiologies should be more strongly considered. In neither case does the test actually determine a specific diagnosis. Most clinical studies have examined the use of coronary calcium for its potential use in estimating the risk of future coronary heart disease events.

Coronary calcium levels can be expressed in many ways. The most common method is the Agatston score, which is a weighted summed total of calcified coronary artery area observed on CT. This value can be expressed as an absolute number, commonly ranging from 0 to 400. These values can be translated into age- and sex-specific percentile values. Different imaging methods and protocols will produce different values based on the specific algorithm used to create the score, but the correlation between any 2 methods appears to be high, and scores from 1 method can be translated into scores from a different method.

**Regulatory Status**
Many models of computed tomography (CT) devices, including electron beam computed tomography and other ultrafast CT devices, have been cleared for marketing by the U.S. Food and Drug Administration through the 510(k) process. FDA product code: JAK.

**POLICY**
The use of computed tomography (CT) to detect coronary artery calcification (CAC) is considered experimental / investigational.
Rationale
This evidence review has been updated periodically with literature review of the MEDLINE database. The most recent update covers the period through July 26, 2016. This review is based, in part, on a 1998 TEC Assessment.1

Coronary Artery Calcium Scoring in Asymptomatic Individuals

Coronary Artery Calcium for Coronary Artery Disease Risk Stratification

Many prospective studies have provided evidence for the predictive capacity of calcium scores in addition to assessment of traditional risk factors for coronary heart disease (CHD) among asymptomatic subjects. This review focuses on relevant large prospective studies.

In 2015, Pursnani et al used data from the offspring and third-generation cohorts of the Framingham Heart Study, including 2435 statin-naive individuals, to evaluate the association of coronary artery calcium (CAC) scores as a predictive factor (beyond typical risk factors) with incident cardiovascular disease (CAD).2 CAC scores greater than 100 and greater than 300 were associated with increased risk of cardiac events in both statin eligible and noneligible subjects. In a study of 1029 asymptomatic adults with at least 1 coronary risk factor, Greenland et al showed that a calcium score of greater than 300 predicted increased risk of cardiac events within Framingham risk categories.3 A study by Arad et al showed similar findings in a population-based sample of 1293 subjects who had both traditional risk factors and calcium scores evaluated at baseline.4 A study by Taylor et al evaluated the association between the Framingham risk scores and calcium scores in a young military population (mean age, 43 years).5 Although only 9 acute coronary events occurred, calcium scores were associated with risk of events while controlling for the risk score. LaMonte et al also analyzed the association between calcium scores and CHD events in 10,746 adults.6 In this study, coronary risk factors were self-reported. During a mean follow-up of 3.5 years, 81 CHD events occurred. Like other studies, the relation between calcium scores and CHD events remained after adjusting for other risk factors. Budoff et al evaluated the association between coronary calcium scores and CHD events during 5-year follow-up of 2232 adults from the Multiethnic Study of Atherosclerosis (MESA), a prospective cohort study to evaluate cardiac risk factors, and 3119 subjects from the Heinz Nixdorf RECALL (Risk factors, Evaluation of Coronary Calcium and Lifestyle Factors) study.7 Increasing Agatston score was associated with increased risk of CHD. In the MESA study, compared with a CAC score of 0, having a score greater than 400 was associated with a hazard ratio (HR) for CHD of 3.31 (95% confidence interval [CI], 1.12 to 9.8) after adjusting for CHD risk factors; a score ranging from 100 to 399 was associated with a hazard ratio of 3.27 (95% CI, 1.19 to 8.95). In the RECALL study, the HR for CHD was 2.96 (95% CI, 1.22 to 7.19). Lower CAC scores were not significantly associated with CHD after adjusting for other risk factors. Other studies have shown similar findings.8-12

Additional analysis of data from the MESA study found that CAC scores are associated with CHD events among individuals at either high or low CHD risk on the basis of traditional risk factors.13 Gibson et al also used data from the MESA study to evaluate the relation between CAC and incidence of cerebrovascular events, including all strokes and transient ischemic attacks (TIAs).14 Over an average of 9.5 years of follow-up, 234 (3.5%) cerebrovascular events occurred. Having an elevated CAC score was independently predictive of both cerebrovascular events (HR=1.70; 95% CI, 1.24 to 2.35; p=0.001) and stroke (HR=1.59; 95% CI, 1.11 to 2.07; p=0.01). Blaha et al also used data from MESA to demonstrate that a CAC score of 0 was associated with the highest reclassification in cardiovascular risk compared with other risk markers (eg, high-sensitivity C-reactive protein [hs-CRP]).15
Other studies have defined how the incorporation of calcium scores into risk scores changes risk prediction. In a study by Polonsky et al, incorporation of calcium score into a risk model resulted in more subjects (77% vs 66%) being classified in either high- or low-risk categories. Subjects reclassified to high risk had a similar risk of CHD events as those originally classified as high risk. A study by Elias-Smale et al showed similar findings; reclassification of subjects occurred most substantially in the intermediate-risk group (5-year risk, 5%-10%) where 56% of persons were reclassified.17

Some studies have evaluated whether CAC score changes CHD risk prediction in addition to other types of noninvasive testing in conjunction with clinical risk scores. Chang et al prospectively evaluated whether CAC score added incremental predictive value to exercise treadmill testing and stress myocardial perfusion single-photon emission computed tomography testing in predicting risk of cardiac events, defined as a composite of cardiac death, nonfatal myocardial infarction, and the need for coronary revascularization, in a cohort of 988 asymptomatic and symptomatic low-risk patients without known CHD.18 Over a median follow-up of 6.9 years, the rate of cardiac events was 11.2% (1.6% per year). Annual event rates were higher in patients with CAC scores above 400 (3.7% per year) compared to those with CAC scores of 10 or less (0.6% per year; p<0.001). The addition of CAC score to risk stratification based on the Framingham risk score improved risk prediction.

Numerous studies have also evaluated the predictive ability of coronary calcium using computed tomography angiography (CTA).19-22 These studies have included different populations, such as patients with or without risk factors or patients with an intermediate risk of CAD. Similar to studies that use external-beam computed tomography (EBCT), these studies have demonstrated that calcium scores derived from CTA provide incremental predictive information for the overall risk of CAD compared with coronary angiography, and for the future occurrence of major cardiac events.

CAC Impact on Cardiac Risk Factor Profiles in Practice
While epidemiologic studies have suggested that CAC scoring may be associated with future CHD risk, this does not, by itself, demonstrate that the use of CAC scoring improves clinical outcomes.

A small number of randomized controlled trials (RCTs) have assessed the impact of CAC measurements on cardiac risk factors. In 2012, Whelton et al published a meta-analysis of RCTs that evaluated the impact of CAC scores on cardiac risk profiles and cardiac procedures.23 There were 4 trials identified (total N=2490 participants); the individual trials ranged in size from 50 to 1934 patients. The reviewers pooled data from 4 trials on the impact of calcium scores on blood pressure, 3 on the impact on low-density lipoprotein, and 2 on the impact on high-density lipoprotein. Pooled analysis did not show a significant change in any of these parameters as a result of calcium scores. Similarly, in 4 studies that looked at the rates of smoking cessation following calcium scores, no significant change was found. Two studies included rates of coronary angiography and 2 studies included rates of revascularization. Pooled analysis of these studies did not show a significant change after measurement of coronary calcium.

Two RCTs representative of this evidence are detailed here. O'Malley et al randomized 450 subjects to receive EBCT or not and assessed outcomes 1 year later for change in Framingham risk score.24 Thus, EBCT was to be used to refine risk in patients and possibly provide motivation...
for behavioral change. The trial was not powered for clinical end points. EBCT did not produce any benefits in terms of a difference in Framingham risk score at 1 year.

A 2011 RCT evaluated the impact of computed tomography (CT) scanning for CAC on cardiac risk factors.25 A total of 2137 healthy subjects were randomized to CT scanning or no CT scanning and followed for 4 years. At baseline, both groups received 1 session of risk factor counseling by a nurse practitioner. The primary outcome was change in 12 cardiac risk profile measures, including blood pressure, lipid and glucose levels, weight, exercise, and the Framingham risk score. At the 4-year follow-up, there was differential dropout among the groups, with 88.2% of follow-up in the scan group versus 81.9% in the no-scan group. Results demonstrated differences in 4 of the 12 risk factor measurements between groups: systolic blood pressure, low-density lipoprotein, waist circumference, and mean Framingham risk score.

This trial highlights the potential benefit of CAC screening in modifying cardiac risk profile but is not definitive in demonstrating improved outcomes. Trial limitations included differing intensities of interventions between groups and differential dropout. It is possible that the small differences reported in the trial result from bias related to these methodologic limitations. In addition, this trial did not compare the impact of other types of risk factor intervention, most notably more intensive risk factor counseling. Finally, the generalizability of the findings is uncertain, because this was a volunteer population that might have been highly motivated for change.

A number of studies have evaluated whether the use of CAC scoring in asymptomatic patients is associated with subsequent behavioral change—particularly related to risk factor reduction or medication adherence. Mamudu et al conducted a systematic review of studies evaluating the effects of CAC screening on behavioral modification, risk perception, and medication adherence in asymptomatic adults.26 Fifteen studies were selected, 3 RCTs and 12 observational studies. The systematic review primarily provided descriptive results of the studies given the lack of standardization across studies in terms of CAC measures and outcome variables. Thirteen of the 15 studies, including 2 of the RCTs, reported increased medication adherence in CAC-screened patients. An example of an observational study included in the Mamudu review was reported by Johnson et al, who assessed the association between CAC score and subsequent health behavior change.27 The study included a convenience sample of 174 adults with CHD risk factors who underwent CAC scoring. The authors found no significant between-group change in risk perception measured by Perception of Risk of Heart Disease Scale scores (CAC score, 0, 1-10, 11-100, 101-400, >400), with the exception of a small increase in the moderate-risk group (CAC score, 101-400) from 55.5 to 58.7 (p=0.004). All groups demonstrated increases in health-promoting behavior over time.

Shreibati et al used Medicare claims data to compare clinical outcomes and cardiac testing utilization for patients who had CAC scoring to patients who had hs-CRP testing or lipid screening.28 The study included 4184 patients with CAC scores who were propensity-score matched to 261,356 patients with hs-CRP testing and 118,093 patients with lipid screening. CAC testing was associated with increased rates of noninvasive cardiac testing within 180 days (HR=2.22 [95% CI, 1.68 to 2.93; p<0.001] vs hs-CRP; HR=4.30 [95% CI, 3.04 to 6.06; p<0.001] vs lipid screening). It was also associated with increased rates of coronary angiography (HR=3.54 [95% CI, 1.91 to 6.55; p<0.001] vs hs-CRP; HR=4.23 [95% CI, 2.31 to 7.74; p<0.001]). Overall rates of the composite outcome of death, myocardial infarction (MI), or stroke were low, but event-free survival was higher in patients who underwent CAC (94.4%) compared with those who had hs-CRP (92.7%; p=0.008).
Section Summary: Coronary Artery Calcium Scoring for Coronary Artery Disease Risk Stratification

Multiple prospective studies have found that CAC scoring is associated with future risk of CHD events. CAC scores likely add to the predictive ability of clinical risk prediction models. However, relevant studies enrolled different populations, assessed different traditional risk factors, and assessed different coronary disease outcomes. Different calcium score cutoffs were analyzed in these studies. Given the variation across studies, the magnitude of increased risk conferred by a given calcium score is still uncertain. Some evidence from cohort studies has also suggested that CAC scoring may be associated with stroke risk. Studies that used CAC scoring in asymptomatic patients have reported mixed findings whether CAC testing leads to improved cardiovascular risk profiles or improvements in other meaningful clinical outcomes. The largest meta-analysis did not find significant improvements in cardiac risk profiles or changes in cardiac procedures with the use of CAC scoring.

CAC for Ruling Out Atherosclerotic Etiology of Disease in Symptomatic Patients

In certain clinical situations, such as patients presenting with chest pain, it is uncertain whether the symptoms are due to CHD. Coronary calcium measurement has been proposed as a method to rule out CHD in certain patients if the coronary calcium score is 0. Because CAD can only very rarely occur in the absence of coronary calcium, the presence of any coronary calcium can be a sensitive but not specific test for coronary disease. False positives occur because the calcium may not be causing ischemia or symptoms. The absence of any coronary calcium can be a specific test for the absence of coronary disease and direct the diagnostic workup toward other causes of the patient’s symptoms. In this context, coronary calcium measurement is not used to make a positive diagnosis but is used as a diagnostic “filter” to rule out an atherosclerotic cause for the patient’s symptoms.

For example, Yerramasu et al prospectively assessed an evaluation algorithm including CAC scoring for patients presenting to a rapid access chest pain clinic with stable chest pain possibly consistent with CHD.29 Three hundred patients presenting with acute chest pain to 1 of 3 chest pain clinics underwent CAC scoring. If the CAC score was 1000 or more Agatston units, invasive coronary angiography (ICA) was performed, and if the CAC score was less than 1000, coronary computed tomography angiography (CCTA) was performed. All patients with a CAC score of 0 and low pretest likelihood of CHD had no obstructive CHD on CCTA and were event-free during follow-up. Of the 18 patients with CAC scores from 400 to 1000, 17 (94%) had greater than 50% obstruction on subsequent CCTA and were referred for further evaluation, 14 (78%) of whom had obstructive CHD. Of 15 patients with CAC scores 1000 or more and who were referred for coronary angiography, obstructive CHD was present in 13 (87%). This study suggested that CAC scoring can be used in the acute chest pain setting to stratify decision making for further testing.

In a study by Laudon et al in the emergency department (ED) setting, 51% (133/263) patients with chest pain and low-to-moderate probability of CAD had calcium scores of 0.30 One of these patients was found to have CAD. The others were presumed to not have CAD, and it is claimed that these patients could have been safely discharged from the ED. However, the study was not rigorous in its methods on the alternative workup of potential CAD in the ED or in the long-term follow-up of patients.

In addition to studies using CAC scores to rule out CHD among patients presenting with symptoms potentially consistent with CHD, CAC scoring has also been evaluated to rule in or out potential CHD in symptomatic patients before ICA or stress nuclear imaging. The 2007 expert
consensus guidelines from the American College of Cardiology Foundation and the American Heart Association stated that CAC may serve "as a filter prior to invasive coronary angiography or stress nuclear imaging" but that "prognostic studies of CAC in symptomatic patients have generally been limited by biased samples (e.g., patients referred for invasive coronary angiography) and small numbers of hard outcome events."³¹

Since that 2007 consensus statement, several studies have addressed the use of CAC scoring as part of a management strategy for patients presenting with symptoms possibly consistent with CHD. In 2015, Pursnani et al published results from a subanalysis of the ROMICAT II trial evaluating the incremental diagnostic value of CAC scoring in addition to CCTA in low- to intermediate-risk patients presenting to the ED with symptoms suggesting acute coronary syndrome (ACS).³² The ROMICAT II trial randomized patients with possible ACS to CCTA as part of an initial evaluation or to the standard ED evaluation strategy, as directed by local caregivers. As part of the protocol, all patients undergoing CCTA had a CAC scan; the present analysis included 473 patients who underwent both CCTA and CAC scanning. Among these patients, the ACS rate (defined as unstable angina and MI during the index hospitalization) was 8% (n=38). Patients with lower CAC scores were less likely to have a discharge diagnosis of ACS. Among 253 patients with a CAC score of 0, 2 (0.8%) patients with ACS (95% CI, 0.1% to 2.8%). Receiver operating characteristic (ROC) curve analysis was used to predict the risk of ACS by CAC score greater than 0, continuous CAC score, CCTA results, and combined CAC and CCTA score. The optimal cut point of CAC for ACS detection was 22 (C statistic, 0.81), with 318 (67%) patients having a CAC score less than 22. All CCTA strategies had high sensitivity for ACS detection, without significant differences across stenosis thresholds. CAC was inferior to CCTA for predicting ACS (C range, 0.86 vs 0.92; p=0.03). The addition of CAC score to CCTA (ie, using selective CCTA only for patients with CAC score >22 or >0) did not significantly improve the detection of ACS (CAC+CCTA C=0.93 vs CCTA C=0.92; p=0.88). Overall, this study suggested that CAC scoring does not provide incremental value beyond CCTA in predicting likelihood of ACS in a low- to intermediate-risk population presenting to the ED.

In 2014, Hulten et al published results from a retrospective cohort study among symptomatic patients without a history of CHD to evaluate the accuracy of CAC for excluding coronary stenosis among symptomatic patients, using CCTA as the criterion standard.³³ The study included 1145 patients who had symptoms possibly consistent with CHD who underwent a noncontrast CAC score and a contrast enhanced CCTA from 2004 to 2011. For detection of greater than 50% stenosis, CAC had a sensitivity of 98% and specificity of 55%, corresponding to a negative predictive value of 99%. For prediction of cardiovascular death or MI, the addition of either or both CAC or CCTA to a clinical prediction score did not significantly increase prognostic value.

In another retrospective study, Chaiyriangkrai et al evaluated whether CAC added incremental value to CCTA for predicting coronary artery stenosis in 805 symptomatic patients without known CHD.³⁴ CAC score was significantly associated with the presence of coronary artery stenosis on CCTA. Both CAC score and the presence of CCTA stenosis were significantly associated with rates of major adverse cardiac events (MACE), including cardiac death, nonfatal MI, and late coronary revascularization. Patients with more than 50% stenosis on CCTA had higher rates of MACE, compared with those with normal CCTA (4.5% vs 0.1%, p<0.001) and with those with less than 50% stenosis (4.5% vs 1.4%, p=0.002). Those with a CAC score of more than 400 had higher rates of MACE than those with scores between 1 and 100 (4.2% vs 1.4%, p=0.014) and those with scores of 0 (4.2% vs 0% p<0.001). The addition of CAC score to a risk prediction model for
MACE, which included clinical risk factors and CCTA stenosis, significantly improved the model’s predictive performance (108 vs 70, p=0.019).

Ten Kate et al prospectively evaluated the accuracy of cardiac CT, including CAC scoring with or without CCTA, in distinguishing heart failure due to CAD from heart failure due to non-CAD causes. Data on the predictive ability of a negative CAC score in ruling out CAD was also included. The study included 93 symptomatic patients with newly diagnosed heart failure of unknown etiology, all of whom underwent CAC scoring. Those with a CAC score of greater than 0 underwent CCTA, and if the CCTA was positive for CAD (>20% luminal diameter narrowing), ICA was recommended. Forty-six percent of patients had a CAC score of 0. At a mean follow-up of 20 months, no patient with a CAC score of 0 had a MI, underwent percutaneous coronary intervention, had a coronary artery bypass graft, or had signs of CAD.

Dharampal et al retrospectively evaluated a cohort of 1975 symptomatic patients who underwent clinical evaluation and CAC scoring and CCTA or ICA. The primary outcome was obstructive CAD (≥50% stenosis) on ICA or CCTA (if ICA was not done). The authors evaluated the net reclassification improvement with the addition of CAC score to a clinical prediction model for patients who had an intermediate probability of CHD (10%-90%) after clinical evaluation based on chest pain characteristic, age, sex, risk factors, and electrocardiogram. Discrimination of CAD was significantly improved by adding the CAC score to the clinical evaluation (area under the curve, 0.80 vs 0.89, p<0.001).

In 2015, in a pilot study, Korley et al described a diagnostic strategy of low- to high-sensitivity troponin I (hsTnI) and CAC to identify individuals at low risk of CAD presenting with suspected ACS, and in whom CCTA could be avoided. The authors reported on 314 patients who presented to an ED with suspected ACS. Using a strategy of no further testing for patients with undetectable hsTnI while obtaining CAC scores for patients with detectable but nonincreased hsTnI and CTA in subjects with an Agatston score greater than 0 yielded an NPV of 100.0% (95% CI, 98.2% to 100%) for significant CAD.

Section Summary: CAC for Ruling Out Atherosclerotic Etiology of Disease in Symptomatic Patients
A number of studies have suggested that CAC scoring could be used to rule in or out CHD, particularly on decisions about further invasive imaging. However, relatively few studies have employed a prospective design. Further studies need to address some of the potential barriers to such an approach, including whether performing CAC scoring in symptomatic patients delays diagnosis or intervention and whether the net effect of CAC scoring is to increase or decrease invasive testing.

Ongoing and Unpublished Clinical Trials
Some currently unpublished trials that might influence this review are listed in Table 1.

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<td>Individualized Comprehensive Atherosclerosis Risk-reduction Evaluation Program</td>
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NCT: national clinical trial.

a Denotes industry-sponsored or cosponsored trial.
Summary of Evidence
For individuals who are asymptomatic with risk of coronary artery disease (CAD) who receive coronary artery calcium (CAC) scoring, the evidence includes multiple prospective studies. Relevant outcomes include overall survival, test accuracy and validity, morbid events, resource utilization, and resource utilization. There is extensive evidence on the predictive value of CAC score screening for cardiovascular disease among asymptomatic patients, and this evidence has demonstrated that scanning has incremental predictive accuracy above traditional risk factor measurement. However, evidence from high-quality studies that has demonstrated that the use of CAC score measurement in clinical practice leads to changes in patient management or in individual risk behaviors that improve cardiac outcomes is lacking. At least 1 randomized controlled trial (RCT) has suggested that the use of CAC score measurement in clinical practice may be associated with improved cardiac risk profiles, but an association between CAC score measurement with improved outcomes has not yet been demonstrated in other studies. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals with signs and/or symptoms suggestive of CAD who receive CAC scoring before other diagnostic testing, the evidence includes prospective and retrospective nonrandomized studies. Relevant outcomes include overall survival, test accuracy and validity, morbid events, resource utilization, and resource utilization. CAC scoring has potential as a diagnostic test to rule out CAD in patients presenting with symptoms or as a “gatekeeper” test before invasive imaging is performed. Evidence from retrospective studies has suggested that negative results on CAC scoring rule out CAD with good reliability, and at least 1 prospective study has suggested that CAC score can be used in an emergency setting to stratify patients for further testing. However, further prospective trials would be needed to demonstrate that such a strategy is effective in practice and is at least as effective as alternative strategies for ruling out CAD. To demonstrate that use of calcium scores improves the efficiency or accuracy of the diagnostic workup of symptomatic patients, rigorous studies that define exactly how CAC scores are used in combination with other tests in the triage of patients would be necessary. The evidence is insufficient to determine the effects of the technology on health outcomes.

Clinical Input Received From Physician Specialty Societies and Academic Medical Centers
While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

2011 Input
In response to requests, input was received from 2 specialty societies and 5 academic medical centers while this policy was under review in 2011. Input was mixed on the investigational status of CAC screening. Four of the 7 reviewers agreed with the investigational status; 3 dissented. The dissenters primarily cited evidence on the accuracy of scanning for risk prediction of CAD.

2008 Input
In response to requests, input was received through 2 physician specialty societies and 4 academic medical centers while this policy was under review in 2008. Most providing input agreed with the conclusions of this policy (investigational) as approved in 2008.
Practice Guidelines and Position Statements

American Heart Association

In 2006, the American Heart Association (AHA) issued a scientific statement on the use of cardiac CT. Most of the document reviewed the utility of calcium scoring for the use of determining prognosis and diagnosis. In addition to reviewing a large body of evidence on calcium scoring, clinical recommendations were offered. No indications received a class I recommendation (ie, evidence and/or agreement that the procedure is useful and effective). Several indications received a class IIb recommendation, which means that there was conflicting evidence and/or a divergence of opinion regarding usefulness or efficacy. Class IIb evidence indicates usefulness/efficacy has been less well-established; class III evidence indicates the procedure or treatment is not useful or possibly harmful.

Class IIb recommendations:
- “...patients with chest pain with equivocal or normal ECGs [electrocardiographs] and negative cardiac enzymes...”
- “...determining the etiology of cardiomyopathy...”
- “...symptomatic patients, ... in the setting of equivocal treadmill or functional tests”
- Asymptomatic patients with “intermediate−CAD risk patients (eg, those with a 10% to 20% Framingham 10-year risk estimate)....”

Class III recommendations:
- “Asymptomatic persons ... found to be at low risk (<10% 10-year risk) and high risk (>20% 10-year risk) do not benefit....”
- “...It is not recommended ... in asymptomatic persons to establish the presence of obstructive disease for revascularization...”
- “Serial imaging for assessment of progression of coronary calcification is not indicated...”
- “...hybrid nuclear/CT imaging is not recommended...”

American College of Cardiology Foundation and American Heart Association

A 2007 clinical consensus document cowritten by the American College of Cardiology Foundation (ACCF) and AHA and other medical societies reviewed much of the same evidence as the 2006 AHA scientific statement. It should be noted that this type of consensus document represents the best attempt of ACCF and AHA to inform clinical practice where rigorous evidence is not yet available. Thus formal grading of evidence and classification of clinical recommendations were not reported. This document essentially concluded that the indications receiving an IIb recommendation in the 2006 scientific statement “may be reasonable.” Recommendations from the 2010 ACCF/AHA guidelines are noted next.

In 2010, ACCF, AHA, and others released recommendations on calcium scoring as part of their guidelines on the management of cardiovascular risk in asymptomatic patients. These recommendations included the following:
- Class IIa recommendation: Measurement of CAC is reasonable for cardiovascular risk assessment in asymptomatic adults at intermediate risk (10% to 20% 10-year risk). (Level of Evidence: B)
- Class IIb recommendation: Measurement of CAC may be reasonable for cardiovascular risk assessment in persons at low to intermediate risk (6% to 10% 10-year risk). (Level of Evidence: B)
- Class III recommendation: No Benefit. Persons at low risk (<6% 10-year risk) should not undergo CAC measurement for cardiovascular risk assessment. (Level of Evidence: B)
In 2012, ACCF, AHA, and others released guidelines for the diagnosis and management of patients with stable ischemic heart disease (IHD) that include some recommendations related to CAC scoring:

Class IIb recommendation: For patients with a low to intermediate pretest probability of obstructive IHD, noncontrast cardiac computed tomography to determine the coronary artery calcium score may be considered. (Level of Evidence: C)

In 2014, ACCF, AHA, and others issued focused update to the 2012 guideline on the diagnosis and management of patients with stable IHD with no additional recommendations related to CAC scoring.

**U.S. Preventive Services Task Force Recommendations**
The U.S. Preventive Services Task Force (USPSTF) issued recommendations on the use of nontraditional or novel risk factors in assessing coronary heart disease risk in asymptomatic persons in 2009. Calcium score was 1 of 9 risk factors considered in the report. The authors concluded that the current evidence was insufficient to assess the balance of benefits and harms of using any of the nontraditional risk factors studied to assess risk of coronary disease in asymptomatic persons. In USPSTF’s focused review of 5 studies, which it judged to have valid study designs, USPSTF found wide variation in the estimates of the risk ratio for higher calcium scores. Higher quality studies had lower relative risks for a given difference in calcium score.

**CODING**
The following codes for treatment and procedures applicable to this policy are included below for informational purposes. Inclusion or exclusion of a procedure, diagnosis or device code(s) does not constitute or imply member coverage or provider reimbursement. Please refer to the member’s contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

**CPT/HCPCS**

- 75571 Computed tomography, heart, without contrast material, with quantitative evaluation of coronary calcium
- S8092 Electron beam computed tomography (also known as ultrafast CT, cine CT)

- There is a category I CPT code for this imaging, which is 75571.
- When quantitative assessment is performed as part of the same encounter as contrast-enhanced cardiac CT (codes 75572-75573) or coronary CT angiography (code 75574), it is included in the service.
- The primary fast CT methods for this determination are electron beam computed tomography (EBCT) and multi-detector computed tomography (MDCT).

**DIAGNOSIS**
Experimental / Investigational for all diagnoses related to this policy.

**REVISIONS**

- 11-14-2008: Changed title from Electron Beam Computerized Tomography (EBCT) Screening for Cardiovascular Calcium Deposits also known as Ultrafast CT, CT angiography and CINE CT to Computed Tomography to Detect Coronary Artery Calcification.
### CT to Detect Coronary Artery Calcification

<table>
<thead>
<tr>
<th>Date</th>
<th>Section/Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-18-2009</td>
<td>Added a rationale section to the policy. In Coding section, added CPT codes: 0144T, 0147T, 0149T.</td>
</tr>
<tr>
<td>01-01-2010</td>
<td>In Header: Added reference policies: Contrast-Enhanced CTA for Coronary Artery Evaluation, CTA and MRA of the Chest (excluding the heart), CTA and MRA of the Head, Neck, Abdomen, Pelvis, Lower Extremity, and Upper Extremity, and Cardiac Computed Tomography (CT). Updated Rationale and References sections</td>
</tr>
<tr>
<td>09-20-2011</td>
<td>In Coding Section: Added CPT Code: 75571. Removed CPT Codes: 0144T, 0147T, 0149T</td>
</tr>
<tr>
<td>11-06-2012</td>
<td>Description section updated. Rationale section added. References section updated.</td>
</tr>
<tr>
<td>11-24-2015</td>
<td>Description section updated. In Policy section: Added &quot;(CAC)&quot; the abbreviation for coronary artery calcification. No change in policy intent is made by this addition. Rationale section updated. References updated.</td>
</tr>
</tbody>
</table>

### REFERENCES

1. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Diagnosis and screening for coronary artery disease with electron beam computed tomography. TEC Assessments. 1998;Volume 13:Tab 27.


24. O'Malley PG, Feuerstein IM, Taylor AJ. Impact of electron beam tomography, with or without case management, on motivation, behavioral change, and cardiovascular risk profile: a randomized controlled trial. JAMA. May 7 2003;289(17):2215-2223. PMID 12734132


