

Prognostic Value of Coronary Artery Calcium Score in Acute Chest Pain Patients Without Known Coronary Artery Disease: Systematic Review and Meta-analysis



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Study objective: Coronary artery calcium score (CACs) is a well-established test for risk stratifying asymptomatic patients. Recent studies also indicate that CACS may accurately risk stratify stable patients presenting to the emergency department (ED) with acute chest pain; however, many were underpowered. The purpose of this systematic review and meta-analysis is to evaluate the prognostic value and accuracy of a zero (normal) CACS for identifying patients at acceptable low risk for future cardiovascular events who might be safely discharged home from the ED.

Methods: We searched multiple databases for longitudinal studies of CACS in symptomatic patients without known coronary artery disease that reported major adverse cardiovascular events (MACEs), including death and myocardial infarction. Pooled risk ratios, sensitivity, specificity, and likelihood ratios were analyzed.

Results: Eight studies evaluated 3,556 patients, with a median follow-up of 10.5 months. Pooled prevalence of zero CACS was 60%. Patients with CACS=0 had a significantly lower risk of cardiovascular events compared with those with CACS greater than 0 (MACEs: relative risk 0.06, 95% confidence interval 0.04 to 0.11, $I^2=0\%$; death/myocardial infarction: relative risk 0.19; 95% confidence interval 0.08 to 0.47, $I^2=0\%$). The pooled event rates for CACS=0 (MACEs 0.8%/year; death/myocardial infarction 0.5%/year) were significantly lower than for CACS greater than 0 (MACEs 14.6%/year; death/myocardial infarction 3.5%/year). Analysis of summary testing parameters showed a sensitivity of 96%, specificity of 60%, positive likelihood ratio of 2.36, and negative likelihood ratio of 0.07.

Conclusion: Acute chest pain patients without history of coronary artery disease, ischemic ECG changes, or increased cardiac enzyme levels commonly have a CACS of zero, with a very low subsequent risk of MACEs or death or myocardial infarction. This meta-analysis proffers the potential role of initial CACS testing for avoiding unnecessary hospitalization and further cardiac testing in acute chest pain patients with a CACS of zero. [Ann Emerg Med. 2016;68:659-670.]

Please see page 660 for the Editor's Capsule Summary of this article.

A [podcast](#) for this article is available at www.annemergmed.com.

0196-0644/\$-see front matter

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<http://dx.doi.org/10.1016/j.annemergmed.2016.07.020>

INTRODUCTION

The coronary artery calcium score (CACs) is a well-established test for risk stratifying asymptomatic patients, is an independent predictor of long-term prognosis,¹ and performs better than many other risk-stratifying tools.² According to the most recent American Heart Association and American College of Cardiology Foundation guidelines, CACS has class IIA and IIB recommendations for assessing risk in intermediate- and low- to intermediate-risk asymptomatic patients, respectively,³ and in guiding management of hyperlipidemia.⁴ Recent studies also indicate that CACS may accurately risk stratify both low-risk stable patients with new-onset chest pain^{5,6} and those presenting to the

emergency department (ED) with acute chest pain symptoms.⁷ Most studies in the latter group were limited by relatively small numbers of patients.

Hence, the objective of this systematic review and meta-analysis was to evaluate the prognostic value and accuracy of a zero (normal) CACS for identifying patients at acceptable low risk for future cardiovascular events who might be safely discharged home from the ED.

MATERIALS AND METHODS

Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines⁸ were followed for the conduct of the current systematic review and meta-analysis. We searched MEDLINE, EMBASE, and the Cochrane Library database

Editor's Capsule Summary

What is already known on this topic

Although coronary artery calcium score (CACS) is used to risk stratify asymptomatic patients for cardiac events, studies examining this test in the emergency department (ED) are underpowered.

What question this study addressed

It described the prognostic value and accuracy of CACS to predict major adverse cardiac events in ED patients.

What this study adds to our knowledge

In this systematic review of 8 studies that included patients with nonischemic ECG results and normal troponin levels, the risk of major adverse cardiac events was considerably lower in the 60% of patients with a CACS of 0 (relative risk 0.06; 95% confidence interval 0.04 to 0.22).

How this is relevant to clinical practice

The absence of calcium on coronary computed tomography is associated with a far lower risk of major adverse cardiac events, but it remains unclear whether this reduction in risk warrants the cost and radiation burden of this procedure.

revascularization (percutaneous coronary intervention and coronary artery bypass graft surgery) who presented with acute chest pain to the ED and were evaluated with CACS testing. Studies with mixed populations (acute chest pain, chronic chest pain, asymptomatic or established coronary artery disease, and suspected coronary artery disease) could be included in our meta-analysis if the studies explicitly mentioned CACS and cardiovascular events in the subgroup of acute chest pain patients without known coronary artery disease. Studies with cross-sectional design were not included.

2. CACS that was performed by CT, either multidetector CT or electron-beam CT, and quantified with the Agatston method. CACS testing could be either isolated CACS assessment or CACS assessment performed before contrast-enhanced coronary CT angiography studies.
3. Studies that reported major adverse cardiovascular events (MACEs) at greater than or equal to 1 month after the index ED visit. MACEs could be all-cause death, cardiac death, acute coronary syndrome, nonfatal myocardial infarction, coronary revascularization, ischemic stroke, or cardiac hospitalization.

We did not include case reports, non-English studies, review articles without systematic approach and meta-analysis data, or conference abstracts. Two physician-investigators (K.C. and H.Y.J.) independently assessed studies for eligibility. Discrepancy was resolved by consensus determined by an additional investigator (physician-investigator G.P.S.S.).

for studies assessing prognostic value of CACS by computed tomography (CT). We used the text words and related Medical Subject Headings for “cardiac,” “calcification,” “computed tomography,” “prognosis,” “mortality,” “event,” “death,” “survival,” and “myocardial infarction.” Our search query was “coronary” OR “cardiac” AND (“calcification” OR “calcified” OR “calcium”) AND (“computed” AND “tomography” OR “CT”) AND (“prognosis” OR “mortality” OR “event” OR “death” OR “survival” OR [“myocardial” AND “infarction”]). We chose not to limit the search by whether the population was symptomatic or asymptomatic from the initial search strategy to include as many potential studies as possible. The initial search results were further investigated manually, as described below. The last search was performed on September 5, 2015.

We initially reviewed the title and abstracts of retrieved citations. Then full texts of those citations considered relevant were assessed for eligibility for inclusion. Inclusion criteria were the following:

1. Prospective cohort studies that involved patients without known coronary artery disease or history of coronary

Data Collection and Processing

Two coauthors (physician-investigators K.C. and H.Y.J.) independently extracted data from the included full-text citations. The following information was abstracted: the last name of the first author; publication year; country where the study was performed; total participants in the study; number of male participants; percentage with white, black, and Asian races, and Hispanic ethnicity; baseline cardiovascular risk profile (mean age, mean body mass index, and percentage with diabetes mellitus, hypertension, dyslipidemia, smoking [ever smoked], or family history of coronary artery disease); type of CT scanner; CACS results; and cardiovascular events with median follow-up duration. Cardiovascular events included the combined incidence of MACEs and the independent outcomes of all-cause death and nonfatal myocardial infarction. For studies that reported adjusted measures of association with MACEs (CACS=0 compared with >0), the variables that were adjusted in these analyses were abstracted. We assessed quality of included studies with the Newcastle-Ottawa Quality Assessment Scale for cohort studies.⁹ Studies

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