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Assessment of the new appropriate use criteria for diagnostic catheterization in the detection of coronary artery disease following noninvasive stress testing

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ABSTRACT

Background: Appropriate use criteria (AUC) for diagnostic catheterization (DC) developed by the American College of Cardiology Foundation (ACCF) and other professional societies were recently published. These criteria have yet to be examined thoroughly using existing DC databases.
Methods and results: New York State's Cardiac Diagnostic Catheterization Database was used to identify patients undergoing DC "for suspected coronary artery disease (CAD)" in 01/2010-06/2011 who underwent noninvasive stress testing. Patients rated for appropriateness using symptoms and stress test results were examined to determine the percentage with obstructive CAD and to explore the benefit of adding Global Risk Score (GRS) to the AUC. Of the 4432 patients who could be rated, 1530 (34.5%) had obstructive CAD, which varied from 22% for patients rated inappropriate to 47% for patients rated appropriate. Of all patients with low risk stress test results/no symptoms, all of whom were rated "inappropriate" for DC, only 8% of those patients with low GRS had obstructive CAD, whereas 44% of the patients with high GRS had obstructive CAD.
Conclusions: Global Risk Score improved the ability of symptoms and stress test results to identify obstructive CAD in patients with "suspected CAD" with prior stress tests, and it might be helpful to add GRS to the DC AUC for those patients. These findings should be regarded as hypothesis generating unless/until they can be confirmed by other data bases.

1. Introduction

In a recent communication, Patel et al. presented appropriate use criteria (AUC) for diagnostic catheterization (DC) that were developed by a group of clinicians representing the American College of Cardiology Foundation (ACCF), the Society for Cardiovascular Angiography and Interventions (SCAI), and several other professional societies [1]. The AUC were based in part on the results of earlier studies that identified the relationship between the presence of coronary artery disease (CAD) and various demographic, clinical and symptomatic factors [2–5].

The AUC separate patients being considered for DC into seven broad categories, some of which are: known acute coronary syndrome (ACS); suspected CAD: no prior noninvasive stress imaging (no prior percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG) surgery, or angiogram showing ≥50% angiographic stenosis); and suspected CAD: prior noninvasive stress imaging (no prior PCI, CABG, or angiogram showing ≥50% angiographic stenosis). The RAND methodology used for the development of other appropriateness criteria was then used to rate patients as appropriate, uncertain or inappropriate for DC for each of the scenarios [6–8]. This process consists of identifying scenarios that are intersections of clinical characteristics, patient history, and presentation that are essential in determining the

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appropriate treatment for a given patient. The clinical scenarios differ as a function of the broad category in which a patient is classified. For example, for "Suspected CAD: prior noninvasive stress imaging", the clinical characteristics used for classification purposes are symptoms (asymptomatic, symptomatic) and stress test findings (low risk, intermediate risk, high risk, discordant or equivocal), whereas for "Suspected CAD: no prior noninvasive stress testing", the characteristics are asymptomatic/global CAD risk and symptomatic/pretest probability [1].

The purpose of this study is to apply one of the major sections of the new DC appropriateness criteria ("suspected CAD: prior noninvasive stress imaging (no prior PCI, CABG, or angiogram showing ≥50% angiographic stenosis)") to a New York State database consisting of patients who underwent DC with prior stress testing. Given that this particular section relates to DC for "suspected CAD" and given that the indications developed by the AUC Task Force focused on "the performance of coronary angiography for the detection of coronary artery disease…" for indications with patients with suspected CAD, the purpose of this exploration is to examine the correspondence between appropriateness ratings and the presence of CAD [1].

2. Methods

2.1. Data

The primary database used in the study was New York State's Cardiac Diagnostic Catheterization Database (CD2), a voluntary data system in New York maintained by the New York State Department of Health. For patients undergoing cardiac catheterization in a subset of hospitals in New York, the database contains information on demographics, primary indication for DC, peripheral vascular disease, cerebrovascular disease, payer, angina type and class; stress test results, type of stress test, previous MI, previous revascularization procedures, ejection fraction, ongoing ischemia, vessels diseased, ejection fraction, congestive heart failure, diabetes; and shock, hemodynamic instability, and area of viable myocardium at risk. Types of stress test were ECG without imaging, stress echocardiogram, and stress testing with single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI).

AUC ratings for patients in the study (patients with suspected CAD and prior noninvasive stress testing) were based on the stress test findings; the presence/absence of symptoms; and in the case of intermediate risk findings, on the type of stress test (ECG vs. imaging). The term "symptomatic" includes anginal equivalents such as jaw pain, left arm pain, shoulder pain, new ECG abnormalities, and dyspnea with exertion. Definitions are provided in the AUC document [1].

2.2. Patients

Candidates for the study were the 6816 patients who underwent diagnostic catheterization procedures between January 1, 2010 and June 30, 2011 in the 18 non-federal New York hospitals in CD2 who had prior stress testing and did not have any of the following: ACS or arrhythmia; a history of previous coronary catheterization, PCI, CABG, or valve surgery; or a significant valvular pathology. Further exclusions were five groups of patients who could not be rated: patients who did not have a well defined risk category based on stress test findings (i.e., a positive test result without further grading of risk level; 1619 patients), who had indeterminate stress test findings (249), who had unavailable stress test results (180), who had missing values for left ventricular ejection fraction (233), and who underwent computed tomography coronary arteriography (241). The total number of mutually exclusive exclusions was 2384, resulting in a final study sample of 4432 patients.

2.3. Statistical analyses

All patients in the study were rated according to the new AUC for DC. Patients who could not be rated were identified and reasons why they could not be rated were enumerated. For patients with each rating (appropriate, uncertain, inappropriate), the number and percentage with obstructive CAD were computed. Obstructive CAD was defined as at least one major epicardial vessel with >70% stenosis and/or left main disease with >50% stenosis. However, sensitivity analyses were performed for two other definitions of CAD: "significant" CAD: at least one major epicardial vessel with >50% stenosis [2–4], and 3-vessel disease: all 3 major epicardial vessels with >70% stenosis and/or left main disease, and the general conclusions were the same.

In addition to assessing the probability of obstructive CAD for the aggregate ratings of appropriate, uncertain, and inappropriate, we also examined the probability of CAD for each of the scenarios that comprised each rating. For example, three groups of patients (low risk stress test findings/symptomatic, intermediate risk findings/asymptomatic, and intermediate risk findings with ECG stress test/symptomatic) were rated as uncertain, so we examined their probabilities of CAD separately.

Since "global CAD risk" [9,10] was used in the diagnostic catheterization AUC [1] for patients without prior noninvasive testing, this measure was added to stress test results and symptoms in patients who had prior noninvasive testing to determine if it would help in the ability to predict presence of CAD in patients with "suspected CAD." The Global Risk Score or Framingham Risk Score is derived from summarizing point score totals based on an individual's gender, age category, cholesterol levels, blood pressure, diabetes, and smoking status [11]. The risk score predicts the probability of developing coronary heart disease (CHD) over a 10-year period in people without CHD [11]. Although global CAD risk could not be captured as defined initially, the modified version presented by Patel et al. (one point imputed for dyslipidemia and for hypertension) was used [12].

Logistic regression models were developed with a dependent variable of CAD. The candidate independent variables were all categorical variables. They included stress test results (low, intermediate, high), symptoms (asymptomatic, symptomatic), Global Risk Score (low, intermediate, high), and the other significant risk factors that are not part of the Global Risk Score (cerebrovascular disease, peripheral vascular disease). Three models were developed using combinations of these variables in an attempt to compare the relative discrimination of the models. The discrimination was evaluated using the C statistics of the models [13] and by examining the probabilities of CAD for each of the scenarios created by different intersections of the measures used (e.g. high Global Risk Score/intermediate stress test results/symptomatic). The C statistic measures the percentage of the time that for each pair of patients, one with and one without CAD, the model assigns a higher predicted probability of CAD to the patient with CAD. The discrimination of various models was also compared to determine whether models with additional variables yielded significantly better discrimination [14].

2.4. Ethics

Retrospective registry based studies do not require ethical approval in the United States.

3. Results

Of the 4432 patients who could be rated for appropriateness, 1687 (38.1%) were rated as appropriate, 1977 (44.6%) were rated as uncertain, and 768 (17.3%) were rated as inappropriate (not shown in tables). A total of 1530 patients (34.5%) had obstructive CAD (see Table 1). The percent of patients with obstructive CAD rose from 22% for patients