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Patterns of Cardiac Stress Testing After Revascularization in Community Practice

Bimal R. Shah, MD, MBA,*† Patricia A. Cowper, PhD,* Sean M. O'Brien, PhD,* Neil Jensen, MHA,‡ Matthew Drawz, MBA,‡ Manesh R. Patel, MD,* Pamela S. Douglas, MD,* Eric D. Peterson, MD, MPH*

Durham, North Carolina; Singapore, Republic of Singapore; and Minnetonka, Minnesota

Objectives The purpose of this study was to determine the pattern of cardiac stress testing after coronary revascularization in community practice.

Background The American College of Cardiology Foundation appropriate use criteria provide guidance for the use of cardiac stress imaging after coronary revascularization. However, little is known regarding the use of routine cardiac stress testing in coronary artery bypass grafting or percutaneous coronary intervention patients as well as their downstream use of invasive procedures after noninvasive testing in community practice.

Methods Use and timing of stress testing more than 90 days after revascularization in patients 18 to 64 years of age were determined from a national health insurance claims database from July 1, 2004, through June 30, 2007. Subsequent rates of angiography and repeat revascularization after stress testing also were examined.

Results Of 28,177 patients undergoing revascularization (21,046 percutaneous coronary intervention procedures and 7,131 coronary artery bypass grafting procedures), 59% had at least 1 cardiac stress test within 24 months. Sixty-one percent of patients with percutaneous coronary intervention and 51% of patients with coronary artery bypass grafting had undergone testing by 24 months. Nuclear imaging was the predominant testing method. The incidence of testing was found to increase at both 6 months and 12 months after revascularization, suggesting an association with elective follow-up office visits. Furthermore, testing varied according to geographic location. Of those tested, only 11% underwent subsequent cardiac catheterization and only 5% underwent repeat revascularization.

Conclusions Although there is limited consensus as to the appropriate role of elective stress testing after coronary revascularization, more than one half of all patients in community practice had at least 1 stress test within 24 months of revascularization. Yield on such testing was low: only 5% of patients tested ultimately required repeat revascularization. These findings support the need to define better the role of stress testing after recent revascularization. (J Am Coll Cardiol 2010;56:1328–34) © 2010 by the American College of Cardiology Foundation

Noninvasive stress testing, with or without imaging methods such as echocardiography, nuclear imaging, and magnetic resonance, improves assessment of cardiac anatomic and pathologic features. Although these testing methods can assist in patient management, there has been rapid expansion in their use over time, and noninvasive imaging has been among the fastest growing components of any physician service in recent years (1,2). This growth has come without sufficient evidence to determine the impact of testing on clinical outcomes (3,4).

To help guide diagnostic imaging use, the American College of Cardiology Foundation (ACCF) has recently developed appropriate use criteria (AUC) (5–7). The ACCF AUC aim to assist clinical decision-making by outlining available evidence coupled with expert consensus on the optimal use of imaging in various clinical situations.

See page 1335

One area with limited data in the ACCF AUC was the routine use of stress testing with imaging (nuclear, echocardiography) after revascularization. However, expert consen-

From the *Duke Clinical Research Institute, Duke University Medical Center, Durham, North Carolina; †Duke–National University of Singapore Graduate Medical School, Singapore, Republic of Singapore; and ‡UnitedHealthCare, Minnetonka, Minnesota. Supported by UnitedHealthCare. Neil Jensen and Matthew Drawz are employees of UnitedHealthCare. Dr. Cowper has received research grant support from UnitedHealthCare. All other authors have reported that they have no relationships to disclose.

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sus concluded that stress testing generally was inappropriate within 2 years for percutaneous coronary intervention (PCI) and within 5 years for coronary artery bypass grafting (CABG), unless prompted by symptoms or other change in clinical status (7).

Having access to an administrative database from a large national health insurer, we sought to assess clinical practice patterns and frequency of stress testing use in patients after coronary revascularization. We also assessed patient and geographic variation in these testing patterns. Finally, we examined downstream angiography and repeat revascularization rates that resulted from initial stress testing.

Methods

Data source. Data were obtained from UnitedHealthCare's administrative billing records for more than 17.7 million members enrolled in employer-sponsored plans from July 1, 2004, through June 30, 2007. All claims (inpatient and outpatient hospital encounters, physician claims) and enrollment information were provided for UnitedHealthCare patients who underwent coronary revascularization with either CABG or PCI during this period. Hospital claims included International Classification of Diseases-9th Revision-Clinical Modification (ICD-9) diagnosis and procedure codes, Current Procedure Terminology (CPT) procedure codes, dates of service, discharge disposition, and zip code of provider. Physician claims included ICD-9 diagnosis codes, CPT procedure codes, and dates of service. Death dates from the Social Security Death Master File also were provided for the sample. To ensure continuous longitudinal follow-up, for the small number (3%) of patients with discontinuous enrollment periods, only the first enrollment period was considered.

Revascularization procedures were identified using CPT and ICD-9 codes (PCI, 92980 through 92982, 92973, 92984, 92995 through 92996, G0290 through G0291, 36.0x, 00.66; CABG, 33510 through 33529, 33533 through 33536, 36.1x, 36.2, 36.31, 36.32). Patients with revascularization claims that appeared in either the hospital or physician claims but not in both sources were excluded from the analysis because of incomplete data capture.

Stress testing. Cardiac stress and imaging tests were identified by CPT codes (electrocardiographic [ECG] stress, 93015 through 93018; nuclear, 78460 through 78461, 78464 through 78466, 78468 through 78469, 78472 through 78473, 78481, 78483, 78491 through 78492, 78494; stress echocardiography, 93350). ECG stress and nuclear imaging procedures performed within 72 h of each other were considered a single stress nuclear event. ECG stress and echocardiographic testing performed on the same day were considered a single stress echocardiography event. Cardiac stress tests occurring within the first 90 days after revascularization were assumed to be performed for the purposes of cardiac rehabilitation, staging of procedures, or functional capacity assessments and were not counted as a post-revascularization stress study. The indications for stress testing were identified using ICD-9 codes recorded at the time of the stress test.

The first identified PCI or CABG procedure for each patient was considered the index revascularization. Multiple revascularization procedures within a single encounter were considered as a single revascularization event for the current analysis. For each patient, we extracted physician claims for all stress tests, coronary angiographies, and coronary revascularizations as well as inpatient and outpatient hospital revascularization and angiography claims occurring after the index revascularization procedure. Patients were included in the primary analysis if they survived 90 days after revascularization without a competing event (death, angiography, or repeat revascularization) or loss of coverage.

Abbreviations and Acronyms

ACCF = American College of Cardiology Foundation
AUC = appropriate use criteria
CABG = coronary artery bypass grafting
CPT = Current Procedure Terminology
ECG = electrocardiographic
ICD-9 = International Classification of Diseases-9th Revision-Clinical Modification
PCI = percutaneous coronary intervention

Statistical analysis. Characteristics of patients undergoing revascularization with PCI or CABG were examined. Time to the first stress test occurring 90 days after the index revascularization episode was examined using cumulative incidence functions that accounted for administrative censoring and treated coronary angiography, repeat revascularization, and death as competing risks. In addition to examining overall stress testing incidence, stress echocardiography and stress nuclear and ECG stress testing were analyzed separately. These analyses were repeated after stratifying by sex, age, comorbidities identified by ICD-9 codes at the time of index revascularization, and core-based statistical area. The core-based statistical area is a standard regional classification based around an urban center with a population of at least 10,000 (8). The univariate association between cumulative incidence and variables of interest was assessed using the Gray test (9).

For patients undergoing stress testing, we analyzed the rates of coronary angiography within 30 days of stress testing as well as the rate of repeat revascularization within 30 days of coronary angiography. The 30-day follow-up windows were chosen to capture sequential procedures most likely to result from testing. To determine the effect on the analysis of excluding stress tests within 90 days of the index revascularization, we removed the 90-day allowance in a sensitivity analysis and examined all stress tests after the revascularization date.

The Duke University Institutional Review Board reviewed and approved the study design. All statistical analyses were performed using SAS software version 9.2 (SAS Institute, Cary, North Carolina) and R Project for Statistical Computing software version 2.11.0 (10).