

Frequency of Electrocardiographic Recordings in Patients Presenting With Angina Pectoris (from the Investigation of National Coronary Disease Identification)

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The appropriate progression of diagnostic testing for acute angina has been the topic of several recommendations by the American College of Cardiology and American Heart Association (ACC/AHA). We measured how frequently electrocardiography (ECG) is provided as the initial cardiac diagnostic test, as recommended for patients with new angina. Using an insurance database representing 2% of the U.S. adult population, we identified patients undergoing a new cardiac diagnostic process for angina. Rates of initial ECG were stratified by age, gender, co-morbid disease, and care setting. Of 4.4 million patients, 18,139 met the entry criteria by presenting with anginal symptoms for testing. A substantial portion (35%, 95% confidence interval [CI] 34% to 35%) did not receive the initial ECG recommended by expert guidelines. Patients treated in emergency departments received an initial ECG more frequently (91%, CI 90% to 92%) than patients tested in outpatient settings (61%, CI 60% to 62%; risk ratio [RR] 0.67, CI for RR 0.65 to 0.68) or in inpatient hospital settings (34%, CI 32% to 37%; RR 0.38, CI for RR 0.36 to 0.40). Slightly lower rates of initial ECG were observed in men (RR 0.93 vs women, CI for RR 0.91 to 0.95) and patients over 64 years (RR 0.93 vs younger patients, CI for RR 0.91 to 0.95). Total diagnostic costs averaged \$954 when testing began with the recommended ECG versus \$1,233 when testing did not. In conclusion, ECG is not universally obtained as the initial test for patients presenting with anginal symptoms despite evidence-based recommendations for such use. Clinicians should be aware that suboptimal use of ECG in certain settings may hinder investigations of heart disease. © 2009 Elsevier Inc. (*Am J Cardiol* 2009;103:312–315)

Using a very large database comprising 2% of the insured U.S. adult population, we measured global and demographic differences between expert recommendations for appropriate use of electrocardiography (ECG) with the actual practice of obtaining ECG as the initial diagnostic test for potential coronary disease.¹ By reporting these measurements, we hoped to improve current practice patterns in specific populations and care settings.

Methods

Data for this investigation were obtained from national private insurance and managed Medicare patient claims records for the 54-month period from July 1, 2000 to December 31, 2004. These data included claims from physi-

cians, hospitals, and outpatient facilities. The databases cover United Healthcare enrollees throughout the United States, including patients insured by employer-sponsored private insurance and Medicare-eligible patients who selected a Medicare Advantage plan. Both the private insurance and Medicare Advantage plans recorded date-specific claims information, allowing investigators to examine sequences of medical events and interventions. Despite the well-known limitations of administrative databases for clinical research, these data can be useful in assessing the extent to which recommended protocols are being implemented in clinical practice, especially for services that are routinely reimbursed and therefore more reliably documented.^{2–6}

Patients for this study were selected from a larger global database of patients who presented in 2001 with symptoms or signs prompting new cardiac evaluations, having had at least 6 continuous previous months free of cardiac diagnoses or testing. This global database was created to allow multiple analyses of testing patterns for cardiac disease within the United States.

To qualify for the Investigation of National Coronary Disease Identification (INCIDENT), patients had to be 45 years or older; have continuous insurance coverage from July 1, 2000 through December 31, 2003 unless they died sooner; and have an initial cardiac test in 2001 for a cardiac-related reason. Cardiac diagnoses and tests were identified using codes from the International Classification of Diseases (ICD-9) and Cur-

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Table 1
Distribution of presenting anginal diagnosis codes

ICD-9 Diagnosis Code	ICD-9 Description	Number of Patients*
413	Angina pectoris	2
413.0	Angina decubitus	58
413.1	Angina, Prinzmetal	42
413.9	Angina pectoris NEC/NOS	1,536
786.5	Pain, chest	93
786.50	Pain, chest NOS	11,605
786.51	Pain, precordial	2,200
786.59	Pain, chest NEC	3,169

* Some patients had more than 1 qualifying diagnosis.
NEC/NOS = not elsewhere classified/not otherwise specified.

rent Procedural Terminology.⁷ Tests were considered to be cardiac-related if their corresponding ICD-9 diagnostic codes were relevant to coronary heart disease, heart failure, or cardiac symptoms, including chest pain and angina.

Patients were excluded from the INCIDENT dataset if they had, within the 6 months previous to their initial cardiac test, a cardiac intervention; a diagnosis of coronary disease, heart failure, or a related symptom in conjunction with a cardiac diagnostic test; or a hospital service for a major adverse cardiac event (MACE), atrial fibrillation, or stroke. MACE was specifically defined as myocardial infarction, cardiac arrest, ventricular fibrillation, ventricular tachycardia, cardiac rupture, or cardiac tamponade. Cardiac intervention was defined as percutaneous coronary intervention, coronary artery bypass grafting, valve surgery, pacemaker or automated defibrillator implantation, or other cardiac surgery.

For the current analysis, a subset of patients was selected from the global INCIDENT database. The subset selection targeted patients with acute symptoms who underwent cardiac diagnostic testing. Thus, in addition to meeting the preceding criteria, such patients also had to present with symptoms of acute angina within 48 hours before the initial diagnostic test (ICD-9 diagnosis codes beginning with 413 or 786; Table 1).

After tabulating patients by age, gender, pre-existing diagnoses, and presenting diagnoses, we organized their claims by date, provider, and care setting (emergency department, inpatient, clinic, and office visits). Patient services were classified by diagnosis and procedure, consolidated, then date-sequenced into predefined categories for diagnostic tests, clinical interventions, and clinical events. When a resting ECG occurred with other cardiac diagnostic tests on the same day, we assumed that it came first, as recommended by the guidelines, so as not to inflate our results.

Cardiac tests of interest included resting ECG, stress ECG, nuclear medicine studies, resting and stress echocardiography, continuous and event ECG monitoring, cardiac computerized tomography, cardiac magnetic resonance imaging, cardiac positron emission tomography, and diagnostic cardiac angiogram. Chest radiography was included as a cardiac test in the analysis but was not used to qualify patients for the study because of significant overlap between cardiac and respiratory symptoms.

Patient deaths were identified in 3 ways: death as the discharge status on inpatient claims; a diagnosis or proce-

Table 2
Distribution of initial diagnostic tests for angina

Diagnostic Test	Number (%)
Resting ECG	11,845 (65%)
Stress ECG with nuclear imaging	2,214 (12%)
Chest radiograph	1,417 (8%)
Stress echocardiogram	1,051 (6%)
Stress ECG without nuclear imaging	801 (4%)
Resting echocardiogram	416 (2%)
Diagnostic angiogram	252 (1%)
Ambulatory monitor	104 (1%)
Other	39 (0%)

Percentages are rounded to nearest integer.

sure code specifying post-mortem examination or death; or an emergency department visit coded with diagnoses associated with significant mortality in the National Hospital Ambulatory Medical Care Survey (e.g., cardiac arrest)⁸ followed by cessation of claims within 48 hours and proximal termination of insurance coverage.

For each patient in the angina cohort, we recorded the sequence of cardiac diagnostic tests from enrollment until 1 of the following 6 outcomes: the patient died; underwent a cardiac intervention; had a major adverse cardiac event; developed atrial fibrillation; had a 6-month period free of cardiac testing, cardiac intervention, or MACE; or reached the end of the study period.

Standard costs were identified and assigned to each diagnostic test by calculating the average actual insurance payment made for each test type, based on claims when the test in question was the only test provided or on claims where sufficient line-item detail was provided to identify the specific payment made for the test.

Investigators conferred frequently to resolve differences in data interpretation, verify accuracy, and review selection criteria. All disagreements were resolved by consensus. These primarily involved definitions of certain events and handling of incomplete data.^{9,10}

Proportions and risk ratios (RRs) were calculated and binary logistic regression analyses performed for 5 groups of patients receiving ECG as the initial diagnostic test for angina. The group variables analyzed were age, gender, care setting, hypertension, and diabetes. Significance was calculated using the Wald test. The 95% confidence intervals (CIs) of the RRs were calculated using the delta method for standard error of the risk ratio log. Our regression model fitness was checked with the Hosmer-Lemeshow test.¹¹

Results

Of 4,355,625 patients enrolled in our database, 42,223 patients met criteria for inclusion into the global INCIDENT database. Approximately half of these patients (52%) were under 65 years of age, 50% were women, 69% had hypertension, and 32% had diabetes.

A total of 18,139 patients (43% of the INCIDENT total) met the criteria for inclusion into the INCIDENT angina cohort. Half (48%) were men and 39% were over 64 years of age. In terms of co-morbid disease, 28% were diabetic, 66% had hypertension, and 24% had both diabetes and hypertension.

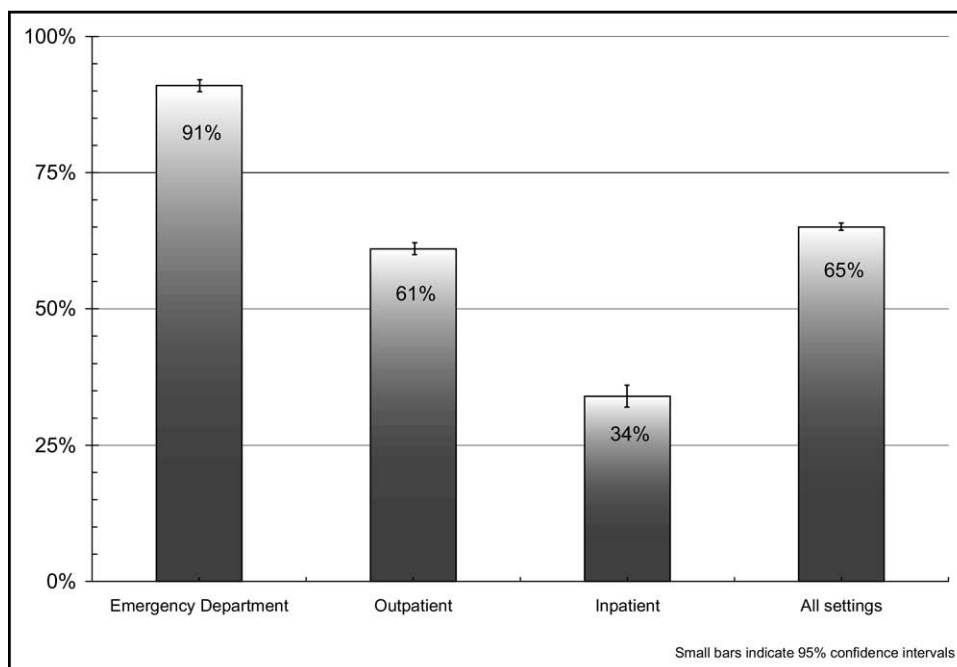


Figure 1. Percentage of patients with new angina who received recommended ECG before other diagnostic tests.

Of the 18,139 patients included in the INCIDENT angina cohort, 6,294 (35%; 95% CI 34% to 35%) did not receive an ECG as an initial screening test. Instead, such patients received a diagnostic stress test (4,066), chest radiography (1,417), echocardiogram (416), cardiac catheterization (252), or another test (143) as their first test (Table 2). Men were less likely to receive initial ECG screening than women (63% vs 67%; RR 0.93, CI 0.91 to 0.95). Patients 65 years and older were also less likely to receive initial ECG screening than younger adults (62% vs 67%; RR 0.93, CI 0.91 to 0.95). However, patients with diabetes, hypertension, or a combination of the 2 received screening ECG at the same rate as those without these conditions (diabetes: 64% vs 66%; RR 0.97, CI 0.95 to 1.00; hypertension: 65% vs 66%; RR 0.99, CI 0.97 to 1.02; both diabetes and hypertension: 65% vs 65%; RR 1.01, CI 0.98 to 1.04).

Patients treated in emergency departments received an initial ECG more frequently (91%; CI 90% to 92%) than patients in outpatient settings (61%; CI 60% to 62%; RR 0.67, CI for RR 0.65 to 0.68) or those in inpatient hospital settings (34%; CI 32% to 37%, RR 0.38, CI for RR 0.36 to 0.40; Figure 1).

The results of the logistic regression further supported the proportionate and RR analyses. Hypertension ($p = 0.806$) and diabetes ($p = 0.349$) were not significant predictors, although gender (odds ratio 0.8 women vs men, $p < 0.001$), age (odds ratio $0.9 \leq 65 > 65$ years, $p < 0.001$), and care setting (odds ratio 18.8 emergency department vs inpatient, odds ratio 6.6 emergency department vs office or clinic, $p < 0.001$) remained significant predictors. The Hosmer-Lemeshow test was not significant ($p = 0.204$), indicating that our data fit the regression model.

Actual health plan reimbursement for screening outpatient ECG averaged \$24 (5% to 95% range \$10–\$33, $n = 87,743$). The average cost of the initial diagnostic pathway

was \$954 when diagnostic testing began with the recommended ECG compared with \$1,233 when testing did not.

Discussion

More than one-third of the patients in this study failed to receive a guideline-recommended resting ECG as the initial test when presenting with angina pectoris, despite the fact that ECG testing has been widely available, is relatively inexpensive, and entails virtually no risk. Cardiac symptoms were not ignored; by virtue of the study criteria, all patients had cardiac testing within 48 hours of presentation. Such results suggest that many physicians forgo an initial screening ECG in favor of stress testing or other more advanced cardiac diagnostic tests. A pattern of substituting tests of greater perceived sophistication was more often applied to older men. This practice may be the result of perceptions that such patients were at greater risk for cardiac disease.

The high rate of guideline compliance in emergency departments may reflect the more systematic use of protocols in this care setting. It may also reflect patient self-selection bias. Chest pain that is sufficiently distressing to induce patients to go to the emergency room imposes considerable pressure upon physicians to rapidly diagnose or exclude the possibility of acute myocardial infarction. In hospitalized patients developing angina, the low rate (34%) of apparent compliance may result from the perception that patients were already receiving general cardiac rhythm monitoring, although such monitoring is insensitive for acute myocardial ischemia or injury.

In certain cases, 12-lead ECGs are performed as part of the baseline measurements for cardiac stress testing. Indeed, if we consider 12-lead ECGs to be universally bundled with all the stress tests counted in our cohort of acutely anginal patients, the proportion of patients receiving an initial ECG

would rise from 65% to 87%. This practice disregards, however, the specific intent of the ACC/AHA recommendations. ECG screening “within 10 minutes” of presentation for anginal patients indisputably aids timely identification of acute myocardial injury or infarction.¹²

Our data included insured patients alone, so our results were limited by selection bias. Such bias, however, may understate the opportunity that exists for improvement in care given the large number of uninsured patients in the United States at present. Our results were also limited by our study type. Claims analyses are restricted by their retrospective nature and incomplete access to specific clinical information. Data obtained are largely administrative, so clinical information can often only be indirectly inferred from diagnosis codes. In this study, for example, we could not link cardiac testing to the presence of chest pain using physician or nursing notes, nor could we characterize chest pain by location, duration, or severity. In addition, the timing and sequence of events that occurred during a single calendar day could not be precisely determined. Our assumption that the ECG was first if multiple tests were performed in 1 day could overstate actual guideline compliance. Nonetheless, such limitations were tempered by the size of our retrospective sample, which measured one-fiftieth of the population of U.S. adults.

The authors of the ACC/AHA guidelines recommend a resting ECG as the initial test for all patients presenting with angina or its equivalents, recognizing that although a normal ECG does not confirm health, an abnormal ECG can immediately identify patients at highest risk for cardiac morbidity. This recommendation appears both simple and reasonable, yet our study suggests that it has been difficult to implement in actual practice. Economically, our results further suggest that compliance with this guideline is not a defensive cost-inflating practice but is associated with a lower-cost diagnostic process. Thus, clinicians should be aware that suboptimal use of ECG may hinder investigations of heart disease and may be less cost efficient. These data support efforts to invigorate or create systems that ensure proper use of diagnostic electrocardiography.

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