Electrocardiogram Timing in Patients Presenting to a VA Emergency Department with Acute Myocardial Infarction

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After their VA medical center instituted a program to improve early ECG performance in patients with symptoms of acute myocardial infarction, these researchers conducted a study to find out how many ECGs still were delayed and why.

Prompt performance of an electrocardiogram (ECG) in patients presenting to the emergency department (ED) with acute myocardial infarction (AMI) leads to early diagnosis and treatment. Indeed, the American College of Cardiology/American Heart Association (ACC/AHA) guidelines recommend that, when a patient reporting chest pain or equivalent AMI symptoms arrives in the ED, an ECG should be obtained and shown to an experienced emergency medicine physician within 10 minutes. AMI—which includes both acute ST-segment elevation myocardial infarction (STEMI) and non–ST-segment elevation myocardial infarction (NSTEMI)—is the leading cause of adult death in the United States, occurring in almost one million patients annually.[1] Failure of health care providers to recognize and diagnose such patients is a serious public health issue—and one that is particularly concerning in the VA given the prevalence of heart disease among veterans.

Recognizing the importance of early ECG acquisition for prompt diagnosis and treatment of AMI, the VA Caribbean Healthcare System in San Juan, Puerto Rico instituted a program to increase rates of early ECG performance. Several years later, we set out to evaluate whether and how our early ECG performance had improved and to identify factors associated with late ECG acquisition.

In this article, we describe this quality improvement study and discuss its findings. First, however, we review the rationale behind early ECG for AMI and provide some background about the changes implemented at our facility to improve the rate of early ECG.

EVALUATING CHEST PAIN IN THE ED

The traditional ED evaluation of patients with chest pain relies heavily on the patient's history, physical examination, a 12-lead ECG, and measurement of cardiac biomarkers for the assessment of myocardial necrosis. In addition to contributing to the risk stratification analysis, the 12-lead ECG is at the center of the therapeutic decision pathway because of strong evidence that the presence of ST-segment elevation signals a patient who will benefit particularly from reperfusion therapy. It has been well established that the use of early reperfusion (the sooner the better) with either fibrinolytic therapy or primary percutaneous coronary intervention (PCI) in patients with STEMI decreases mortality and post-AMI complications.[2–4] The ACC/AHA guidelines and clinical performance measures recommend a door-to-needle time within 30 minutes and a door-to-balloon time within 90 minutes.[2,5]

Unfortunately, fewer than 50% of the patients treated with thrombolytic therapy in the United States meet the 30-minute recommendation, and only 40% of those treated with primary PCI meet the 90-minute goal.[6] Potential reasons for delays include inappropriate triage, an overcrowded or understaffed ED, a tardy ECG, failure to recognize STEMI on the ECG, and failures related to reperfusion responsibility and selection. Ideally, the emergency medicine physician on duty in the ED should make the reperfusion decisions, based on a predetermined, institution-specific, written protocol. This protocol should be developed mainly

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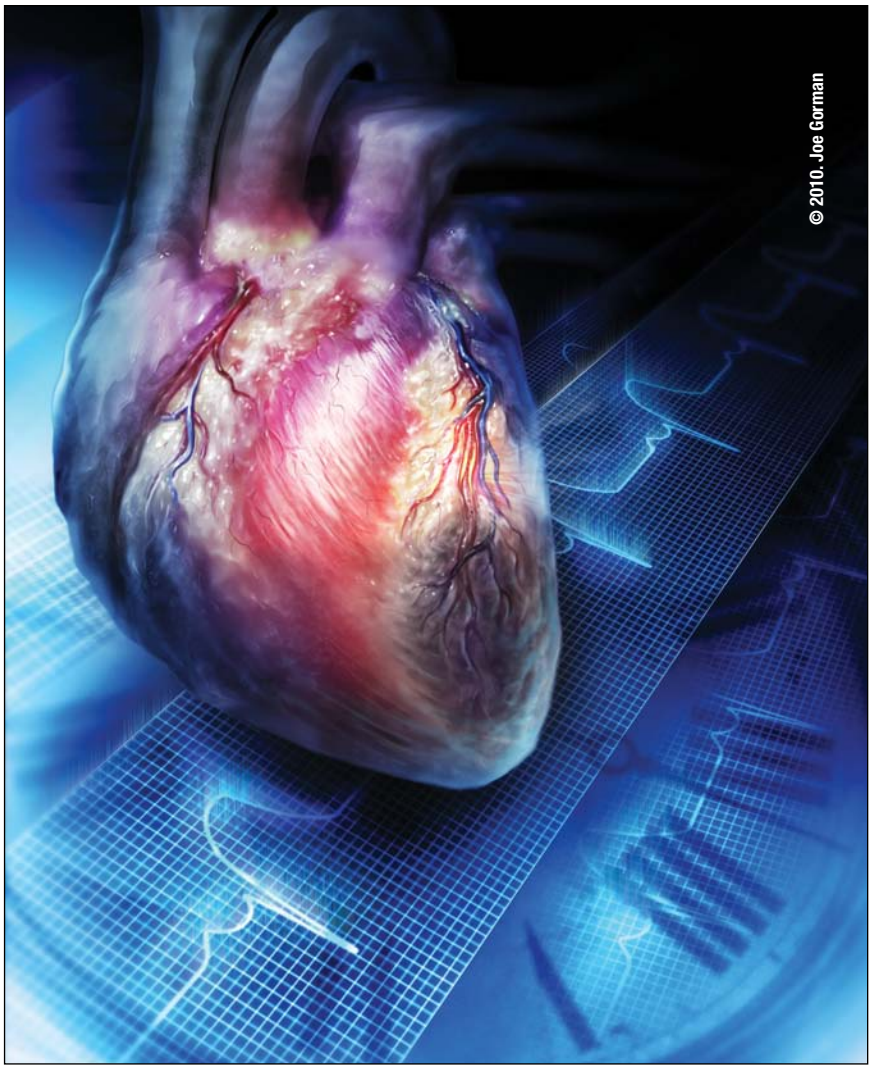
with input from cardiologists—both interventional cardiologists and cardiologists involved in coronary care unit management—and emergency medicine physicians.[2] Studies in the STEMI population suggest that a prolonged time to ECG acquisition is a significant factor contributing to delayed administration of thrombolytic therapy.[7,8]

Patients with non–ST-segment elevation acute coronary syndrome (NSTE-ACS) may be assumed also to benefit from early ECG because the ECG may facilitate appropriate (more aggressive) and timely management of those at high risk, as indicated by ST-segment changes.[9,10] These changes also provide additional prognostic information.[11] No conclusive or robust evidence exists, however, to support outcome benefit with early ECG in NSTE-ACS. Studies that evaluated adverse outcome (non-fatal AMI or death) in NSTE-ACS related to ECG performed after more than 10 minutes did not reveal significant differences during the hospital stay or one month later.[12,13]



IMPROVING EARLY ECG PERFORMANCE

VHA performance measures of AMI and acute coronary syndrome (ACS) include and exceed historic Joint Commission AMI core measures. In 2004, VHA performance measures began to include acquiring an ECG within 10 minutes for any patient arriving in the ED with ACS.[14] We at the VA Caribbean Healthcare System, therefore, have been monitoring this performance measure in our hospital since 2004 with an external peer review program. For fiscal year 2004, our initial early ECG performance was below 50%. To improve this and all other AMI performance measures, we created a chest pain committee, which includes representatives from all services involved in the care of patients with ACS—most significantly, the ED and cardiology staffs.

In approaching improvement of our facility's performance regarding early ECG acquisition, we identified the following major categories as potential causes of ECG delay:

- failures in ED staff responsibility and commitment;
- equipment issues (related to ECG machine amount, location, or time synchronization or the functioning of the ECG image archive system);
- clerical issues related to patient registration;
- patient issues related to where to go, whom to notify, and awareness of existing clinical problem;
- bed availability; and
- triage process variation related to different shifts.

Using the cause-and-effect method, we implemented multiple measures to improve our ECG performance. The most important changes included:

- assignment of ECG responsibility and competencies to nursing;
- communication to the entire ED staff about the importance of the performance measure and of having constant feedback;

- increase in staff and patient education related to ACS;
- increase in availability of ECG machines distributed throughout the ED;
- ongoing ECG machine inspection and time adjustment to the computerized patient record system time (atomic time);
- provision of posters in the ED and the waiting room reminding patients to notify the triage nurse immediately if they are experiencing described AMI symptoms;
- unification and adherence to a single chest pain triage process (first patient contact with a nurse rather than a clerk);
- designation of dedicated beds for patients with chest pain for faster ECG performance within the ED;
- creation of specific nurse and physician templates to improve documentation; and
- ongoing internal monitoring of this measure for continuous improvement.

After implementing these changes, our early ECG performance in fiscal year 2006 increased to 74%. These results oscillated, however, and in general still fell short of exceeding the targeted successful performance level of 75% in a sustained fashion.

As a result, we designed a study to assess our early ECG performance in patients presenting with AMI (STEMI or NSTEMI) in the ED and to identify factors associated with late ECG acquisition.

STUDY DESIGN

We conducted a retrospective analysis of patients admitted to the VA Caribbean Healthcare System with a primary diagnosis of AMI between October 1, 2005 and March 20, 2006. Inclusion criteria required the presence of AMI symptoms within 24 hours prior to ED arrival. For the purposes of analysis, we divided the patients into those with STEMI and those with NTSEMI, based on the presenting ECG and serial cardiac marker assessment. STEMI was confirmed using the ACC/AHA and the European Cardiac Society definition.[2,15] NSTEMI was defined as the occurrence of a cardiac marker (troponin-T) that exceeded the institutional threshold definition for AMI in patients without ST-segment elevation.

Our local Institutional Review Board approved this study. All pertinent medical data—including medical history, demographics (gender and ethnicity), laboratory tests, arrival information, and ECG—were obtained from the VA electronic medical record system.

With regard to presenting symptoms, we emphasized documentation of chest pain and its intensity or, if the patient did not report chest pain, any other equivalent AMI symptom. Chest pain symptoms included central, substernal, or epigastric (nontraumatic) pain that may be described as a pressure, tightness, heaviness, cramping, burning or aching sensation. Equivalent AMI symptoms assessed included shortness of breath, nausea or vomiting, diaphoresis, dizziness, and loss of consciousness. Time to ECG was defined as the time from hospital arrival (the time of earliest documented patient contact, typically with a triage nurse, ED clinician, or registration) to ECG performance.

We summarized the data using the mean and median values for continuous data and frequencies and percentages for categorical data. Differences between participant groups were tested using the Wilcoxon rank-sum test for continuous variables and chi-square test for categorical variables. To determine which factors influenced patients' receipt of an ECG within 10 minutes of arrival, we used logistic regression to compare patient variables (or groups). We expressed the results as odds ratios (ORs) and 95% confidence intervals (CIs) of the ORs. We set $P < .05$ as the threshold for statistical significance.

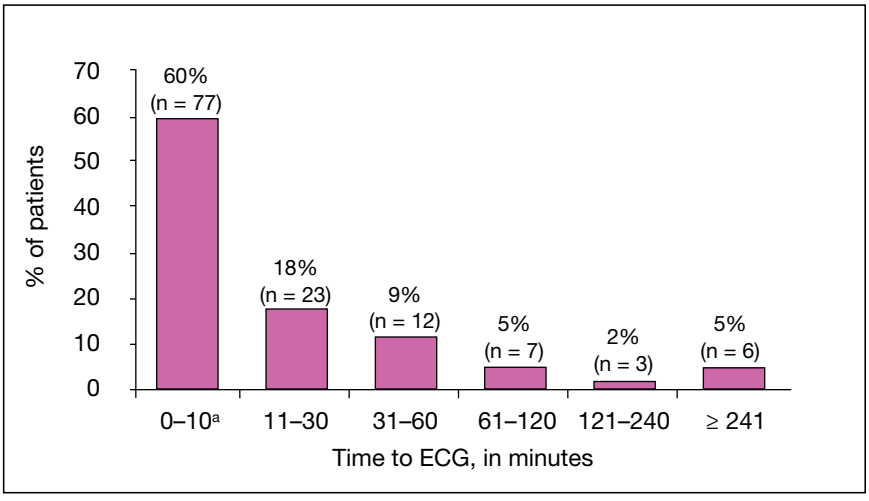


Figure 1. Time to electrocardiogram (ECG) (from arrival in the emergency department) for 128 study patients. [a]This bar represents the expected ECG performance time of ≤ 10 minutes. For all patients, the mean time was 43.2 minutes, the median time was 6.5 minutes, and the range was 0 to 880 minutes.

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Table 1. Baseline patient characteristics, according to time to ECG[a]

Characteristics	All patients (n = 128)	ECG time ≤ 10 minutes (n = 77)	ECG time > 10 minutes (n = 51)	*P* value
Age in years, mean (SD)	76.1 (10.4)	76.1 (9.9)	75.9 (11.3)	.94
Ethnicity, no. (%)				.62
Black	10 (7.8)	5 (6.5)	5 (9.8)	
Hispanic	63 (49.2)	40 (52.0)	23 (45.1)	
White	55 (43.0)	32 (41.6)	23 (45.1)	
Medical history, no. (%)				
Diabetes mellitus	79 (61.7)	47 (61.0)	32 (62.8)	.84
Hypertension	119 (93.0)	72 (93.5)	47 (92.2)	> .99
Hyperlipidemia	71 (55.5)	48 (62.3)	23 (45.1)	.06
CHF[b]	42 (32.8)	24 (31.2)	18 (35.3)	.63
Known CAD[c]	56 (43.8)	34 (44.2)	22 (43.1)	.91
Previous MI[d]	46 (35.9)	29 (37.7)	17 (33.3)	.62
CABG[e]	22 (17.2)	15 (19.5)	7 (13.7)	.40
PTCA[f]	9 (7.0)	5 (6.5)	4 (7.8)	> .99
CVA[g]	25 (19.5)	12 (15.6)	13 (25.5)	.17
Renal insufficiency[h]	33 (25.8)	17 (22.1)	16 (31.4)	.24
Any cigarette smoking	67 (52.3)	44 (57.1)	23 (45.1)	.18
Current smoking	18 (14.1)	13 (16.9)	5 (9.8)	.26
PVD[i]	19 (14.8)	11 (14.3)	8 (15.7)	.83
Atrial fibrillation	12 (9.4)	7 (9.1)	5 (9.8)	.89
Significant valvular disease	17 (13.3)	8 (10.4)	9 (17.7)	.24

[a]ECG = electrocardiogram. [b]CHF = congestive heart failure. [c]CAD = coronary artery disease. [d]MI = myocardial infarction. [e]CABG = coronary artery bypass grafting. [f]PTCA = percutaneous transluminal coronary angioplasty. [g]CVA = cerebrovascular accident. [h]Creatinine level > 2 mg/dL. [i]PVD = peripheral vascular disease.

RESULTS

From an initial list of 250 patients with a coded discharge diagnosis of AMI, we included in the study 128 patients who met inclusion criteria: 108 patients (84%) who were categorized as having NSTEMI and 20 (16%) who were categorized as having STEMI. Patients ranged in age from 45 to 97 years; the mean (SD) age was 76 (10.4) years. All patients except one were male.

Time to initial ECG acquisition ranged from 0 to 880 minutes, with a median time of 6.5 minutes and a mean time of 43 minutes. Overall, 60% of all patients with any AMI presentation received an ECG within 10 minutes (Figure 1).

To determine whether early or delayed ECG was associated with any baseline characteristics, we divided the patients into two groups: (1) the 77 patients (60% of total) with an ECG time of 10 minutes or less and (2) the 51 patients (40%) whose ECG was performed after 10 minutes. The two groups had a similar mean age and did not differ significantly in terms of ethnicity or baseline medical history and characteristics (Table 1).

Factors that affected ECG time

Evaluation of ECG time by AMI category, however, told a different story. Compared with patients with NSTEMI, Patients with STEMI were significantly more likely to undergo an early ECG (80% versus 56%, respectively; *P* = .048) (Table 2). The median ECG time in STEMI patients was 0 minutes (less than 60 seconds or before registration) compared with 9 minutes in NSTEMI patients (*P* = .006) (Table 3).

Chest pain as a presenting symptom also had a significant impact on ECG performance. From the full group, 93 patients (73%) reported experiencing chest pain within 24 hours prior to ED presentation. Median ECG time for these patients was 1 minute, compared with 42 minutes for patients who presented without chest pain (*P* < .0001). Of the patients presenting with chest pain,

Table 2. Presenting clinical characteristics and their association with ECG[a] performance

Clinical presentation	All patients (n = 128)	ECG time ≤ 10 minutes (n = 77)	ECG time > 10 minutes (n = 51)	*P* value
MI[b] type, no. (%)				.048
STEMI[c]	20 (15.6)	16 (80)	4 (20)	
NSTEMI[d]	108 (84.4)	61 (56)	47 (44)	
Reported chest pain, no. (%)				< .001
Yes	93 (72.7)	73 (78)	20 (22)	
No	35 (27.3)	4 (11)	31 (89)	
Median pain score[e]	2	3	0	< .001
Onset of symptoms, median time in hours	8	6	12	.138

[a]ECG = electrocardiogram. [b]MI = myocardial infarction. [c]STEMI = ST-segment elevation MI. [d]NSTEMI = non–ST-segment elevation MI. [e]On a scale of 0 to 10.

Table 3. ECG[a] performance according to MI[b] type and chest pain presentation

Patient group	No. of patients	ECG time in minutes			*P* value[c]
		Mean	Median	Range	
All patients	128	43.0	7	0–880	–
MI type					.006
STEMI[d]	20	10.4	0	0–100	
NSTEMI[e]	108	49.1	9	0–880	
Chest pain reported?					< .0001
Yes	93	9.9	1	0–203	
No	35	131.7	42	0–880	

[a]ECG = electrocardiogram. [b]MI = myocardial infarction. [c]For median ECG times. [d]STEMI = ST-segment elevation MI. [e]NSTEMI = non–ST-segment elevation MI.

78% had an ECG within 10 minutes, compared with only 11% of those without chest pain ($P < .001$). The intensity of chest pain upon presentation, quantified by the patient on a scale of 0 to 10, also correlated with faster ECG acquisition time. Patients whose ECG was delayed had a significantly lower median pain score than those with an early ECG time ($P < .001$).

Almost one third (32%) of patients were transported to the ED by ambulance. Surprisingly, 70% of those who arrived through walk-in triage had an early ECG compared with only 39% of those transported by ambulance ($P = .001$) (Table 4). Half of the ambulance arrivals, however, were transferred from local health centers or hospitals, where they may have had some treatment, and they often were free of chest pain upon arrival at our institution. Indeed, patients who arrived by triage had a higher median chest pain intensity score than those who arrived by ambulance—although this difference did not attain statistical significance ($P = .065$).

Patients who arrived at the ED during the regular work shift (from 8:00 AM to 4:00 PM; 49% of all patients) were far more likely than those who arrived during off-regular work shifts (between 4:00 PM and 8:00 AM; 51% of all patients) to have an early ECG time (76% versus 45%, respectively; $P = .0002$). The fact that almost twice as many nurses and physicians are on duty during the regular work shift as during the off-regular shifts may help account for this difference. Early ECG acquisition was not significantly different between patients who presented on regular working weekdays and those who presented on holidays or weekend days.

Our analysis showed that 20% of study patients were evaluated by either a full-time ED cardiologist or a cardiology fellow, and 80% were evaluated by emergency or internal medicine physicians. Although a car-

Table 4. ED[a] arrival and evaluation characteristics and their association with ECG[b] performance

Characteristic	All patients (n = 128)	ECG time ≤ 10 minutes (n = 77)	ECG time > 10 minutes (n = 51)	*P* value
ED presentation, no. (%)				.001
Ambulance	41 (32.0)	16 (39)	25 (61)	
Walk-in triage	87 (68.0)	61 (70)	26 (30)	
ED day, no. (%)				.488
Weekday	91 (71.1)	53 (58)	38 (42)	
Weekend/holiday	37 (28.9)	24 (65)	13 (35)	
ED work shift, no. (%)				< .001
Regular[c]	63 (49.2)	48 (76)	15 (24)	
Off-regular[d]	65 (50.8)	29 (45)	36 (55)	
ED medic on duty, no. (%)				.05
Cardiologist/cardiovascular fellow	26 (20.3)	20 (77)	6 (23)	
Noncardiologist	102 (79.7)	57 (56)	45 (44)	

[a]ED = emergency department. [b]ECG = electrocardiogram. [c]Regular work shift is 8:00 AM to 4:00 PM. [d]Off-regular work shifts are between 4:00 PM and 8:00 AM.

diologist evaluation was associated with more frequent early ECG (77% compared to 56% for evaluation by a noncardiologist), this finding was only marginally significant ($P = .05$).

In 77% of the study patients, the ED physician documented the ECG as part of the progress notes for the initial evaluation (Figure 2). This early ECG documentation was found more often if the patient presented with chest pain (86%) or if the initial evaluation was performed by a cardiologist (100%). Some physicians may document an ECG in their plan of action, and some may not perform an ECG until after having a positive cardiac marker for myocardial necrosis (most commonly with atypical presentations)—despite the fact that our institution's protocol specifies that an ECG should be the first step in assessing a suspected AMI.

ECG findings were interpreted correctly in 88% of the study patients, and no STEMI cases were missed. In general, 59% of the patients had ECG findings of acute ischemia (ST-segment elevation, ST segment depression, or T wave inversions), 18% had nondiagnostic ECG results (chronic left bundle branch block, pacing rhythm, or preexitation), and 23% had ECG results indicating no acute ischemia (nonspecific changes or normal findings) (Figure 3).

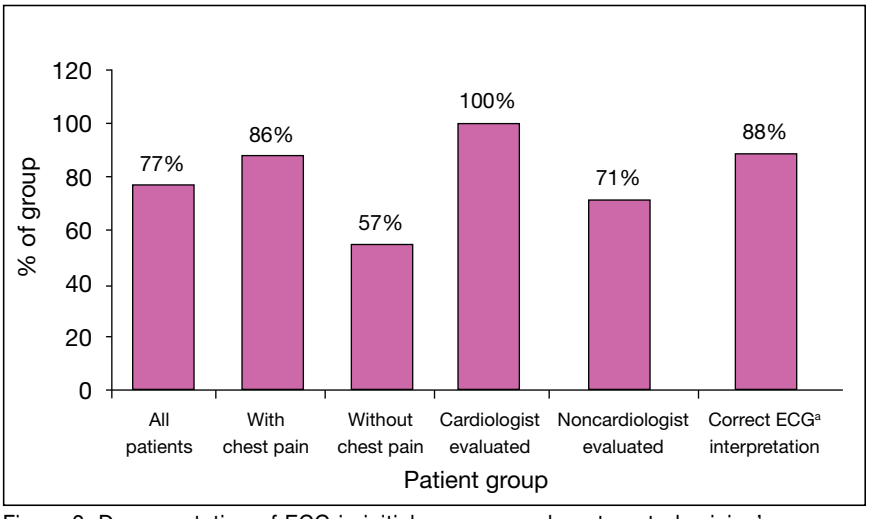

Figure 2. Documentation of ECG in initial emergency department physician's progress note. [a]ECG = electrocardiogram.

Odds ratios

Multiple logistic regression analysis showed that the most significant factor to correlate independently with a delayed ECG was the absence of chest pain (OR, 19.45; $P < .0001$) (Table 5). On the other hand, an ED arrival by walk-in triage (rather than

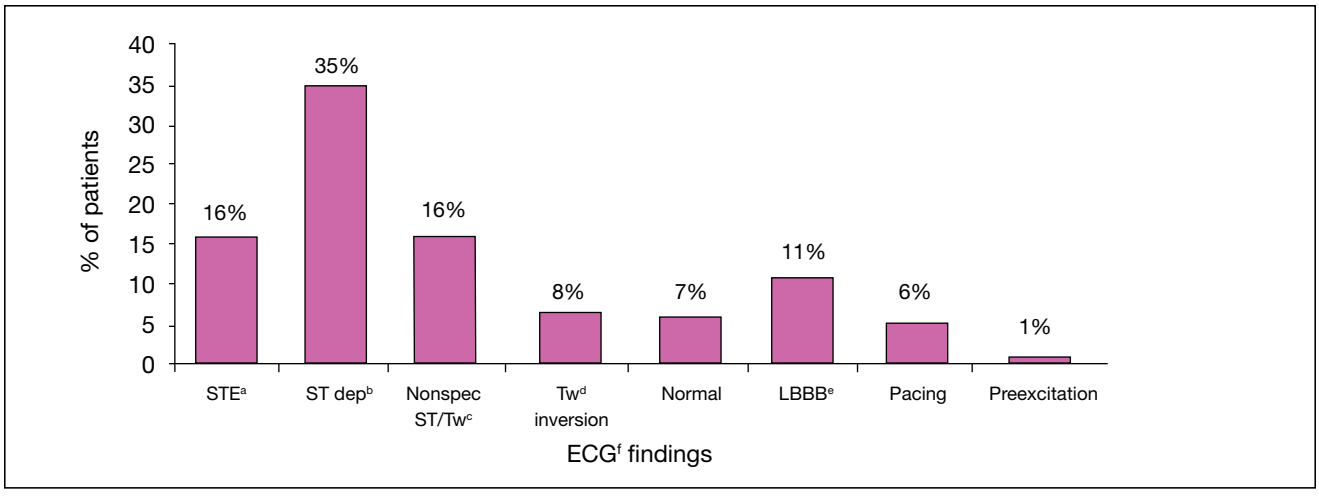

Figure 3. Initial findings of ECG upon arrival in the emergency department for study patients (n = 128). [a]STE = ST-segment elevation. [b]ST dep = ST-segement depression. [c]Nonspec ST/Tw = nonspecific ST-segment or T wave changes. [d]Tw = T wave. [e]LBBB = left bundle branch block. [f]ECG = electrocardiogram.

Table 5. Association of variables with delayed ECG[a,b]

Variable	Odds ratio	95% CI[c]	*P* value
Absence of chest pain	19.45	5.31, 71.23	< .0001
ED[d] presentation during off-regular work shift[e]	2.77	0.96, 8.00	.060
Low pain score[f]	2.69	0.81, 8.89	.105
Evaluated by noncardiologist ED physician	2.63	0.98, 7.10	.056
ED arrival by walk-in triage (versus ambulance)	0.33	0.11, 0.55	.001
STEMI[g] (versus NSTEMI[h])	0.32	0.10, 1.03	.057

[a]ECG = electrocardiogram. [b]Delayed ECG defined as one that was performed more than 10 minutes after documented ED arrival. [c]CI = confidence interval. [d]ED = emergency department. [e]From 4:00 PM to 8:00 AM (versus regular work shift, from 8:00 AM to 4:00 PM). [f]Score ≤ 3 on a 0–10 scale. [g]STEMI = ST-segment elevation myocardial infarction. [h]NSTEMI = non–ST-segment elevation myocardial infarction.

by ambulance) was associated with a reduced risk of a delayed ECG (OR, 0.33; *P* = .001).

DISCUSSION

In our study, 78% of patients with AMI presenting to the ED with chest pain received an ECG within 10 minutes, surpassing the current VHA fully successful target of 75%. When all patients with AMI were included, however, early ECG performance dropped to 60%. Predictors of ECG delay in our patient sample included: absence of patient-reported chest pain, initial evaluation by a noncardiologist, presenting with NSTEMI (rather than STEMI), and presenting during an off-regular work shift.

In two prior studies evaluating ECG time in patients arriving through the ED with ACS, acquisition of ECG within 10 minutes was poor, averaging 35% for patients with high risk NSTE-ACS (positive cardiac markers for AMI or ischemic ST-segment changes) and 41% for patients with STEMI.[12,13] Among the multiple baseline variables analyzed, female gender was the only positive predictor for a delayed ECG in both STEMI and NSTE-ACS patients.[8,13] A study limited to STEMI patients found that African Americans had better ECG times than whites.[12] In our study, gender and race status were limited by very limited number of female patients (one) and African American patients (10) included in the sample. None of these studies analyzed data regarding clinical presentation, physician evaluation, or ECG documentation.

Atypical AMI presentation

Among hospitalized patients who have AMI, 13% to 26% have been described as having no chest pain

or other chief symptoms.[16,17] In our study, the frequency of atypical presentations without chest pain (most often shortness of breath) was 27%. This relatively high figure likely is related to the prevalence of diabetes and the advanced age of our patient population. In our study, only 11% of patients with an atypical presentation had an ECG within 10 minutes.

In addition to being at risk for delayed ECG, patients with atypical symptoms also may delay seeking help because they fail to recognize that they may be experiencing symptoms of an AMI. Patient education on how to recognize both typical and atypical AMI symptoms and to seek help promptly is therefore critical and fundamental.

NSTEMI vs STEMI

Atypical presentations were more common in our patients with NSTEMI, which could explain why this group experienced more ECG delay. Conversely, STEMI patients may have better ECG times because of a more extensive and active state of myocardial ischemia that may have greater clinical relevance—for example, more severe chest pain or suggestive clinical appearance. It is noteworthy that ECGs were delayed in the three patients with STEMI who presented without chest pain.

Noncardiologist evaluation

We may assume that early ECG was attained more frequently when the initial patient evaluation was performed by a cardiology fellow or attending because these specialists were more aware of atypical AMI presentations than noncardiologists. If so, it may be reasonable to suggest that the ED implement an ECG policy that incorporates all potential AMI equivalent symptoms to avoid delaying recognition and treatment of AMI. Provision of real-time feedback to ED and catheterization laboratory staff has been shown to improve time to primary PCI in patients with STEMI, with an absolute time reduction of close to nine minutes.[18]

Ambulance arrival

The association between ECG delay and ambulance arrival was unexpected. In a previous study of patients with STEMI, Lambrew and colleagues found that, compared with other modes of transportation, ambulance arrival at the ED reduced the time to ECG by half.[8] Our conflicting finding may be related to multiple factors, including the fact that half of the patients who arrived by ambulance were transferred from other health care facilities. The care these patients received prior to their transfer may have led to their arriving in our ED with fewer symptoms and less chest pain than those who walked in, which may have made the need for ECG seem less urgent. Many transfers in this situation are issued because the patient prefers continuity of care in the VA system, lacks medical insurance, or cannot afford to pay for private care. Additionally, patients arriving by ambulance may have been registered more promptly than those who arrived through walk-in triage, thus giving the patients transported by ambulance a more accurate arrival time from which to begin calculating time to ECG performance. Walk-in patients, on the other hand, may have gone through an unaccounted transit time before they were evaluated by the triage nurse and registered to the ED, which would have artificially shortened the time between "arrival" and ECG.

Whatever the cause of ECG delay in patients arriving in ambulances, our chest pain committee alerted ED management to this finding. As a result, we are now using a dedicated bed for ambulance arrivals to implement faster triage and early ECG acquisition.

Presentation during off-regular work shift

The delay in ECG acquisition among patients who arrived during an off-regular work shift noted in our study may have been related to the decreased number of staff assigned during these shifts—in conjunction with possible issues of patient overcrowding in the ED. Patient flow issues and overcrowding were not measured in our study, but they are important areas for improvement and should be evaluated further. Recruitment of ECG technicians in the ED may improve ECG time, especially when the delay in ECG is related specifically to issues of understaffing and patient overcrowding. Although the presence of an ECG technician cannot replace a keen and effective triage, it should decrease the responsibility of the nurse and the physician who are already overburdened with many time-sensitive patient care responsibilities.

Study limitations

In addition to the limitations stemming from the relatively homogenous study population (with regard to ethnicity and gender) and the failure to address ED workflow and overcrowding issues, our study did not take into consideration insurance status. This status, however, does not affect acute patient care within the VHA. Additionally, ED arrival time was obtained mostly from clerk registration, initial documentation of patient arrival, or initial documentation of active patient care—none of which are necessarily good surrogates for the actual time the patient enters the ED or the triage area.

CONCLUSIONS

Early ECG performance in the evaluation of a patient arriving at the ED with possible ACS is essential for the diagnosis, treatment and risk stratification benefits. The sooner this ECG is performed, the faster the patient may receive treatment tailored to the type of ACS presentation according to established clinical pathways. Our findings indicate that, during the period studied, the VA Caribbean Healthcare System still was not meeting the VHA performance expectation that 75% of patients with ACS receive an ECG within 10 minutes of ED presentation—despite strong gains from previous levels of compliance. Based on our findings regarding factors related to ECG delay, we are making further changes at our institution to exceed and remain above this goal.

Every hospital should create a specific ECG policy for the diagnosis of AMI with typical and atypical presentations. This policy should also address the option of performing an ECG as a screening tool in higher risk patients with atypical presentations—for example, as seen in elderly and female patients and patients with diabetes. This ECG policy needs to be implemented and disseminated to the full ED staff, including the triage nurses and clerks, who usually are the initial patient contact.

Hospitals also should create a specific multidisciplinary committee to guide and lead the process of improving all pertinent AMI performance measures. This committee should be responsible for continuous monitoring of performance, assessment of problems, implementation of strategies, staff education, and overall maintenance and success of the improvement process.

Finally, constant feedback about early ECG performance is necessary to create awareness about its importance and to motivate the staff toward improvement.

Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

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