The Impact of Prehospital 12-Lead Electrocardiograms on Door-to-Balloon Time in Patients With ST-Elevation Myocardial Infarction

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The Impact of Prehospital 12-Lead Electrocardiograms on Door-to-Balloon Time in Patients With ST-Elevation Myocardial Infarction

Authors: Mary Meadows-Pitt, RN, MSN, MICN, CEN, and Willa Fields, DNSc, RN, FHIMSS, La Mesa and San Diego, CA

Introduction: Multiple strategies have been implemented to reduce door-to-balloon times. The purpose of this study was to compare door-to-balloon times between ST-elevation myocardial infarction (STEMI) patients who arrived at the emergency department by ambulance with a pre-hospital electrocardiogram (ECG), to those who self-transported and had an ECG on ED arrival.

Methods: This retrospective, comparative study evaluated differences in door-to-balloon times from October 2006 to December 2009 between STEMI patients that had a 12-lead ECG done in the ambulance prior to ED arrival and patients who self-transported and had an ECG on ED arrival.

Results: Of the 367 patients, 62% (n=228) arrived by ambulance and 38% (n=139) self-transported to the emergency department. Door-to-balloon times were 30 minutes less (P <.001) than patients who were self-transported.

Discussion: Door-to-balloon times can be reduced when chest pain patients are transported to the emergency department by ambulance. The paramedics are equipped to perform an ECG, thereby making a preliminary diagnosis of STEMI. The emergency department can then prepare for potential angioplasty or percutaneous coronary intervention. An opportunity exists for emergency nurses to educate the public about the importance of calling 911 for chest pain.

Key words: STEMI; Prehospital; 12-lead

Cardiovascular disease is the leading cause of death in the United States. The most common type of cardiovascular disease is coronary artery disease (CAD), which accounts for 1 in 5 deaths and is the number 1 killer of both men and women. CAD begins when cholesterol substances or plaque are deposited within the coronary arteries. Plaque is formed by low-density lipoprotein (LDL) cholesterol, which is known as the "bad" cholesterol. When LDL reacts with free radicals in the body, it forms oxidized LDL. Once LDL is oxidized, it goes directly to the inner lining of any artery in the body, such as lesion-prone coronary arteries. Once there, oxidized LDL stimulates accumulation of inflammatory cells such as macrophages and platelets at the site of the vessel and adheres to the damaged area. More macrophages, cholesterol, and other lipids begin to accumulate at the site, forming a plaque that grows thicker and thicker. Over time, this can slow or completely restrict the amount of blood flow that travels to one or more areas of the body. This buildup of plaque can result in an acute coronary syndrome, which is precipitated by a sudden reduction of blood flow to the heart. The resultant syndrome may include unstable angina, non–ST-elevation myocardial infarction, or ST-elevation myocardial infarction (STEMI). Unstable angina occurs when symptoms of myocardial ischemia are present but there is no evidence of myocardial injury. In a non–ST-elevation myocardial infarction, there is evidence of myocardial injury produced by platelet embolization or transient vessel occlusion, evidenced by laboratory results including troponin and other cardiac markers. A STEMI is produced quickly by complete occlusion of the infarct artery. A STEMI diagnosis is based...
on electrocardiographic changes that show evidence of evolving myocardial injury, as well as the presentation of the patient. When there are electrocardiographic changes and the patient presents with pain or symptoms of suspected cardiac origin, the patient goes directly to the cardiac catheterization laboratory for a possible reperfusion treatment. Therefore STEMI patients benefit the most from rapid coronary reperfusion therapy.  

STEMIs represent 30% to 45% of acute coronary syndromes. Morbidity and mortality rates in STEMI patients have been shown to be directly related to the degree of myocardial damage sustained as a result of vessel occlusion. An important determinant of outcomes for the STEMI patient is timely reperfusion of the coronary arteries. Reperfusion of the affected artery can salvage myocardium that would otherwise become necrotic. The American College of Cardiology (ACC) and the American Heart Association (AHA) endorse the concept that a reduction in the time from arrival at the hospital to receiving either thrombolytic therapy or percutaneous coronary intervention (PCI), defined as balloon angioplasty, decreases STEMI patient morbidity and mortality rates. The goals of the thrombolytic therapy and PCI are to reopen the occluded artery, limit the size of the infarct, reduce left ventricular dysfunction, and therefore, improve the prospect of patient survival. In STEMI patients, early PCI has shown improved outcomes over thrombolytic therapy. 

A key quality-of-care indicator for STEMI patients is “door-to-balloon time,” or the interval between the time the patient arrives at the emergency department and the time that balloon angioplasty is performed in the cardiac catheterization laboratory. Guidelines recommend door-to-balloon times of 90 minutes or less. The purpose of this study was to compare door-to-balloon times between STEMI patients who arrived at the emergency department by ambulance with a prehospital electrocardiogram (ECG) and patients who self transported and in whom an ECG was obtained on ED arrival.

**Background**

Multiple strategies have been implemented to reduce door-to-balloon times. In 2000 the AHA recommended that paramedics obtain 12-lead ECGs before ED arrival to help decrease door-to-balloon times. Brown et al compared door-to-balloon times between patients who had a prehospital STEMI activation based on a 12-lead ECG computer interpretation and STEMI patients who presented to the emergency department during the same period. Those patients who had a prehospital STEMI activation had a significant difference ($P < .001$) in door-to-balloon time ($73 \pm 19$ minutes) compared with non–field STEMI patients ($130 \pm 66$ minutes).

A prospective study in Los Angeles County was performed to determine the performance of a regional STEMI system with prehospital 12-lead ECG identification and direct paramedic transport. The study showed that patients who had a 12-lead ECG computer-identified STEMI before ED arrival and were diverted to the closest STEMI receiving center had a door-to-balloon time no longer than 90 minutes 89% of the time, as compared with a rate of 4% from the National Registry of Myocardial Infarction. Those patients who were diverted from a closer emergency department to a STEMI receiving center had a median increase in transport time of 3.8 minutes.

Increased door-to-balloon time is related to increased patient mortality rate despite a patient’s risk factors. It has been shown that with every minute of delay in having a PCI for a STEMI, the mortality rate increases. For every 30-minute delay in reperfusion therapy, the 1-year mortality rate is estimated to increase by 7.5%. The immediate treatment of a STEMI limits the size of the infarct by reopening the occluded artery, reducing left ventricular dysfunction, and therefore, ultimately improving survival.

In 2004 the ACC and AHA set a goal to reduce the door-to-balloon time to less than 90 minutes in 75% of STEMI cases. The Centers for Medicare & Medicaid Services and The Joint Commission determined that a door-to-balloon time of less than 90 minutes should be the standard of care.

In 2005 the ACC created the Door-to-Balloon: An Alliance for Quality initiative, advocating adoption of 6 key strategies to reduce door-to-balloon time: (1) an emergency physician activates the cardiac catheterization laboratory, (2) one call activates the cardiac catheterization laboratory, (3) the cardiac catheterization laboratory team is ready in 20 to 30 minutes, (4) prompt data feedback regarding the follow-up on the patient from the cardiac catheterization laboratory is provided to those in the emergency department who cared for the patient, (5) there is senior management commitment, and (6) a team-based approach is used in caring for the patient.

Also in 2005 the AHA recommended more specific prehospital guidelines for chest pain patients: (1) prehospital 12-lead ECG diagnostic programs in urban and suburban emergency medical services, (2) routine use of prehospital 12-lead ECGs and advanced notification for patients with signs and symptoms of acute coronary syndromes, (3) prehospital personnel’s acquisition and transmission of either diagnostic-quality ECGs or their interpretation of them to the receiving hospital, and (4) advanced notification of the arrival of the patient with acute
coronary syndromes. Since that time, the AHA has developed the program Mission: Lifeline, which is a comprehensive national initiative to improve the quality of care and outcomes of STEMI patients by improving health care system readiness and response to care for these patients.

The ACC and AHA guidelines have recognized the importance of prehospital 12-lead ECGs in reducing door-to-balloon time. In 2006 San Diego County EMS developed strategies to ensure rapid cardiac reperfusion of STEMI patients. These strategies include 12-lead ECG computer interpretation before ED arrival and a regional STEMI receiving system with designated STEMI centers, with diversion of potential STEMI patients to the closest STEMI receiving center. Emergency departments designated as STEMI receiving centers have a cardiac catheterization laboratory and interventional cardiologist available 24 hours a day, 7 days a week, along with the ability to perform a PCI within 90 minutes.

Sharp Grossmont Hospital, a 536-bed community hospital with a 60-bed emergency department, is a designated STEMI center in San Diego County. The emergency department serves an urban and rural population and cares for approximately 80,000 patients overall and 150 STEMI patients annually.

Sharp Grossmont Hospital implemented a paramedic-activated STEMI protocol that included a prehospital 12-lead ECG with computer interpretation in patients with chest pain or pain of suspected cardiac origin. If the ECG results indicate a STEMI, the paramedic notifies the emergency department that a STEMI patient is en route. The mobile intensive care nurse then activates a STEMI code. The interventional cardiologist and cardiac catheterization team are paged to come to the emergency department. The cardiac catheterization laboratory is staffed from 7 AM to 7 PM Monday through Saturday and from 8 AM to 5 PM on Sundays. The interventional cardiologists provide STEMI call coverage 24 hours a day, 7 days a week, and are often in house during catheterization laboratory service hours. For those patients who arrive by private transport, a 12-lead ECG is obtained within 10 minutes of ED arrival. The emergency physician interprets the ECG and activates the STEMI code as appropriate.

Methods

This study was a retrospective, comparative evaluation of the differences in door-to-balloon times between STEMI patients who had a 12-lead ECG obtained before arrival at the emergency department and STEMI patients who self transported to a STEMI receiving center that services both urban and rural areas. This study was approved by the Internal Review Board at Sharp Healthcare, as well as San Diego State University.

Sample

Inclusion criteria included STEMI patients who had PCIs between October 1, 2006, and December 31, 2009. A
comparison of door-to-balloon times was made between those patients who were identified with a STEMI by a prehospital ECG and those patients who self transported to the emergency department and were identified with a STEMI by the emergency physician’s interpretation of the ED ECG. In all patients who were transported by an ambulance and had chest pain or pain of suspected cardiac origin, a 12-lead ECG was obtained before ED arrival. Those patients who were in the emergency department whose initial ED 12-lead ECG was negative for a STEMI but in whom a STEMI developed during their stay in the emergency department were not included in the study. Patients who were in cardiac arrest were excluded from the study, as were STEMI patients who had prescheduled PCI procedures. Other patients who were excluded from the study were those who had an atypical cardiac presentation and so no ECG was obtained by the paramedics, those who refused a PCI, those with a contraindication to having a PCI, and those with a valid do-not-resuscitate order.

DATA COLLECTION AND ANALYSIS

Demographic data included patient age and gender. Also included in the analysis was the reported time interval between patient onset of symptoms and balloon angioplasty, as well as the interval between the patient arriving at the emergency department and the patient undergoing balloon angioplasty in the cardiac catheterization laboratory.

Data were retrieved from the electronic health record. Demographic data were analyzed with descriptive statistics. Comparisons of ED arrival to balloon inflation and onset of symptoms to balloon inflation between the 2 groups of STEMI patients were analyzed with an analysis of variance test. Statistical significance was set at $P \leq .05$. Statistical analyses were conducted with SPSS software, version 17.0.17

Results

There were a total of 367 patients; 62% (n = 228) arrived in the emergency department by paramedic ambulance, and 38% (n = 139) self transported to the hospital. Of the patients, 74% (n = 273) were men and 26% (n = 94) were women. The mean age of the group transported by paramedic ambulance was 62 years (SD, 12.69 years) versus 58 years (SD, 11.03 years) for the group that self transported to the hospital. The difference in the ages was statistically significant ($P = .046$), although there was no difference in door-to-balloon times based on age.

Both men and women arrived in the emergency department predominately by paramedic transport, although men had a higher probability of using private transport and women had a higher probability of using paramedic transport ($P = .034$). There was no significant difference in door-to-balloon time for gender.

Patients who were transported by paramedics arrived at the emergency department within 15 minutes to 240 hours after symptom onset, with a mean of 5.87 hours. In contrast, patients who self transported to the emergency department arrived from 15 minutes to 336 hours after symptom onset, with a mean of 14.52 hours. In addition, once the patients arrived at the emergency department, those who were transported by paramedics had had a prehospital 12-lead ECG, and therefore, the hospital was on alert for a potential STEMI patient; these patients had a door-to-balloon time 30 minutes shorter ($P < .001$) than that in patients who self transported, with a partial $\eta^2$ of 0.299, which shows a large effect size. The time from onset of symptoms to balloon time was approximately 2.5 times longer for those patients who self transported ($P = .006$) (Table).

An average of 27% of the STEMI patients who had a prehospital 12-lead ECG reading indicative of a STEMI did not have the same results on the repeat ECG in the emergency department (false positive). Multiple reasons for the false-positive 12-lead ECG, such as poor-quality 12-lead ECGs, dysrhythmias, and other medical conditions, were determined.

Discussion

Implementing successful strategies to improve the care of the STEMI patient by reducing door-to-balloon time has been associated with reductions in morbidity and mortality rates.18 One of the recommendations by the ACC and AHA to achieve this goal is for the paramedics to obtain 12-lead ECGs in the field. Once a STEMI patient has been identified by the prehospital 12-lead ECG, hospital notification can result in earlier activation of the cardiac catheterization laboratory team.

This study showed a significant difference in door-to-balloon times between STEMI patients who were transported by paramedics and those who self transported to the emergency department. The difference in time can be attributed to the emergency department receiving notification that a STEMI patient was arriving from the field and having additional time to prepare a room for the patient in the emergency department; call in the cardiac catheterization laboratory staff, as well as the interventional cardiologist; and prepare the cardiac catheterization laboratory for an incoming patient.

This study also showed a significant difference between time of symptom onset and time to arrival at the emergency department; and prepare the cardiac catheterization laboratory for an incoming patient.
department. The patients who were transported by paramedics arrived within 5 hours of symptom onset, whereas those who arrived by private car arrived more than 13 hours after symptom onset. Both groups showed a delay in seeking care. In a study by Lesneski,19 several predictors of patients’ delays in seeking care for their acute myocardial infarction were found. Being home when symptoms began resulted in a longer delay to treatment, as well as the perception that the patient’s pain was not severe. Participants who thought that their symptoms were not heart related also delayed treatment. Participants who had a companion or someone that they told about their symptoms had a shorter delay in seeking care.

Early recognition of symptoms and avoidance of delay in calling 911 are key elements in preventing morbidity and death in STEMI patients. Prompt treatment can decrease myocardial damage. Emergency nurses can educate high-risk patients and their families, as well as the community, on symptoms of myocardial infarction and the benefits of early treatment. The public needs to be aware of symptoms of a myocardial infarction and to call 911 promptly should these symptoms occur.

Over the past several years, our institution has reduced the door-to-balloon time in patients arriving by ambulance, as well as those arriving by private vehicle. This is believed to be the result of many factors: (1) having the mobile intensive care nurse activate a STEMI code when notified by paramedics that they have a 12-lead ECG that is positive for a STEMI without involvement from the emergency physician or interventional cardiologist, (2) having a single call to the operator to activate the cardiac catheterization laboratory team and the interventional cardiologist, (3) expecting the cardiac catheterization laboratory staff and interventional cardiologist to arrive within 30 minutes of being paged, and (4) providing data feedback to the emergency department and cardiac catheterization laboratory staff. These interventions as well as obtaining a prehospital 12-lead ECG are critical components in shortening door-to-balloon time.

LIMITATIONS

The data reported represent 1 institution. The practices at this hospital may be different from those at other hospitals. The specialization of this hospital in treating STEMI patients, including 1 call to activate the cardiac catheterization laboratory and the interventional cardiologist, the expectation of the team’s arrival within 30 minutes, prompt data feedback, senior management commitment, and a team-based approach, may limit its generalizability.

There were other limitations in this study including the timing of the onset of symptoms that is obtained from the patient, which may not be accurate. Patients frequently are uncertain of the exact time of the onset of their symptoms, as well as the onset of their acute myocardial infarction, which may have been preceded by hours of unstable angina. Therefore it is frequently impossible to establish the exact time of the onset of an acute myocardial infarction.

Although the false-positive rate of the prehospital 12-lead ECGs was reported to be 27%, the treatment of patients in the field by the paramedics may have resulted in resolved ST-segment elevation by the time the patients arrived in the emergency department, which resulted in a higher false-positive rate. Other reasons for the false-positive 12-lead ECGs were poor-quality ECGs, dysrhythmias, and other medical conditions. Those patients who had a negative prehospital 12-lead ECG and then, upon arrival at the emergency department, were positive for a STEMI (ie, false negative) were not captured, because those patients could have been directed to a non-STEMI receiving center.

Implications for Emergency Nursing

Recognition is the first step to prompt treatment when a patient is having an acute myocardial infarction. Emergency nurses have the opportunity to raise awareness of CAD and provide education to high-risk patients and the community, as well as the signs and symptoms of an acute myocardial infarction. Emergency nurses need to develop educational interventions to decrease decision delays by persons who are at high risk of acute myocardial infarction or who are having symptoms of an acute myocardial infarction, as well as their family members. A plan regarding the appropriate response when one is having acute myocardial infarction symptoms needs to be in place so that when these symptoms occur, patients and their families know to immediately call 911 to receive prompt treatment of symptoms. It is our responsibility to explain the importance of correcting risk factors, as well as to educate patients on how to recognize signs and symptoms of chest pain and atypical chest pain. Our patients and community also need to be educated on the benefits of calling 911 when cardiac symptoms occur. General public health education needs to focus on symptom recognition and the need for and benefit of calling 911 promptly, as well as an awareness that doing anything other than calling 911 can delay treatment time.

Exploring the reasons why patients wait to access medical care for their symptoms would yield valuable data. New strategies and research in effective public education on
seeking immediate care in those patients with chest pain are also needed.

Conclusion

The standard of care for the treatment of STEMI patients is timely restoration of blood flow through the blocked coronary artery and myocardial reperfusion. Shortened reperfusion times will lead to improved patient outcomes; therefore efforts should continue to reduce the time to reperfusion. This study showed that patients who arrived at the emergency department by ambulance had shorter door-to-balloon times than those who self transported. Therefore emergency nurses must identify strategies for patients to access the emergency response system in a timely manner for transportation to the emergency department during cardiac events.

REFERENCES

2. Stocker R, Keaney F. Role of oxidative modifications in atherosclerosis. 
6. Pride YB, Appelbaum E, Lord EE. Relation between myocardial infarct size and ventricular tachyarrhythmia among patients with preserved left ventricular ejection fractions following fibrinolytic therapy for ST-segment elevation myocardial infarction. 
17. SPSS. SPSS Statistics for Windows, version 17.0SPSS; 2008.