A community hospital's effort to expedite treatment for patients with chest pain

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Griffin, H., Davis, L., Gant, E., Savona, M., Shaw, L., Strickland, J. (1999). A community hospital's effort to expedite treatment for patients with chest pain. *Heart and Lung*, 28 (6), 402-408.

Abstract:

Objective: The purpose of this study was to determine treatment times at a community hospital that does not receive prehospital electrocardiogram (ECG) transmission and to determine the effect of time to first hospital ECG on overall door-to-drug time. **Design:** Descriptive. **Setting:** 238-bed Regional Medical Center in Burlington, North Carolina. **Sample:** One hundred four patients with a final diagnosis of acute myocardial infarction were included in this 16-month study. **Results:** A median door-to-ECG time of 5 minutes was within the American College of Cardiology/American Heart Association recommendation of 10 minutes. Shorter treatment times to obtain the first ECG and initiate thrombolytic therapy were associated with younger patients and those arriving by ambulance. **Conclusions:** While efficiency in obtaining a first hospital ECG on patients with suspected acute myocardial infarctions was achieved, this did not result in low door-to-drug times. Further streamlining of protocol and the exploration of prehospital initiatives may result in a significant reduction in door-to-drug times. (Heart Lung® 1999;28:402-8)

Keywords: door-to-ECG time | North Carolina Acute Coronary Response ECG Study (NC CARES) | acute myocardial infarction | community hospitals

Article:

The time from a patient's arrival at a hospital emergency facility with presumed acute coronary thrombosis to the time of delivery of reperfusion therapy, the "door-to-drug" time, is a critical period for determining the extent of an acute myocardial infarction (AMI). With achievement of complete reperfusion in an occluded artery by mechanical or pharmacologic means, the likelihood increases that an AMI patient will survive and that the size of the infarct will be reduced.[1,2] Previous studies[3-6] have shown wide-ranging benefits, such as improved left ventricular ejection fraction (LVEF), myocardial salvage, and reduced mortality because of a

reduction in the time to treatment among patients with AMIs. In an effort to help patients with AMIs obtain these benefits, clinicians have adopted many initiatives to reduce door-to-drug times. These strategies include public educational initiatives,[7-9] implementation of quality control measures, the development of patient identification and treatment protocols,[10,11] prehospital thrombolysis,[12] and the use of prehospital electrocardiogram (ECG) transmission.[13,14]

In 1994, the Duke University Cooperative Cardiovascular Society (DUCCS) organized the North Carolina Acute Coronary Response ECG Study (NC CARES) for the purpose of assisting North Carolina medical communities in reducing door-to-drug times. Currently, NC CARES includes 16 medical centers throughout central and eastern North Carolina. NC CARES has encouraged the development of rapid prehospital and hospital ECG protocols for patients with AMIs via the sharing of experiences and innovations in AMI management through meetings, surveys, publications, and analysis of treatment times. Alamance Regional Medical Center (ARMC), located in Burlington, NC, is a 238-bed hospital and member site of NC CARES. This study was designed to answer the following questions: (1) What is the door-to-drug time at ARMC, a community hospital that does not receive prehospital ECG transmission? (2) What effect did decreased door-to-ECG time have on overall door-to-drug time? (3) Are longer door-to-ECG or ECG-to-drug times associated with patients with certain baseline characteristics? To answer these questions, diagnostic ECG and thrombolytic therapy time intervals were evaluated for patients with AMIs over a 16-month period. Since initiatives by ARMC's emergency department (ED) staff have focused on rapidly obtaining an ECG on patients with suspected AMIs, the primary study hypothesis was that ARMC's door-to-ECG times would meet state and national goals.

METHODS

Participants

ARMC serves patients from Alamance County and neighboring communities. Because ARMC is not classified as a level I trauma center, there is an increased proportion of cardiac emergencies among patients seen in the ED. Approximately 70 patients with AMI undergo intravenous thrombolytic therapy annually. The cardiology staff does not perform primary percutaneous transluminal coronary angioplasty (PTCA). The Alamance County emergency medical system does not obtain a prehospital ECG. If the emergency medical technician paramedic (EMT-P) suspects that a patient is having an AMI, an intravenous catheter is inserted, a cardiac monitor is attached, oxygen is administered, and a radio call is placed to communicate to the ARMC ED about the pending arrival of the patient. Frequently, additional advanced cardiac life support (ACLS) orders are transmitted to the EMT-P by ARMC emergency physicians.

ARMC's ED protocol for diagnosing patients with suspected AMIs

Experienced ARMC emergency nurses are assigned to triage patients with chest pain to a diagnosis and treatment area immediately. Standing orders allow the emergency nurse to obtain a standard 12-lead ECG as soon as possible. These nurses have been trained to detect acute ECG changes and alert the ED physician immediately if changes are present. If the attending emergency physician concurs with the diagnostic ECG changes, a brief history is obtained to

assess the inclusion criteria for the reperfusion therapy via a thrombolytic therapy checklist. ARMC requires patients to sign informed consent for thrombolytic therapy. The emergency nurses reconstitute and administer the thrombolytic agent, tissue plasminogen activator (t-PA), which is stored in the hospital's ED.

Experienced ED staff

The majority of ARMC's emergency physicians are board certified in emergency medicine. The nurses are experienced emergency nurses, and a majority have ACLS certification. Since the early 1980s, the hospital's ED staff has participated in thrombolytic clinical trials, which require efficiency in identifying and treating patients with AMIs.

ED nursing orientation at ARMC is extensive and competency based. Nurses are reevaluated annually for competency in cardiac assessment and proper use of thrombolytic therapy. Before completion of orientation, ED nurses must demonstrate proper lead placement and recording of an ECG to their preceptor and the unit coordinator. Emergency nurses must also pass a medication safety and arrhythmia test before employment.

Patient population

From November 1994 to March 1996, 289 patients with a discharge diagnosis of myocardial infarction (MI) were managed at ARMC. Of these, 112 patients (39%) were patients with AMIs who were eligible for intravenous thrombolytic therapy. The remaining 117 patients did not receive thrombolytic therapy because of nondiagnostic ECGs or contraindications to thrombolytic therapy. Two patients who received thrombolytic therapy at ARMC were excluded from the study because they had an ECG taken in a medical office before their arrival at ARMC. Six patients were excluded from the study because of missing or incomplete data. The remaining 104 patients who received thrombolytic therapy were included. Fig 1 outlines the patient population, with an emphasis on the final study group of patients.

Data collection

The second phase of the National Registry of Myocardial Infarction (NRMI-2), implemented in November 1994, has made it possible to track the door-to-drug times and other important characteristics of all patients with AMIs.[15] From NRMI-2 case report forms and copies of the patient's ECGs, the hospital arrival time, first ECG time, and time of initiation of thrombolytic therapy were determined for each of the study patients. Calculations of the hospital arrival time, the first ECG time, and the time of initiation of thrombolytics are in accordance with the NRMI-2 guidelines. Hospital arrival time was obtained from the earliest recorded time in the patient's record from either the ED triage nurse's note, the physician's note, or the time of registration listed on the front sheet of the ED chart. In some cases, the time printed on the patient's ECG was used as the arrival time if the ECG was taken before registration or the initiation of the medical record. In these cases, the patient's ECG was initiated as the patient was being registered and the nurse's or physician's notes were being started. The first ECG time was obtained from the time indicated on the earliest ECG in the patient's records. In 22 of the 104 patients (21%), the first ECG was not considered sufficiently "diagnostic" of thrombosis-induced MI to indicate

thrombolytic therapy. Thrombolytic therapy initiation time was obtained from the recorded time of t-PA bolus administration in the nurse's note under "medications." By subtracting first ECG time from initiation time of thrombolytic therapy, ECG-to-drug time was obtained. Door-to-drug times were calculated for each of the study's patients whose first ECG was considered diagnostic of a thrombotic coronary occlusion (n = 82).

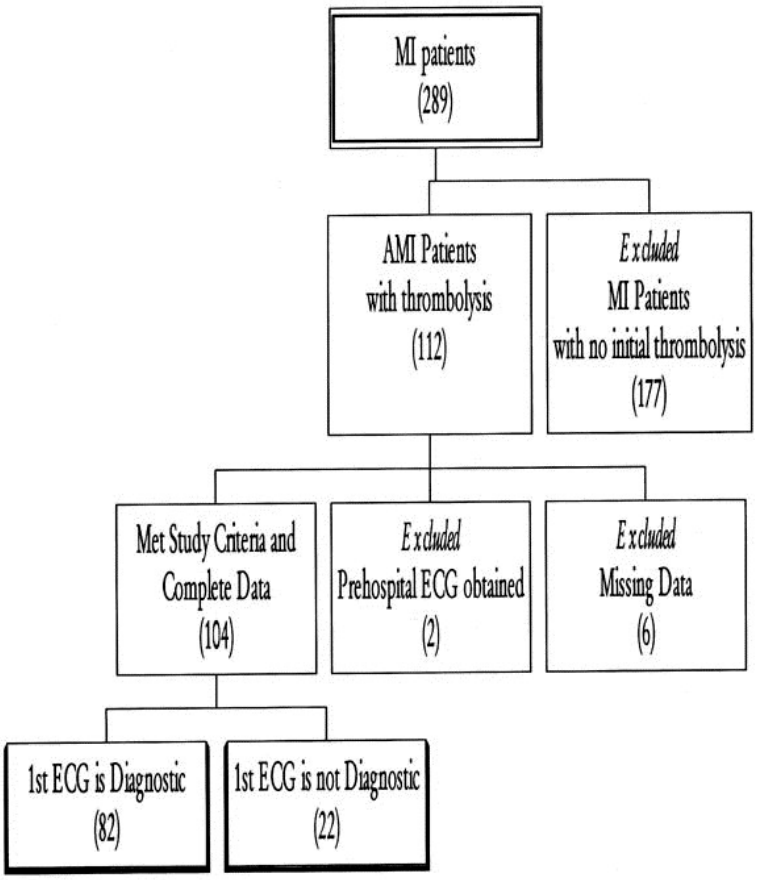

Fig. 1. Patient population: patients with a final diagnosis of an AMI who were treated at ARMC according to NRMI-2.

Door-to-ECG times were considered for all study patients; however, only patients whose first ECG was considered diagnostic of acute coronary occlusion were included in the calculation of overall ECG-to-drug time. Distributions of door-to-ECG and ECG-to-drug times for patients according to mode of transportation to the ED, sex, age, and race were examined. To gain additional insights into possible causes of delay, hospital records were examined for patients with door-to-ECG times greater than 16 minutes and ECG-to-drug times greater than 41 minutes.

Data analysis

Medians with 25th and 75th percentiles were calculated for continuous baseline variables. Categoric variables are expressed as percentages. The nonparametric Wilcoxon rank test was used to examine differences in continuous variables. All statistical results are unadjusted for other covariates.

RESULTS

Baseline characteristics for the total population and the subset of patients with diagnostic ECGs are displayed in Table I. The cohort includes a population that is 72% male (n = 75) and 88% white (n = 91). Forty-eight percent (n = 50) were transported to the ED by ambulance. The median age for the group was 63 years old.

Table I. Baseline characteristics

Characteristic	**Total population (n = 104)**	**Diagnostic ECG patients (n = 82)**
Race: White	88%	88%
Sex: Male	72%	73%
Transported by ambulance	48%	51%
Age, y*	63 (54,73)	62 (54,72)
Outcomes		
Door-to-ECG, min*	5 (1.5,9.5)	5 (2,8)
ECG-to-drug, min*	34 (20,58)	30 (19,45)
Door-to-drug, min*	40 (25,65)	33 (24,55)
*Median (25th, 75th quartiles).		

Door-to-ECG time

The door-to-ECG time distribution for all patients and the subset of patients whose first ECG was diagnostic of an AMI are displayed in Table I. The median door-to-ECG time for both groups of patients was 5 minutes. Twenty-five percent of all patients (n = 26) received their first ECG within 1.5 minutes of arrival to the ED. Of the 82 patients whose first ECG was diagnostic of an AMI, 25% (n = 21) had had those ECGs within 2 minutes of arrival. Seventy-five percent of all patients (n = 78) in the study received their first ECG within 9.5 minutes or less.

ECG-to-drug time

Table I presents the ECG-to-drug time distribution for the 82 patients whose first ECG was considered diagnostic. Twenty-five percent of the patients (n = 21) whose first ECG was diagnostic for AMI were given thrombolytic therapy within 19 minutes of the ECG time. The median ECG-to-drug time for this group of patients was 30 minutes, and 75% of these patients (n = 62) received thrombolytics within 45 minutes or less.

Door-to-drug time

The door-to-drug time distribution for the 82 patients whose first ECG was considered diagnostic for an AMI is included in Table I. The median door-to-drug time for this group was 33 minutes, with 75% of these patients (n = 62) receiving thrombolytic therapy within 55 minutes or less.

Comparison of time intervals according to baseline characteristics

Fig 2 presents median values for door-to-ECG times and overall door-to-drug times for patients grouped according to baseline characteristics.

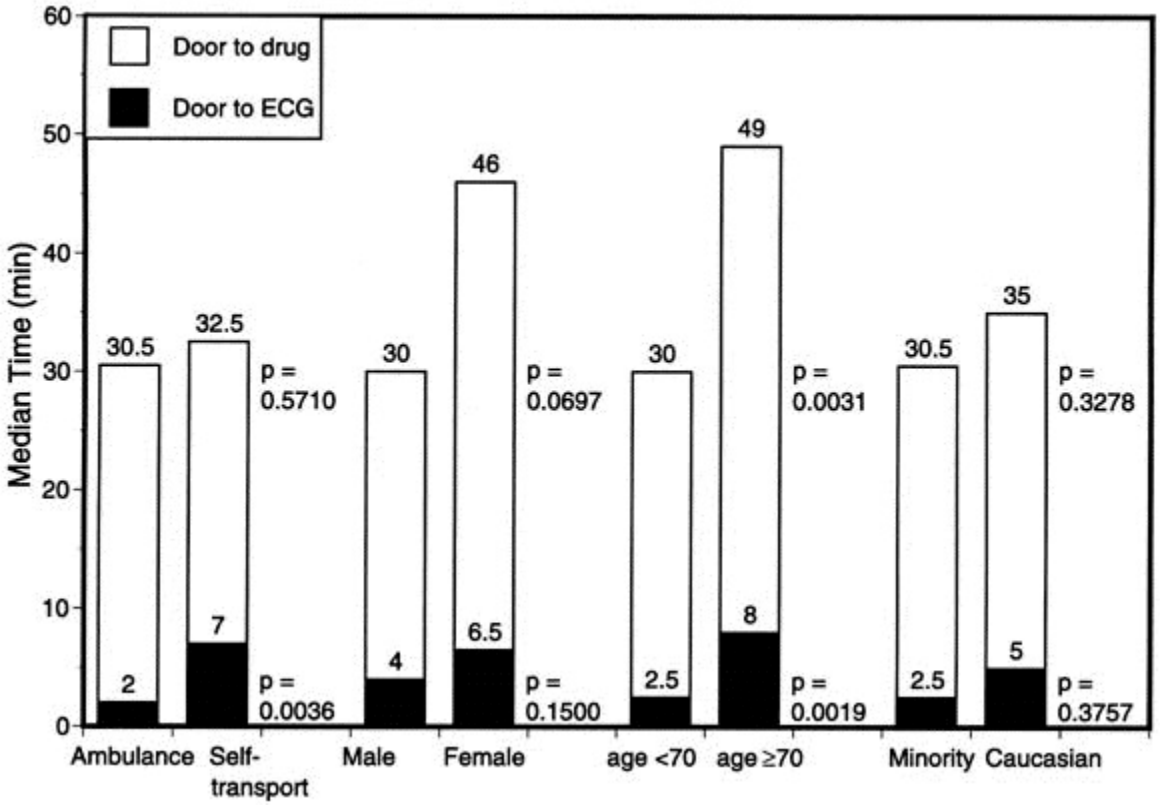

Fig. 2. Distribution of median time in minutes for door-to-ECG times and door-to-drug times according to baseline characteristics of the patients whose first ECG was diagnostic for an AMI.

Patients who arrived via Alamance County emergency medical services (EMS) had significantly shorter door-to-ECG times (*P* = .0036) than patients who arrived at ARMC via private vehicle. The median time for door-to-ECG time for patients arriving by ambulance was 2 minutes, compared with the median time of 7 minutes for private transport. Seventy-five percent of the patients (n = 62) transported by ambulance had door-to-ECG times of 7 minutes or less, as compared with 11 minutes or less for self-transported patients. However, the difference in overall door-to-drug times for these patients was not statistically significant, with median times of 30.5 minutes and 32.5 minutes respectively.

Although there was not a statistically significant difference in door-to-ECG times according to sex (*P*= .150) in this group of patients, there is a trend toward longer door-to-ECG times for women. The median door-to-ECG time for men was 4 minutes, as compared with 7 minutes for women. Similarly, this trend toward shorter times for men is evident in the median door-to-drug

times for men and women (P = .0697). Men have a median door-to-drug time of 30 minutes, while women have a median time of 46 minutes. Interquartile ranges for men were 24-49 minutes for door-to-drug time and 30-62 minutes for women.

Patients under 70 years old had significantly shorter door-to-ECG times (P = .0019) as compared with older patients. The median door-to-ECG time for patients with age < 70 years was 2.5 minutes, as compared with the median time of 8 minutes for age ≥ 70. This group of patients continued to have significantly shorter door-to-drug times (P = .0031), with median door-to-drug times being 30 minutes for age ≤ 70 years and 49 minutes for patients age ≥ 70 years.

The median door-to-ECG times for white patients was 5 minutes as compared with minority patients, with a median time of 2 minutes. However, there was no statistically significant difference in door-to-ECG times by race. Nor was there a statistically significant difference between door-to-drug times by race.

DISCUSSION

ARMC's ED personnel are efficient in rapidly obtaining a first hospital ECG for patients with suspected AMIs even in the absence of prehospital ECG transmission. The hospital has answered nationwide calls to decrease the time to treatment for patients with AMIs. With a median door-to-ECG time of 5 minutes, ARMC has met the American College of Cardiology (ACC)/American Heart Association (AHA) recommendation of obtaining a diagnostic ECG within 10 minutes[16] and has attained a median time below recently reported national and state times of 7 and 8 minutes respectively from NRMI-2 database. (The NRMI-2 is supported by Genentech, Inc., San Francisco, Calif.)

ARMC has adopted several strategies designed to decrease door-to-drug time. In 1990, ARMC began tracking door-to-drug times for patients treated with thrombolytic therapy as a part of a quality improvement (QI) project. One of the goals for the QI project was to reduce door-to-drug times to less than 60 minutes. Results of quarterly QI data collected were presented in the ED nursing and physician staff meetings. Educational initiatives were used to assist nurses in rapidly identifying and treating patients with AMIs. The development of standing AMI protocol allowed the ED nurses to be proactive in obtaining assessments, diagnostic data, and first line treatment. The need for additional time for acquisition of oral and written physician's orders was eliminated with the development of this protocol. Because diagnosis of AMI caused by coronary thrombus is supported primarily by observing ST segment elevation on the standard 12-lead ECG,[17] early recording of this clinical test is a primary goal.

Although ARMC has achieved exceptionally low door-to-ECG times, a further reduction in ECG-to-drug times may be possible. The ACC/AHA recommendation for door-to-drug times is 30 minutes, which is less than the median door-to-drug time for ARMC patients (33 minutes). However, 75% of the ARMC patients (n = 62) had a door-to-drug time of 55 minutes or less, which was less than the hospital goal set for 60 minutes. Because one fourth of the patients (n = 21) received thrombolytic therapy within 24 minutes, such low door-to-drug times are possible in this environment. With an increased emphasis on decreasing ECG-to-drug times, ARMC may be able to achieve such optimum times for a majority of its patients in the future.

Longer door-to-ECG times were associated with patients who arrived via private vehicle, as well as for older patients. It is possible that patients transported to ARMC via EMS received an ECG earlier than self-transported patients because the ED triage team, alerted to a suspected AMI patient's arrival by radio, was prepared to obtain an ECG as soon as the patient entered the door. Older patients may have longer door-to-ECG times because of difficulties in obtaining their history, moving them to the treatment area, and preparing them for ECGs. ECG-to-drug times also differed significantly according to age. Other studies using NRMI data have demonstrated that delays in initiating thrombolytic therapy for a suspected AMI patient are associated with sex, older age, delivery of thrombolytic therapy only after admission to CCU, and transportation via private vehicle to the ED.[18,19]

The cases of patients with door-to-ECG times greater than 16 minutes (12 patients) and overall door-to-drug times greater than 41 minutes (27 patients) were examined. Potential causes for longer ECG time intervals were vague symptoms or symptoms of long duration (5 patients) and unstable blood pressure (1 patient). Possible causes for longer door-to-drug time intervals were that 18 patients with door-to-drug times > 41 minutes had cardiology consultation done before drug therapy intervention (half of those were patients with controversial ECGs). Other possible causes included the arrival of patients in very unstable conditions requiring immediate intervention, that is, pacemaker, central intravenous line access, cardioversion, and/or defibrillation (9 patients) and the arrival of patients having potential contraindications to thrombolytic therapy that had to be "cleared" by an attending physician (4 patients).

Additionally, during a majority of the study period, ARMC was a leading enrollment site participating in an AMI clinical drug trial examining the adjunctive use of antiplatelet agents with thrombolytic therapy. The additional time required to obtain research consent forms, validate research inclusion criteria, and call the enrollment hotline could have potentially increased door-to-drug times. However, participation in the research trials may have helped decrease times by instilling in ED staff the importance of identifying and diagnosing patients with AMIs quickly. Currently, ARMC is involved in an AMI thrombolytic trial that includes a substudy examining the impact of research trials on door-to-drug times.

Because of the small patient population, differences in treatment times among subgroups may not have achieved statistical significance. A larger sample size would provide more confidence in our ability to assess the results. As an observational study, only trends in the data can be examined. Without a sufficiently powered, controlled, randomized study, factors such as mode of transportation to the ED, sex, race, and age cannot be cited as factors influencing treatment times. Although differences in door-to-ECG and ECG-to-drug times may be associated with the variables examined, other variables associated with particular subgroups may have influenced these times.

The low door-to-ECG times presented in this study may not be attainable in all hospitals. Community hospitals such as ARMC may have an advantage over tertiary care hospitals in attaining low door-to-ECG times because more resources are allocated to the care of patients with AMIs in the absence of other competing emergencies. In addition, ARMC uses 1

thrombolytic agent as the standard of care for AMI reperfusion. Differences in time to treatment may vary for hospitals where more than 1 thrombolytic agent or reperfusion strategy is used.

This study did not determine the accuracy of ARMC in the diagnosis of AMI. A future study examining the accuracy of ARMC in identifying patients with AMIs would be required for determining whether sacrifices in accuracy occurred as a result of efforts to treat patients rapidly. Examining the ECGs for patients not diagnosed as having AMIs in the ED would reveal whether such inaccuracies in diagnosis occurred.

CONCLUSIONS

This study has shown that a community hospital can attain remarkably low door-to-ECG times with a concerted effort by hospital ED staff to obtain a first hospital ECG rapidly. ARMC, with a median door-to-ECG time of 5 minutes, met national goals and performed more efficiently than the norm of NRMI-2 enrolled hospitals. Despite this accomplishment, the hospital's overall median door-to-drug time was above the national goal of 30 minutes.

To achieve maximum reperfusion benefits for patients with AMIs, prehospital initiatives need to be explored as part of the community's AMI management plan. Technologic breakthroughs such as the transmission of prehospital ECGs from the EMS to the hospital ED could potentially result in a further reduction of door-to-drug times at ARMC. In a future study, treatment times at ARMC will be compared to the times at NC CARES hospitals using prehospital ECG transmission to determine the potential costs and benefits of this strategy.

Acknowledgements

This study was possible because of the support and encouragement of faculty at the North Carolina School of Science and Mathematics (NCSSM). We especially thank Anita McCoy, chair of NCSSM's mentorship program, for facilitating the implementation of this study and Gloria Barrett and Dr. Daniel Teague for their statistical assistance. Last, without the dedication of the ED staff at ARMC, this study would not have been possible.

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