Transporting without Infusions: Effect on Door-to-Needle Time for Acute Coronary Syndrome Patients

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Abstract

Background. Standard of care for patients with acute coronary syndrome/ST-segment elevation myocardial infarction (ACS/STEMI) is rapid revascularization of ischemic myocardium. Current optimal treatment is primary percutaneous coronary intervention (PCI) within 90 minutes after the patient accesses the health care system, and strategies to lower this time may improve outcomes. **Objective.** To compare interhospital transport times (TTs) before and after instituting a no-medication-infusion policy during transport of ACS patients. Our hypothesis was that transporting patients using only bolus medications would significantly reduce transport times without increasing hospital length of stay (LOS) or increasing mortality. **Methods.** We conducted an institutional review board (IRB)-approved retrospective chart review of all patients transferred from an outlying hospital to a primary PCI center using either critical care helicopter or ground transport. The study period was January 2006 through January 2008, with the policy of discontinuing infusions instituted in April 2007. The TT was calculated using departure and arrival times from dispatch logs. The LOS was determined via electronic medical record review. The TT and LOS differences were calculated using two-tailed t-tests with Welch's correction where appropriate. **Results.** A total of 154 ACS/STEMI transports were completed during the study period (74 before and 80 after policy initiation). The mean (± standard error of the mean) TT was 43.5 ± 1.2 minutes before the policy and 37.1 ± 0.9 minutes after the policy ($p < 0.01$). To specifically address different transport distances, we analyzed TTs from an identical group of referral hospitals in both the before- and after-policy groups. A significant reduction in TT remained in this after-policy group (TTs 43.5 ± 1.2 minutes before the policy and 37.1 ± 0.9 minutes after; $p = 0.01$). Data on LOS were available for 127 patients (58 patients before and 69 patients after) and averaged 4.6 ± 0.8 days prior to the new policy and 3.9 ± 0.4 days after ($p = 0.41$). Overall, only one patient died (after-policy group) (p = not significant). **Conclusions.** A policy of transferring patients from one hospital directly to a cardiac catheterization laboratory using only bolus medications significantly reduces total door-to-needle time without adverse effects on LOS or mortality. Other institutions may want to consider such policies for interfacility transport of ACS patients. **Key words:** acute coronary syndrome; air medical transport; intravenous medications; patient transfers; transport times

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Introduction

Acute coronary syndromes (ACSs) are a major cause of morbidity and mortality in the United States, with approximately 500,000 patients presenting with ST-segment elevation myocardial infarction (STEMI) each year.[1,2] Early revascularization of ischemic myocardium is the mainstay of care for these patients. Studies have demonstrated that patients with more rapid revascularization have better outcomes, while delays in care lead to more extensive infarct size and myocardial damage with resultant worsening of left ventricular function and increased morbidity and mortality.[3–5] These findings have resulted in the specific goal that in the setting of a STEMI, primary percutaneous coronary intervention (PCI) should be performed within 90 minutes after the patient accesses the health care system.[2]

Research in the last several years has looked at ways to reduce door-to-balloon times for patients presenting either to emergency medical services (EMS) or directly to the emergency department (ED) with STEMI. While these studies have focused on factors such as prehospital identification of STEMIs, emergency physician activation of cardiac catheterization laboratories, and ED bypass direct to the catheterization laboratory,[6–9] there has been less research attempting to reduce time to PCI for patients who present to non-PCI centers and require transfer to a primary PCI center.[4] These patients inherently experience a greater delay to PCI because of the time it takes to complete the transfer.[10]

The overall goal of this study was to examine the effect that transporting STEMI patients without continuous intravenous infusions would have on overall transport time to a primary PCI center. Our hypothesis was that transporting patients using only bolus medication would significantly reduce transport time and not result in adverse outcomes such as mortality and increased length of hospitalization.

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The authors report no conflict of interest.

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METHODS

This study was reviewed by the University of Massachusetts Medical School Institutional Review Board (IRB) and was granted an exemption from full IRB review based on our plan to use only existing data and minimize the use of patient-identifying information. The transport agency used in this study was a hospital-based critical care air/ground system with an annual volume of 700 calls and an average transport time of 15 minutes from the base of operations to most destination facilities. The average patient-loaded transport distance is 23 miles, and 80% of the requests for this service are for interfacility transfers; studying these transfers formed the basis of this study. The transporting vehicle is an EC145 helicopter (Eurocopter, Marignane, France) staffed with a critical care nurse and an emergency medicine resident or emergency medicine attending physician. A ground ambulance with the same staffing model is used for patient transport only when weather conditions or patient size prohibits transport by air. The quality assurance (QA) committee performs 100% chart review including monitoring policy compliance and looking at all response times for patients being transported directly to a cardiac catheterization laboratory.

The parent institution for the transport agency, and destination for the majority of transfers, is an urban, tertiary care, university teaching hospital in central Massachusetts with approximately 85,000 annual ED patient visits. This institution's cardiac catheterization laboratory performs approximately 700 catheterizations per year in the setting of either non-STEMI or STEMI. Furthermore, the Centers for Medicare & Medicaid Services (CMS) has found that our primary study institution is rated as the fifth best institution in the United States for surviving a heart attack, and has a door-to-needle time effort that is now roughly 30 minutes lower than the national average.

Development of the Transfer Policy

The policy of transporting STEMI patients to a primary PCI center without medication infusions was developed by the critical care transport service's medical director team in conjunction with the division of interventional cardiology at the primary study institution. This policy was aimed at simplifying and reducing transport times by eliminating those medication infusions felt not to be essential and by using medication boluses prior to transport. The policy included administering aspirin, a bolus of heparin, and a bolus of a glycoprotein IIb/IIIa inhibitor. All other medications were administered at the discretion of the referring physician. A copy of the policy was circulated electronically to the physicians at all of the referral agencies that are included in the transport agency's usual service area. Hospital leadership and physicians at these institutions also received a presentation on the new policy during a public relations campaign. Follow-up education was done at all hospitals several months after protocol implementation to address procedures and concerns. Transport times were examined before and after instituting the "no-infusion" policy (discontinuing continuous medication infusions for transport) in April 2007.

Subject Population

All patients being transported from an outlying hospital to a primary PCI center for treatment of an ACS using both the institution's critical care helicopter and ground service were included in the study. ACS was diagnosed by each referring institution and defined as having symptoms consistent with ACS and ST-segment elevation greater than 1 mm in at least two anatomically contiguous leads or a new left bundle branch block. Data regarding each individual transport for both the pre- and postpolicy cohorts were obtained from the dispatch sheet in the patient care report (PCR). Data obtained from the PCR included time of arrival at both the originating hospital and the cardiac catheterization laboratory. The total transport time was calculated from the time the aircraft launched from point of origination to the time the patient was brought to his or her final destination. All PCRs between January 2006 and April 2007 were included in the "before-policy" category and all PCRs examined between May 2007 and January 2008 were included in the "after-policy" category. Additional data regarding patient characteristics and other information such as time to needle insertion in the catheterization laboratory and outcomes were obtained by performing a structured chart review after patient discharge using the hospital's electronic medical record and interventional cardiology reports.

Our main outcomes of hospital length of stay (LOS) and mortality were determined by review of each patient's medical record. We also measured cardiac-related readmission rates at three months, success of PCI at attaining Thrombolysis in Myocardial Infarction (TIMI) grade III flow, and total time spent in the catheterization laboratory. LOS data were obtainable only for patients who returned to the primary study institution. All outcome data were obtained without knowledge of cohort status.

Statistical Analysis

Patient characteristics and catheterization laboratory parameters for each cohort were compared using t-test or Fisher's exact test. Transport time and LOS differences were calculated using unpaired two-tailed t-tests for unequal variances (where appropriate) with a

TABLE 1. Patient Characteristics

	Before Policy Change	After Policy Change	Total	p-Value
No. patients	74	80	154	
Gender—male	50 (68%)	62 (78%)	112 (73%)	0.16
Age 25–44 yr	8 (11%)	9 (11%)	17 (11%)	0.93
Age 45–64 yr	40 (54%)	44 (55%)	84 (55%)	0.90
Age 65–79 yr	16 (22%)	20 (25%)	36 (23%)	0.62
Age ≥80 yr	10 (14%)	7 (9%)	17 (11%)	0.35

statistical significance defined as $p < 0.05$. All calculations and graphs were made using GraphPad Prism (GraphPad Software, San Diego, CA).

RESULTS

A total of 154 transports for urgent PCI were completed during the study period. Seventy-four of these were done prior to the no-infusion policy and 80 were done after. All but one of the transports in each group was done by air. Of the patients transported before the policy was started, 68% (50) were male, compared with 78% (62) of the patients transported after the initiation of the policy. Furthermore, there was no significant difference in the age ranges between the two cohorts (Table 1).

The mean (± standard error of the mean [SEM]) transport time before implementing the new policy was 43.5 ± 1.2 minutes, whereas the mean transport time after the policy was 37.1 ± 0.9 minutes ($p < 0.0001$). The absolute difference in transport times was 6.5 ± 1.5 minutes.

To control for variability in referral patterns between cohorts, as well as to account for potential imbalances in the distance of transports, a subgroup analysis was performed using two of the most common referral hospitals. These two hospitals represent two facilities of average transport distance for this service. Twenty-eight patients were transported from these facilities before the policy was started and 23 were transported after. The mean (± SEM) transport time before the policy was 37.5 ± 1.4 minutes and the mean transport time after the policy was 32.3 ± 1.3 minutes ($p < 0.01$). The absolute difference in transport times between these two groups was 5.2 ± 1.9 minutes (Fig. 1).

In regard to outcome, LOS data were available for 127 patients (82% of the total population) (58 patients before and 69 patients after). The mean (± SEM) LOS was 4.6 ± 0.8 days prior to the new policy and 3.9 ± 0.4 days after ($p = 0.41$) (Fig. 2). There was only 1 death overall, which was in the after-policy, no-infusion group (p = not significant). This patient was hypotensive on presentation, with an inferior STEMI requiring administration vasopressors at the referring facility. This medication was continued during transport. The patient's cardiac catheterization showed diffuse disease and was not amenable to intervention. The patient developed multisystem organ failure and died.

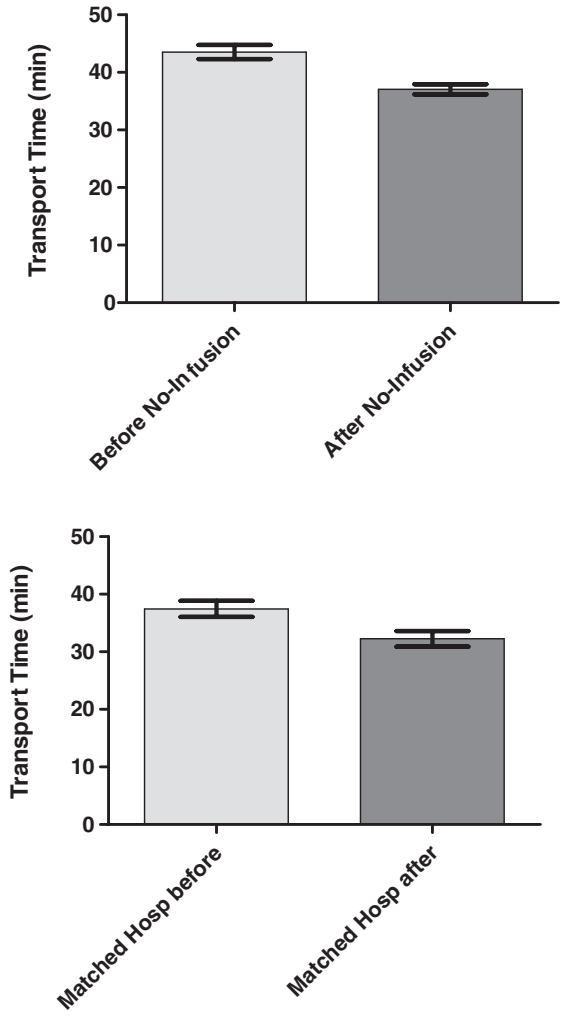

FIGURE 1. Transport times before and after instituting the "no-infusion" policy in all patients (*top*) and in a subgroup of matched hospitals (*bottom*).

In addition, three-month readmission rates for cardiac-related chief complaints were compared between the two study populations. These data were available for 56 patients in the before-policy group and 69 patients in the after-policy group. Ten patients were readmitted in the before group and 15 were readmitted in the after group. The difference in readmission rates was not statistically significant ($p = 0.66$).

Also, total amounts of time spent in the catheterization laboratory did not differ between the two groups of patients. The average time in the laboratory in the before-policy group was 66.8 minutes and the average time in the after-policy group was 62.9 minutes ($p = 0.47$). Lastly, 33 of 40 patients in the before-policy group had TIMI III flow after cardiac catheterization,

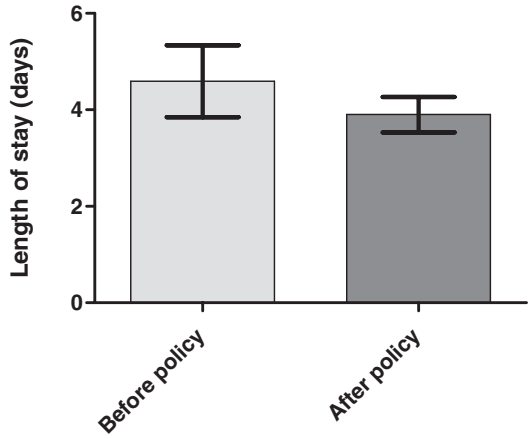

FIGURE 2. Length of stay before and after instituting the "no-infusion" policy.

and 53 of 58 patients in the after-policy group had TIMI III flow after cardiac catheterization ($p = 0.22$) (Fig. 3).

DISCUSSION

A patient presenting to a non–primary PCI center with signs and symptoms of a STEMI can have significant delays in obtaining the desired PCI procedure. This can ultimately affect the decision as to whether a patient is a candidate for primary PCI or should receive thrombolytic agents. Expediting the transfer process is critical in reducing the impact of delays resulting from acute myocardial infarction patients presenting to facilities unable to perform PCIs. In this study we found that discontinuing infusions during transport resulted in a significant reduction in transport time(s) with no adverse effect on hospital LOS and mortality. In addition, discontinuing these infusions did not significantly extend the time the patient spent in the catheterization laboratory, nor did it impact the incidence of TIMI III flow. Lastly, this change in practice did not impact the incidence of readmission to the hospital for cardiac-related chief complaints.

One factor in the delay in the transfer of a patient between facilities is the use of medication infusions. One of the main reasons for this is that many institutions use infusion pumps and/or tubing that is incompatible with the transferring agency or the receiving institution, necessitating that the infusions be stopped, the tubing changed, and administration of the medications restarted on the agency's own infusion pump. Many of the common medications used in the setting of ACS such as unfractionated heparin and glycoprotein IIb/IIIa inhibitors have durations of action that exceed the average transport time for most EMS agencies. Other parenteral medications, such as nitroglycerin infusions, have acceptable longer-acting or nonparenteral alternatives, or are not essential for patient care. Therefore, having the referring institution administer the initial bolus of medications ensures initial optimal cardiac care, and withholding the continued infusion removes a significant delay and simplifies patient transfer. In our study, administering only bolus medications shortened transfer times by approximately 7 minutes, making the goal of door-to-balloon times of 90 minutes or less more attainable,

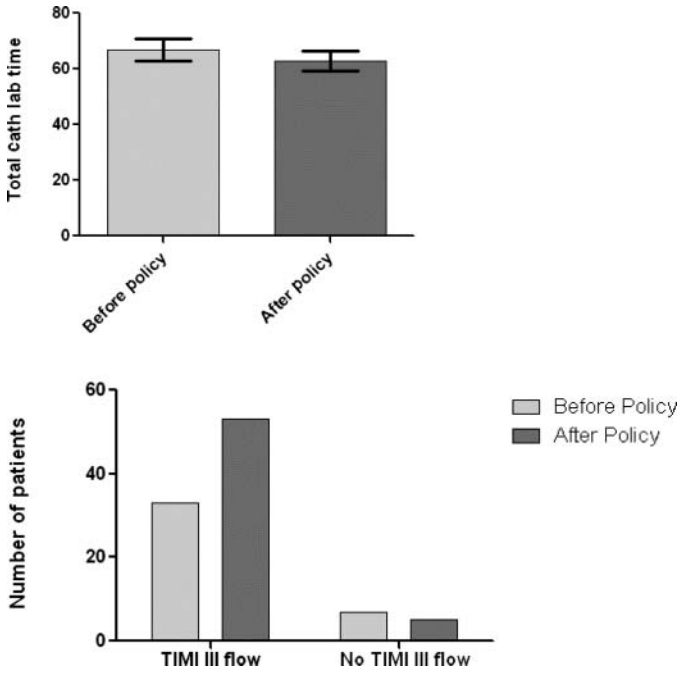

FIGURE 3. *Top:* Total catheterization laboratory time before and after instituting the "no-infusion" policy. *Bottom:* Thrombolysis in Myocardial Infarction (TIMI) grade III flow or 0% stenosis before and after implementing the policy.

even for patients who initially presented to non-PCI hospitals.

Our critical care ambulance service (air and ground) covers a large area of central Massachusetts and a large number of facilities of varied distances from the primary study institution. When we analyzed transport times only from a selected group of matched hospitals, we still found that up to 7 minutes was saved transporting a patient without infusing medications. This reduction, although modest, is important because it would help to reduce the overall door-to-balloon times.

LIMITATIONS

This study had several limitations worth mentioning. First, the sample size was small and it is possible that a larger sample size would find a difference in outcomes between the two groups. Secondly, this study originated from a single transport agency with readily available critical care transport and a single institution and may not be generalizable to other hospital and EMS systems, including EMS systems that cannot transport cardiac medication infusions. It is also notable that data such as LOS, catheterization laboratory times, TIMI III flow, and hospital readmission rates were available only for patients who were transported to the parent institution. Furthermore, this study was conducted at a time when there was an overall institutional effort from the division of interventional cardiology and department of emergency medicine to decrease door-to-balloon times for all patients presenting to the study institution. It is therefore possible that some of these time reductions are due to an increased awareness of the need to transport these patients rapidly, although this was not part of the institutional strategy. It is also possible that other processes were altered outside of the primary transport agency during the post-policy period, leading to a decrease in door-to-balloon times that were unrelated to the no-infusion transport procedures. Lastly, there may have been differences between the cohorts in regard to clinical characteristics such as comorbid disease burden and medication usage that could have influenced our outcomes.

CONCLUSIONS

A policy of transferring patients from one hospital directly to a cardiac catheterization laboratory by discontinuing continuous infusions and using only bolus medications significantly reduces the total door-to-needle time and has no adverse effects on length of hospitalization and does not appear to adversely affect catheterization laboratory procedures. This simple change may help many patients obtain PCIs within the desired 90-minute intervention window. Other institutions may want to consider such policies for interfacility transports of patients diagnosed with ACS.

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