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# Minimizing Transfer Time to an ST Segment Elevation Myocardial Infarction Receiving Center: A Modified Delphi Consensus

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## Abstract

Of patients with ST segment elevation myocardial infarction (STEMI), approximately two-thirds present to a hospital not capable of percutaneous coronary intervention. Transfer to a STEMI receiving center delays time to reperfusion in patients with STEMI, but factors that affect this delay have not been well studied. We performed a three-round modified Delphi study to identify system practices that minimize transfer time to a STEMI receiving center. A comprehensive literature review was used to identify candidate system practices. Emergency medical services, emergency medicine, and cardiology experts were invited to participate. Consensus was defined as 80% agreement that a variable was “very important (5)” or “important (4)” with a mean score ≥4.25 or 80% agreement that a variable was “not important (1)” or “somewhat important (2)” with a mean score ≤1.75. In Round 1, participants rated the candidate items and suggested additional items. Individual feedback was provided, and participants discussed items via conference calls before rating them again in Round 2. In Round 3, participants ranked the consensus items from Rounds 1-2 from most to least important, and the mean score for each item was calculated. Of the 98 experts invited, 29 participated in Round 1, 22 in Round 2, and 14 in Round 3. Participants identified 18 system practices that they agree are critical in minimizing transfer time to STEMI receiving centers, with the most important being performance of a prehospital electrocardiogram and having established transfer protocols. These factors should be considered in the development of STEMI systems of care.

### Keywords

STEMI; regionalization; acute myocardial infarction; door-to-balloon time

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## Introduction

Approximately 250,000 patients suffer from an ST segment elevation myocardial infarction (STEMI) each year in the United States.[1] Of these patients, over three-quarters present to the hospital via private vehicle rather than via emergency medical services (EMS),[2] and approximately two-thirds receive initial care at a hospital without primary percutaneous coronary intervention (PCI) capability.[3] Timely PCI for patients with STEMI reduces mortality and morbidity.[4] American College of Cardiology (ACC)/American Heart Association (AHA) guidelines recommend total ischemic time of less than 120 minutes from initial EMS contact and less than 90 minutes from hospital door to balloon.[5] Additionally, the AHA's Mission:Lifeline program recommends a door-in-door-out time at the STEMI referral hospital of less than 45 minutes.[6] Transfer from a STEMI referral hospital to a STEMI receiving center has been shown to delay time to reperfusion in patients with STEMI, with as few as 6.5% of transferred patients meeting the 90-minute door to balloon goal.[7]

STEMI receiving center strategies for reducing time to reperfusion have been studied, but few investigations have focused on the entire STEMI system of care, which includes EMS and STEMI referral hospitals.[8] Furthermore, the AHA recognizes that "although some regions have successfully adopted a STEMI systems approach, there currently is no data repository in which to catalog examples of protocols used or transfer policies or to review assessment of why elements of the STEMI system succeeded or failed in a region."[9]

The objective of this study is to identify system practices that minimize the transfer time to a STEMI receiving center for patients who present to a STEMI referral hospital.

## Methods

### Study Design

We utilized a modified Delphi technique to identify expert consensus on factors important in minimizing transfer time to STEMI receiving center for patients who present via emergency medical services (EMS) or private vehicle to a STEMI referral hospital. Transfer time was defined as the time from patient arrival at a STEMI referral hospital to arrival at a STEMI receiving center. This method uses a systematic approach to achieve consensus among a panel of experts on a topic where existing knowledge is incomplete.[10] This study was approved by the University of California Davis Institutional Review Board.

### Study Setting and Population

Expert participants were identified by three mechanisms: (1) first or senior author on a study addressing barriers to timely transport of STEMI patients to a STEMI receiving center, (2) panelist on AHA Mission Lifeline regional committees, and/or (3) recommendation from an individual meeting one of the criteria above. Efforts were made to include individuals with expertise in EMS systems, emergency medicine, and interventional cardiology from diverse geographic and clinical settings. The study investigators served as process moderators and did not contribute their opinions to the process. Potential participants were emailed two invitations to participate.

### Study Protocol

Candidate prehospital, STEMI referral hospital, and STEMI receiving center processes that minimize transfer time were identified via literature review.

In Round 1, participants rated the importance of each of the candidate processes with regards to minimizing transfer time using a five-point Likert scale with the options “Very important” (5), “Important” (4), “Don’t know/Neutral” (3), “Somewhat important” (2), “Not at all important” (1). Participants were invited to suggest additional items for consideration. Aggregate and individual response data were distributed to each participant, and participants discussed all items in conference calls moderated by the investigators. The goals of the conference calls were to allow participants to present the rationale for their ratings, to debate the importance of candidate items, and to refine the additional items suggested during Round 1. To preserve anonymity, participants identified themselves by number during the conference calls.

In Round 2, participants rated each of the non-consensus items from Round 1 as well as the items suggested by panelists during Round 1 using the same five-point Likert scale.

In Round 3, participants ranked consensus items from Rounds 1 and 2 in order of their importance for minimizing transfer time. Final rank order was determined by each item’s mean rank score.

### Measurements or key outcome measures

The primary outcome was expert consensus on system processes. Consensus was defined as 80% agreement that an item was “Very important (5)” or “Important (4)” with a mean score ≥4.25 or 80% agreement that an item was “Not at all important (1)” or “Somewhat important (2)” with a mean ≤1.75. When participants reached consensus that an item was not important, the item was removed from further discussion. In Round 3, mean rank score was calculated by adding all respondents’ scores for each item and dividing by the number of respondents.

### Data Analysis

Summary and descriptive statistics were performed using Microsoft Excel 2010 (Microsoft, Redmond, WA).

## Results

Ninety-eight experts were invited to contribute; twenty-nine participated in Round 1, twenty-two in Round 2, and fourteen in Round 3. Only those experts who participated in Round 1 were invited to contribute in Rounds 2-3. Overall, 23% (15/65) of responses were from interventional cardiologists. (Table 1.)

Thirty candidate system processes reported to affect transfer time were identified during literature review. These included 8 prehospital processes and 22 hospital processes. Six patient factors were also evaluated. During Round 1, experts suggested four additional EMS processes, 7 additional hospital processes, and 5 additional patient factors.

During Rounds 1 and 2, participants reached on consensus on 18 items felt to be important for minimizing transfer time and two items felt not to be important for minimizing transfer time. (Figure 1.) In Round 3, the most important system practices for minimizing transfer time from a STEMI referral hospital to a STEMI receiving center were prehospital providers performing an electrocardiogram and STEMI referral hospitals and receiving centers having an established transfer protocol. (Table 2.) Participants also reached consensus agreement that patient insurance status was not important in determining transfer time from a STEMI referral hospital to a STEMI receiving center.

## Limitations

Our data are limited by our survey response rate; however, participants included experts from EMS systems, emergency medicine, and interventional cardiology. While our results may not be generalizable to all settings, we included participants from varied practice environments to generate processes that are applicable to a broad range of STEMI systems. Lastly, the impact of each of these strategies on actual transfer times from STEMI referral hospitals to STEMI receiving centers remains unknown.

## Discussion

Of 41 systems processes evaluated by participants, consensus was achieved on 20 items, with 18 felt to be important and two deemed unimportant. The most important EMS processes focused on early recognition of STEMI and notification of the STEMI referral hospital. While participants agreed that performance of prehospital electrocardiograms (ECGs) was critical, they disagreed on the importance of paramedic versus machine interpretation of the ECG and generally felt that this distinction should be made by individual EMS systems based on available resources. These EMS actions enable the STEMI referral hospital to prepare for the patient's arrival and to initiate downstream steps in the protocol.

Consensus hospital processes centered on having established protocols with dedicated resources for the care of STEMI patients at the STEMI referral hospital. Participants also emphasized the importance of minimizing administrative tasks related to patient transfer, and they felt that dedication to the AHA goals and strong communication within the STEMI system with regards to individual patients and overall system performance were key components. These themes are similar to those identified in a meta-analysis of system processes to reduce door-to-balloon times at STEMI receiving centers.[8]

One quality improvement protocol designed to reduce time to reperfusion for patients with STEMI is North Carolina's statewide RACE program. During this program, patients transferred from a STEMI referral hospital to a STEMI receiving center had a median door-in-door-out time of 67 minutes and a median time from first medical contact to PCI of 152 minutes.[7] These data suggest that additional strategies are needed to reach the AHA goals for transferred patients. Participants in our study agreed that seven of the eight system processes recommended in the RACE program[11] were important, and they identified ten

additional processes that may enable systems to meet AHA time goals for transferred STEMI patients.

By integrating expert opinions from EMS, emergency medicine, and interventional cardiology, we propose a set of system processes to minimize the transfer time from a STEMI referral hospital to a STEMI receiving center.

## Conclusions

Expert participants identified 18 system practices that they agree are critical in minimizing transfer time to STEMI receiving centers. These factors should be considered in the development of STEMI systems of care.

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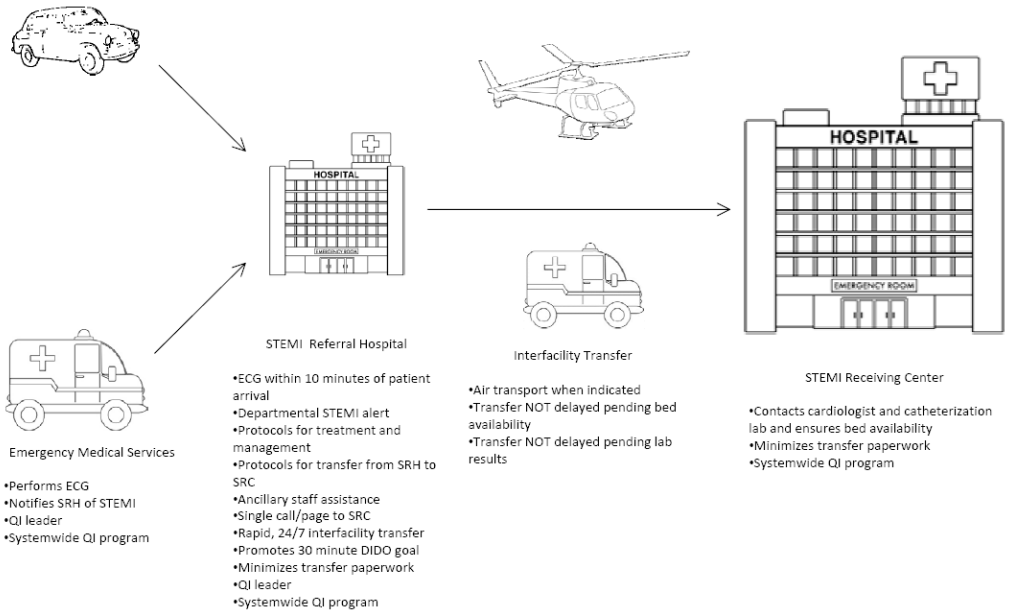


**Figure 1.**

Patient flow chart indicating the 18 consensus system practices.

Legend:

ECG = Electrocardiogram; STEMI = ST segment elevation myocardial infarction; SRH = STEMI referral hospital; SRC = STEMI receiving center; QI = Quality improvement; DIDO = Door in door out

## Table 1

Participants by specialty in each round.

| Specialty | Round 1 | Round 2 | Round 3 |
|---|---|---|---|
| EMS | 11 | 9 | 4 |
| Emergency Medicine | 10 | 7 | 6 |
| Interventional Cardiology | 7 | 5 | 3 |
| Other | 1 | 1 | 1 |
| Total | 29 | 22 | 14 |

**Table 2**

Round 1, Round 2, and Round 3 (Final Ranking) survey results.

| ROUND 3 FINAL RANKING | Sytem Practice | ROUND 1 RESULTS | | | ROUND 2 RESULTS | | |
|---|---|---|---|---|---|---|---|
| | | Mean Score | Important/Very Important | Not at all/ Somewhat Important | Mean Score | Important/Very Important | Not at all/ Somewhat Important |
| 1 | EMS providers performing a prehospital ECG | 4.59 | 89% | 7% | - | - | - |
| 2 | Having protocols in place for transfer of patient from STEMI Referral Hospital to STEMI Receiving Center | 4.89 | 96% | 0% | - | - | - |
| 3 | Notification of STEMI from the prehospital setting to STEMI Referral Hospital | 4.59 | 89% | 7% | - | - | - |
| 4 | STEMI Referral Hospital has protocol for treatment and management of STEMI patients | 4.89 | 96% | 0% | - | - | - |
| 5 | Having a single call transfer protocol or direct page to interventional cardiologist (accepting physician) at STEMI Receiving Hospital | 4.81 | 96% | 0% | - | - | - |
| 6 | STEMI Referral Hospital has a protocol for rapid, 24/7 interfacility transfer | - | - | - | 4.89 | 100% | 0% |
| 7 | Obtaining an ECG within 10 minutes of patient arrival at STEMI Referral Hospital | 4.78 | 93% | 0% | - | - | - |
| 8 | Transfer to STEMI Receiving Center is not delayed pending bed availability/assignment | 4.84 | 89% | 0% | - | - | - |
| 9 | Activating a departmental STEMI alert at STEMI Referral Hospital (to engage extra nurse, ED physician, social worker, call to STEMI Receiving Center, etc.) | 4.33 | 85% | 11% | - | - | - |
| 10 | NOT delaying transfer pending STEMI Referral Hospital lab results | 3.63 | 63% | 26% | 4.95 | 100% | 0% |
| 11 | STEMI Referral Hospital has protocols for the use of air transport when indicated | 4.31 | 81% | 7% | - | - | - |
| 12 | STEMI Referral Hospital adopts and promotes the 30-minute Door-In-Door-Out time goal set by the American College of Cardiology/American Heart Association | - | - | - | 4.79 | 100% | 0% |
| 13 | STEMI Receiving Center personnel calls cardiologist, activates cardiac cathertization lab, and ensures bed availability | 4.48 | 89% | 7% | - | - | - |
| 14 | Minimizing transfer paperwork | 4.63 | 93% | 4% | - | - | - |

| ROUND 3 FINAL RANKING | Sytem Practice | ROUND 1 RESULTS | | | ROUND 2 RESULTS | | |
|---|---|---|---|---|---|---|---|
| | | Mean Score | Important/Very Important | Not at all/ Somewhat Important | Mean Score | Important/Very Important | Not at all/ Somewhat Important |
| 15 | Presence of a STEMI quality improvement (QI) leader at the STEMI Referral Hospital | - | - | - | 4.28 | 89% | 5% |
| 16 | Assigning ancillary staff to assist with transfer paperwork and logistics at STEMI Referral Hospital | 4.33 | 89% | 7% | - | - | - |
| 17 | Presence of a STEMI quality improvement (QI) leader within the EMS system | - | - | - | 4.26 | 89% | 0% |
| 18 | Presence of a systemwide quality improvement program including EMS, STEMI Referral Hospital, and STEMI Receiving Center that routinely reviews, critiques, and trends performance and patient outcomes | - | - | - | 4.63 | 95% | 0% |
| | **PREHOSPITAL PROCESSES** | | | | | | |
| - | Having Advanced Life Support (ALS) providers respond to EMS calls involving possible STEMI patients | - | - | - | 4.11 | 89% | 0% |
| - | Machine interpretation of prehospital ECG | 3.48 | 56% | 37% | 3.84 | 68% | 26% |
| - | Paramedic interpretation of prehospital ECG | 3.85 | 70% | 22% | 4.16 | 84% | 16% |
| - | Comprehensive paramedic training and education in prehospital ECG interpretation | - | - | - | 4.21 | 89% | 11% |
| - | Transmission of prehospital ECG to STEMI Referral Hospital | 3.19 | 52% | 44% | 3.58 | 68% | 21% |
| | **STEMI REFERRAL HOSPITAL PROCESSES** | | | | | | |
| - | Keeping patient on EMS gurney at STEMI Referral Hospital | 3.07 | 52% | 41% | 3.79 | 68% | 11% |
| - | Using the initial EMS unit for transfer to STEMI Receiving Center | 3.85 | 74% | 15% | 3.89 | 74% | 11% |
| - | Using the 911 system to transfer patients to a STEMI Receiving Center | 3.44 | 59% | 30% | 3.63 | 53% | 11% |
| - | Repeating an ECG upon ED arrival at STEMI Referral Hospital if prehospital EKG shows STEMI | 1.93 | 19% | 74% | 2.21 | 16% | 58% |
| - | Assigning a designated nurse to STEMI patient at STEMI Referral Hospital | 4.11 | 74% | 15% | 4.05 | 84% | 5% |
| - | Drawing blood at STEMI Referral Hospital | - | - | - | 2.26 | 21% | 63% |
| - | Using low molecular weight heparin (LMWH) instead of heparin at STEMI Referral Hospital to | 2.37 | 26% | 59% | 2.26 | 11% | 47% |

| ROUND 3 FINAL RANKING | Sytem Practice | ROUND 1 RESULTS | | | ROUND 2 RESULTS | | |
|---|---|---|---|---|---|---|---|
| | | Mean Score | Important/Very Important | Not at all/ Somewhat Important | Mean Score | Important/Very Important | Not at all/ Somewhat Important |
| | avoid infusion during transport to STEMI Receiving Center avoid infusion during transport to STEMI Receiving Center | | | | | | |
| - | Avoiding the use of continuous intravenous infusions | - | - | - | 3.42 | 53% | 26% |
| - | Limiting medications to the scope of transporting EMS providers | - | - | - | 4.11 | 79% | 0% |
| - | STEMI Referral Hospital transmits ECG to STEMI Receiving Center | 3.74 | 63% | 26% | 3.58 | 74% | 21% |
| - | STEMI Referral Hospital prepares patient for catheterization (shaving of groin, etc.) | 1.78 | 7% | 78% | 1.79 | 5% | 68% |
| - | STEMI Referral Hospital communicates time of symptom onset, time of arrival (‘Door in’ time), and time of departure (‘Door out’ time) to STEMI Receiving Center | - | - | - | 4.11 | 84% | 11% |
| - | Ambulance on premises at STEMI Referral Hospital | 2.63 | 26% | 59% | 3.21 | 53% | 37% |
| - | STEMI patient is evaluated by cardiologist at STEMI Referral Hospital* | 3.67 | 67% | 26% | 1.32 | 0% | 95% |
| - | STEMI Referral Hospital has a social worker present to address family concerns | 1.96 | 4% | 78% | 2.37 | 16% | 63% |
| - | Imaging is obtained at STEMI Referral Hospital* | 3.81 | 70% | 19% | 1.32 | 0% | 100% |
| - | STEMI Referral Hospital has an established STEMI team | 3.15 | 52% | 37% | 3.37 | 37% | 21% |
| - | STEMI Referral Hospital has a transport unit available for interhospital transfers | 3.41 | 52% | 37% | 3.95 | 79% | 16% |
| | **PATIENT CHARACTERISTICS** | | | | | | |
| - | Night time presentation (7pm to 7am) | 3.85 | 74% | 11% | 3.32 | 63% | 32% |
| - | Weekend/holiday presentation | - | - | - | 3.11 | 61% | 26% |
| - | Atypical presentation | 4.15 | 78% | 4% | 3.37 | 63% | 26% |
| - | Patient age | 3.15 | 52% | 33% | 2.89 | 42% | 42% |
| - | Extremes in patient age (e.g., younger than 30 years and older than 80 years) | - | - | - | 3.32 | 63% | 32% |
| - | Patient gender | 2.19 | 22% | 63% | 2.53 | 32% | 47% |
| - | Arrival to hospital by private vehicle | 3.70 | 67% | 19% | 3.84 | 84% | 11% |
| - | Patient is self-pay or underinsured | 1.52 | 4% | 81% | - | - | - |

| ROUND 3 FINAL RANKING | Sytem Practice | ROUND 1 RESULTS | | | ROUND 2 RESULTS | | |
|---|---|---|---|---|---|---|---|
| | | Mean Score | Important/Very Important | Not at all/ Somewhat Important | Mean Score | Important/Very Important | Not at all/ Somewhat Important |
| - | Recent stimulant (e.g., cocaine, methamphetamine) use by patient | - | - | - | 3.33 | 50% | 21% |
| - | Left bundle branch block (LBBB) pattern on EKG | - | - | - | 3.68 | 74% | 11% |
| - | Patient eligibility for fibrinolytic therapy (per American College of Cardiology/American Heart Association guidelines) | - | - | - | 3.84 | 79% | 11% |

Legend:

* Item phrasing was changed from negative in Round 1 to positive in Round 2.

EMS = Emergency medical services; STEMI = ST segment elevation myocardial infarction; ECG = Electrocardiogram

Items suggested by participants during Round 1 were not scored during Round 1.
Participants ranked consensus items only in Round 3.