

EMERGENCY MEDICAL SERVICES MANAGEMENT OF ST-ELEVATION MYOCARDIAL INFARCTION

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INTRODUCTION

According to data published by the American Heart Association (AHA), the annual incidence of acute myocardial infarction (AMI) in the United States approximates 850,000, resulting in over 150,000 deaths per year.¹ The emergency medical services (EMS) system plays a significant role in the management of AMI with respect to caring for those who access the health care system via EMS and also in administering public educational programs to encourage early access via EMS.

It is generally well accepted that early reperfusion is the primary goal of therapy for patients having an acute ST-segment-elevation myocardial infarction (STEMI).^{2,3} Because many patients access the health care system via EMS, EMS providers are well positioned to facilitate achieving the goal of early reperfusion throughout the community.⁴ Consequently, the National Association of EMS Physicians (NAEMSP) has developed a position statement on the role of EMS in the management of the STEMI patient and the development of cardiovascular systems of care.⁵

The NAEMSP believes that advanced life support EMS providers should have the education, appropriate training, equipment, and protocols to facilitate early identification and the initial care of patients with STEMI. These protocols should address the appropriate use of 12-lead electrocardiograms (ECGs) to facilitate early diagnosis of STEMI and initiation of pathways to ensure early definitive reperfusion. EMS systems

should be integrated with regional cardiac care programs and participate in developing these systems. Such reperfusion strategies may include a variety of methods of early reperfusion, from prehospital fibrinolytics to primary transportation for percutaneous coronary intervention (PCI). In addition to meeting the goal of early reperfusion, EMS providers have a role in the appropriate management of the STEMI patient with other adjunctive therapies. This paper highlights the important components of the NAEMSP position statement and the supporting science behind the statement.

EARLY IDENTIFICATION OF THE STEMI PATIENT

To achieve an optimal outcome, it is critical to consider the role of public education and early activation of EMS. Patients' and bystanders' recognition of the signs and symptoms of an AMI and their willingness to activate the EMS system impact the time to reperfusion therapy. With each 30-minute increment in delay to reperfusion, one-year mortality increases by 7.5%.⁶ In the United States, median delay from onset of symptoms to hospital arrival ranges from 1.5 to 6 hours.⁷ Similar delay trends exist in other countries as well.⁸⁻¹⁰

Several factors have been implicated in the delay of symptom recognition and access, including sociodemographic (female, minority, older age, fewer years of education, lower income), clinical (history of diabetes), social (consultation with family, consultation with family physician), patient appraisal (minimizing), and emotional (concern about troubling others, being embarrassed about seeking help, living alone) factors.⁹ Unfortunately, general public awareness and educational campaigns have not been shown to have an effect on minimizing delays in accessing the health care system.¹¹ Once AMI patients decide to access medical care, a substantial number of them do not call EMS, even though the use of EMS and subsequent hospital prenotification have been shown to reduce time delay to reperfusion.¹²⁻¹⁴

Once the patient has accessed the EMS system, it is important that EMS providers perform an appropriate history and physical examination to evaluate for acute coronary syndromes. EMS providers are often taught that the chief complaint for a patient having an AMI

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is chest pain. While this is often the case, chest pain is not always the chief complaint.¹⁵ Therefore, in order to avoid missing a potential STEMI, the EMS provider should also ask the patient about other anginal equivalents, including dyspnea, palpitations, syncope, and fatigue.^{15,16} Clinical presentations of STEMI with symptoms other than chest pain are frequent in diabetic patients, female patients, and elderly patients. Chest discomfort with evidence of diaphoresis significantly increases the likelihood for AMI or unstable angina.¹⁷ Other physical findings associated with STEMI may include abnormal vital signs or lung sounds consistent with heart failure.

UTILITY OF THE ELECTROCARDIOGRAM

Beyond the identification of the potential STEMI patient through appropriate history and physical examination, EMS providers have a role in making the definitive diagnosis of STEMI through the acquisition and interpretation of a 12-lead ECG and subsequent advance hospital notification. The AHA recommends implementation of out-of-hospital 12-lead ECG diagnostic programs in urban and suburban EMS systems as a Class I recommendation.¹⁸ In a recent meta-analysis, the average 1.2 minutes of extra time that the paramedics took on scene to complete an ECG led to an average of 36.1 minutes of savings in door-to-needle time.¹⁹

However, despite the strength of evidence supporting prehospital ECGs in reducing both door-to-needle and door-to-balloon times, many communities do not fully take advantage of this technology. Some EMS systems simply do not have 12-lead ECG devices. Others may have appropriate devices, but do not use them consistently or lack the ability to convey the information to local emergency departments (EDs). Urban and suburban EMS systems should prioritize acquiring and implementing effective prehospital 12-lead ECG diagnostic programs.

Once the EMS provider has acquired the 12-lead ECG, the tracing will need to be interpreted to determine if the patient is having a STEMI. The two primary options for interpretation of the 12-lead ECG are interpretation directly by the EMS provider (either independently or aided by the 12-lead device's interpretation software) and interpretation by a physician after transmission of the ECG to the physician via a communication device. Based on review of the available literature, there is no clear answer regarding which option results in the best outcome in terms of both patient mortality and resource allocation for the health care system. EMS system medical directors and administrators will need to consider local circumstances to determine the appropriate method of ECG interpretation for the potential STEMI patient.

In order for a prehospital 12-lead ECG program to be successful, the EMS system must allow for the acquisi-

tion and interpretation of the 12-lead ECG, the appropriate transport policies that match the detected prehospital pathology with the receiving hospital's capability to care for the patient, communication of the information to clinicians at the receiving hospital, and policies to utilize the information provided by the EMS system to expedite care upon arrival at the hospital.

Once the potential STEMI patient has been identified by EMS personnel, the providers should complete a reperfusion checklist during transport (including inclusion/exclusion criteria for either fibrinolysis or PCI) and relay this information to the receiving hospital.^{20,21}

STANDARD THERAPIES FOR STEMI

Cardiac Monitor

Patients experiencing AMI are at high risk for potentially life-threatening arrhythmias. In 1968, Adgey et al. reported 335 of 550 patients (61%) having significant bradyarrhythmia in posterior myocardial infarctions.²² More recently, Scrutinio et al. found an incidence of 52% of patients having serious ventricular arrhythmias during the initial phase of STEMI.²³ In addition, Swart et al. found that 55.6% of EMS patients with atrioventricular block were having AMI.²⁴ Therefore, all patients identified as having STEMI should be placed on a cardiac monitor and continuously evaluated for life-threatening arrhythmias.

Intravenous Access

Because of the high risk of malignant arrhythmia and the potential need to treat the patient with antiarrhythmic medications and/or medications for acute heart failure, EMS providers should attempt to establish peripheral intravenous access in all STEMI patients. However, while EMS providers have certainly established proficiency at placement of peripheral intravenous lines, attempts prior to transport can extend the overall out-of-hospital time.^{25,26} Therefore, if the providers are not able to quickly establish intravenous access, attempts should be aborted until the patient is in transport. Further attempts can be done while in transport.

Oxygen

While supplemental oxygen is routinely used by EMS providers in the management of AMI, there is no clear evidence that oxygen actually has a beneficial effect in the management of the STEMI patient. In fact, some have suggested that oxygen may be harmful because of a theoretical effect of causing vasoconstriction and resultant decrease in coronary supply.^{27,28} However, others have demonstrated that oxygen therapy can reduce both angina and ischemia.^{29,30} Therefore, patients who

are hypoxemic (i.e., oxygen saturation less than 90%) should have administration of oxygen as necessary to correct the hypoxemia. Furthermore, it is reasonable to provide low-flow oxygen therapy by nasal cannula for those patients who are not hypoxemic. However, 100% oxygen therapy with a non-rebreather mask is not recommended unless necessary to correct hypoxemia.

Aspirin

A significant component of the pathophysiology of disease of AMI is clot formation and platelet aggregation.^{31,32} Barbash et al. found that those patients treated with prehospital aspirin had better outcomes.³³ While there may be a theoretical adverse effect if the patient is having an aortic dissection with a coexisting STEMI, this has not been scientifically demonstrated. Therefore, antiplatelet therapy should be at the forefront of the management of the STEMI patient and administered by EMS personnel as soon as possible. The only absolute contraindication and risk for aspirin therapy is with a patient who has a true anaphylactic allergic reaction to aspirin or other salicylates.

Nitroglycerin

Acting as a vasodilator, nitroglycerin can be helpful in reducing angina as well as decreasing cardiac workload. Nitroglycerin can increase the perfusion of the diseased subendocardial regions of the heart as well as decrease both preload and afterload.^{34,35} Therefore, nitroglycerin has long been used as standard therapy in the management of the AMI patient and should still be considered as part of first-line therapy.^{36,37} However, it should also be understood that the benefit of nitroglycerin is in the management of a patient's symptoms and not in reversal of the cause of the infarction. Therefore, whereas nitroglycerin may be helpful in the management of the STEMI patient, it should not be given a higher priority over treatment modalities that will help to reverse the underlying pathology such as aspirin. Furthermore, because nitroglycerin can cause a precipitous drop in a patient's blood pressure, EMS providers should use nitrates with caution.

Opiates

Because of concerns that treatment with morphine may be associated with worse outcomes for non-STEMI patients, there has been some controversy regarding the use of morphine in the setting of AMI.³⁸ However, as the only study demonstrating this association has significant study design issues, there is no definitive evidence that morphine or other opiates such as fentanyl are harmful to the AMI patient. Therefore, because the evidence that morphine may be harmful is weak, it is reasonable to treat pain associated with STEMI with opiates.

CHOICE OF REPERFUSION STRATEGY

All patients with chest pain and ST-segment elevation on the initial ECG should be considered candidates for early reperfusion.¹⁸

There is evidence from a number of randomized controlled trials showing that primary PCI is superior to fibrinolysis for reperfusion in acute STEMI. Keeley et al. published a systematic review and meta-analysis of 23 trials demonstrating that patients who received primary PCI had lower rates of short-term mortality (odds ratio [OR] 0.70; 95% confidence interval [CI] 0.58–0.85), nonfatal reinfarction (OR 0.35; 95% CI 0.27–0.45), and stroke (OR 0.46; 95% CI 0.30–0.72).² However, since timely access to primary PCI is often problematic in certain geographic locations, fibrinolytics are often the treatment modality of choice. The major advantages of fibrinolytics are wide availability, rapid administration, and operator independence (i.e., the benefit of therapy does not depend on the skill of the operator as is the case with primary PCI).³⁹

Several disadvantages to fibrinolytic therapy must also be considered. First, approximately 20–30% of all STEMI patients who present within 12 hours after symptoms have contraindications to fibrinolysis.^{40,41} In the 2005 AHA emergency cardiovascular care guidelines, which were based on the 2005 International Liaison Committee on Resuscitation (ILCOR) Consensus on Science, absolute contraindications for fibrinolysis include prior intracranial hemorrhage, known structural cerebral vascular lesion (e.g., arterio-venous malformation [AVM]), known malignant intracranial neoplasm, ischemic stroke within three months (except acute ischemic stroke within three hours), suspected aortic dissection, active bleeding or bleeding diathesis, and significant closed head trauma or facial trauma within three months.¹⁸ Second, fibrinolysis fails in up to 24% of patients,^{42–44} and third, approximately 25% of patients receiving a fibrinolytic agent will have a reinfarction within three months after the initial event.⁴⁵

According to the most recent American College of Cardiology/American Heart Association (ACC/AHA) recommendations, an invasive strategy is generally preferred if symptom onset to medical contact is greater than three hours, skilled primary PCI facilities are available with surgical backup, medical contact-to-balloon or door-to-balloon time can be achieved in less than 90 minutes, and door-to-balloon time minus door-to-needle time (the delta time) can be achieved in less than 60 minutes.⁴⁶ In addition, PCI is preferred if there are contraindications to fibrinolysis, there is an increased risk of bleeding, the patient has a "high-risk STEMI," or the diagnosis of STEMI is in doubt. A "high-risk STEMI" is defined as STEMI with associated cardiogenic shock. It should be noted that the goal of performing PCI within 90 minutes after the first medical contact represents the *longest* time that should be considered,

rather than the ideal time frame.⁴⁷ Moreover, recent evidence suggests that acceptable reperfusion delay (i.e., the difference between time to balloon and time to drug) varies considerably depending on patient age, symptom duration, and infarct location.⁴⁸

Fibrinolytic therapy may be preferred in patients whose first medical contact is less than three hours when PCI is not immediately available,^{49–51} especially in those who seek medical therapy within one hour after the onset of symptoms, as there is some evidence that very early fibrinolysis may abort the infarction.³⁹

Regardless of the timing of the onset of symptoms, because of improved outcomes with an invasive strategy, patients who are in cardiogenic shock and/or those with acute congestive heart failure should be considered for either direct or secondary transfer to a center that has the capabilities for PCI if the invasive strategy can be performed within 18 hours after the onset of shock.^{52–54} Furthermore, it is reasonable to consider secondary transfer if primary PCI can be achieved within 90 minutes from the time that the patient arrives at the primary hospital.^{50,55} However, according to data from the National Registry of Myocardial Infarction (NRM), the median time from presentation at the first hospital to PCI at the second hospital in the United States is 180 minutes,⁵⁶ which greatly exceeds the current recommendations for 90-minute medical contact-to-balloon interval.

For those patients who are given fibrinolytics and do not have resolution of symptoms or ST elevations within 90 minutes, rescue PCI should be performed immediately.^{57,58} However, facilitated PCI (half- or full-dose fibrinolytics followed by planned PCI) has not been shown to be helpful and is generally not recommended.⁵⁹

Finally, because there is a diminished advantage of PCI when the delta time exceeds 60 minutes, and prehospital fibrinolysis has been demonstrated to be relatively safe and efficacious,^{60,61} the AHA guidelines support the use of prehospital fibrinolytics for those patients who do not have contraindications and have a transport time greater than 60 minutes.¹⁸

PREHOSPITAL FIBRINOLYTICS

A number of randomized clinical trials have shown that prehospital fibrinolytics can significantly decrease the time from symptom onset to reperfusion treatment when compared with ED fibrinolysis.^{60–63} In general, prehospital fibrinolysis compared with ED fibrinolysis is associated with a reduction of 45–60 minutes in the delay to treatment and is associated with a significant reduction in mortality.⁶¹

The benefit of prehospital fibrinolysis has been shown in large registry data sets. Using data from a registry of 13,158 patients in Sweden, Björklund et al. compared patients who were given prehospital fibrinolyt-

ics (PHT) with those STEMI patients who were transported by EMS and were given fibrinolytics on ED arrival (IHT). They found that there was a 52-minute time savings in time to treatment (median time to treatment: PHT 113 min, IHT 165 min) and a 29% reduction in the odds of death at 12 months (OR 0.71; 95% CI 0.55–0.92).⁶⁴ In Canada, during the Assessment of the Safety and Efficacy of a New Thrombolytic Regimen (ASSENT) III Plus Prehospital Lysis Trial, a registry of all concurrent myocardial infarctions was documented.⁶⁵ The median times to fibrinolysis treatment were 103 minutes in the prehospital fibrinolysis cohort, 158 minutes for in-hospital fibrinolysis for ambulatory patients who arrived at the ED without EMS, and 163 minutes for in-hospital fibrinolysis for patients who arrived by ambulance. Prehospital fibrinolysis led to 55-minute and 60-minute time savings, respectively.⁶⁵

The United Kingdom has successfully implemented a countrywide prehospital fibrinolysis program.⁶⁶ The Fifth Public Report on the Treatment of Heart Attack Patients from the Myocardial Infarction National Audit Project (MINAP) presents data from all hospitals and ambulance services in England and Wales that provided care for patients with suspected heart attack from April 2005 to March 2006 (2005–2006) in comparison with data from the previous year (2004–2005).⁶⁷ The report shows that fibrinolytic treatment is increasingly being given by paramedics before the patient reaches the hospital, reducing the time to treatment. Twenty-eight of the 31 ambulance services in England and the Welsh ambulance service now give fibrinolytic treatment to patients before they reach the hospital. In 2005–2006, 2,231 patients received prehospital fibrinolytic treatment, compared with 1,374 patients in 2004–2005. Currently, 83% of eligible patients in England receive thrombolytic treatment within 30 minutes after arrival at the hospital, compared with 44% during early 2001.⁶⁸ This is also reflected in other registry data sets across the globe.^{69,70} Prehospital fibrinolysis is a growing and feasible option globally, particularly in those centers without timely access to cardiac catheterization facilities.

Randomized controlled trials and registry data support the safety and efficacy of prehospital fibrinolysis for patients with STEMI.⁴⁷ Inappropriate or unjustified administration of fibrinolytics to patients who do not have a STEMI will always be a risk, but contemporary data demonstrate low rates compared with the rates for in-hospital treatment.⁷¹ Because there are a few reports of patients having an aortic dissection coexisting with an AMI,⁷² clinical scenarios suggestive of dissection should be incorporated into prehospital fibrinolysis training programs. Nevertheless, with appropriate training, EMS providers should be able to safely administer prehospital fibrinolytics when indicated—i.e., when treating patients who have long transport

times and/or patients who present very early in the time course of their STEMI (especially within two hours after symptom onset).^{39,49,73–77}

REQUIREMENTS FOR A SITE TO BE CONSIDERED A PRIMARY PCI CENTER

According to the ACC/AHA guidelines, an important consideration in the design of EMS destination protocols for primary PCI is the availability of “skilled” PCI facilities with surgical backup. Criteria for skilled facilities include minimum requirements for the facility and minimum requirements for the operator. A skilled PCI facility performs at least 200 PCIs per year,¹⁸ of which a minimum of 36 are primary PCIs. A skilled PCI operator is one who performs at least 75 PCIs per year.¹⁸ Several analyses have demonstrated a direct relationship between both facility and operator procedural volume and better clinical outcomes with respect to PCI.⁷⁸ In addition, the percentage of STEMIs treated with primary PCI within a given institution has a positive effect on reducing delay to reperfusion and improving clinical outcomes.⁷⁹ In a retrospective analysis of more than 360,000 PCI procedures, it was shown that the in-hospital mortality was 2.56% in low-volume centers (<200 PCI procedures per year), 1.83% in medium-volume centers (200–399/year), 1.64% in high-volume centers (400–999/year), and 1.35% in very-high-volume centers (>1,000/year).⁸⁰ The NRM-2 registry showed that the mortality of patients who received primary PCI at institutions that performed more than 33 primary PCIs per year had an odds-adjusted mortality that was 33% lower than that for patients in institutions that performed fewer than 12 primary PCIs per year.⁸¹

Urgent surgical backup, typically needed for acute coronary artery occlusion occurring during the procedure or for identified coronary artery dissection, is needed for very few patients who receive primary PCI (~0.5–1%).⁸² However, patients who need emergent surgery are often hemodynamically unstable and may be difficult to stabilize and transport. There has been much debate about whether or not on-site surgical backup should be a requirement for primary PCI programs. The ACC/AHA guidelines include a Class IIb recommendation that primary PCI can be performed without on-site surgical backup, provided that the facility and operator are “skilled,” there is capability at the PCI center for advanced hemodynamic support, and there is a proven plan for rapid transport to off-site surgical backup.⁴⁶ Some have suggested that this should be upgraded to a Class IIa recommendation given the accumulated evidence in support of this practice.⁸² More than 15 registries of patients treated with primary PCI in centers without on-site surgical backup have demonstrated the safety of this approach.⁸²

PREHOSPITAL TRIAGE TO THE PCI LABORATORY

Several centers across North America are using paramedics to triage patients directly to the PCI laboratory.⁸³ Henry et al. reported that implementation of a standardized protocol and integrated transfer system significantly reduced door-to-balloon times.⁸⁴ In a comprehensive STEMI program in Calgary, Alberta, Canada, investigators describe a collaborative effort in their implementation of a prehospital pathway for accessing the PCI laboratory.⁸³ Their combined efforts resulted in a 3.1% 30-day mortality rate for STEMI patients.⁸³ The dynamic partnership involving medical personnel and EMS focused on the prehospital diagnosis of STEMI and the subsequent activation of the PCI laboratory. Through intensive multidisciplinary collaboration, their pathway achieved door-to-balloon times of less than 60 minutes and 90 minutes in 49% and 79% of patients, respectively.⁸³ This study was conducted in a large urban Canadian city with a contemporary EMS system and a leading national PCI program. Le May et al. compared door-to-balloon times for patients referred to PCI directly from the field by specially trained paramedics and patients referred to PCI by outside EDs.⁸⁵ Patients referred by the specially trained paramedics had shorter median door-to-balloon times (69 minutes compared with 123 minutes; $p < 0.001$) and a higher percentage of door-to-balloon times of less than 90 minutes (79.7% compared with 11.9%; $p < 0.001$).⁸⁵ Therefore, EMS medical directors should consider direct admission to the PCI laboratory from the out-of-hospital environment if local capabilities support this approach.

OTHER THERAPIES TO CONSIDER

Clopidogrel (Plavix)

Clopidogrel, an adenosine diphosphate receptor antagonist, has activity in inhibiting the activation and aggregation of platelets.⁸⁶ Sabatine et al. randomly assigned patients to clopidogrel or placebo prior to in-hospital fibrinolysis followed by angiography and demonstrated a reduction of the composite endpoint of death from cardiovascular causes, recurrent myocardial infarction, or recurrent ischemia (OR 0.64; 95% CI 0.53–0.76), without an increased risk of major bleeding.⁸⁷ Other authors have found similar or equivocal results in outcomes, also without an increased risk of bleeding.^{88,89} In the use of clopidogrel and fibrinolysis compared with placebo and fibrinolysis for the prehospital management of STEMI, Verheugt et al. found equivocal results without an increased risk of bleeding.⁹⁰ Therefore, although the scientific evidence does not demonstrate a clear benefit to clopidogrel in the prehospital environment, some EMS systems

may consider its use for the treatment of the STEMI patient.

QUALITY ASSURANCE

In developing a system for the management of STEMI patients, EMS medical directors and administrators should establish a program of quality assurance and quality improvement (QA/QI). This system should begin with the training of EMS providers in the recognition, assessment, and diagnosis of the STEMI patient. The QA/QI program should include the development of a regional STEMI database that can be used to correlate care delivered with patient outcomes. Finally, regular review of the system should be performed and improvement should be based on findings as recorded in the database.

INTEGRATION OF THE EMS SYSTEM WITH COMMUNITY AND REGIONAL CARDIAC SYSTEMS OF CARE

In order to maximize the care of STEMI patients, EMS providers should receive regular continuing education in the identification and management of STEMI patients. This should include understanding the typical and atypical presentations of acute coronary syndromes, as well as interpretation of 12-lead ECGs.

Once STEMI patients are identified, EMS providers should communicate early with receiving hospitals so that these hospitals are prepared for patient arrival. Some systems may even adopt the model of direct transport from the field to the catheterization laboratory, bypassing the ED.

The choice of reperfusion strategy and the method to deliver this strategy will be determined by a combination of the evolving science and local circumstances. In general, some guidelines for the appropriate strategy are as follows:

1. The prehospital 12-lead ECG is the cornerstone for optimized care of the STEMI patient throughout the community. Every urban and suburban EMS system should prioritize the implementation of effective prehospital 12-lead ECG diagnostic programs. In fact, NAEMSP encourages rural EMS systems to also utilize 12-lead ECG programs for the early diagnosis of STEMI.
2. All STEMI patients who present to the health care system within 12 hours after symptom onset should be considered for early reperfusion. In addition, patients in cardiogenic shock should be considered for early reperfusion in the first 18 hours after the onset of symptoms.
3. For patients who present within three hours after symptom onset, it is not fully known if PCI is supe-

rior to fibrinolytics. However, when the provider is given an equal choice, it is reasonable to choose PCI because of the lower risk of reinfarction and significant bleeding.

4. For patients who present between three and 12 hours after the onset of symptoms, PCI is the superior choice of reperfusion strategy. However, the advantages of PCI over fibrinolytics diminish with a medical contact-to-balloon time of more than 90 minutes or a 60-minute delay beyond the time that fibrinolytics could have been given. Therefore, if these times are expected to exceed 90 minutes or 60 minutes, respectively, fibrinolytics may be the preferred option.
5. When considering primary transport to a center capable of PCI vs. transport to the closest facility, the EMS system should be designed in such a manner as to account for the relationship between the timing of symptoms and the available treatment modalities. It may be beneficial to transport a patient to a PCI-capable center if the difference in transport time does not exceed the time window of 90 minutes from the time at which the patient could have presented to the closest hospital compared with the balloon time at the PCI-capable center. This consideration would also be the case (and would be even more difficult to accomplish) for those patients who are cared for initially at a non-PCI center and then transferred to a PCI center for the purpose of primary PCI.
6. For those systems that have a transport time greater than 60 minutes, prehospital fibrinolytics should be considered.

Regardless of the chosen treatment strategy, it is obvious that the best care will be achieved only with a systematic approach. Jollis et al. demonstrated that with the development of a coordinated approach, reperfusion times improve.⁹¹ With the implementation of a statewide system to facilitate early reperfusion, median times to reperfusion for patients presenting to PCI hospitals improved from 85 minutes to 74 minutes ($p < 0.001$), and median reperfusion times for patients transferred to PCI hospitals improved from 165 minutes to 128 minutes ($p < 0.001$).⁹¹ Therefore, early reperfusion is best achieved with a coordinated effort of the EMS system, the EDs, and the cardiovascular services within a given hospital and regional health care system.

FUTURE RESEARCH

It is important to recognize that the science of the EMS management of STEMI is in continuous evolution. Therefore, the recommendations of this paper should be taken in the context of the published literature available at the time of writing. Future studies should focus on the effects of physician vs. paramedic interpretation of 12-lead ECGs, direct transport to the catheterization laboratory from the field, bypass of the closest hospital

to a PCI center, and the use of other adjunctive agents by EMS providers such as clopidogrel and the glycoprotein IIb/IIIa inhibitors.

CONCLUSION

EMS medical directors and administrators should work together with the local health care system to develop a coordinated approach to the STEMI patient. EMS providers should focus on early identification of the STEMI patient and subsequent notification to the receiving hospital. The system should be designed to maximize achieving treatment time goals of less than 30 minutes for first medical contact or door to fibrinolytic administration, and less than 90 minutes for first medical contact or door to inflation of catheterization balloon.

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