ST-segment Elevation Myocardial Infarction (STEMI): Decreasing The Time To Treatment In The ED

Dear Colleagues,

Patients presenting to the Emergency Department (ED) with ST-segment elevation acute myocardial infarction (STEMI) require rapid diagnosis and treatment to optimize their outcome. Early diagnosis is accomplished by acquiring a 12-lead electrocardiogram within 10 minutes after ED presentation to identify STEMI and then begin treatment. Most irreversible myocardial damage occurs within the first 3 hours after symptom onset so delivery of fibrinolytic therapy or mechanical opening of the coronary artery using percutaneous coronary intervention (PCI) must be initiated early after presentation to the hospital to achieve greatest benefit. Since 1986, fibrinolytic therapy administered within the first 30 minutes after ED presentation (door-to-drug) has been a mainstay of STEMI therapy. In the middle of the 1990’s particularly with the advent of intra-coronary stenting, PCI has been found to be effective when provided within 90 minutes after ED presentation (door-to-balloon). PCI offers the advantage of improved TIMI 3 flow rate and less significant bleeding. For patients being transferred from a hospital to a PCI capable hospital typically makes PCI under 90 minutes after ED presentation impossible except for a small number (typically 5%) of patients. To maximize reperfusion in 3 hours or less after symptom onset, the ACC/AHA Guidelines for STEMI patients indicate that fibrinolytic therapy should be administered if the delay to PCI exceeds the 1 hour or less ideal difference between the delivery of fibrinolytic therapy (30 minutes or less) and the door-to-balloon time of 90 minutes.

In addition, the American College of Cardiology recently initiated the D2B (Door-to-Balloon) program which emphasizes an enhanced role for emergency physicians in the delivery of PCI care for STEMI patients. Through direct activation of the cardiac catheterization laboratory by the emergency physician, without first contacting the interventional cardiologist, the ACC hopes to decrease the door-to-balloon time substantially for STEMI. Through this EMCREG-International newsletter, we wish to provide background information regarding optimal STEMI care that will enhance the emergency physician’s diagnosis and treatment of this critically important disease process, ultimately improving the outcome of our patients.

Sincerely,

W. Brian Gibler, MD
President, EMCREG-International

W. Brian Gibler, MD
Professor and Chairman, Department of Emergency Medicine, University of Cincinnati College of Medicine, Cincinnati, OH
President, EMCREG-International

Introduction

For the last 2 decades, it has been well recognized that decreasing time to opening an occluded coronary artery in patients with ST-segment elevation myocardial infarction (STEMI) reduced mortality. Rapid reperfusion of ischemic myocardium improves left ventricular function, reduces infarct size, and ultimately increases patient survival. In the middle to late 1980’s, multiple large randomized trials began to demonstrate the efficacy of fibrinolytic therapy for treating STEMI. During the 1990’s, percutaneous coronary intervention (PCI), first through balloon angioplasty with evolution to routine stent placement, showed favorable comparison to fibrinolytic therapy in multiple trials, becoming the favored method for opening coronary arteries in STEMI patients at many institutions in the US that served as tertiary cardiac referral centers. Requirements for cardiothoracic surgery back-up for PCI limited the availability of interventional cardiology for STEMI to a relatively small number of hospitals. During the last 5 years there has been a resurgence of interest in defining the optimal approach to reperfusion therapy. In 2004, the American College of Cardiology/American Heart Association (ACC/AHA) Guidelines for the management of patients with ST-segment elevation myocardial infarction recommended PCI as optimal therapy if the door to balloon opening time was 90 minutes or less from time of patient presentation to the emergency department (ED).1 If the delay in providing PCI was greater than 1 hour more than the 30 minute time period required to deliver intravenous fibrinolitics in the ED, fibrinolysis was considered the preferred reperfusion therapy. For patients presenting less than 3 hours after symptom onset, and there is no delay to an invasive strategy, there is no preference for either strategy (Figure 1).

Fibrinolysis

In 1986, the GISSI, ISAM, AIMS, ISIS-2 and ASSET trials provided conclusive evidence in a randomized fashion versus placebo that streptokinase, streptokinase, anistreplase (APSAC), streptokinase, and tissue plasminogen activator respectively reduced mortality in patients with STEMI, typically within 6-12 hours after symptom onset.2-7 Beginning in the early 1990’s, study groups such as EMERAS and

Peer Reviewer for Industry Bias: Brian R. Holroyd, MD, Chairman, Department of Emergency Medicine, University of Alberta, Edmonton, Alberta, Canada
the LATE investigators began to explore treatment 6 hours or greater after symptom onset for STEMI patients. In 1994, the Fibrinolytic Therapy Trialist group performed a meta-analysis of all randomized fibrinolytic trials greater than 1000 patients showing that mortality benefit for patients receiving fibrinolysis was critically time-dependent. The greatest mortality benefit was noted in the first 3 hours after symptom onset, particularly in the first hour, with some statistical improvement in mortality seen up to 12 hours after symptom onset. For patients treated within 1 hour after symptom onset, there was an absolute mortality benefit of 39 lives saved per 1000 patients. If treated between 2-3 hours after symptom onset, 30 lives were saved per 1000 patients and 21 lives were saved if patients were treated between 7-12 hours after symptoms began. Effectively, an absolute benefit reduction of 1.6 lives was realized for each hour of delay. Data from pre-hospital fibrinolytic trials indicate that the original Boersma curve demonstrating mortality benefit from fibrinolysis could actually be shifted 45-60 minutes to the right (Figure 2). These data are well summarized in an excellent recent publication evaluating indications for reperfusion therapy in patients with suspected MI. Current fibrinolytic agents such as rPA (reteplase) and TNK-tPA (tenecteplase) provide improved fibrin specificity combined with easier administration regimens compared to the original fibrinolytic agents, tPA (alteplase) and SK (streptokinase).

**Figure 1.** Assessment of reperfusion options. STEMI indicates ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; ICH, intracranial hemorrhage. *Applies to fibrin-specific agents. †Operator experience greater than a total of 75 primary PCI cases per year. ‡Team experience greater than a total of 36 primary PCI cases per year. §This calculation implies that the estimated delay to the implementation of the invasive strategy is greater than 1 hour vs initiation of fibrinolytic therapy immediately with a fibrin-specific agent. Adapted with permission from Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction—Executive Summary A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1999 Guidelines for the Management of Patients With Acute Myocardial Infarction). J Am Coll Cardiol 2004;44:671–719.

**Figure 2.** Number of extra lives saved per 1000 patients treated with fibrinolytics at different time treatment delays from symptom onset. Adapted with permission from Terkelsen CJ, Lassen JF, Norgaard BL, et al. Are we underestimating the full potential of early thrombolytic treatment in patients with acute myocardial infarction? Heart 2003; 89:483-484.
Percutaneous Coronary Intervention

For patients presenting directly to a hospital with experienced acute interventional capabilities, PCI offers advantages including a higher TIMI-3 flow rate (greater than 95% compared to approximately 65% for fibrinolytic therapy) with a lower risk of intracranial hemorrhage. Bleeding at the site of skin/femoral artery penetration, typically in the groin, is greater for patients undergoing PCI though this bleeding can be controlled and usually is nonfatal. Finally, if time to balloon opening is 90 minutes or less after presentation, the advantages of greater TIMI-3 flow rate with less intracranial bleeding translates into improved mortality.18-20

In patients enrolled in the National Registry of Myocardial Infarction between June 1994 and March 1998, Cannon and colleagues found that multivariate-adjusted odds of mortality were increased over 40% when the door to balloon time was longer than 2 hours.21 Berger et al evaluated time or randomization to angioplasty during 4 time intervals from the GUSTO-IIb trial: <60, 61-75, 76-90, and >91 minutes for mortality. Each time interval had a 1.6-fold greater risk for death than the preceding time interval.1 [95% confidence interval (CI), 1.13-2.26, P value = 0.008].22 Despite a Danish trial demonstrating favorable results for patients transferred from 24 community hospitals transferred to 5 invasive treatment centers,23 results from 4,278 transferred patients from the National Registry of Myocardial Infarction from January 1999 through December 2002 showed a median door to balloon time of 180 minutes, with only 4.2% treated within 90 minutes.24,25

Impact of Time to Treatment

Over the last 3 years, the routine use of PCI for patients with STEMI, regardless of whether the patient presents primarily to an interventional cardiology center (PCI capable) or is transferred from a non-PCI capable center to an interventional center, has become controversial.26 The additional time required to perform PCI, due to logistics, particularly for patients presenting “off hours” at an institution offering primary PCI for STEMI or to a non-PCI capable institution requiring transfer for PCI, may eliminate the advantages of PCI over intravenous fibrinolytics (Figures 3, 4, and 5).24,37 In these circumstances where the cardiac catheterization team is not “in house” at a PCI-capable center or for patients presenting to a non-PCI capable hospital, administration of fibrinolytic therapy may provide the best opportunity to gain coronary artery reperfusion within the first 2-3 hours after symptom onset. This represents the ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction optimal strategy of giving fibrinolytic therapy intravenously if the delay compared to door to balloon time for PCI exceeds 60 minutes.2

Developing Institutional Care Pathways

For each institution, collaboration between emergency physicians, cardiologists, nursing, prehospital care providers, hospital administrators, and pharmacists for creation of a standardized approach to STEMI care is essential.37 This requires the routine use of pre-hospital electrocardiography, if available, to identify patients with STEMI in the pre-hospital setting before arrival at the hospital. Emergency physicians and nurses should have agreed upon standard order sets which include performance of a 12-lead electrocardiogram in 10
minutes or less and a uniform approach to ensuring that the STEMI patient receives appropriate adjunctive therapy including aspirin, beta-blockers, heparin/low molecular weight heparin, clopidogrel, and glycoprotein IIb/IIIa receptor inhibitors as indicated. Cardiologists and emergency physicians must agree on the appropriate reperfusion therapy, either PCI or fibrinolytic therapy, based on a realistic time estimate of door to balloon opening versus administration of fibrinolytic therapy within 30 minutes after presentation as a standard. Establishing a standardized approach to data collection and continuous quality improvement processes is essential for evaluation of the system. Each institution should have regular meetings of its STEMI team to evaluate the significant data points for its STEMI patients including 1) time to receiving ECG (% 10 minutes of less), 2) administration of adjunctive therapy including aspirin, beta-blockers, heparin/low molecular weight heparin, clopidogrel, and glycoprotein IIb/IIIa receptor inhibitors, 3) door to administration of intravenous fibrinolytic therapy (% 30 minutes or less), and 4) door to balloon time for patients receiving primary PCI (% 90 minutes or less). Candid appraisal of these treatment approaches with discussion of outlying patients through a continuous quality improvement effort will ensure optimal care for an institution’s STEMI patients. 38,39

**Door to Balloon (D2B) Initiative**

During the 206 American Heart Association meeting in Chicago (November, 2006), the American College of Cardiology announced the D2B (Door to Balloon) initiative. 40 The ACC is challenging institutions to have greater than 75% of patients having a door to balloon time of less than 90 minutes. For this to be accomplished, it is imperative that the ED has efficient care plans for patients with STEMI that includes early 12-lead ECG acquisition so emergency physicians can call in the cardiac catheterization team for a rapid response including notification of the interventional cardiologist. Clearly this strategy will emphasize the importance of improving time to treatment by highlighting the 90 minute door to balloon goal on every STEMI patient. As importantly, for patients with STEMI that have no chance of receiving PCI close to the 90 minute standard, routine use of intravenous fibrinolytic therapy should be considered.

**REFERENCES**


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CME Post Test

After you have read the monograph carefully, record your answers by circling the appropriate letter answer for each question.

1. For patients presenting to the emergency department with STEMI, the ideal maximum door to needle time for infusion of fibrinolytic therapy is 30 minutes while the maximum door to balloon inflation time for percutaneous coronary intervention (PCI) is 90 minutes.
   a. True
   b. False

2. Myocardial muscle salvage for patients with STEMI, based on trials of fibrinolytic therapy, occurs up to the following time after symptom onset:
   a. 4 hours
   b. 8 hours
   c. 12 hours
   d. 16 hours
   e. 20 hours

3. Based on National Registry of Myocardial Infarction data for patients undergoing PCI for STEMI from 1994 through 1998, the advantage for mechanical intervention decreases substantially how many minutes after presentation to the ED:
   a. 30 minutes
   b. 60 minutes
   c. 90 minutes
   d. 120 minutes

4. For patients being transferred from one hospital to another hospital for PCI, what percentage of patients typically receive a door-to-balloon time of 90 minutes or less at the receiving hospital?
   a. 5%
   b. 10%
   c. 15%
   d. 20%
   e. 30%

5. In the D2B program instituted by the American College of Cardiology in November 2006, emergency physicians are responsible for activating the cardiac catheterization team to decrease the door-to-balloon time for patients presenting with STEMI.
   a. True
   b. False
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