INTRODUCTION

In August 2004 the American College of Cardiology and the American Heart Association Task Force on Guidelines for the Management of Patients with ST-Segment Elevation Myocardial Infarction (STEMI) published their recommendations.1 This is the first time that guidelines have focused specifically on STEMI. Many of the recommendations confirm those from the 1999 recommendations within the guidelines for management of myocardial infarction but certain changes are significant and clarify appropriate current management.

This paper outlines the Class I recommendations (should be performed) for prehospital and emergency department (ED) phases of care for STEMI. Level of evidence will be cited as A (effective based on evidence from multiple randomized trials or meta-analyses), B (effective based on limited evidence from a single randomized trial or nonrandomized studies) or C (effective based on expert opinion, case studies or standard of care).

The most important change in the guidelines relates to identification of the best first reperfusion therapy, fibrinolysis or primary percutaneous coronary intervention (PCI). Primary PCI is not always the therapy of choice and may often be inferior to rapid delivery of fibrinolysis. The reasons for a variable approach based on the degree of incremental benefit in certain patient situations are advanced below.

2004 AHA/ACC STEMI GUIDELINES: CLASS I RECOMMENDATIONS

Prehospital Recommendations
1. All EMS first responders who respond to patients with chest pain and/or suspected cardiac arrest should be trained and equipped to provide early defibrillation. (Level A)
2. All public safety first responders who respond to patients with chest pain and/or suspected cardiac arrest patients should be trained and equipped to provide early defibrillation with AEDs. (Level B)
3. Dispatch staffing 9-1-1 center emergency medical calls should have medical training, should use nationally developed and maintained protocols, and should have a quality improvement system in place to ensure compliance with protocols. (Level C)

4. Prehospital EMS providers should administer 162 to 325 mg of aspirin (chewed) to chest pain patients suspected of having STEMI unless contraindications exist or aspirin has already been taken by patient at home prior to EMS arrival. Although some trials have used enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated formulations. (Level C)

5. Patients with STEMI who have cardiogenic shock and are less than 75 years of age should be brought immediately or secondarily transferred to facilities capable of cardiac catheterization and rapid revascularization (PCI or CABG) if it can be performed within 18 hours of the onset of shock. (Level A)

6. Patients with STEMI who have contraindications to fibrinolytic therapy should be brought immediately or secondarily transferred promptly (i.e., primary-receiving hospital door-to-departure time less than 30 minutes) to facilities capable of cardiac catheterization and rapid revascularization (PCI or CABG). (Level B)

7. Every community should have a written protocol that guides EMS system personnel in determining where to take patients with suspected or confirmed STEMI. (Level C)

Note: The use of 12-Lead ECGs, fibrinolytic check-lists and prehospital fibrinolysis all remain Class IIa recommendations with Level B or C levels of evidence.

ED Initial Assessment

1. A targeted history of STEMI patients taken in the ED should ascertain whether the patient has had prior episodes of myocardial ischemia such as stable or unstable angina, MI, CABG, or PCI. Evaluation of the patient’s complaints should focus on chest discomfort, associated symptoms, sex- and age related differences in presentation, hypertension, diabetes mellitus, possibility of aortic dissection, risk of bleeding, and clinical cerebrovascular disease (amaurosis fugax, face/limb weakness or clumsiness, face/limb numbness or sensory loss, ataxia or vertigo. (Level C)

2. A physical examination should be performed to aid in the diagnosis and assessment of the extent,
ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION: NEW GUIDELINES WITH A REFOCUS ON TIME TO TREATMENT

location and presence of complications of STEMI. (Level C)

3. A brief, focused and limited neurologic examination to look for the evidence of prior stroke or cognitive deficits should be performed on STEMI patients before administration of fibrinolytic therapy. (Level C)

4. A 12-lead ECG should be performed and shown to an experienced emergency physician within 10 minutes of ED arrival for all patients with chest discomfort (or anginal equivalent) or other symptoms suggestive of STEMI. (Level C)

5. If the initial ECG is not diagnostic of STEMI but the patient remains symptomatic, and there is a high clinical suspicion for STEMI, serial ECGs at 5- to 10-minute intervals or continuous 12-lead ST-segment monitoring should be performed to detect the potential development of ST-segment elevation. (Level C)

6. In patients with inferior STEMI, right-sided ECG leads should be obtained to screen for right ventricular (RV) infarction. (Level B)

ED Laboratory and Imaging

1. Laboratory examinations should be performed as part of the management of STEMI patients but should not delay the implementation of therapy. (Level C)

2. Cardiac-specific troponins should be used as the optimum biomarkers for the evaluation of patients with STEMI who have coexistent skeletal muscle injury. (Level C)

3. For patients with ST-segment elevation on the 12-lead ECG and symptoms of STEMI, reperfusion therapy should be initiated as soon as possible and is not contingent on biomarker assay. (Level C)

4. Although handheld bedside (point-of-care) assays may be used for a qualitative assessment of the presence of an elevated level of a serum cardiac biomarker, subsequent measurements of cardiac biomarker levels should be performed with a quantitative test. (Level B)

5. Patients with STEMI should have a portable chest X-ray, but this should not delay implementation of reperfusion therapy (unless a potential contraindication, such as aortic dissection, is suspected). (Level C)

6. Imaging studies such as high-quality portable chest X-ray, transthoracic and/or transesophageal echocardiography and a contrast chest computed tomography scan or an MRI scan should be used to differentiate STEMI from aortic dissection in patients for whom this distinction is unclear. (Level B)

ED Ancillary Treatment

1. Supplemental oxygen should be administered to patients with arterial oxygen desaturation (SaO2 less than 90%). (Level B)

2. Patients with ongoing ischemic discomfort should receive sublingual nitroglycerine (0.4 mg) every 5 minutes for a total of 3 doses, after which an assessment should be made about the need for intravenous nitroglycerine. (Level C)

3. Intravenous nitroglycerine is indicated for relief of ongoing ischemic discomfort, control of hypertension, or management of pulmonary congestion. (Level C)

4. Morphine sulfate (2-4 mg IV with increments of 2-8 mg IV repeated at 5- to 15-minute intervals) is the analgesic of choice for management of pain associated with STEMI. (Level C)

5. Aspirin should be chewed by patients who have not taken aspirin before presentation with STEMI. The initial dose should be 162 mg (Level A) to 325 mg (Level C). Although some trials have used enteric-coated aspirin for initial dosing, more rapid absorption occurs with non-enteric-coated aspirin formulations.

6. Oral beta-blocker therapy should be administered promptly to those patients without a contraindication irrespective of concomitant fibrinolytic therapy or performance of primary PCI. (Level A)
7. Patients undergoing percutaneous or surgical revascularization should be given UFH. (Level C)

8. UFH should be given intravenously to patients undergoing reperfusion therapy with alteplase, reteplase, or tenecteplase with heparin dosing as follows: bolus of 60 U/kg (maximum 4000U) followed by an initial infusion of 12 U/kg per hour (maximum 1000U/hour) adjusted to maintain a partial thromboplastin time (aPTT) at 1.5 to 2.0 times control (approximately 50 to 70 seconds). (Level C)

Note: LMWH may be considered acceptable in patients less than 75 years of age and without significant renal dysfunction. (Class IIb)

9. UFH should be given intravenously to patients treated with nonselective fibrinolytic agents (streptokinase, anistreplase, or urokinase) who are at high risk of systemic emboli (large or anterior MI, atrial fibrillation, previous embolus, or known LV thrombus). (Level B)

ED First Reperfusion Therapy

1. All STEMI patients should undergo rapid evaluation for reperfusion therapy and have a reperfusion strategy implemented promptly after contact with the medical system. (Level A)

2. STEMI patients presenting to a facility without the capability for expert, prompt intervention with primary PCI within 90 minutes of first medical contact should undergo fibrinolysis unless contraindicated. (Level A)

3. In the absence of contraindications, fibrinolytic therapy should be administered to STEMI patients with symptom onset within the prior 12 hours and the ST-segment elevation greater than 0.1 mV in at least 2 contiguous precordial leads or at least 2 adjacent limb leads. (Level A)

4. In the absence of contraindications, fibrinolytic therapy should be administered to STEMI patients with symptom onset within the prior 12 hours and new or presumably new LBBB. (Level A)

5. Healthcare workers should ascertain whether the patient has neurologic contraindications to fibrinolytic therapy, including any history of intracranial hemorrhage (ICH), significant closed head or facial trauma, uncontrolled hypertension or ischemic stroke within the past 3 months. (Level A)

6. STEMI patients at substantial (greater than or equal to 4%) risk of ICH should be treated with PCI rather than fibrinolytic therapy. (Level A)

7. The occurrence of a change on neurologic status during or after fibrinolytic therapy, particularly within the first 24 hours after initiation of treatment, is considered to be due to ICH until proven otherwise. Fibrinolytic, antiplatelet, and anticoagulant therapies should be discontinued until brain imaging scan shows no evidence of ICH. (Level A)

8. Neurologic and/or neurosurgery or hematology consultation should be obtained for STEMI patients who have ICH as dictated by clinical circumstances. (Level C)

9. In patients with ICH, infusions of cryoprecipitate, fresh frozen plasma, protamine, and platelets should be given, as dictated by clinical circumstances. (Level C)

10. Diagnostic angiography should be performed in candidates for primary or rescue PCI (Level A); in patients with cardiogenic shock who are candidates for revascularization (Level A); in candidates for surgical repair of ventricular septal rupture or severe mitral regurgitation (Level B); and in patients with persistent hemodynamic and/or electrical instability. (Level C)

11. If immediately available, primary PCI should be performed in patients with STEMI (including true posterior MI) or MI with new or presumably new LBBB who can undergo PCI of the infarct artery within 12 hours of symptom onset, if performed in a timely fashion (balloon inflation within 90 minutes of presentation) by persons skilled in the procedure (individuals who perform more
than 75 PCI procedures per year). The procedure should be supported by experienced personnel in an appropriate laboratory environment (performs more than 200 PCI procedures per year), of which at least 36 are for primary PCI for STEMI, and has cardiac surgery capability. (Level A)

12. Primary PCI should be performed as quickly as possible, with a goal of a medical contact-to-balloon time of within 90 minutes. (Level B)

13. If the symptom duration is within 3 hours and the expected door-to-balloon time minus the expected door-to-needle time is within 1 hour, primary PCI is generally preferred; if greater than 1 hour, fibrinolysis is generally preferred. (Level B)

14. If the symptom duration is greater than 3 hours primary PCI is generally preferred and should be performed with a medical contact-to-balloon time as brief as possible with a goal of within 90 minutes. (Level B)

15. Primary PCI should be performed for patients younger than 75 years old with ST-segment elevation or LBBB who develop shock within 36 hours of AMI and are suitable to revascularization that can be performed within 18 hours of shock, unless further support is futile because of patient’s wishes or contraindications/unsuitability for further invasive care. (Level A)

16. Primary PCI should be performed in patients with severe CHF and/or pulmonary edema and onset of symptoms within 12 hours. The door-to-balloon time should be as short as possible (goal within 90 minutes). (Level B)

17. Primary PCI should be performed in fibrinolytic-ineligible patients who present with STEMI within 12 hours of onset of symptoms. (Level C)

PCI vs Fibrinolytic: Rapid Reperfusion is Still the Goal

Importance of Time to Treatment

One of the mantras of emergency physicians is “time is muscle”. The understanding that viable myocardium, now ischemic due to occlusion of the nutrient coronary artery, and will necrose within 4-6 hours mandates rapid diagnosis and rapid reperfusion therapy coordinated by the physician of first contact. [Figure 1]

Time to treatment with Fibrinolytics GISSI-1 demonstrated the relationship of time to treatment and the observation has been repeated many times since.2 The Fibrinolytic Therapy Trials group combined data sets from fibrinolytic vs placebo trials and demonstrated a 5-6% absolute reduction in mortality for patients seen in the first hour and ever-diminishing return for each subsequent hour.3

Figure 1. Number of lives saved per 1000 patients treated with fibrinolysis. (Adapted from Boersma E, et al. Lancet. 1996;348:771-775) 4
Time to Treatment with Primary Angioplasty

Although some studies have demonstrated that primary angioplasty is not dependent on time, recent evidence demonstrates and the new STEMI guidelines articulate that time matters with PCI much as it does with fibrinolysis. De Luca and others have recently demonstrated that patients treated in the first 2 hours after symptom onset have better outcomes than those treated later.5,6 As time marches on, PCI and the opening of the infarct-related artery provide benefit for the healing of the infarct zone, however the ability of fibrinolysis to dissolve the clot and maintain an open artery becomes more difficult. The benefit provided by PCI is not as time sensitive only because benefit is more notable in late presenters. In early presenters (< 3 hours), the reperfusion time delays are as important as with fibrinolysis. Antoniucci demonstrated that in low-risk infarctions there is little advantage of early PCI vs later PCI but in high risk infarctions, the reduced mortality associated with early treatment was clear.7 Patients with a substantial myocardium at risk also demonstrate a greater benefit with rapid PCI compared to delayed PCI. (Figure 2)

Three Important Time Intervals

We traditionally have tried to reduce time to treatment by attempting to reduce 2 consecutive time intervals:

1. Time from onset of symptoms to arrival at hospital
2. Time from arrival to delivery of the treatment (pharmacologic or mechanical intervention).

However, a third very important time interval must be evaluated in order to choose the best first reperfusion therapy:

3. The interval from potential delivery of the fibrinolytic therapy to the time when the balloon is inflated in the artery (door to balloon time – door to fibrinolytic time).

At the point when the diagnosis is made, and the patient is eligible for fibrinolytic therapy, PCI may be the best choice but only if it can be delivered in an appropriate time frame. That appropriate time frame is now considered to be less than 60 minutes.

Figure 2.

Absolute risk reduction in 4- to 6-week mortality rates with primary PCI as a function of PCI-related time delay. Circle sizes reflect the sample size of the individual study. Values >0 represent benefit and values <0 represent harm. Solid line represents weighted meta-regression. Reprinted with permission from Nallalmothu et al. Am J Cardiol 2003.9
The initial primary angioplasty vs fibrinolytic therapy trials had an average added time for angioplasty of 47 minutes. A meta-analysis by Nallamothu evaluated the incremental benefit of primary angioplasty compared with fibrinolysis and related the benefit to this time difference. He concluded that the benefit was greatest the shorter the delay, and at 60 minutes after potential fibrinolysis, the incremental benefit of PCI disappeared.

**Duration of Symptoms Modifies PCI Benefit**

It is also true that the duration of symptoms modifies this differential benefit. In the MITI trial evaluating prehospital fibrinolysis, the 30 day mortality rate for patients treated within 70 minutes of symptom onset was 1.2%. It is unlikely that primary angioplasty can improve on this excellent result. The CAPTIM trial in France, comparing ambulance fibrinolysis to urgent transfer for primary angioplasty, found an overall benefit for primary angioplasty. However, in those presenting in < 2 hours, the mortality was the lowest in the fibrinolysis group (p=0.58).

**Figure 3**

**Practical Choice of Optimum Reperfusion Therapy for Stable Patients**

The new ACC/AHA STEMI guidelines help to define the best choice of first reperfusion therapy based on the time difference between potential fibrinolytic therapy and guaranteed balloon inflation. These recommendations exclude patients in shock or those ineligible for fibrinolytic therapy.

In patients presenting in less than 3 hours, fibrinolysis will be the treatment of choice unless angioplasty can be accomplished in less than 60 minutes from that decision point. This will virtually never be possible if a transfer to an interventional center is needed. In fact it not be possible at some interventional centers and certainly not unless cardiac catheterization staff are in-house. Although not specifically mentioned in the guidelines, the earlier the patient presents even within the first 3 hours, the less acceptable any delay to angioplasty. The target of 60 minutes from potential fibrinolysis to balloon inflation may be too long in patients presenting within one hour of symptoms.

For patients presenting after more than 3 hours of pain, PCI will generally be the preferred reperfusion method and the sooner the better but only if the balloon can be inflated less than 90 minutes after first medical contact. Once again, this time goal will be difficult to achieve in patients presenting in less than 3 hours, fibrinolysis will be the treatment of choice unless angioplasty can be accomplished in less than 60 minutes from that decision point. This will virtually never be possible if a transfer to an interventional center is needed. In fact it not be possible at some interventional centers and certainly not unless cardiac catheterization staff are in-house. Although not specifically mentioned in the guidelines, the earlier the patient presents even within the first 3 hours, the less acceptable any delay to angioplasty. The target of 60 minutes from potential fibrinolysis to balloon inflation may be too long in patients presenting within one hour of symptoms.

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many situations and if it cannot, fibrinolysis is the preferred first treatment of choice.

The result of this fresh look at time and its importance in the prevention of myocardial necrosis will correct a misconception PCI is preferred regardless of the potential delay. PCI should be the preferred therapy only if the health care system measures time to balloon inflation and there is strong assurance that the delay will be less than 60 minutes from the time of potential fibrinolysis administration. In all other cases, fibrinolysis is preferable and it should be delivered within 30 minutes of arrival. Use of fibrinolysis as the first reperfusion therapy of choice does not preclude appropriate subsequent mechanical intervention for failure to reperfuse, development of CHF or shock, and for subsequent spontaneous or provokable ischemia.

SUMMARY

The new ACC/AHA guidelines for STEMI are a must read for emergency physicians. The most profound impact is the re-instatement of fibrinolysis as the preferred treatment for STEMI unless PCI can be guaranteed in a very timely manner.

REFERENCES


