THOMSON
AMERICAN HEALTH CONSULTANTS

Rapid Reference Card Enclosed

The Practical Journal for Emergency Physicians

Emergency Medicine Reports®

Volume 25, Number 8

April 5, 2004

Reperfusion Strategies for ST-Segment Elevation Myocardial Infarction: An Overview of Current Therapeutic Options

Part II: Mechanical Reperfusion

Author: **Mary C. Meyer, MD**, Emergency Physician, Kaiser Walnut Creek and Richmond, CA.

Peer Reviewers: **Charles L. Emerman, MD**, Chairman, Department of Emergency Medicine, MetroHealth Medical Center, Cleveland Clinic Foundation, Cleveland, OH; and **Steven M. Winograd, MD, FACEP**, Attending Physician, Emergency Department, St. Joseph Medical Center, Reading, PA.

Optimizing outcomes in patients with acute coronary syndrome requires matching patients with strategies that will produce the best results in specific clinical subgroups. Identifying those patients with ST elevation myocardial infarction (STEMI) who represent ideal candidates for fibrinolysis, and who are likely to have outcomes that are at least as favorable as they would have with percutaneous interventions, has become an area of intense focus among cardiologists and emergency physicians. Although percutaneous coronary intervention (PCI) has become the standard of care in the overwhelming majority of patients with STEMI, some hospitals still do not maintain interventional capabilities, and therefore, when immediate patient transfer to a cath-capable institution site is not possible, fibrinolysis remains a core strategy for optimizing clinical outcomes. A number of factors that should be considered when assessing patients with STEMI for either percutaneous or fibrinolytic therapy are discussed in the following review.

An important advance in fibrinolytic management of acute myocardial infarction (AMI) is the emerging evidence defining a pivotal role for enoxaparin as part of a fibrinolytic strategy in STEMI. The largest body of published literature evaluating low molecular-weight heparins (LMWH) in the setting of acute coronary ischemia has focused on enoxaparin. Because the most recent, significant data to emerge from large, well-designed, prospective trials, especially Assessment of the Safety and Efficacy of a New Thrombolytic-III (ASSENT-III), involve enoxaparin, its role in pharmacological strategies for reperfusion will be discussed.

The mandate to implement prompt reperfusion therapy in fibrinolytic-ineligible patients, as well as the other limitations of fibrinolytic therapy, have encouraged many clinicians to advocate PCI with coronary artery stenting, as the primary treatment

modality for the majority of patients with AMI. Recent studies suggest the introduction of coronary artery stenting has favorably altered the outcomes of patients with STEMI, confirming stent placement a superior method of management for appropriately selected patients at institutions where physicians are experienced in this procedure.

Stenting represents a significant advance in the management of patients with AMI by PCI. In the recent past, early use of stenting in the AMI patient was considered problematic due to the possibility of prompt stent thrombosis or subsequent unexpected stent restenosis. With the introduction of aggressive antiplatelet therapy using aspirin and antagonists of platelet ADP and GPIIb/IIIa receptors, the rates of stent thrombosis have significantly decreased. Exploring early stent placement in the AMI patient, the PAMI-stent trial compared urgent treatment with percutaneous transluminal coronary angioplasty (PTCA) with or without stenting in 900 patients. Stenting significantly reduced both stenosis and reocclusion at six months. No differences in death, reinfarction, or stroke at six months, however, were noted. Thus, it appears that in selected patients with AMI, primary stenting can be applied safely and effectively, resulting in a lower incidence of recurrent infarction and a significant reduction in the need for subsequent target-vessel revascularization compared with balloon angioplasty.

Significant improvements in patient outcomes will be made when patients are managed according to their institutional capabilities, with the understanding that prompt thrombolysis in the setting of STEMI is fundamental to optimal patient care. This article, the second in a two-part series, provides a practical, evidence-based approach to comprehensive management of this patient population.

—The Editor

Mechanical Reperfusion

Primary PCI. Where thrombolytics achieve reperfusion via lysis of the coronary thrombus, primary PCI restores blood flow by mechanically disrupting occlusive clot.[1,2] Initially introduced as an alternative to fibrinolysis, primary PCI now is recognized as the reperfusion modality of choice in STEMI. After two decades and nearly two dozen trials, there now is little doubt that primary PCI is superior to thrombolysis—it is associated with decreased death, reinfarction, intracranial bleeding, reocclusion of the infarct-related artery, and recurrent ischemia.

In the early 1990s, several trials suggested a benefit of primary PCI over thrombolysis.[3,4] Subsequently, a landmark meta-analysis involving 2606 patients and 10 trials compared fibrinolysis vs. primary PCI.[5] Primary PCI was associated with both a 34% relative reduction in 30-day mortality (4.4% vs 6.5%, $p = 0.02$) and a significant reduction in the combined endpoint of death or nonfatal reinfarction (13.4% vs 23.9%, $p = 0.01$).[5] This translates into 21 additional lives saved per 1000 patients treated with PCI rather than thrombolytic therapy. The reduction in death and reinfarction was particularly pronounced in patients older than 60 years of age. Furthermore, PCI was associated with a negligible risk of hemorrhagic stroke (0.1% vs 1.1% with thrombolytics, $p < 0.001$).[5]

The introduction of stents and the GPIIb/IIIa inhibitors appears to have only widened the gap between primary PCI and fibrinolysis.[6] In 2003, researchers published a meta-analysis of 23 trials comparing fibrinolysis to primary PCI.[6] A total of 7739 patients were enrolled; stents were used in 12 of the studies and eight trials included GP IIb/IIIa inhibitors. Those patients treated with primary PCI fared better on all counts. Primary PCI was associated with a statistically significant reduction in mortality (5% vs 7%, $p = 0.0003$), non-fatal reinfarction (3% vs 7%, $p < 0.0001$), and stroke (1% vs 2%, $p = 0.0004$).[6] This advantage

Emergency Medicine Reports™ (ISSN 0746-2506) is published biweekly by Thomson American Health Consultants, 3525 Piedmont Road, N.E., Six Piedmont Center, Suite 400, Atlanta, GA 30305. Telephone: (800) 688-2421 or (404) 262-7436.

Vice President/Group Publisher: Brenda Mooney
Editorial Group Head: Valerie Loner
Managing Editor: Allison Mechem
Marketing Manager: Schandale Kornegay
GST Registration No.: R128870672

Periodicals postage paid at Atlanta, GA. **POSTMASTER:** Send address changes to ***Emergency Medicine Reports***, P.O. Box 740059, Atlanta, GA 30374.

Back issues: $31. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

Multiple copy prices: One to nine additional copies, $359 each; 10 to 20 additional copies, $319 each.

Accreditation

Emergency Medicine Reports™ continuing education materials are sponsored and supervised by Thomson American Health Consultants. Thomson American Health Consultants designates this continuing education activity for up to 60 hours in Category 1 credit toward the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

This CME activity was planned and produced in accordance with the ACCME Essentials.

Emergency Medicine Reports™ also is approved by the American College of Emergency Physicians for 60 hours of ACEP Category 1 credit and has been approved for 52 Category 2B credit hours by the American Osteopathic Association. Emergency Medicine Reports has been reviewed by the American Academy of Family Physicians as having educational content acceptable for Prescribed credit hours. This volume has been approved for up to 60 Prescribed credit hours. Term of approval covers issues published within one year from the beginning distribution date of 1/04. Credit may be claimed for one year from the date of this issue.

Thomson American Health Consultants (AHC) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

This is an educational publication designed to present scientific information and opinion to health professionals, to stimulate thought, and further investigation. It does not provide advice regarding medical diagnosis or treatment for any individual case. It is not intended for use by the layman. Opinions expressed are not necessarily those of this publication. Mention of products or services does not constitute endorsement. Clinical, legal, tax, and other comments are offered for general guidance only; professional counsel should be sought for specific situations.

This CME activity is intended for emergency physicians. It is in effect for 36 months from the date of the publication.

THOMSON™
AMERICAN HEALTH CONSULTANTS

Subscriber Information

Customer Service: 1-800-688-2421

Customer Service E-Mail: customerservice@ahcpub.com
Editorial E-Mail: allison.mechem@thomson.com

World Wide Web page: http://www.ahcpub.com

Subscription Prices

1 year *with* 60 ACEP/60 AMA/60 AAFP Category 1/Prescribed credits (52 AOA Category 2B credits): $544
1 year *without* credit: $399
Resident's rate $199

All prices U.S. only.
U.S. possessions and Canada, add $30 plus applicable GST. Other international orders, add $30.

For Customer Service and CME questions,

Please call our customer service department at **(800) 688-2421.** For editorial questions or comments, please contact **Allison Mechem,** Managing Editor, at allison.mechem@thomson.com or (404) 262-5589.

Statement of Financial Disclosure

In order to reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Drs. Meyer (author) and Winograd (peer reviewer) report no relationships with companies related to the field of study covered by this CME program. Dr. Emerman (peer reviewer) is a consultant for Adventis, Scios, and AstraZeneca; is on the speaker's bureau for Scios, Pfizer, and Roche; and receives research grants from Scios and Adventis. Dr. Bosker (editor) is on the speaker's bureau for Pfizer, Rhone-Poulenc Rorer, and Parke-Davis. Dr. Bosker also acknowledges that he receives royalties, commissions, and other compensation relating to the sale of textbooks, reprints of articles, and other written materials to the following pharmaceutical companies: Pfizer, Genentech, Aventis, Pharmacia, and Bayer. This publication does not receive commercial support.
The information in Table 1 was generated by a consensus panel that received funding from Aventis Pharmaceuticals.

occurred despite which thrombolytic was used, with or without the inclusion of high-risk patients such as the elderly and those in cardiogenic shock, and was sustained at long-term follow up. When the results of the first 10 trials were compared to the latter 13, clinical outcomes remained the same.

Unfortunately, although the benefits of primary PCI have been clearly demonstrated in multiple trials and meta-analyses, these results have limited applicability in routine practice. All of the references trials involved experienced interventional centers. By contrast, fewer than 25% of U.S. hospitals and fewer than 10% of European hospitals have the capability to perform PCI, much less do it on a routine basis.[7] It has been documented widely that the benefit of PCI, to a certain extent, depends on a center's volume of procedures and the physician's level of experience.[8,9] Given the current practice of transporting AMI patients to the nearest hospital, more than 50% initially are evaluated in facilities that lack PCI capability;[10] thrombolytics remain the dominant strategy in these centers.[1,9,10] In such a situation, primary PCI necessitates an ambulance transfer and its inherent time delay, as well as any risks associated with transportation. This raises the obvious question of whether primary PCI still is superior to fibrinolysis when a transfer delay is involved.[11,12] The answer is not intuitive.

Although primary PCI is not as time-dependent as fibrinolysis, several studies have suggested that the interval between hospital arrival and balloon catheter inflation directly is related to in-hospital mortality, particularly in patients presenting more than three hours after symptoms. Several of the early studies suggested that prolonged delay in achieving reperfusion had deleterious results: In GUSTO-IIb patients whose arteries were opened fewer than 60 minutes after randomization had a 30-day mortality of 1% vs. 6.4% when the delay was greater than 90 minutes.[13] Based on prospective data collected via the National Registry of Myocardial Infarction (NRMI), researchers noted a mortality of 4.2% for those who underwent PCI within 60 minutes of arrival, vs. 5.1% in those treated at 91-120 minutes, vs. 6.7%-8.5% for patients with door-to-balloon time greater than 180 minutes.[10] The adjusted odds of mortality significantly were increased by 41-62% once patients had a door-to-balloon time greater than two hours. By comparison, overall mortality associated with fibrinolysis in the GUSTO V trial was 6%.[14] As a result, an American College of Cardiology and American Heart Association task force (ACC/AHA) has recommended a door-to-balloon time of 90 ± 30 minutes.[15] One of the maxims of therapy for acute STEMI is that if PCI cannot be performed within two hours of a patient's arrival in the ED, fibrinolysis is the preferred treatment because, by extrapolation of the NRMI and GUSTO V data, thrombolytics will result in lower mortality.[15]

Given the need to minimize time to reperfusion and the well-demonstrated superiority of PCI, a new wave of reperfusion trials has emerged—this wave has been described as real world research. The question of how to treat STEMI patients at interventional centers has been resolved: The answer is primary PCI. By contrast, the real world trials address reperfusion issues in centers that lack PCI capability. One initial approach was an attempt to shorten patient delay times with public education about the warning signs of myocardial infarction. Unfortunately, these education campaigns have been largely ineffective. Patients still delay, on average, more than an hour before seeking help, and as many as 50% of AMI patients transport themselves to the hospital.[16-19] Subsequent research has focused on problems such as time-to-reperfusion, logistics, transfer times, and adjunctive drug treatment during transfer. The new trials also take into account very early thrombolysis with modern agents, the current standard of care at most U.S. hospitals.

Because optimal management of STEMI patients requires strategies that are institution-specific—and which account for catheterization capabilities, ability to transfer patients, and institutional protocols—a critical pathway approach to STEMI treatment will permit emergency physicians to select those options best suited for their practice environment. Table 1 illustrates STEMI treatment protocols generated by a multi-disciplinary consensus panel consisting of cardiologists and emergency physicians.

Primary PCI Without Cardiac Surgery Back-up. One of the limitations to widespread implementation of PCI in community hospitals has been the traditional view that back-up cardiac surgery must be available when PCI is performed. This maxim is based on the concept that, although rare, certain complications of PCI must be managed surgically—abrupt artery closure, dissection, or perforation.[20] All told, up to 5% of patients who undergo primary PCI require urgent bypass surgery.[21] A number of states actually prohibit PCI without surgical back-up.[20] Recently, the Atlantic Cardiovascular Patient Outcomes Research Team (C-PORT) presented the idea that expansion of PCI into hospitals that lack on-site cardiac surgery is both safe and effective.[20] In fact, the C-PORT trial noted the same advantage for primary PCI over thrombolysis that was documented in other comparison trials. The approach is appealing because it theoretically can expand the general population's access to primary PCI while avoiding the inherent delay associated with interhospital transport.[16]

The C-PORT trial prospectively randomized 451 AMI patients to primary PCI or thrombolysis at a community hospital.[20] Prior to the enrollment of patients, 11 community hospitals underwent a PCI development program. They were required to have an intra-aortic balloon pump and operators who performed a minimum of 50 interventions per year. Although underpowered, the primary endpoint of death, myocardial infarction, or stroke was reached in 17.7% of thrombolysis patients and 10.7% of PCI patients ($p = 0.03$).[20] Overall mortality in the PCI group (5.3%) compared favorably with that of other recent trials. The median length of stay was reduced from 6 days to 4.5 days in patients who underwent PCI ($p = 0.02$). Furthermore, there were no primary PCI patients who required emergency cornonary artery bypass graft surgery.

The C-PORT study is significant in that it suggests that PCI safely can be extended into community hospitals. This approach would help overcome the challenge of geography and make PCI accessible to the general population. It has been suggested that it is time to discard the practice of transporting STEMI patients to the nearest hospital; instead, these individuals should be treated as "trauma victims" with prehospital triage to institutions where PCI can be performed immediately.[16,20,22] The model for this care strate-

Table 1. ST-Elevation Myocardial Infarction (STEMI): Site-, Specialty-, and Spectrum-of-Care Strategies for Outcome-Effective Management

ACS CARE LEVEL: A SITE

Interventional cardiology services are available, percutaneous coronary intervention (PCI) is the dominant strategy for patients with STEMI, and coronary artery bypass graft (CABG) is available: ACS Care Level A institutions maintain cardiac catheterization facilities and skilled interventional operators capable of performing cardiac angiography and PCI, as well as facilities for performing CABG. As a result, interventional strategies will dominate management of STEMI patients at these sites, and pharmacological antithrombotic therapy should be consistent with this approach.

Level A Site:

EMERGENCY DEPARTMENT

At ACS Care Level A site, STEMI patients should be managed with PCI as the dominant strategy. Pharmacological stabilization and antithrombotic therapy prior to PCI should include:

- **Aspirin 162-325 mg PO**
- **UFH or enoxaparin**

If patient is to be transferred directly from the emergency department to the cardiac catheterization laboratory to undergo coronary angiography and possible PCI, the emergency physician, in consultation with the interventional cardiologist, may initiate antiplatelet therapy with the GP IIb/IIIa inhibitor abciximab in addition to the core regimen above:

- **Abciximab (0.25 mg/kg bolus IV, followed by 0.125 mcg/kg/min [max 10 mcg/min] infusion for 12 hrs).** (Alternative GP IIb/IIIa inhibitor for primary PCI: eptifibatide, 180 mcg/kg IV bolus x 2, 10 min apart, followed by 2.0 mcg/kg/min infusion for 18-24 hrs.)

As dictated by clinical presentation and need to implement appropriate measures for acute medical management of ischemic chest pain, pulmonary edema, hypertension, and other hemodynamic abnormalities in the emergency department, the following agents may be initiated according to clinical protocols:

- Nitroglycerin IV/SC/TC/SL
- Morphine sulfate IV
- Lopressor 5 mg q 5 min x 3 doses

CARDIAC CATHETERIZATION LABORATORY/PCI

STEMI patients should undergo invasive assessment of their coronary anatomy with the intention for PCI in the cardiac catheterization laboratory. The pharmacological foundation regimen in these patients should include the following:

- **Abciximab (0.25 mg/kg bolus IV, followed by 0.125 mcg/kg/min [max 10 mcg/min] infusion for 12 hrs)** if not already started in the emergency department (alternative GP IIb/IIIa inhibitor for primary PCI: eptifibatide, 180 mcg/kg IV bolus x 2, 10 min apart, followed by 2.0 mcg/kg/min infusion for 18-24 hrs.)[1]

PLUS

- **Clopidogrel 300 mg loading dose**
- **Aspirin 162-325 mg PO**
- **UFH or enoxaparin**[2]

As dictated by clinical presentation and need to implement appropriate measures for acute management of ischemic chest pain, pulmonary edema, hypertension, and/or other hemodynamic abnormalities, adjunctive pharmacology should be employed per standard protocols.

INPATIENT CARE (STEP-DOWN UNIT/CORONARY CARE UNIT/MEDICAL INTENSIVE CARE UNIT)

After coronary angiography/PCI, the following pharmacological agents should be continued or initiated in the CCU or other inpatient setting prior to discharge:

- **Aspirin 162 mg PO QD**
- **Abciximab (continue infusion for 12 hours)** (alternative GP IIb/IIIa inhibitor for primary PCI: eptifibatide, 180 mcg/kg IV bolus x 2, 10 min apart, followed by 2.0 mcg/kg/min infusion for 18-24 hrs.)
- **Clopidogrel 75 mg PO QD**[3]

As dictated by presentation, and based on the presence of ischemic symptoms, abnormal hemodynamic parameters, cardiac risk factors, hypertension, diabetes, and/or left ventricular dysfunction, the following agents, if not contraindicated, should be considered for administration during acute hospitalization; when indicated, these agents should be continued for cardioprotection and/or management of symptoms following discharge:

- Statin therapy (within 96 hours of acute ischemic event)
- Beta-blockers
- ACE inhibitors
- Maintenance nitrate therapy

Table 1. ST-Elevation Myocardial Infarction (STEMI): Site-, Specialty-, and Spectrum-of-Care Strategies for Outcome-Effective Management, continued

ACS Care Level: B Site

Medical management is the dominant strategy at ACS Care Level B site, although rapid patient transfer is possible.
Level B institution or site-of-care has no facilities for performing percutaneous coronary intervention (PCI), although transfer of STEMI patients to an institution capable of PCI is possible or likely.

Level B Site:

EMERGENCY DEPARTMENT

Medical Management (Fibrinolysis is Dominant Strategy at ACS Care Level B Site)[4]

*Recommended First-Line Fibrinolytic Regimen**

- **Aspirin 162-325 mg PO**
- **Enoxaparin 30 mg IV bolus[5] followed by 1 mg/kg SC q 12 hrs** (maximum dose 100 mg SC q 12 hrs for first 24 hours)
- **Full-dose tenecteplase (TNK), weight-based dosing per package insert**

* **Alternative first-line fibrinolytic regimens:** tPA in combination with either of the following anticoagulant regimens: enoxaparin 30 mg IV bolus[5] followed by 1 mg/kg SC q 12 hrs, or unfractionated heparin (60 U/kg bolus, followed by 12 U/kg/hr); OR rPA in combination with UFH.

As dictated by clinical presentation and need to implement appropriate measures for acute medical management of ischemic chest pain, pulmonary edema, hypertension, and other hemodynamic abnormalities in the emergency department, the following agents may be initiated according to clinical protocols:

- Nitroglycerin IV/SC/TC/SL
- Morphine sulfate IV

INPATIENT CARE (STEP-DOWN UNIT/CORONARY CARE UNIT/MEDICAL INTENSIVE CARE UNIT)

If STEMI patient is not transferred to Level A site, medical/fibrinolytic/antithrombotic management[4] should be continued as follows:

- **Aspirin 162 mg PO**
- **Enoxaparin 1 mg/kg SC q 12 hrs x 7 days**
- **Consider clopidogrel therapy**

As dictated by presentation, and based on the presence of ischemic symptoms, abnormal hemodynamic parameters, cardiac risk factors, hypertension, diabetes, and/or left ventricular dysfunction, the following agents, if not contraindicated, should be considered for administration during acute hospitalization, and when indicated, these agents should be continued for cardioprotection and/or management of symptoms following discharge:

- Nitroglycerin IV/SC/TC/SL
- Morphine sulfate IV
- Beta-blockers
- ACE inhibitors
- Statin therapy (within 96 hours of acute ischemic event)

TRANSFER TO LEVEL A SITE FOR CARDIAC CATHETERIZATION

Because ACS Level B sites do not maintain invasive cardiology capabilities, transfer of STEMI patients to an ACS Care Level A site is strongly recommended. The decision to (a) initiate immediate fibrinolysis for STEMI patients at a Level B site and then, transfer or (b) to facilitate immediate transfer to Level A site for catheterization/PCI without lysis, will depend on timing considerations, which will vary among institutions. Although there will be exceptions, the Panel recommends that STEMI patients in whom the time from door arrival at the B Level hospital to anticipated cath lab needle time at the Level A hospital is likely to *exceed 90 minutes,* undergo immediate fibrinolysis per protocol above at the Level B site prior to transfer.

Key

1. A GP IIb/IIIa inhibitor (abciximab) should be used for rescue PCI in the STEMI patient. If PCI is performed after successful fibrinolysis, and following initial stabilization, a GP IIb/IIIa inhibitor is indicated but the choice of which agent is less clear.
2. Anticoagulation for STEMI patients undergoing PCI may be accomplished with either enoxaparin or UFH. Results of one study (ENTIRE-TIMI 23B) evaluating outcomes in STEMI patients undergoing fibrinolysis-facilitated mechanical reperfusion suggests anticoagulation with enoxaparin ± 30 mg IV bolus infusion followed by 1 mg/kg SC q 12 hrs plus full-dose tenecteplase was preferable (less death/MI at 30 days) to full-dose tenecteplase plus UFH. Head-to-head studies comparing enoxaparin vs. UFH in STEMI patients undergoing PCI who are being treated with GP IIb/IIIa inhibitors are not currently available. Weight-adjusted heparin dosing can be utilized during PCI. In those not treated with a GP IIb/IIIa inhibitor, 100 IU/kg IV initially should be administered; the target ACT is 300-350 sec when measured by the Hemochron device. In those who are treated with a GP IIb/IIIa inhibitor, 60-70 IU/kg should initially be administered; the target ACT is generally given as 200-300 sec, with some recommending a target ACT of 200-250 sec. If, after sheath removal manual compression is to be utilized, sheaths can be removed when the ACT is < 180 sec. (Popma JJ, Ohman EM, Weitz J, et al. Antithrombotic therapy in patients undergoing percutaneous coronary intervention. *Chest* 2001;119[Suppl]:321S-336S; Smith SC, Dove JT, Jacobs AK, et al. ACC/AHA guidelines for percutaneous coronary intervention. *J Am Coll Cardiol* 2001;37:1-66.)
3. Although studies evaluating outcomes in STEMI patients placed on chronic clopidogrel therapy (plus aspirin) following PCI are not currently available, the CATH Panel recommends consideration of clopidogrel-based antiplatelet therapy in patients with documented coronary heart disease whether or not PCI is performed.
4. Patient transfer for cardiac catheterization/PCI is strongly recommended in STEMI patients who are unstable so they can receive definitive, interventional and/or cardiology-directed specialty care at appropriate sites of care.
5. Results from the ASSENT-3 PLUS study indicate that STEMI patients > 75 years of age who were treated in the prehospital setting with 30 mg IV enoxaparin followed by 1 mg/kg enoxaparin SC had a higher risk of intracranial hemorrhage than patients treated with UFH plus TNK. Consequently, until further data are forthcoming, it is recommended that in STEMI patients > 75 years of age who are managed using fibrinolysis, the 30 mg enoxaparin IV bolus dose be withheld, and that the subcutaneous dose of enoxaparin be reduced to 0.75 mg/kg SC q 12 hrs. In the ASSENT-3 trial, a maximum dose of 100 mg of enoxaparin was used for the first two doses of enoxaparin in the first 24 hours, after which full 1 mg/kg SC q 12 h dosing is resumed.

gy already exists in the current system of regional trauma centers. Obviously, for such a policy to be feasible, widespread implementation of PCI at community hospitals will have to occur first.

Transfer for Primary PCI. For years, concerns about the deleterious effects of treatment delay prevented investigators from research regarding the feasibility of transferring patients with AMI to facilities where PCI can be performed.[22,23] Several trials had suggested that mortality increased with prolonged door-to-balloon time, and it was felt that delays associated with transfer would be prohibitive. Nonetheless, as the past decade saw ever increasing and compelling data regarding the benefits of primary PCI, several groups broke with tradition and began experimenting with this concept. There now have been six published trials and one meta-analysis that examined the advantages of transfer for primary PCI over thrombolysis. The results have been slightly mixed, but they have led many investigators and commentators to suggest that it is time for a change in policy regarding the initial management of STEMI.

The seven published trials examining the relationship between immediate thrombolysis vs. transfer for primary PCI are listed in Table 2. The first two trials were hampered by small sample size; the Air Primary Angioplasty in Myocardial Infarction (AIR-PAMI) trial was terminated at just 30% of its anticipated sample size due to poor recruitment.[24,25] A study at the University Hospital of Maastricht in the Netherlands was designed as a feasibility study and was not sufficiently powered to detect differences in clinical endpoints.[26] Nonetheless, the trial did demonstrate that ambulance transfer of the patient with acute STEMI is both feasible and safe.[26] The PRAGUE trial was the first study sufficiently powered to assess clinical outcomes of transfer for primary PCI. Published in 2000, this small study of 300 patients noted a significant advantage for patients transferred for primary PCI in the combined endpoint of death, reinfarction, and stroke (8% primary PCI vs 23% thrombolytics, $p < 0.02$).[27] This difference was driven largely by a significant reduction in reinfarction in patients who underwent primary PCI (1% vs 10%, $p < 0.03$); mortality and stroke were not individually different between the two groups.[27]

In August 2003 the Danish Trial in Acute Coronary Angioplasty in Acute Myocardial Infarction (DANAMI-2) was published—it is notable because of its randomized design and careful attention to time intervals between symptom onset and reperfusion. In the study, 1900 patients were planned for randomization into either 100 mg of front-loaded tPA or transfer for immediate PCI.[28,29] The study was stopped prematurely after 1550 patients had been enrolled due to a clear advantage for PCI. The 790 patients who underwent primary PCI showed a significant advantage in the primary endpoint of death, recurrent MI, or stroke at 30 days (8.0%, vs 13.7% in the thrombolysis group, $p = 0.0003$).[29] Hence, primary PCI was associated with a 40% relative risk reduction in the combined endpoint. As in the PRAGUE study, this benefit was again largely driven by a reduction in reinfarction (1.6% vs 6.3% respectively, $p < 0.0001$)—individually, there was no advantage for death (6.6% vs 7.6% respectively, $p = 0.35$) or stroke (1.1% vs 2.0% respectively, $p = 0.15$).[29]

Perhaps most importantly, more than 96% of patients were transferred within two hours of randomization. Average time from symptom onset to hospital arrival was 105 minutes. Average symptom onset-to-fibrinolysis time was 160 minutes vs. a symptom onset-to-balloon time of 260 minutes.[29] Stated differently, patients who were transferred for PCI experienced an additional 100-minute delay until reperfusion. The study had one notable weakness: Patients in the thrombolysis group who experienced repeat ischemia or infarction were treated with repeat fibrinolysis rather than rescue catheterization, as is standardly recommended.[23,29]

Shortly on the heels of DANAMI-2, the PRAGUE-2 trial compared two reperfusion strategies: local thrombolysis with streptokinase vs. transfer for PCI.[30] The study ultimately enrolled 850 patients—enrollment was stopped prematurely due to excess mortality in patients who were treated with thrombolytics more than three hours after symptom onset.[30] GP IIb/IIIa use was allowed in the PCI group but discouraged in patients receiving thrombolysis. The primary endpoint of 30-day mortality was not significantly different: 10% in the thrombolysis group vs. 6.8% in the PCI group ($p = 0.12$).[30] A secondary combined endpoint of death, reinfarction, and stroke, however, was reached in 15.2% of the thrombolysis group vs. 8.4% of the transfer group ($p < 0.02$). Individually, there was no difference in reinfarction (3.1% thrombolysis vs 1.4% PCI) but the incidence of non-fatal stroke was lower in patients treated with PCI (2.1% vs 0.2%, $p < 0.03$).[30]

At the suggestion of the ethics committee, investigators also examined mortality in patients treated within 0-3 hours of symptom onset, vs. 3-12 hours. In patients who presented after three hours of symptoms, mortality was 15.3% in the thrombolysis group vs. 6.0% in the PCI group ($p < 0.02$).[30] In fact, as the trial progressed, investigators noted an increasing reluctance on the part of participating physicians to randomize these patients into the thrombolytics arm, preferring transfer for primary PCI. Mortality among patients treated within 0-3 hours was not different between the two groups.

Again, the study is noteworthy for its rapid transfer times. Patients arrived at the hospital and were randomized, on average, 173-183 minutes after symptom onset. Following randomization, average fibrinolysis occurred in 12 minutes and balloon inflation occurred in 97 minutes. Hence, transfer for primary PCI involved a delay of just 85 minutes over thrombolysis.

Most recently, a meta-analysis of the six published trials was performed.[31] This included the Comparison of Angioplasty and Prehospital Thrombolysis in Acute MI (CAPTIM) trial, which compared prehospital thrombolysis with transfer for primary PCI. Investigators found that the relative risk of death, reinfarction, and stroke was significantly reduced by 42% (CI 29-53%, $p < 0.001$) in patients transferred for primary PCI compared to those receiving thrombolytics.[31] There was a nonsignificant trend toward reduced mortality in the PCI group (CI -3%-36%, $p = 0.08$).[31] The relative risks of reinfarction and stroke were both significantly reduced individually.

Taken as a whole, the research on transfer for primary PCI yields several striking points. First, transfer of the patient with STEMI appears to be fairly safe. In the Maastricht trial, there were

Table 2. Trials Comparing Immediate Thrombolysis to Transfer for Primary PCI

STUDY	NO. PCI	TIME TO PCI (MIN)	NO. LYTIC	PRIMARY END POINT	P VALUE
Maastrict[26]	75	85	75	Safety/feasibility of transfer	n/a
PRAGUE-1[27]	101	80	99	30-day death/re-MI/stroke	p < 0.02
AIR-PAMI[25]	71	122	66	30-day death/re-MI/stroke	p = 0.331
CAPTIM[40]	421	82	419	30-day death/re-MI/stroke	p = 0.29
DANAMI-2[29]	790	90	782	30-day death/re-MI/stroke	p = 0.0003
PRAGUE-2[30]	429	97	421	30-day mortality	p = 0.12
				> 3 hours symptoms	p < 0.02
Meta-Analysis[31]	1887	n/a	1862	30-day death/re-MI/stroke	p < 0.001

Adapted from Dalby M, et al. Transfer for primary angioplasty versus immediate thrombolysis in acute myocardial infarction. *Circulation* 2003;108:1811.

no deaths associated with transfer—two patients were cardioverted for ventricular arrhythmia and two received atropine secondary to bradycardia.[26] Complication rates were similar in the other trials.

Second, transfer for primary PCI very well may be superior to thrombolysis in the treatment of AMI, particularly in certain subsets of patients. The decreasing efficacy of all thrombolytics with increasing symptom-to-reperfusion time is well documented. In contrast, the exact cut-off time for benefit from primary PCI is not well defined.[32-38] The combined results of these trials suggest that patients with AMI who present within 2-3 hours of symptom onset should be administered thrombolytics, provided there are no contraindications. These patients who are treated early—during the "golden hour"—are likely to do well with thrombolytics.[23,32,33] However, when more than three hours have elapsed since symptom onset, transfer for primary PCI strongly should be considered. This is particularly true for high-risk patients—very late presenters, the elderly, and those with extensive infarcts or hemodynamic compromise.[23,32,33]

Integral to this strategy is the concept of rapid transfer times. Although a few patients in DANAMI-2 were transported up to three hours after randomization, the vast majority were transferred in fewer than two hours. This was accomplished, in part, by using the same ambulance for interhospital transport in which the patient initially arrived. Similarly, randomization to balloon time in PRAGUE-2 was an impressive 97 minutes. This contrasts sharply with the community experience: Data from the NRMI-4 revealed a median door-to-balloon time of 185 minutes for patients who required transfer for primary PCI.[39]

One can expect that the benefit of primary PCI will evaporate with prolonged delays. Clearly, an integrated approach to reperfusion therapy is critical for the successful implementation of this strategy, and it will require major efforts on the part of EMS systems, emergency personnel, and PCI centers. Nonetheless, the data is intriguing. As phrased by one commentator, it suggests that primary PCI "is indeed worth the wait."[23]

On the other hand, the results of the CAPTIM trial suggest that a policy of very early (prehospital) fibrinolysis and liberal rescue PCI may be as effective as transfer for primary PCI.[32,40] Clearly, large, randomized and well-designed trials are needed to clarify these distinctions. Some questions that remain to be answered are: Is there a cut-off time for effectiveness of primary PCI? How do we incorporate primary PCI into clinical practice? Which patients will receive maximal benefit from transfer?

GPIIb/IIIa Inhibitors with Primary PCI. There is good evidence that the GPIIb/IIIa inhibitors improve outcomes in patients with non-ST-elevation coronary syndromes undergoing PCI.[41,42] By contrast, there have been surprisingly few studies to examine their impact in conjunction with primary PCI for STEMI. Nonetheless, the weight of evidence suggests that they reduce ischemic complications and improve outcomes—most institutions that conduct primary PCI currently administer a GPIIb/IIIa inhibitor during the procedure.[43] Virtually all of the trials used abciximab, making it the recommended GPIIb/IIIa during primary PCI due to lack of data regarding tirofiban and eptifibatide.[43]

Current recommendations regarding GPIIb/IIIa inhibitor use with primary PCI are based on three main trials. In 1998, the Reopro and Primary PTCA Organization and Randomized Trial (RAPPORT) evaluated the effects of abciximab or placebo in 438 patients with STEMI.[44] The composite endpoint of death, nonfatal MI, and urgent revascularization significantly was reduced at seven days, 30 days, and six months in the abciximab group. Most of this triple-end-point benefit arose from a near 75% reduction in the need for urgent revascularization. Although the RAPPORT results were encouraging, they are somewhat outdated as the trial discouraged stent placement during PCI.[44]

In 2001, the Abciximab before Direct Angioplasty and Stenting in Myocardial Infarction Regarding Acute and Long-term Follow-up (ADMIRAL) trial randomized 300 patients with STEMI to primary PCI with stenting and abciximab or placebo.[45] At 30 days and at six months, the primary composite endpoint of death, recurrent MI, and urgent revascularization was reduced by almost 50% with abciximab administration (14.6% vs 7.7%, p = 0.04 at 30 days/ 15.9% vs 8%, p = 0.04 at six months). Importantly, patients who received abciximab had higher TIMI 3 flow rates at balloon inflation (16.1% vs 5.4%, p = 0.01).[45] The degree of TIMI 3 flow at balloon inflation previously has been identified

Table 3. Current and Future Treatment Options for the STEMI Patient

PREHOSPITAL CARE

ECG PERFORMED IN AMBULANCE

↓

ECG CONSISTENT WITH STEMI

↓

Current Protocol:	Future Possibilities:
• Alert ED of MI patient's arrival	• Transfer patient, preferentially to hospital with PCI capability
• Administer ASA, O_2, NTG, morphine	• Administer thrombolytics

EMERGENCY DEPARTMENT CARE (HOSPITAL WITH PCI)

Current Protocol:	Future Possibilities:
• Aspirin 162-325 mg PO	• Abciximab 0.25 mg/kg bolus IV, followed by 0.125 mcg/kg/min × 12 hours—administered in the emergency department for earlier perfusion
• Unfractionated heparin or enoxaparin	
• Lopressor 5 mg IV q5 min × 3 doses	
• NTG, morphine as clinically indicated	• Reduced-dose fibrinolytic prior to PCI

EMERGENCY DEPARTMENT CARE (HOSPITAL WIHTOUT PCI)

Current Protocol:	Future Possibilities:
• Aspirin 162-325 mg PO	• Transport patient with symptoms > 3 hours to hospital with PCI capability
• Full-dose fibrinolysis (TNK, rPA, or tPA)	• Half-dose fibrinolytic prior to transfer
• Unfractionated heparin or enoxaparin	• Abciximab infusion during transfer
• Lopressor 5 mg IV q5 min × 3 doses	
• NTG, morphine as clinically indicated	

in the PAMI trials as an independent predictor of mortality.[46]

Given the encouraging results of the RAPPORT and ADMIRAL trials, the results of the Controlled Abciximab and Devise Investigation to Lower Late Angioplasty Complicataions (CADILLAC) trial were a little surprising.[47] CADILLAC was a four-arm study designed to evaluate both stent vs. PTCA and abciximab vs. placebo. Although the 30-day combined endpoint of death, recurrent MI, revascularization, and stroke was lower with abciximab administration (4.6% vs 7%, p = 0.01), the 12-month combined endpoint did not differ between the two groups. As always, the initial reduction in the combined endpoint was driven mostly by a decreased need for revascularization.[47] Patients who received abciximab did not show higher rates of intracranial hemorrhage or severe bleeding.

It has been suggested that the CADILLAC study's lack of significant findings was due to the late administration of abciximab.[48,49] In the ADMIRAL study, patients received abciximab before sheath insertion and sometimes in the ED or ambulance.[45] There was a one-hour difference between patients who received abciximab in the ambulance vs. the catheterization lab—in a subanalysis, those patients with earlier abciximab administration showed higher TIMI 3 flow during catheterization and better clinical outcomes at six months. In the CADILLAC trial, abciximab was not given until just prior to balloon inflation.[47] Hence, earlier administration of the GPIIb/IIIa inhibitors may be necessary for maximal effectiveness.

These findings have direct impact on emergency physicians. In the Emergency Room Administration of Eptifibatide before Primary Angioplasty (RAPIER) study, patients who received eptifibatide in the ED had higher rates of TIMI 2 and 3 flow than those who received it in the catheterization lab (56.7% vs 13.3%, p = 0.001).[50,51] The study was not a randomized trial, and it was underpowered to examine clinical events. Similarly, another small study evaluated coronary artery patency rates after ED administration of abciximab for primary PCI. TIMI 2 or 3 flow during angiography was present in 40% of abciximab-treated patients but only 27% of placebo-treated patients.[52]

To summarize, the use of GPIIb/IIIa inhibitors in primary PCI leads to reductions in urgent revascularization, indicating that they probably reduce the incidence of reocclusion.[53] Early administration of the GPIIb/IIIa inhibitors appears to decrease procedural complications—possibly by reducing thrombus burden in the infarct-related artery.[53] Reductions in death and recurrent MI have not been demonstrated.[49,50] It currently is acceptable to begin GPIIb/IIIa inhibition in the ED or in the catheterization lab. In the future, it may become standard of care to administer GPIIb/IIIa inhibitors in the ED—again, the emphasis is on the earliest possible reperfusion prior to PCI. Emergency physicians should watch for the Addressing the Value of Facilitated Angioplasty After Combination Treatment or Eptifibatide Monotherapy in Acute Myocardial Infarction (ADVANCE-MI) study, in which patients will receive eptifibatide and half-dose TNK or eptifibatide alone prior to arrival in the catheterization lab for primary PCI.[48]

Facilitated PCI. Perhaps one of the most dramatic changes in current reperfusion strategies has been the resurgence of "facilitated PCI." Facilitated PCI involves a pharmacoinvasive approach, in which thrombolytics administration is followed by immediate mechanical revascularization. As a strategy, it should be differentiated from rescue PCI, which is performed in the patient with failed thrombolysis, and delayed PCI, which occurs in the stable patient more than 48 hours after thrombolysis.

By contrast, facilitated PCI has inherent appeal, as it blends the benefits of both reperfusion strategies—capitalizing on the rapidity and widespread feasibility of thrombolysis coupled with the more complete reperfusion afforded by PCI. The goal is rapid administration of thrombolytics in the community hospital or even during transport in an attempt to induce early reperfusion and provide a better substrate for PCI with improved TIMI flow at balloon inflation. As noted previously the degree of TIMI 3 flow at balloon inflation has been identified as an independent predictor of mortality.[46]

As early as the 1980s several investigators examined the combined effects of fibrinolysis and angioplasty, but initial results were disappointing. The Thrombolysis and Angioplasty in Myocardial Infarction (TAMI-1) study, the TIMI-IIa study, and the European Cooperative Study Group all demonstrated that routine angioplasty following fibrinolysis conferred no benefit with respect to survival or ventricular function. Combination therapy in four trials was associated with a lower success rate, higher mortality, and higher rates of reinfarction, bypass surgery, and transfusion when compared to delayed intervention or a conservative approach.[54-57] Based on these early studies, the ACC/AHA subsequently classified routine PCI within 24 hours of thrombolysis as a class III contraindication.[15]

However, these initial studies now are outdated for several reasons.[58] The past two decades have witnessed the advent of fibrin-specific thrombolytics, improved antiplatelet agents, and huge advances in PCI technique, including the use of stents. These developments have prompted some investigators to suggest that it may be time to readdress the issue of facilitated PCI in a more modern setting.

In 1999, the Plasminogen-Activator Angioplasty Compatibility (PACT) trial demonstrated that half-dose tPA safely can be combined with PCI.[59,60] The study prospectively randomized 606 patients to half-dose tPA or placebo in a double-blind fashion, followed by transfer for immediate PCI. The PACT trial differed from previous studies in two important ways. The dose of thrombolytic administered was half that given in the early trials and it was given as a bolus prior to PCI, rather than as a continuous infusion during PCI.[59] In their results, investigators noted that preadministration of tPA doubled the incidence of TIMI 3 flow at initial angiography (15% vs 33%, $p < 0.0001$). Rates of early reocclusion and bleeding were not significantly changed. The primary endpoint (left ventricular ejection fraction at discharge) also did not differ between the two groups.[59]

Two additional studies give credence to the idea that facilitated PCI in a modern setting is safe. The Strategies for Patency Enhancement in the Emergency Department (SPEED) trial initially was designed to compare standard reteplase vs. reduced-dose reteplase and abciximab therapy.[61] In a post-hoc analysis, several investigators examined the outcome of those patients who subsequently underwent PCI vs. those who did not. Early PCI was associated with a procedural success rate of 88%, as well as significantly lower rates of reinfarction and need for urgent revascularization.[61] The study is nonrandomized and suffers from many limitations—most notably, although early PCI was encouraged in all study patients, only 61% actually underwent the procedure.[58,61] Hence, caution should be exercised in drawing too many conclusions from the analysis, but it does support the position that facilitated PCI is safe in a modern setting.

In a similar post-hoc study, researchers reviewed data from 1938 patients enrolled in the TIMI-10B and TIMI-14 trials.[62] The subgroup of patients who received a thrombolytic and either immediate, rescue, or delayed PCI experienced a 54% reduction in the combined incidence of death and recurrent infarction when compared with patients who received thrombolytics but did not undergo revascularization.[62] Like the SPEED study, this analysis suffers from many limitations, but suggests that is now appropriate to re-perform standardized clinical trials comparing facilitated PCI with standard treatment for AMI.

Three large trials now are underway and will address the modern role of facilitated PCI: the Facilitated Intervention with Enhanced Reperfusion Speed to Stop Events (FINESSE) trial, the ADVANCE-MI trial, and the ASSENT-4 PCI trial.[16] Most recently, the Bavarian Reperfusion Alternatives Evaluation (BRAVE) trial was completed. It is a small study that assessed the impact of retevase and abciximab vs. abciximab alone in patients undergoing primary PCI. Final infarct size was not significantly improved with combination therapy; nor was a secondary endpoint of death, recurrent MI, or stroke altered by the addition of r-A.[63] The emergency physician should watch for the results of ongoing studies—the goal of all of them is to find a good solution for the patient with STEMI who presents to community hospitals that lack PCI.

Conclusion

Modern day therapy for the patient with STEMI has evolved substantially during the past three decades, and will continue to do so. Treatment options currently available to the emergency physician vary widely, largely dependent on whether or not a facility has PCI capability. Table 3 presents an overview of current treatment protocols and issues that still are being determined. Many of the current issues surrounding therapy of the AMI patient will be resolved, as future trials clarify exactly what is the optimal treatment for the patient with STEMI.

References

1. Fibrinolytic Therapy Trialists' (FTT) Collaborative Group. Indications for fibrinolytic therapy in suspected myocardial infarction: Collaborative overview of early mortality and major morbidity results from all randomized trials of more than 1000 patients. *Lancet* 1994;343:311-322.
2. Waters RE 2nd, Mahaffey KW, Granger CB, et al. Current perspectives on reperfusion therapy for acute ST-elevation myocardial infarction: Integrating pharmacologic and mechanical reperfusion strategies. *Am Heart J* 2003;146:958-968.
3. Zijlstra F, De Boer MJ, Hoorntje JCA, et al. A comparison of immediate coronary angioplasty with intravenous streptokinase in acute myocardial infarction. *N Engl J Med* 1993;328:680-684.
4. Grines CL, Browne KF, Marco J, et al. A comparison of immediate angioplasty with thrombolytic theapy for acute myocardial infarction. *N Engl J Med* 1993;328:673-679.
5. Weaver WD, Simes RJ, Betriu A, et al. Comarison of primary coronary angioplasty and intravenous thrombolytic therapy for acute myocardial infarction. *JAMA* 1997;278:2093-2098.
6. Dzavik V. New frontiers and unresolved controversies in percutaneous coronary intervention. *Am J Cardiol* 2003;91(3A);27A-33A.
7. Ryan TJ, et al. ACC/AHA guidelines for the management of patients with acute myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol* 2002;89:1156-1161.
8. Magid DJ, Callonge BN, Rumsfeld JS, et al. Relation between hospital primary angioplasty volume and mortality for patients with acute MI treated with primary angioplasty vs. thrombolytic therapy.

JAMA 2000;284:3131-3138.
9. Canto JG, Every NR, Magid DJ, et al. The volume of primary angioplasty procedures and survival after acute myocardial infarction. *N Engl J Med* 2000;342:1573-1580.
10. Cannon CP, Gibson CM, Lambrew CT, et al. Relationship of symptom onset-to-balloon time and door-to-balloon time with mortality in patients undergoing angioplasty for acute myocardial infarction. *JAMA* 2000;283:2941-2946.
11. Natarajan M, Yusuf S. Primary angioplasty for ST-segment elevation myocardial infarction: Ready for prime time? *JAMC* 2003;169: 32-35.
12. Ghali WA, Donaldson CR, Knudtson ML, et al. Rising to the challenge: Transforming the treatment of ST-segment elevation myocardial infarction. *CMAJ* 2003;169:35-37.
13. Berger PB, Ellis SG, Holmes DR Jr, et al. Relationship between delay in performing direct coronary angioplasty and early clinical outcome in patients with acute myocardial infarction: Results from the Global Use of Strategies to Open Occluded Arteries in Acute Coronary Syndromes (GUSTO-IIb) trial. *Circulation* 1999;100:14-20.
14. GUSTO-V Investigators. Reperfusion therapy for acute myocardial infarction with fibrinolytic therapy or combination reduced fibrinolytic therapy and platelet glycoprotein IIb/IIIa inhibition. *Lancet* 2001;357:1905-1914.
15. The American College of Cardiology/American Heart Association Task Force on Practice Guidelines. ACC/AHA guidelines for the management of patients with acute myocardial infarction. Available at: http://www.acc.org/clinical/guidelines/nov96/1999/index.htm.
16. McKay RG. Evolving strategies in the treatment of acute myocardial infarction in the community hospital setting. *J Am Coll Cardiol* 2003;42:642-645.
17. Kelly AM, Kerr D, Patrick I, et al. Call-to-needle times for thrombolysis in acute myocardial infarction in Victoria. *Med J Aust* 2003; 178:381-385.
18. Goldberg RJ, Steg PG, Sadiq I, et al. Extent of, and factors associated with, delay to hospital presentation in patients with acute coronary disease (the GRACE registry). *Am J Cardiol* 2002;89:791-796.
19. Blohm MB, Hartford M, Karlson BW, et al. An evaluation of the results of media and education campaigns designed to shorten the time taken by patients with acute myocardial infarction to decide to go to hospital. *Heart* 1996;76:430-434.
20. Aversano T, Aversano LT, Passamani E, et al. Thrombolytic therapy vs primary percutaneous coronary intervention for myocardial infarction in patients presenting to hospitals without on-site cardiac surgery. A randomized controlled trial. *JAMA* 2002;287:1943-1951.
21. Grech ED, Ramsdale DR. Acute coronary syndrome: ST segment elevation myocardial infarction. *BMJ* 2003;326:1379-1381.
22. Ghali W, Donaldson R, Knudtson M, et al. Rising to the challenge: Transforming the treatment of ST-segment elevation myocardial infarction. *CMAJ* 2003;169:35-37.
23. Jacobs A. Primary angioplasty for acute myocardial infarction—is it worth the wait? *N Engl J Med* 2003;349:798-800.
24. Dauerman HL, Sobel BE. Synergistic treatment of ST-segment elevation myocardial infarction with pharmacoinvasive recanalization. *J Am Coll Cardiol* 2003;42:646-651.
25. Grines CL, Westerhausen DR Jr, Grines LL, et al. A randomized trial of transfer for primary angioplasty versus on-site thrombolysis in patients with high-risk myocardial infarction. The Air Primary Angioplasty in Myocardial Infarction Study. *J Am Coll Cardiol* 2002;39:1713-1719.
26. Vermeer F, Oude Ophuis AJ, vd Berg EJ, et al. Prospective randomised comparison between thrombolysis, rescue PTCA, and primary PTCA in patients with extensive myocardial infarction admitted to a hospital without PTCA facilities: A safety and feasibility study. *Heart* 1999;82:426-431.
27. Widimsky P, Groch L, Zelizko M, et al. Multicentre randomized trial comparing transport to primary angioplasty vs immediate thrombolysis vs combined strategy for patients with acute myocardial infarction presenting to a community hospital without a catheterization laboratory. The PRAGUE Study. *Eur Hear J* 2000;21:823-831.
28. Andersen HR, Nielsen TT, Vesterlund T, et al. DANAMI-2 Investigators. Danish multicenter randomized study on fibrinolytic therapy versus acute coronary angioplasty in acute myocardial infarction: Rationale and design of DANish trial in Acute Myocardial Infarction-2 (DANAMI-2). *Am Heart J* 2003;146:234-241.
29. Andersen HR, Nielsen TT, Rasmussen K, et al. DANAMI-2 Investigators. A comparison of coronary angioplasty with fibrinolytic therapy in acute myocardial infarction. *N Engl J Med* 2003;349:733-742.
30. Widimsky P, Budesinsky T, Vorac D, et al. Long distance transport for primary angioplasty vs immediate thrombolysis in acute myocardial infarction. Final results of the randomized national multicentre trial-PRAGUE-2. *Eur Heart J* 2003;24:94-104.
31. Dalby M, Bouzamondo A, Lechat P, et al. Transfer for primary angioplasty versus immediate thrombolysis in acute myocardial infarction: A meta-analysis. *Circulation* 2003;108:1809-1814.
32. Dalby M, Montalescot M. Transfer for primary angioplasty: Who and how? *Heart* 2002;88:570-572.
33. Armstrong P, Welsh R. Tailoring therapy to best suit ST-segment elevation myocardial infarction: searching for the right fit. *CMAJ* 2003;169:925-927.
34. Juliard JM, Feldman LJ, Golmard JL, et al. Relation of mortality of primary angioplasty during acute myocardial infarction to door-to-thrombolysis in myocardial infarction (TIMI) time. *Am J Cardiol* 2003;91:1401-1405.
35. Brodie RB, Stuckey TD, Muncy DB, et al. Importance of time-to-reperfusion in patients with acute myocardial infarction with and without cardiogenic shock treated with primary percutaneous coronary intervention. *Am Heart J* 2003;145:708-715.
36. Liem AL, van't Hof AW, Hoorntje JC, et al. Influence of treatment delay on infarct size and clinical outcome in patients with acute myocardial infarction treated with primary angioplasty. *J Am Coll Cardiol* 1998;32:629-633.
37. Brodie BR. When should patients with acute myocardial infarction be transferred for primary angioplasty? *Heart* 1997;78:327-328.
38. French WJ, Sada MJ. Benefit of primary angioplasty in patients presenting late with ST segment elevation and acute myocardial infarction. *J Am Coll Cardiol* 1998;31 (Suppl A):211A.
39. Angela BG, Givson CM, Chin R, et al. Predictors of door-to-balloon delay in primary angioplasty. *Am J Cardiol* 2002;89:1156-1161.
40. Bonnefoy E, Lapostolle F, Leizorovicz A, et al. Primary angioplasty versus prehospital fibrinolysis in acute myocardial infarction: A randomized study. *Lancet* 2002;360:825-829.
41. Kong DF, Califf RM, Miller DP, et al. Clinical outcomes of therapeutic agents that block the platelet glycoprotein IIb/IIIa integrin in ischemic heart disease. *Circulation* 1998;98:2829-2835.
42. Madan M, Berkowitz SD, Tcheng JE, et al. Glycoprotein IIb/IIIa integrin blockade. *Circulation* 1998;98:2629-2635.
43. Dobesh PP, Kasiar JB. Administration of glycoprotein IIb/IIIa inhibitors in patients with ST-segment elevation myocardial infarc-

tion. *Pharmacotherapy* 2002;22:864-888.
44. Brener SJ, Barr LA, Burchenal JE, et al, for the RAPPORT investigators. Randomized, placebo-controlled trial of platelet glycoprotein IIb/IIIa blockade with primary angioplasty for acute myocardial infarction. *Circulation* 1998;98:734-741.
45. Montalescot G, Barragan P, Wittenberg O, et al. ADMIRAL Investigators. Abciximab before Direct Angioplasty and Stenting in Myocardial Infarction Regarding Acute and Long-term Follow-up. Platelet glycoprotein IIb/IIIa inhibition with coronary stenting for acute myocardial infarction. *N Engl J Med* 2001;344:1895-1903.
46. Stone GW, Cox D, Garcia E, et al. Normal flow (TIMI-3) before mechanical reperfusion therapy is an independent determinant of survival in acute myocardial infarction: Analysis from the primary angioplasty in myocardial infarction trials. *Circulation* 2001;104:636-641.
47. Tcheng JE, Kandzari DE, Grines CL, et al. Benefits and risks of abciximab use inprimary angioplasty for acute myocardial infarction. The Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) Trial. *Circulation* 2003;108:1316-1323.
48. Montalescot G. Defining standards of care for facilitated and direct percutaneous coronary intervention. *Clin Cardiol* Suppl I 2002; 25:I27-I32.
49. Eisenberg MJ, Jamal S. Glycoprotein IIb/IIIa inhibition in the setting of acute ST-segment elevation myocardial infarction. *J Am Coll Cardiol* 2003;42:1-6.
50. Howard HC. Triple therapy for acute myocardial infarction: Combining fibrinolysis, platelet IIb/IIIa inhibition, and percutaneous coronary intervention. *Am J Cardiol* 2000;85:10C-16C.
51. Cutlip DE, Cove CJ, Irons D, et al. Emergency room administration of eptifibitide before primary angioplasty for ST elevation acute myocardial infarction and its effect on baseline coronary flow and procedure outcomes. *Am J Cardiol* 2001;88:62-64.
52. van den Merkhof LF, Zijlstra F, Olsson H, et al. Abciximab in the treatment of acute myocardial infarction eligible for primary percutaneous trnasluminal coronary angioplasty: Results of the Glycoprotein Receptor Antagonist Patency Evaluation (GRAPE) pilot study. *J Am Coll Cardiol* 1999;33:1528-1532.
53. Norris RM, Caughey DE, Mercer CJ, et al. Prognosis after myocardial infarction. Six-year follow-up. *Br Heart* 1974;36:786-790.
54. Topol EJ, Califf RM, George BS, et al. A randomized trial of immediate versus delayed elective angioplasty after intravenous tissue plasminogen activator in acute myocardial infarction. *N Engl J Med* 1987;317:581-588.
55. Rogers WJ, Baim DS, Gore JM, et al. Comparison of immediate invasive, delayed invasive, and conservative strategies after tissue-type plasminogen activator: Results of the Thrombolysis in Myocardial Infarction (TIMI) phase II-A trial. *Circulation* 1990;81:1457-1476.
56. The TIMI Research Group. Immediate vs. delayed catheterization and angioplasty following thrombolytic therapy for acute myocardial infarction. *JAMA* 1988;260:2849-2858.
57. Simoons ML, Arnold AE, Betriu A, et al. Thrombolysis with tissue plasminogen activator in acute myocardial infarction: No additional benefit from immediate percutaneous coronary angioplasty. *Lancet* 1988;1:197-203.
58. Gibson M. A union in reperfusion: The concept of facilitated percutaneous coronary intervention. *J Am Coll Cardiol* 2000;36:1497-1499.
59. Ross AM, Coyne KS, Reiner JS, et al. A randomized trial comparing primary angioplasty with a strategy of short-acting thrombolysis and immediate planned rescue angioplasty in acute myocardial

infarction: The PACT Trial. *JAMA* 1999;32:1954-1962.
60. Keeley EC, Weaver D. Combination therapy for acute myocardial infarction. *J Am Coll Cardiol* 1999;34:1963-1965.
61. Herrmann HC, Moliterno DJ, Ohman EM, et al. Facilitation of early percutaneous coronary intervention after reteplase with or without abciximab in acute myocardial infarction. Results from the SPEED (GUSTO-4 Pilot) Trial. *J Am Coll Cardiol* 2000;36:1489-1496.
62. Schweiger MG, Cannon CP, Murphy SA, et al. Early coronary intervention following pharmacologic therapy for acute myocardial infarciton (the combined TIMI 10B-TIMI 14 experience). *Am J Cardiol* 2001;88:831-836.
63. Kastrati A, Mehilli J, Schlotterbeck K, et al. Early administration of reteplase plus aciximab vs aciximab alone in patients with acute myocardial infarction referred for percutaneous coronary intervention. A randomized controlled trial. *JAMA* 2004;291:947-954.

Physician CME Questions

71. Primary PCI is superior to fibrinolysis in which outcome measure?
    A. Mortality
    B. Reinfarction
    C. Intracranial hemorrhage
    D. All of the above

72. In the PRAGUE-2 trial, which subset of patients demonstrated im-proved mortality with transfer for primary PCI over immediate fibrinolysis?
    A. 0-3 hours from symptom onset
    B. More than 3 hours after symptom onset

73. According to the author's summary, the use of GPIIb/IIIa inhibitors during primary PCI has been shown to lead to reductions in:
    A. the need for urgent revascularization.
    B. reinfarction.
    C. mortality.

74. Early studies of combination therapy with full-dose fibrinolysis and PCI demonstrated worse outcomes compared to standard therapy.
    A. True
    B. False

75. In the PACT study, preadministration of tPA resulted in improvement in which outcome measure?
    A. Hemorrhage
    B. Reocclusion
    C. Initial TIMI 3 flow at angiography
    D. Left ventricular ejection fraction at hospital discharge

76. Several studies have suggested that primary PCI is less effective with increasing door-to-balloon time.
    A. True
    B. False

77. What percentage of PCI patients require urgent bypass surgery?
    A. 1%
    B. 5%
    C. 20%
    D. 30%

78. In the C-PORT trial, primary PCI was associated with which improvements compared to primary thrombolysis?
    A. Reduced length of stay
    B. Reduced rates of death, MI, and stroke
    C. Mortality rates comparable to other large primary PCI studies
    D. All of the above

79. It currently is acceptable to begin a GPIIb/IIIa inhibitor prior to PCI in either the ED or the catherization lab.
    A. True
    B. False

80. Delays from infarction to reperfusion may be attributed to all of the following *except*:
    A. patient delay in seeking help.
    B. initiation of GP IIB/IIIA inhibitors.
    C. patient driving self to the hospital.
    D. transfer to a hospital with cardiac surgery backup.

CME Answer Key

71. D	73. A	75. C	77. B	79. A
72. B	74. A	76. A	78. D	80. B

In Future Issues: **Acute Bacterial Rhinosinusitis**

CME Instructions

Physicians participate in this continuing medical education program by reading the article, using the provided references for further research, and studying the questions at the end of the article. Participants should select what they believe to be the correct answers, then refer to the list of correct answers to evaluate their knowledge. To clarify confusion surrounding any questions answered incorrectly, please consult the source material. *After completing this activity, you must complete the evaluation form that will be provided at the end of the semester and return it in the reply envelope provided to receive a certificate of completion.* When your evaluation is received, a certificate will be mailed to you.

CME Objectives

To help physicians:

- quickly recognize or increase index of suspicion for specific conditions;
- understand the epidemiology, etiology, pathophysiology, and clinical features of the entity discussed;
- apply state-of-the-art diagnostic and therapeutic techniques (including the implications of pharmaceutical therapy discussed) to patients with the particular medical problems discussed;
- understand the differential diagnosis of the entity discussed;
- understand both likely and rare complications that may occur.

Emergency Medicine Reports
The Practical Journal for Emergency Physicians

ST Elevation MI Part II

ST-Elevation Myocardial Infarction (STEMI): Site-, Specialty-, and Spectrum-of-Care Strategies for Outcome-Effective Management

ACS CARE LEVEL: A SITE

Interventional cardiology services are available, PCI is the dominant strategy for patients with STEMI, and coronary artery bypass graft (CABG) is available: ACS Care Level A institutions maintain cardiac catheterization facilities and skilled interventional operators capable of performing cardiac angiography and percutaneous coronary intervention (PCI), as well as facilities for performing CABG. As a result, interventional strategies will dominate management of STEMI patients at these sites, and pharmacological antithrombotic therapy should be consistent with this approach.

Level A Site:

EMERGENCY DEPARTMENT

At ACS Care Level A site, STEMI patients should be managed with PCI as the dominant strategy. Pharmacological stabilization and antithrombotic therapy prior to PCI should include:

- **Aspirin 162-325 mg PO**
- **UFH or enoxaparin**

If patient is to be transferred directly from the emergency department to the cardiac catheterization laboratory to undergo coronary angiography and possible PCI, the emergency physician, in consultation with the interventional cardiologist, may initiate antiplatelet therapy with the GP IIb/IIIa inhibitor abciximab in addition to the core regimen above:

- **Abciximab (0.25 mg/kg bolus IV, followed by 0.125 mcg/kg/min [max 10 mcg/min] infusion for 12 hrs).** (Alternative GP IIb/IIIa inhibitor for primary PCI: eptifibatide, 180 mcg/kg IV bolus x 2, 10 min apart, followed by 2.0 mcg/kg/min infusion for 18-24 hrs.)

As dictated by clinical presentation and need to implement appropriate measures for acute medical management of ischemic chest pain, pulmonary edema, hypertension, and other hemodynamic abnormalities in the emergency department, the following agents may be initiated according to clinical protocols:

- Nitroglycerin IV/SC/TC/SL
- Morphine sulfate IV
- Lopressor 5 mg q 5 min x 3 doses

CARDIAC CATHETERIZATION LABORATORY/PCI

STEMI patients should undergo invasive assessment of their coronary anatomy with the intention for PCI in the cardiac catheterization laboratory. The pharmacological foundation regimen in these patients should include the following:

- **Abciximab (0.25 mg/kg bolus IV, followed by 0.125 mcg/kg/min [max 10 mcg/min] infusion for 12 hrs)** if not already started in the emergency department (alternative GP IIb/IIIa inhibitor for primary PCI: eptifibatide, 180 mcg/kg IV bolus x 2, 10 min apart, followed by 2.0 mcg/kg/min infusion for 18-24 hrs.)[1]

PLUS

- **Clopidogrel 300 mg loading dose**
- **Aspirin 162-325 mg PO**
- **UFH or enoxaparin**[2]

As dictated by clinical presentation and need to implement appropriate measures for acute management of ischemic chest pain, pulmonary edema, hypertension, and/or other hemodynamic abnormalities, adjunctive pharmacology should be employed per standard protocols.

INPATIENT CARE (STEP-DOWN UNIT/CORONARY CARE UNIT/MEDICAL INTENSIVE CARE UNIT)

After coronary angiography/PCI, the following pharmacological agents should be continued or initiated in the CCU or other inpatient setting prior to discharge:

- **Aspirin 162 mg PO QD**
- **Abciximab (continue infusion for 12 hours)** (alternative GP IIb/IIIa inhibitor for primary PCI: eptifibatide, 180 mcg/kg IV bolus x 2, 10 min apart, followed by 2.0 mcg/kg/min infusion for 18-24 hrs.)
- **Clopidogrel 75 mg PO QD**[3]

As dictated by presentation, and based on the presence of ischemic symptoms, abnormal hemodynamic parameters, cardiac risk factors, hypertension, diabetes, and/or left ventricular dysfunction, the following agents, if not contraindicated, should be considered for administration during acute hospitalization; when indicated, these agents should be continued for cardioprotection and/or management of symptoms following discharge:

- Statin therapy (within 96 hours of acute ischemic event)
- Beta-blockers
- ACE inhibitors
- Maintenance nitrate therapy

ACS Care Level: B Site

Medical management is the dominant strategy at ACS Care Level B site, although rapid patient transfer is possible. Level B institution or site-of-care has no facilities for performing percutaneous coronary intervention (PCI), although transfer of STEMI patients to an institution capable of PCI is possible or likely.

Level B Site:

EMERGENCY DEPARTMENT

Medical Management (Fibrinolysis is Dominant Strategy at ACS Care Level B Site)[4]

*Recommended First-Line Fibrinolytic Regimen**

- **Aspirin 162-325 mg PO**
- **Enoxaparin 30 mg IV bolus[5] followed by 1 mg/kg SC q 12 hrs** (maximum dose 100 mg SC q 12 hrs for first 24 hours)
- **Full-dose tenecteplase (TNK), weight-based dosing per package insert**

* **Alternative first-line fibrinolytic regimens:** tPA in combination with either of the following anticoagulant regimens: enoxaparin 30 mg IV bolus[5] followed by 1 mg/kg SC q 12 hrs, or unfractionated heparin (60 U/kg bolus, followed by 12 U/kg/hr); OR rPA in combination with UFH.

As dictated by clinical presentation and need to implement appropriate measures for acute medical management of ischemic chest pain, pulmonary edema, hypertension, and other hemodynamic abnormalities in the emergency department, the following agents may be initiated according to clinical protocols:

- Nitroglycerin IV/SC/TC/SL
- Morphine sulfate IV

INPATIENT CARE (STEP-DOWN UNIT/CORONARY CARE UNIT/MEDICAL INTENSIVE CARE UNIT)

If STEMI patient is not transferred to Level A site, medical/fibrinolytic/antithrombotic management[4] should be continued as follows:

- **Aspirin 162 mg PO**
- **Enoxaparin 1 mg/kg SC q 12 hrs x 7 days**
- **Consider clopidogrel therapy**

As dictated by presentation, and based on the presence of ischemic symptoms, abnormal hemodynamic parameters, cardiac risk factors, hypertension, diabetes, and/or left ventricular dysfunction, the following agents, if not contraindicated, should be considered for administration during acute hospitalization, and when indicated, these agents should be continued for cardioprotection and/or management of symptoms following discharge:

- Nitroglycerin IV/SC/TC/SL
- Morphine sulfate IV
- Beta-blockers
- ACE inhibitors
- Statin therapy (within 96 hours of acute ischemic event)

TRANSFER TO LEVEL A SITE FOR CARDIAC CATHETERIZATION

Because ACS Level B sites do not maintain invasive cardiology capabilities, transfer of STEMI patients to an ACS Care Level A site is strongly recommended. The decision to (a) initiate immediate fibrinolysis for STEMI patients at a Level B site and then, transfer or (b) to facilitate immediate transfer to Level A site for catheterization/PCI without lysis, will depend on timing considerations, which will vary among institutions. Although there will be exceptions, the Panel recommends that STEMI patients in whom the time from door arrival at the B Level hospital to anticipated cath lab needle time at the Level A hospital is likely to *exceed 90 minutes,* undergo immediate fibrinolysis per protocol above at the Level B site prior to transfer.

Key

1. A GP IIb/IIIa inhibitor (abciximab) should be used for rescue PCI in the STEMI patient. If PCI is performed after successful fibrinolysis, and following initial stabilization, a GP IIb/IIIa inhibitor is indicated but the choice of which agent is less clear.
2. Anticoagulation for STEMI patients undergoing PCI may be accomplished with either enoxaparin or UFH. Results of one study (ENTIRE-TIMI 23B) evaluating outcomes in STEMI patients undergoing fibrinolysis-facilitated mechanical reperfusion suggests anticoagulation with enoxaparin ± 30 mg IV bolus infusion followed by 1 mg/kg SC q 12 hrs plus full-dose tenecteplase was preferable (less death/MI at 30 days) to full-dose tenecteplase plus UFH. Head-to-head studies comparing enoxaparin vs. UFH in STEMI patients undergoing PCI who are being treated with GP IIb/IIIa inhibitors are not currently available. Weight-adjusted heparin dosing can be utilized during PCI. In those not treated with a GP IIb/IIIa inhibitor, 100 IU/kg IV initially should be administered; the target ACT is 300-350 sec when measured by the Hemochron device. In those who are treated with a GP IIb/IIIa inhibitor, 60-70 IU/kg should initially be administered; the target ACT is generally given as 200-300 sec, with some recommending a target ACT of 200-250 sec. If, after sheath removal manual compression is to be utilized, sheaths can be removed when the ACT is < 180 sec. (Popma JJ, Ohman EM, Weitz J, et al. Antithrombotic therapy in patients undergoing percutaneous coronary intervention. *Chest* 2001;119(Suppl):321S-336S; Smith SC, Dove JT, Jacobs AK, et al. ACC/AHA guidelines for percutaneous coronary intervention. *J Am Coll Cardiol* 2001;37:1-66.)
3. Although studies evaluating outcomes in STEMI patients placed on chronic clopidogrel therapy (plus aspirin) following PCI are not currently available, the CATH Panel recommends consideration of clopidogrel-based antiplatelet therapy in patients with documented coronary heart disease whether or not PCI is performed.
4. Patient transfer for cardiac catheterization/PCI is strongly recommended in STEMI patients who are unstable so they can receive definitive, interventional and/or cardiology-directed specialty care at appropriate sites of care.
5. Results from the ASSENT-3 PLUS study indicate that STEMI patients > 75 years of age who were treated in the prehospital setting with 30 mg IV enoxaparin followed by 1 mg/kg enoxaparin SC had a higher risk of intracranial hemorrhage than patients treated with UFH plus TNK. Consequently, until further data are forthcoming, it is recommended that in STEMI patients > 75 years of age who are managed using fibrinolysis, the 30 mg enoxaparin IV bolus dose be withheld, and that the subcutaneous dose of enoxaparin be reduced to 0.75 mg/kg SC q 12 hrs. In the ASSENT-3 trial, a maximum dose of 100 mg of enoxaparin was used for the first two doses of enoxaparin in the first 24 hours, after which full 1 mg/kg SC q 12 h dosing is resumed.

Trials Comparing Immediate Thrombolysis to Transfer for Primary PCI

STUDY	NO. PCI	TIME TO PCI (MIN)	NO. LYTIC	PRIMARY END POINT	P VALUE
Maastrict	75	85	75	Safety/feasibility of transfer	n/a
PRAGUE-1	101	80	99	30-day death/re-MI/stroke	p < 0.02
AIR-PAMI	71	122	66	30-day death/re-MI/stroke	p = 0.331
CAPTIM	421	82	419	30-day death/re-MI/stroke	p = 0.29
DANAMI-2	790	90	782	30-day death/re-MI/stroke	p = 0.0003
PRAGUE-2	429	97	421	30-day mortality	p = 0.12
				> 3 hours symptoms	p < 0.02
Meta-Analysis	1887	n/a	1862	30-day death/re-MI/stroke	p < 0.001

Adapted from Dalby M, et al. Transfer for primary angioplasty versus immediate thrombolysis in acute myocardial infarction. *Circulation* 2003;108:1811.

Current and Future Treatment Options for the STEMI Patient

PREHOSPITAL CARE

ECG PERFORMED IN AMBULANCE

↓

ECG CONSISTENT WITH STEMI

↓

Current Protocol:
- Alert ED of MI patient's arrival
- Administer ASA, O_2, NTG, morphine

Future Possibilities:
- Transfer patient, preferentially to hospital with PCI capability
- Administer thrombolytics

EMERGENCY DEPARTMENT CARE (HOSPITAL WITH PCI)

Current Protocol:
- Aspirin 162-325 mg PO
- Unfractionated heparin or enoxaparin
- Lopressor 5 mg IV q5 min × 3 doses
- NTG, morphine as clinically indicated

Future Possibilities:
- Abciximab 0.25 mg/kg bolus IV, followed by 0.125 mcg/kg/min × 12 hours—administered in the emergency department for earlier perfusion
- Reduced-dose fibrinolytic prior to PCI

EMERGENCY DEPARTMENT CARE (HOSPITAL WIHTOUT PCI)

Current Protocol:
- Aspirin 162-325 mg PO
- Full-dose fibrinolysis (TNK, r-PA, or t-PA)
- Unfractionated heparin or enoxaparin
- Lopressor 5 mg IV q5 min × 3 doses
- NTG, morphine as clinically indicated

Future Possibilities:
- Transport patient with symptoms > 3 hours to hospital with PCI capability
- Half-dose fibrinolytic prior to transfer
- Abciximab infusion during transfer

Supplement to *Emergency Medicine Reports*, April 5, 2004: "Reperfusion Strategies for ST-Segment Elevation Myocardial Infarction: An Overview of Current Therapeutic Options, Part II." *Author:* **Mary C. Meyer, MD**, Emergency Physician, Kaiser Walnut Creek and Richmond, CA.