ACC/AHA Guidelines for the Management of Patients With ST-Elevation Acute Myocardial Infarction- Focus Emergency Care

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1999 Guidelines for the Management of Patients with Acute Myocardial Infarction)

Available as full text or executive versions at http://www.acc.org
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AMI Stats

• **Incidence in the United States***
  - Estimated 900,000 will suffer AMI this year
    • ~565,000 will be new attacks (avg. age- 65.8yrs/males, 70.4yrs/female)
    • ~300,000 will be recurrent attacks
  - 42% of AMI pts will die within 1 year
  - Approximately half of these deaths occur before reaching the emergency department
  - Most cardiac deaths are the result of fatal arrhythmias

• **Types of arrival/discharge AMI***s**
  - Upon arrival: STEMI on 1st ECG-26%; STEMI on 1st or subsequent ECG-35%; NSTEMI-65%
  - Non-Q-wave: 75%  Q-wave: 25%

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*American Heart Association. *Heart Disease & Stroke Statistics-2004 Update*

Pathophysiology of ST-Elevation Myocardial Infarction

Generally caused by a completely occlusive thrombus in a coronary artery

Results from stabilization of a platelet aggregate at site of plaque rupture by fibrin mesh
Recent Influences of Practice

- Superiority of Primary Percutaneous Coronary Intervention (PPCI) over fibrinolysis if Door-to-Balloon completed in a timely fashion
- Acknowledgement that Time Matters in PPCI
  - Recommendations for time to reperfusion updated
- Studies published on Combination Therapy
  - GP IIb/IIIa receptor antagonists in combination with ½ dose fibrinolysis
- Studies with LMWH in treatment of STEMI (enoxaparin + full dose TNK-tPA)
- European STEMI trials influence the guidelines
  - Prehospital, Transfer PCI→Prehospital Destination Protocols
Classification of Recommendations

**Class I:** Conditions for which there is evidence and/or general agreement that a given procedure or treatment is beneficial, useful, and effective.

**Class II:** Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

**Class IIa:** Weight of evidence/opinion is in favor of usefulness/efficacy.

**Class IIb:** Usefulness/efficacy is less well established by evidence/opinion.

**Class III:** Conditions for which there is evidence and/or general agreement that a procedure/treatment is NOT useful/effective and in some cases may be harmful.
**Level of Evidence**

**Level of Evidence A:** Data derived from multiple randomized clinical trials or meta-analyses.

**Level of Evidence B:** Data derived from a single randomized trial, or nonrandomized studies.

**Level of Evidence C:** Only consensus opinion of experts, case studies, or standard of care.
Achieve Coronary Patency

• **Initial Reperfusion Therapy**
  – Defined as the initial strategy employed to restore blood flow to the occluded coronary artery

• **3 Major Options:**
  - Pharmacological Reperfusion
  - PCI
  - Acute Surgical Reperfusion

• Under both Pharmacological and PCI are listed several lower recommendations & investigational reperfusion strategies

*Class I* All patients should undergo rapid evaluation for reperfusion therapy & have a reperfusion strategy implemented promptly after contact with the medical system

Importance of Early Reperfusion Therapy in STEMI

Outcomes Dependent Upon:

• Time to treatment - TIME IS STILL MUSCLE

• Early and full restoration in coronary blood flow

• Sustained restoration of flow
Prehospital Issues

• **EMS**
  – Emphasis on early defibrillation; AEDs; 911 dispatchers training & use of national protocols

• **Chest Pain Evaluation & Treatment**
  – Emphasis on giving chewable ASA, unless contraindicated & prehospital ECG & checklist

• **Prehospital Fibrinolysis**
  – Upgraded to a Class IIa (Level B) Recommendation

• **Prehospital Destination Protocols**
  – Where to transport STEMI patients-Have a plan in place
  – Special considerations
    • Cardiogenic Shock
    • Fibrinolytic contraindicated

Class I
Delay in patient contact (arrival at the ED or contact with paramedics) to:

- fibrinolytic therapy less than 30 minutes
- PCI less than 90 mins

(Level of Evidence: B)

2. The choice of initial STEMI treatment should be made by ED Physician on duty based on a predetermined, institution-specific, written protocol…. For unclear cases, not covered by the protocol, contact cardiologist immediately.

(Level of Evidence C).

Patients Transported by EMS After Calling 9-1-1

Onset of STEMI Symptoms → Call 9-1-1 → 9-1-1 EMS Dispatch → EMS on-scene

- Encourage 12-lead ECG
- Consider prehospital fibrinolytic if capable and EMS-to-needle < 30 min

EMS Triage Plan
- Not PCI Capable Hospital
- PCI Capable Hospital
- Interhospital Transfer

Goals
- Patient: 5 min after Symptom onset
- Dispatch: 1 min
- EMS on scene: Within 8 min
- EMS transport: EMS to Balloon within 90 min
- Patient self-transport: Hospital Door-to-Balloon within 90 min

Total ischemic time: Within 120 min*

* Golden hour = First 60 min

Adapted from Panel A Figure 1
Antman et al. JACC 2004;44:676.
Adapted from Panel B Figure 1
Antman et al. JACC 2004;44:676.

Fibrinolysis

Not PCI Capable
PCI Capable

Receiving Hospital

Noninv. Risk Stratification

PCI or CABG

Primary PCI

Late Hospital Care & Secondary Prevention

Ischemic driven
Rescue
Initial Recognition & Management in the ED

Optimal Strategies for the ED Triage

- Initial Patient Evaluation
- History
- Physical Exam
- ECG
- Laboratory Examinations
- Biomarkers of Cardiac Damage
- Imaging
- Routine Measures

Selection of Reperfusion Strategy

Step 1: Assess Time and Risk

- **Time from Onset of Symptoms**
  - Differentiation made for early presenters
- **Risk of STEMI**
  - High risk (eg, cardiogenic shock) PPCI preferred
- **Risk of Bleeding**
  - High Risk of bleeding-PPCI Preferred
- **Time Required for Transport to a Skilled PCI Lab**
  - Availability of PCI labs
  - Importance of reduction of recurrent MI
  - Time-to-PCI minus Time-To Balloon

Antman et al. JACC 2004;44:682.
Pharmacological Reperfusion

Available Resources

**Class I**

1. 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 of Evidence: A)*

Antman et al. JACC 2004;44:682.
1. In the absence of contraindication, fibrinolytic therapy should be administered to STEMI patients with symptom onset within the prior 12 hours & ST elevation > 0.1mV in at least 2 contiguous precordial leads or at least 2 adjacent limb leads.

2. 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.

Fibrinolytic Therapy

**Class IIa**

1. In the absence of contraindication, fibrinolytic therapy is reasonable to administer to STEMI patients with symptom onset within the prior 12 hours & 12-lead ECG findings consistent with a true posterior MI (Level C).

2. In the absence of contraindications, it is reasonable to administer to fibrinolytic therapy to patients with symptoms of STEMI beginning within the prior 12 hours to 24 hours who have continuing ischemic symptoms & ST elevation \( \geq 0.1 \text{mV} \) in at least 2 contiguous precordial leads or at least 2 adjacent limb leads (Level B).

Absolute Contraindications

• Any prior ICH
• Known structural cerebral vascular lesion
  -eg, AVM
• Known malignant intracranial neoplasm
• -primary or metastatic
• Ischemic stroke within 3 months
  -EXCEPT AIS within 3 hours
• Suspected aortic dissection
• Active bleeding or bleeding diathesis
  (does not include menses)
• Significant closed head or facial trauma
  within 3 months

Fibrinolytic Therapy

Step 2: Determine Whether Fibrinolysis or an Invasive Strategy is Preferred

If presentation is less than 3 hours and there is no delay to an invasive strategy, there is no preference for either strategy.

<table>
<thead>
<tr>
<th>Fibrinolysis is generally preferred if:</th>
<th>An invasive strategy is generally preferred if:</th>
</tr>
</thead>
</table>
| **Early presentation** (3 hours or less from symptom onset & delay to invasive strategy; see below) | **Skilled PCI laboratory available with surgical backup**
Medical contact-to- balloon time is > than 90 min
(Door-to Balloon) – (Door-to- needle time) is > 1 hr |
| **Invasive strategy is not an option**
Catheterization lab occupied/not available
Vascular access difficulties
Lack of access to a skilled PCI lab-
Operator experience > 75 PPCI cases per year/
Team experience >36 PPCI cases per year | **High risk from STEMI**
Cardiogenic shock
Killip class greater than or equal to 3 |
| **Delay to invasive strategy**
Prolonged transport
(Door-to Balloon) – (Door-to- needle) time is > 1 HR
Medical contact-to- balloon time is > than 90 min | **Contraindications to fibrinolysis, including increased risk of bleeding and ICH** |
| **Late presentation**
Symptom onset was more than 3 hours ago | **Diagnosis of STEMI is in doubt** |

Adapted from Figure 3; Antman et al. *JACC* 2004;44:682.
Comparison of Angioplasty and Prehospital Thrombolysis in Acute Myocardial Infarction

AMI within 6 hours
1200 planned
840 enrolled

Prehospital Thrombolysis n=419
Primary Angioplasty n=421

Primary Composite Endpoint- Death, Reinfarction, Disabling Stroke

CAPTIM - 1 Year Results
Sx to Treatment Analysis

Sx < 2 h

Death

\[ P = 0.057 \]

5.7

Pre-hospital Lysis

Primary PCI

Sx ≥ 2 h

Death

\[ P = 0.47 \]

5.9

Pre-hospital Lysis

Primary PCI

Touboul P. Presented at: The 18th International Symposium on Thrombolysis and Interventional Therapy in Acute Myocardial Infarction - George Washington University Symposium; November 16, 2002; Chicago, Ill.
# Comparison of Approved Fibrinolytic Agents

<table>
<thead>
<tr>
<th></th>
<th>Streptokinase</th>
<th>Alteplase</th>
<th>Reteplase</th>
<th>Tenecteplase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dose</strong></td>
<td>1.5 MU over</td>
<td>Up to 100mg in</td>
<td>10U x 2</td>
<td>30-50mg</td>
</tr>
<tr>
<td></td>
<td>30-60 min</td>
<td>90 min (wt-based)</td>
<td>each over 2 min</td>
<td>based on weight</td>
</tr>
<tr>
<td><strong>Bolus Admin.</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Antigenic</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Allergic React</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Systemic</strong></td>
<td>Marked</td>
<td>Mild</td>
<td>Moderate</td>
<td>Minimal</td>
</tr>
<tr>
<td>Fibrinogen Depletion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>~90-min patency rates (%)</strong></td>
<td>50</td>
<td>75</td>
<td>75?</td>
<td>75</td>
</tr>
<tr>
<td><strong>TIMI grade 3 flow, %</strong></td>
<td>32</td>
<td>54</td>
<td>60</td>
<td>63</td>
</tr>
</tbody>
</table>

**Class IIb**

1. Combination pharmacological reperfusion with abciximab and half-dose reteplase or tenecteplase may be considered for prevention of reinfarction (*Level of Evidence: A*) and other complications of STEMI in selected patients: anterior location of MI, age less than 75 years, and no risk factors for bleeding. In two clinical trials of combination reperfusion, the prevention of reinfarction did not translate into a survival benefit at either 30 days or 1 year. (*Level of Evidence: B*)

2. Combination pharmacological reperfusion with abciximab and half-dose reteplase or tenecteplase may be considered for prevention of reinfarction and other complications of STEMI in selected patients (anterior location of MI, age less than 75 years, and no risk factors for bleeding) in whom an early referral for angiography and PCI (ie, facilitated PCI) is planned. (*Level of Evidence: C*)

“Studies evaluating the use of glycoprotein IIb/IIIa inhibitors as the sole means of reperfusion (i.e., without a fibrinolytic or in conjunction with PCI) do not suggest that the isolated use of a GP IIb/IIIa inhibitor restores TIMI 3 flow in a sufficient proportion of patients to make it a viable pharmacologic strategy”.

- pg 54, Full Text Guidelines

From the TIMI-14, SPEED, INTRO-AMI data sets

Accessed on August 6, 2004
Combination Therapy of Full Dose Fibrinolytic + GP IIbIIIa Inhibitor

Class III

1. Combination pharmacological reperfusion with abciximab and half-dose reteplase or tenecteplase should not be given to patients aged greater than 75 years because of an increased risk of ICH.

(Level of Evidence: B)

Primary Percutaneous Coronary Intervention

Class I

1. General considerations:
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 primary PCI for STEMI, and has cardiac surgery capability). (Level of Evidence: A)

Antman et al. JACC 2004;44: 682.
NRMI 2: Primary PCI Door-to-Balloon Time vs. Mortality

CM Gibson

Door-to-Balloon Time (minutes)

MV Adjusted Odds of Death

P = 0.01  P = 0.0007  P = 0.0003

n = 2,230  5,734  6,616  4,461  2,627  5,412

0-60  61-90  91-120  121-150  151-180  >180
Time from Symptom Onset to Treatment Predicts 1-year Mortality after Primary PCI

The relative risk of 1-year mortality increases by 7.5% for each 30-minute delay

Mortality rates with primary PCI as a function of PCI-related time delay

Circle sizes = sample size of the individual study.
Solid line = weighted meta-regression.

P = 0.006

For Every 10 min delay to PCI: 1% reduction in mortality difference towards lytics

Nallamothu BK, Bates ER. Am J Cardiol. 2003;92:824-6
Primary Percutaneous Coronary Intervention

Class I

2. Specific Considerations:
   a. Primary PCI should be performed as quickly as possible, with a goal of a medical contact–to-balloon or door-to-balloon time of within 90 minutes. *(Level of Evidence: B)*

   b. If the symptom duration is within 3 hours and the expected door-to-balloon time minus the expected door-to-needle time is:
      i) within 1 hour, primary PCI is generally preferred. *(Level of Evidence: B)*
      ii) greater than 1 hour, fibrinolytic therapy (fibrin-specific agents) is generally preferred. *(Level of Evidence: B)*

   c. If symptom duration is greater than 3 hours, primary PCI is generally preferred and should be performed with a medical contact–to-balloon or door-to-balloon time as brief as possible, with a goal of within 90 minutes. *(Level of Evidence: B)*

2. Specific Considerations (continued)

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

e. Primary PCI should be performed in patients with severe CHF and/or pulmonary edema (Killip class 3) and onset of symptoms within 12 hours. The medical contact–to-balloon or door-to-balloon time should be as short as possible (ie, goal within 90 min). *(Level of Evidence: B)*

Primary Percutaneous Coronary Intervention
PPCI without On-Site Cardiac Surgery

**Class IIb**
1. Primary PCI might be considered in hospitals without on-site cardiac surgery, provided that there exists a proven plan for rapid transport to a cardiac surgery operating room in a nearby hospital with appropriate hemodynamic support capability for transfer. The procedure should be limited to patients with STEMI or MI with new, or presumably new, LBBB on ECG, and should be done in a timely fashion (balloon inflation within 90 minutes of presentation) by persons skilled in the procedure (at least 75 PCIs per year) and at hospitals that perform a minimum of 36 primary PCI procedures per year. *(Level of Evidence: B)*

Interhospital Transfer for Primary PCI

“To achieve optimal results, time from the first hospital door to the balloon inflation in the second hospital should be as short as possible, with a goal of within 90 minutes. Significant reductions in door-to-balloon times might be achieved by directly transporting patients to PCI centers rather than transporting them to the nearest hospital, if interhospital transfer will subsequently be required to obtain primary PCI”.

DANAMI-2: Results

Door to Balloon Times Among Patients Transferred in NRMI 4

Door to Data:
- 50th: 9 Min.
- 25th: 4 Min.
- 75th: 16 Min.

Data to Cath Lab Arrival:
- 50th: 132 Min.
- 25th: 88 Min.
- 75th: 219 Min.

Cath Lab to Balloon:
- 50th: 37 Min.
- 25th: 28 Min.
- 75th: 50 Min.

Total Door 1 to Balloon Time: 185 minutes (25th: 137; 75th: 276)

Percent of Patients with Door to Balloon Time < 90 Min.: 3.0%

Sample Size: 1,346; Time Period: January 2002 – December 2002

Primary stenting has been compared with primary angioplasty in 9 studies. There were no differences in mortality (3.0% versus 2.8%) or reinfarction (1.8% versus 2.1%) rates. However, major adverse cardiac events were reduced, driven by the reduction in subsequent target-vessel revascularization with stenting.

Preliminary reports suggest that compared with conventional bare metal stents, drug-eluting stents are not associated with increased risk when used for primary PCI in STEMI patients. Postprocedure vessel patency, biomarker release, and the incidence of short-term adverse events were similar in patients receiving sirolimus (n equals 186) or bare metal (n equals 183) stents. Thirty-day event rates of death, reinfarction, or revascularization were 7.5% versus 10.4%, respectively (P equals 0.4).

Definition of Terms:
Nomenclature for fPCI

- Facilitated PCI (fPCI)- fibrinolytics or other pharmacologics ‘facilitate’ PCI
- Pharmacoinvasive Recanalization- capitalizes on the rapidity of initiation & widespread feasibility of pharmacologic thrombolysis to promptly restore ‘some’ myocardial blood flow, coupled with the more complete restoration achievable with subsequent PCI

Dauerman & Sobel, JACC 2003;42:646-51
Primary Percutaneous Coronary Intervention
Facilitated PCI

**Class IIb**

1. Facilitated PCI might be performed as a reperfusion strategy in higher-risk patients when PCI is not immediately available and bleeding risk is low. *(Level of Evidence: B)*

   - The text mentions all pharmacological options to facilitate, PCI including; full-dose fibrinolysis, ½ dose fibrinolysis, & a GP IIb-IIIa.

   - The strategy holds promise for higher-risk AMI when PPCI is not readily available.

Primary Percutaneous Coronary Intervention

Rescue PCI

**Class I**

1. Rescue PCI should be performed in patients less than 75 years old with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient’s wishes or contraindications/unsuitability for further invasive care. *(Level of Evidence: B)*

2. Rescue PCI should be performed in patients with severe CHF and/or pulmonary edema (Killip class 3) and onset of symptoms within 12 hours. *(Level of Evidence: B)*

**Class IIa**

1. Rescue PCI is reasonable for selected patients 75 years or older with ST elevation or LBBB or who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock. Patients with good prior functional status who are suitable for revascularization and agree to invasive care may be selected for such an invasive strategy. *(Level of Evidence: B)*

2. It is reasonable to perform rescue PCI for patients with 1 or more of the following:
   
   a. Hemodynamic or electrical instability *(Level of Evidence: C)*
   b. Persistent ischemic symptoms. *(Level of Evidence: C)*

Percutaneous Coronary Intervention After Fibrinolysis

**Class I**

1. In patients whose anatomy is suitable, PCI should be performed when there is objective evidence of recurrent MI. *(Level of Evidence: C)*

2. In patients whose anatomy is suitable, PCI should be performed for moderate or severe spontaneous or provokable myocardial ischemia during recovery from STEMI. *(Level of Evidence: B)*

3. In patients whose anatomy is suitable, PCI should be performed for cardiogenic shock or hemodynamic instability. *(Level of Evidence: B)*

Percutaneous Coronary Intervention After Fibrinolysis- continued

**Class IIa**

1. It is reasonable to perform routine PCI in patients with LV ejection fraction (LVEF) less than or equal to 0.40, CHF, or serious ventricular arrhythmias. (*Level of Evidence: C*)

2. It is reasonable to perform PCI when there is documented clinical heart failure during the acute episode, even though subsequent evaluation shows preserved LV function (LVEF greater than 0.40). (*Level of Evidence: C*)

**Class IIb (New, previously Class III)**

1. Routine PCI might be considered as part of an invasive strategy after fibrinolytic therapy. (*Level of Evidence: B*)

Kaplan-Meier survival estimates, by PCI After Lysis in 20,101 Patients

Gibson CM et al, JACC 2003
Acute Surgical Reperfusion

Class I

Emergency or urgent CABG in patients with STEMI should be undertaken in the following circumstances:

a. Failed PCI with persistent pain or hemodynamic instability in patients with coronary anatomy suitable for surgery.  
   *(Level of Evidence: B)*

b. Persistent or recurrent ischemia refractory to medical therapy in patients who have coronary anatomy suitable for surgery, have a significant area of myocardium at risk, and are not candidates for PCI or fibrinolytic therapy.  
   *(Level of Evidence: B)*

Acute Surgical Reperfusion (continued)

Class I

c. At the time of surgical repair of postinfarction ventricular septal rupture (VSR) or mitral valve insufficiency. *(Level of Evidence: B)*
d. Cardiogenic shock in patients less than 75 years old with ST elevation, LBBB, or posterior MI who develop shock within 36 hours of STEMI, have severe multivessel or left main disease, and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient’s wishes or contraindications/unsuitability for further invasive care. *(Level of Evidence: A)*
e. Life-threatening ventricular arrhythmias in the presence of greater than or equal to 50% left main stenosis and/or triple-vessel disease. *(Level of Evidence: B)*
Ancillary Therapy-Antithrombins
Heparin- UFH

Class I

1. Patients undergoing percutaneous or surgical revascularization should be given UFH. \(\text{(Level of Evidence: C)}\)

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

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

4. Platelet counts should be monitored daily in patients

Ancillary Therapy-Antithrombins
Heparin- UFH

**Class IIb**

1. It may be reasonable to administer UFH intravenously to patients undergoing reperfusion therapy with streptokinase. *(Level of Evidence: B)*

Ancillary Therapy-Antithrombins
Low-Molecular-Weight-Heparin

Class IIb

1. LMWH might be considered an acceptable alternative to UFH as ancillary therapy for patients less than 75 years of age who are receiving fibrinolytic therapy, provided that significant renal dysfunction (serum creatinine greater than 2.5 mg/dL in men or 2.0 mg/dL in women) is not present. Enoxaparin (30 mg IV bolus followed by 1.0 mg/kg subcutaneous injection every 12 hours) with full-dose tenecteplase is the most comprehensively studied regimen in patients less than 75 years of age. (Level of Evidence: B)

Antman et al. JACC 2004;44:689.
**Class IIa**

1. In patients with known heparin-induced thrombocytopenia, it is reasonable to consider bivalirudin as a useful alternative to heparin to be used in conjunction with streptokinase. Dosing according to the HERO (Hirulog and Early Reperfusion or Occlusion)-2 regimen (a bolus of 0.25 mg/kg followed by an intravenous infusion of 0.5 mg/kg per hour for the first 12 hours and recommended but with a reduction in the infusion rate if the PTT is above 75 seconds within the first 12 hours. *(Level of Evidence: B)*

Class I

1. A daily dose of aspirin (initial dose of 162 to 325 mg orally; maintenance dose of 75 to 162 mg) should be given indefinitely after STEMI to all patients without a true aspirin allergy. 

*(Level of Evidence: A)*
Ancillary Therapy-Antipllatelets
Thienopyridines

**Class I**

1. In patients who have undergone diagnostic cardiac catheterization and for whom PCI is planned, clopidogrel should be started and continued for at least 1 month after bare metal stent implantation, for several months after drug-eluting stent implantation (3 months for sirolimus, 6 months for paclitaxel), and for up to 12 months in patients who are not at high risk for bleeding. *Level of Evidence: B*

2. In patients taking clopidogrel in whom CABG is planned, the drug should be withheld for at least 5 days, and preferably for 7, unless the urgency for revascularization outweighs the risks of excess bleeding. *Level of Evidence: B*

**Class IIa**

1. Clopidogrel is probably indicated in patients receiving fibrinolytic therapy who are unable to take aspirin because of hypersensitivity or major gastrointestinal intolerance. *Level of Evidence: C*

Antman et al. JACC 2004;44:689.
Ancillary Therapy-Antiplatelets
GP IIb/IIIa Inhibitors

**Class IIa**
1. It is reasonable to start treatment with abciximab as early as possible before primary PCI (with or without stenting) in patients with STEMI. *(Level of Evidence: B)*

**Class IIb**
1. Treatment with tirofiban or eptifibatide may be considered before primary PCI (with or without stenting) in patients with STEMI. *(Level of Evidence: C)*

Routine Measures

Class I

**Oxygen**

1. Supplemental oxygen should be administered to patients with arterial oxygen desaturation ($\text{SaO}_2$ less than 90%).

(Level of Evidence: B)

**Analgesia**

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

(Level of Evidence: C)

Routine Measures

Nitroglycerin

**Class I**

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

2. Intravenous nitroglycerin is indicated for relief of ongoing ischemic discomfort, control of hypertension, or management of pulmonary congestion. *(Level of Evidence: C)*

**Class III**

1. Nitrates should not be administered to patients with systolic blood pressure less than 90 mm Hg or greater than or equal to 30 mm Hg below baseline, severe bradycardia (less than 50 bpm), tachycardia (more than 100 bpm), or suspected RV infarction. *(Level of Evidence: C)*

2. Nitrates should not be administered to patients who have received a phosphodiesterase inhibitor for erectile dysfunction within the last 24 hours (48 hours for tadalafil). *(Level of Evidence: B)*

Routine Measures

**Aspirin**

**Class I**

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

Routine Measures

**ß-blocking agents**

**Class I**
1. 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 of Evidence: A)*

**Class IIa**
1. It is reasonable to administer IV beta-blockers promptly to STEMI patients without contraindications, especially if a tachyarrhythmia or hypertension is present. *(Level of Evidence: B)*

Inhibition of Renin-Angiotensin-Aldosterone System

**Class I**

1. An angiotensin converting enzyme (ACE) inhibitor should be administered **orally** within the **first 24 hours of STEMI** to patients with anterior infarction, pulmonary congestion, or LVEF less than 0.40, in the absence of hypotension (systolic blood pressure less than 100 mm Hg or less than 30 mm Hg below baseline) or known contraindications to that Class of medications. *(Level of Evidence: A)*

2. An angiotensin receptor blocker (ARB) should be administered to STEMI patients who are **intolerant of ACE inhibitors** and who have either clinical or radiological signs of heart failure or LVEF less than 0.40. Valsartan and candesartan have established efficacy for this recommendation. *(Level of Evidence: C)*

**Class IIa**

1. An ACE inhibitor administered orally within the first 24 hours of STEMI can be useful in patients without anterior infarction, pulmonary congestion, or LVEF less than 0.40 in the absence of hypotension (systolic blood pressure less than 100 mm Hg or less than 30 mm Hg below baseline) or known contraindications to that class of medications. The **expected treatment benefit in such patients is less** (5 lives saved per 1000 patients treated) than for patients with LV dysfunction. *(Level of Evidence: B)*

NEW: STRICT GLUCOSE CONTROL DURING STEMI

**Class I**
1. An insulin infusion to normalize blood glucose is recommended for patients with STEMI and complicated courses. *(Level of Evidence: B)*

**Class IIa**
1. During the acute phase (first 24 to 48 hours) of the management of STEMI in patients with hyperglycemia, it is reasonable to administer an insulin infusion to normalize blood glucose, even in patients with an uncomplicated course. *(Level of Evidence: B)*

Magnesium

**Class IIA**

1. It is reasonable that documented magnesium deficits be corrected, especially in patients receiving diuretics before the onset of STEMI. (*Level of Evidence: C*)

2. It is reasonable that episodes of torsade de pointes-type ventricular tachycardia (VT) associated with a prolonged QT interval be treated with 1 to 2 g of magnesium administered as an intravenous bolus over 5 minutes. (*Level of Evidence: C*)

Calcium Channel Blockers

**Class IIa**

1. It is reasonable to give verapamil or diltiazem to patients in whom beta-blockers are ineffective or contraindicated (eg, bronchospastic disease) for relief of ongoing ischemia or control of a rapid ventricular response with atrial fibrillation or flutter after STEMI in the absence of CHF, LV dysfunction, or atrioventricular (AV) block. *(Level of Evidence: C)*

Summary: Selection of the Optimal Reperfusion Options for the STEMI Patient: 2004

**Full Dose Fibrinolytic Monotherapy**
- Door to balloon (D-B) > 90 min
- Lack of access to skilled PCI center
- (D-B) – (D-N) > 1 h
- < 3 h from symptom onset

**Invasive Strategy**
- Cardiogenic shock (age < 75)
- Bleeding risk
- Diagnosis in doubt (pericarditis/aneurysm)
- Door to balloon < 90 min
- Skilled PCI center available, defined by:
  - Operator experience > 75 cases/yr
  - Team experience > 36 primary PCI/yr
- Age > 75
- Symptoms > 2-3 h