ACC/AHA 2004 Practice Guidelines for STEMI

6.3. Management
6.3.1. Routine Measures
6.3.1.1. Oxygen

Class I
Supplemental oxygen should be administered to patients with arterial oxygen desaturation (SaO2 less than 90%). (Level of Evidence: B)

Class IIa
It is reasonable to administer supplemental oxygen to all patients with uncomplicated STEMI during the first 6 hours. (Level of Evidence: C)

6.3.1.2. 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 beats per minute [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)

6.3.1.3. Analgesia

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

6.3.1.4. Aspirin

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

6.3.1.5. Beta-Blockers

Class I
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
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)

6.3.1.6. Reperfusion
6.3.1.6.1. GENERAL CONCEPTS

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

6.3.1.6.3.1. Indications for Fibrinolytic Therapy

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

Class IIa
1. In the absence of contraindications, it is reasonable to administer fibrinolytic therapy to STEMI patients with symptom onset within the prior 12 hours and 12-lead ECG findings consistent with a true posterior MI. *(Level of Evidence: C)*
2. In the absence of contraindications, it is reasonable to administer fibrinolytic therapy to patients with symptoms of STEMI beginning within the prior 12 to 24 hours who have continuing ischemic symptoms and ST elevation greater than 0.1 mV in at least 2 contiguous precordial leads or at least 2 adjacent limb leads. *(Level of Evidence: B)*

Class III
1. Fibrinolytic therapy should not be administered to asymptomatic patients whose initial symptoms of STEMI began more than 24 hours earlier. *(Level of Evidence: C)*
2. Fibrinolytic therapy should not be administered to patients whose 12-lead ECG shows only ST-segment depression except if a true posterior MI is suspected. *(Level of Evidence: A)*

6.3.1.6.3.8. Combination Therapy With GP IIb/IIIa Inhibitors

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 (394a) *(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 (i.e., facilitated PCI) is planned. *(Level of Evidence: C)*

Class III
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)*

6.3.1.6.8.1.1. Unfractionated heparin as ancillary therapy to reperfusion therapy.

Class I
1. Patients undergoing percutaneous or surgical revascularization should receive UFH. *(Level of Evidence: C)*
2. Unfractionated heparin 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 infusion of 12 U/kg/hr (maximum 1000 U) initially adjusted to maintain activated partial thromboplastin time (aPTT) at 1.5 to 2.0 times control (approximately 50 to 70 seconds). *(Level of Evidence: C)*
3. Unfractionated heparin should be given intravenously to patients treated with nonselective fibrinolytic agents (streptokinase, anistreplase, urokinase) who are at high risk for systemic emboli (large or anterior MI, atrial fibrillation (AF), previous embolus, or known LV thrombus). *(Level of Evidence: B)*
4. Platelet counts should be monitored daily in patients taking UFH. *(Level of Evidence: C)*

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

6.3.1.6.8.1.2. Low-molecular-weight heparin as ancillary therapy to reperfusion therapy.

Class IIb
Low-molecular-weight heparin might be considered an acceptable alternative to UFH as ancillary therapy for patients aged less than 75 years 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/kgm SC every 12 hours until hospital discharge) used in combination with full-dose tenecteplase is the most comprehensively studied regimen in patients aged less than 75 years of age. *(Level of Evidence: B)*
Class III
1. Low-molecular-weight heparin should not be used as an alternative to UFH as ancillary therapy in patients aged more than 75 years who are receiving fibrinolytic therapy. (*Level of Evidence: B*)
2. Low-molecular-weight heparin should not be used as an alternative to UFH as ancillary therapy in patients less than 75 years who are receiving fibrinolytic therapy but have significant renal dysfunction (serum creatinine greater than 2.5 mg/dL in men or 2.0 mg/dL in women). (*Level of Evidence: B*)

6.3.1.6.8.2. Antiplatelets

6.3.1.6.8.2.1. Aspirin.

Class I
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*)

6.3.1.6.8.2.2. 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 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 days, unless the urgency for revascularization outweighs the risks of excess bleeding. (*Level of Evidence: B*)

Class IIa
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*)

6.3.1.6.8.2.3. Glycoprotein IIb/IIIa inhibitors.

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

6.3.1.6.9. OTHER PHARMACOLOGICAL MEASURES.

6.3.1.6.9.1. Inhibition of Renin-Angiotensin- Aldosterone System

Class I
1. An 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
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 mmHg 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*)

Class III
An intravenous ACE inhibitor should not be given to patients within the first 24 hours of STEMI because of the risk of hypotension. (A possible exception may be patients with refractory hypertension.) (*Level of Evidence: B*)
6.3.1.6.9.3. 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 pointe-type VT associated with a prolonged QT interval be treated with 1 to 2 grams of magnesium administered as an IV bolus over 5 minutes. (Level of Evidence: C)

Class III
In the absence of documented electrolyte deficits or torsade de pointes-type VT, routine intravenous magnesium should not be administered to STEMI patients at any level of risk. (Level of Evidence: A)

6.3.1.6.9.4. Calcium Channel Blockers

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

Class III
1. Diltiazem and verapamil are contraindicated in patients with STEMI and associated systolic LV dysfunction and CHF. (Level of Evidence: A)
2. Nifedipine (immediate-release form) is contraindicated in the treatment of STEMI because of the reflex sympathetic activation, tachycardia, and hypotension associated with its use. (Level of Evidence: B)

7.2.4. Analgesia/Anxiolytics

Class IIa
1. It is reasonable to use anxiolytic medications in STEMI patients to alleviate short-term anxiety or altered behavior related to hospitalization for STEMI. (Level of Evidence: C)
2. It is reasonable to routinely assess the patient's anxiety level and manage it with behavioral interventions and referral for counseling. (Level of Evidence: C)

7.4. Medication Assessment
7.4.1. Beta-Blockers

Class I
1. Patients receiving beta-blockers within the first 24 hours of STEMI without adverse effects should continue to receive them during the early convalescent phase of STEMI. (Level of Evidence: A)
2. Patients without contraindications to beta-blockers who did not receive them within the first 24 hours after STEMI should have them started in the early convalescent phase. (Level of Evidence: A)
3. Patients with early contraindications within the first 24 hours of STEMI should be re-evaluated for candidacy for beta-blocker therapy. (Level of Evidence: C)

7.4.2. Nitroglycerin

Class I
1. Intravenous nitroglycerin is indicated in the first 48 hours after STEMI for treatment of persistent ischemia, CHF, or hypertension. The decision to administer intravenous nitroglycerin and the dose used should take into account that it should not preclude therapy with other proven mortality-reducing interventions such as beta-blockers or ACE inhibitors (Level of Evidence: B)
2. Intravenous, oral, or topical nitrates are useful beyond the first 48 hours after STEMI for treatment of recurrent angina or persistent CHF if their use does not preclude therapy with beta-blockers or ACE inhibitors. (Level of Evidence: B)

Class IIb
The continued use of nitrate therapy beyond the first 24 to 48 hours in the absence of continued or recurrent angina or CHF may be helpful, although the benefit is likely to be small and is not well established in contemporary practice. (Level of Evidence: B)

Class III
Nitrate therapy 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 RV infarction. (Level of Evidence: C)
7.4.3. Inhibition of the Renin-Angiotensin-Aldosterone System

Class I

1. An ACE inhibitor should be administered orally during convalescence from STEMI in patients who tolerate this class of medication, and it should be continued over the long term. (Level of Evidence: A)

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

3. Long-term aldosterone blockade should be prescribed for post-STEMI patients without significant renal dysfunction (creatinine should be less than or equal to 2.5 mg/dL in men and less than or equal to 2.0 mg/dL in women) or hyperkalemia (potassium should be less than or equal to 5.0 mEq/L) who are already receiving therapeutic doses of an ACE inhibitor, have an LVEF of less than or equal to 0.40, and have either symptomatic heart failure or diabetes. (Level of Evidence: A)

Class IIa

In STEMI patients who tolerate ACE inhibitors, an ARB can be useful as an alternative provided there are either clinical or radiological signs of heart failure or LVEF is less than 0.40. Valsartan and candesartan have established efficacy for this recommendation. (Level of Evidence: B)

7.4.4. Antiplatelets

Class I

1. Aspirin 162 to 325 mg should be given on day 1 of STEMI and in the absence of contraindications should be continued indefinitely on a daily basis thereafter at a dose of 75 to 162 mg. (Level of Evidence: A)

2. A thienopyridine (preferably clopidogrel) should be administered to patients who are unable to take aspirin because of hypersensitivity or major gastrointestinal intolerance. (Level of Evidence: C)

3. For patients taking clopidogrel for whom CABG is planned, the drug should be withheld for at least 5 days if possible, and preferably for 7, unless the urgency for revascularization outweighs the risks of bleeding. (Level of Evidence: B)

4. For 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 and for severe infarct, oral 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)

Class IIb

Prophylaxis for DVT with subcutaneous LMWH (dosed appropriately for specific agent) or with subcutaneous UFH, 7500 to 12 500 U twice per day until completely ambulatory, may be useful, but the effectiveness of such a strategy is not well established in the contemporary era of routine aspirin use and early mobilization. (Level of Evidence: C)

7.4.5. Antithrombotics

Class I

Intravenous UFH (bolus of 60 U/kg, maximum 4000-U IV bolus; initial infusion of 12 U/kg/h, maximum 1000 U/h) or LMWH should be used in patients after STEMI who are at high risk for systemic emboli (large or anterior MI, AF, previous embolus, known LV thrombus, or cardiogenic shock). (Level of Evidence: C)

Class IIa

It is reasonable that STEMI patients not undergoing reperfusion therapy who do not have a contraindication to anticoagulation be treated with intravenous or subcutaneous UFH or with subcutaneous LMWH for at least 48 hours. In patients whose clinical condition necessitates prolonged bedrest and/or minimized activities, it is reasonable that treatment be continued until the patient is ambulatory. (Level of Evidence: C)

Class IIb

Prophylaxis for DVT with subcutaneous LMWH (dosed appropriately for specific agent) or with subcutaneous UFH, 7500 to 12 500 U twice per day until completely ambulatory, may be useful, but the effectiveness of such a strategy is not well established in the contemporary era of routine aspirin use and early mobilization. (Level of Evidence: C)
Table 23. Sample Admitting Orders for the Patient With STEMI

1. **Condition:** Serious
2. **IV:** NS on D5W to keep vein open. Start a second IV if IV medication is being given. This may be a saline lock.
3. **Vital signs:** every 1.5 h until stable, then every 4 h and as needed. Notify physician if HR is less than 60 bpm or greater than 100 bpm, BP is less than 100 mm Hg systolic or greater than 150 mm Hg diastolic, respiratory rate is less than 8 or greater than 22 bpm.
4. **Monitor:** Continuous ECG monitoring for arrhythmia and ST-segment deviation.
5. **Diet:** NPO except for sips of water until stable. Then start 2 grams sodium/day, low saturated fat (less than 7% of total calories/day), low cholesterol (less than 200 mg/d) diet, such as Total Lifestyle Change (TLC) diet.
6. **Activity:** Bedside commode and light activity when stable.
7. **Oxygen:** Continuous oximetry monitoring. Nasal cannula at 2 L/min when stable for 6 h, reassess for oxygen need (i.e., O2 saturation less than 90%), and consider discontinuing oxygen.
8. **Medications:**
   a. **Nitroglycerin** (See Section 6.3.1.2 for further discussion.)
      1. Use sublingual NTG 0.4 mg every 5 min as needed for chest discomfort.
      2. Intravenous NTG for CHF, hypertension, or persistent ischemia.
   b. **Aspirin** (See Section 6.3.1.4.)
      1. If aspirin not given in the ED, chew non-enteric-coated aspirin† 162 to 325 mg.
      2. If aspirin has been given, start daily maintenance of 75 to 162 mg. May use enteric-coated for gastrointestinal protection.
   c. **Beta-Blocker** (See Section 6.3.1.5.)
      1. If not given in the ED, assess for contraindications, i.e., bradycardia and hypotension. Continue daily assessment to ascertain eligibility for beta-blocker.
      2. If given in the ED, continue daily dose and optimize as dictated by HR and BP.
   d. **ACE Inhibitor** (See Section 6.3.1.6.9.1.)
      1. Start ACE inhibitor orally in patients with anterior infarction, pulmonary congestion, or LVEF less than 0.40 if the following are absent: hypotension (SBP less than 100 mm Hg or less than 30 mm Hg below baseline) or known contraindications to this class of medications.
   e. **Angiotensin Receptor Blocker** (See Section 6.3.1.6.9.1.)
      1. Start ARB orally in patients who are intolerant of ACE inhibitors and who have either clinical or radiological signs of heart failure or LVEF less than 0.40.
   f. **Pain Medications** (See Section 6.3.1.3.)
      1. IV morphine sulfate 2 to 4 mg with increments of 2 to 8 mg IV at 5- to 15-minute intervals as needed to control pain.
   g. **Anxiolytics** (based on a nursing assessment) (See Section 7.2.4.)
   h. **Daily Stool Softener**
9. **Laboratory Tests:** Serum biomarkers for cardiac damage,*CBC with platelet count, INR, aPTT, electrolytes, magnesium, BUN, creatinine, glucose, serum lipids (see Table 9).

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STEMI = ST-elevation myocardial infarction; IV = intravenous; NS = normal saline; h = hours; bpm = beats per minute; ECG = electrocardiogram; NPO = nothing by mouth; min = minutes; NTG = nitroglycerin; CHF = congestive heart failure; ED = emergency department; HR = heart rate; BP = blood pressure; ACE = angiotensin converting enzyme; LVEF = left ventricular ejection fraction; SBP = systolic blood pressure; ARB = angiotensin receptor blocker; CBC = complete blood count; INR = international normalized ratio; aPTT = activated partial thromboplastin time; BUN = blood urea nitrogen.

* Do not wait for results before implementing reperfusion strategy.
† Although some trials have used enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated formulations.

Modified with permission from Ryan et al. J Am Coll Cardiol 1999;34:890-911 (3).