# Chapter 63
# Approach to STEMI in the ICU

## 63.1 Introduction

ST-elevation myocardial infarction (STEMI) is a critical form of acute coronary syndrome resulting from a complete occlusion of a coronary artery, leading to significant myocardial ischemia and necrosis. Rapid recognition and immediate intervention are paramount to minimize myocardial damage, preserve cardiac function, and improve survival rates. This chapter delineates a comprehensive approach to STEMI management, integrating current guidelines to optimize care from initial presentation through post-reperfusion and secondary prevention phases [1, 2] [Ref: Algorithm 63.1].

## 63.2 Management

The prompt administration of a loading dose of aspirin—typically 300 mg (162–325 mg)—is recommended immediately upon STEMI diagnosis, unless contraindicated. Aspirin inhibits platelet aggregation, reducing thrombus formation and limiting myocardial damage, and should be continued indefinitely as part of long-term management.

Upon presentation, swiftly establishing eligibility for reperfusion therapy is crucial to avoid delays.. Early stratification using clinical assessment and diagnostic tools, such as a 12-lead electrocardiogram (ECG), helps determine the most appropriate reperfusion strategy. ST-elevation in specific leads correlates with the infarct location and guides subsequent interventions.

## 63.3 Reperfusion Therapy Decision-Making

The choice between primary percutaneous coronary intervention (PCI) and fibrinolytic therapy is a critical decision in the management of STEMI, significantly impacting patient outcomes. This decision hinges on several factors, including the timing of symptom onset, the availability and proximity of PCI-capable facilities, patient-specific contraindications, and logistical considerations that may affect treatment delays.

## 63.4 Timing Since Symptom Onset

Guidelines universally emphasize the importance of time in myocardial salvage—the adage "time is myocardium" underscores that delays in reperfusion increase the extent of myocardial necrosis and worsen clinical outcomes. For patients presenting within 12 h of symptom onset, reperfusion therapy is strongly recommended unless contraindicated. Early intervention within this window maximizes the potential for myocardial salvage and improves survival rates.

## 63.5 Primary PCI Within 120 min

Primary PCI is the preferred reperfusion strategy. Factors favoring primary PCI include:

- Symptom Onset within 12 h: Patients presenting early benefit most from PCI.
- High-Risk Features: Hemodynamic instability, cardiogenic shock, severe heart failure, or arrhythmias.
- Diagnosis Uncertainty: PCI allows for definitive diagnosis and treatment.
- Late Presentation: Patients presenting between 12 and 24 h after symptom onset may still benefit from PCI, especially if there is evidence of ongoing ischemia.

## 63.6 Logistical Considerations

The total ischemic time should remain within the 120-minute window. If anticipated delays exceed this timeframe, alternative strategies should be considered.

## 63.7   Fibrinolytic Therapy

If primary PCI cannot be performed within 120 min, immediate initiation of fibrinolytic therapy is recommended, ideally within 30 min of diagnosis of STEMI. Commonly used fibrinolytics include tenecteplase, alteplase, or reteplase are administered to dissolve the thrombus occluding the coronary artery (Table 63.1). Tenecteplase is often preferred due to its ease of administration (single bolus) and fibrin specificity.

## 63.8   Criteria for Fibrinolysis

- Symptom Onset within 12 h: Greatest benefit when administered early.
- PCI Delay: When PCI cannot be achieved within the recommended timeframes.
- No Contraindications to Fibrinolysis: Absence of bleeding disorders, recent surgeries, or history of hemorrhagic stroke.
- Contraindications to Fibrinolysis:

  - Absolute: Any prior ICH known structural cerebral vascular lesion (e.g., AVM), Known malignant intracranial neoplasm (primary or metastatic), ischemic stroke within 3 months EXCEPT acute ischemic stroke within 3 h, suspected aortic dissection, active bleeding or bleeding diathesis (excluding menses), significant closed head or facial trauma within 3 months.
  - Relative: History of chronic severe, poorly controlled hypertension, severe uncontrolled hypertension on presentation (SBP greater than 180 mm Hg or DBP greater than 110 mm Hg), history of prior ischemic stroke greater than 3 months, dementia, or known intracranial pathology not covered in contraindications, Traumatic or prolonged (greater than 10 min) CPR or major surgery (less than 3 weeks), recent (within 2–4 weeks) internal bleeding, noncompressible vascular punctures, For streptokinase/anistreplase: prior exposure (more than 5 days ago) or prior allergic reaction to these agents, pregnancy, active peptic ulcer.

**Table 63.1**   Dosing regimens for common fibrinolytic agents used in STEMI management

| Drug | Dose |
| --- | --- |
| Streptokinase | 1.5 million U over 30–60 min IV |
| Reteplase (rPA) | 10 U IV bolus initially, followed by 10 U IV bolus 30 minute after |
| Alteplase (tPA) | Bolus 15 mg IV, followed by infusion 0.75 mg/kg for 30 min (up 50 mg) and then 0.5 mg/kg for 60 min (up to 35 mg) |
| Tenecteplase (TNK-tPA) | Single IV bolus with 30 mg for 60 kg; 35 mg for 60–69 kg;40 mg for 70–79 kg; 45 mg for 80–89 kg; 50 mg for ≥ 90 kg |

## 63.9    Monitoring and Follow-Up

After fibrinolysis, patients should be closely monitored for signs of reperfusion, such as resolution of chest pain, reduction of ST-segment elevation by ≥50% within 60–90 min, and the occurrence of reperfusion arrhythmias. Failure to achieve reperfusion criteria necessitates immediate rescue PCI.

## 63.10    Pharmacologic Support in PCI

Antithrombotic therapy is a cornerstone of STEMI management during and after PCI, aiming to prevent thrombotic complications while minimizing bleeding risks. The selection of specific agents and dosing regimens should consider individual patient factors, access site, and concomitant therapies.

## 63.11    Anticoagulant Therapy (Up to 8 Days/ until Revascalurization)

- Unfractionated Heparin (UFH): UFH is widely used due to its rapid onset and ease of monitoring. The recommended dosing during PCI is 70–100 IU/kg when GPIs are not used and 50–70 IU/kg when GPIs are administered. Activated clotting time (ACT) should be monitored to guide dosing.
- Bailout Glycoprotein IIb/IIIa Inhibitors (GPIs): Agents such as abciximab, tirofiban, or eptifibatide may be used selectively in cases of large thrombus burden, slow-flow/no-reflow phenomena, or other thrombotic complications during PCI. Their use requires careful consideration due to increased bleeding risk.
- Bivalirudin: A direct thrombin inhibitor, bivalirudin is an alternative to UFH, particularly beneficial when femoral arterial access is used. It has a lower risk of bleeding complications compared to UFH with GPIs. The recommended dosing is a bolus of 0.75 mg/kg followed by an infusion of 1.75 mg/kg/h during the procedure.
- 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 h until hospital discharge) used in combination with full-dose tenecteplase is the most comprehensively studied regimen in patients less than 75 years of age.

Patients who fail thrombolysis (ST segments fail to decrease by 50%) should undergo rescue PCI (if available) or may be shifted to a center that is equipped for PCI.

## 63.12   Antiplatelet Therapy

- Aspirin: A loading dose of 162–325 mg orally (or 75–250 mg IV) should be administered followed by a maintenance dose of 75–162 mg daily indefinitely.
- P2Y12 Inhibitors:
  - Prasugrel: Recommended for patients undergoing primary PCI who are not on oral anticoagulants and have no history of stroke or transient ischemic attack. Loading dose is 60 mg orally, followed by 10 mg daily. Prasugrel is associated with a faster onset of action and greater platelet inhibition compared to clopidogrel but with an increased bleeding risk.
  - Clopidogrel: Preferred in patients on oral anticoagulants or with contraindications to prasugrel. Loading dose is 300–600 mg orally, followed by 75 mg daily. It has a slower onset and variable antiplatelet effect due to genetic polymorphisms affecting metabolism.
  - Ticagrelor: An alternative to prasugrel and clopidogrel, ticagrelor has a rapid onset and potent platelet inhibition. Loading dose is 180 mg orally, followed by 90 mg twice daily. Caution is advised in patients with a history of intracranial hemorrhage or severe hepatic impairment.

## 63.13   Individual Patient Factors

- Renal Function: Adjust dosing of anticoagulants in patients with renal impairment. Bivalirudin infusion rate should be reduced in severe renal dysfunction.
- Bleeding Risk: Assess bleeding risk using scoring systems (e.g., CRUSADE score) to guide antithrombotic therapy choices.
- Drug Interactions and Allergies: Review medications to avoid adverse interactions and consider allergies to antiplatelet agents or anticoagulants.

## 63.14   Post-PCI Antithrombotic Therapy

- Dual Antiplatelet Therapy (DAPT): Continue DAPT for at least 12 months unless contraindicated. Duration may be adjusted based on bleeding risk and stent type.
- Anticoagulation: Generally discontinued after PCI unless there is an indication for long-term anticoagulation (e.g., atrial fibrillation), in which case triple therapy strategies should be carefully managed to minimize bleeding.

## 63.15   Considerations for High Bleeding Risk Patients

Patients with a high risk of bleeding present a therapeutic challenge, requiring a delicate balance between preventing thrombotic events and minimizing hemorrhagic complications. Risk factors for bleeding include advanced age, low body weight, renal insufficiency, history of bleeding, anemia, and use of other anticoagulant or antiplatelet medications.

## 63.16   Risk Stratification

- Bleeding Risk Scores: Utilize tools like the HAS-BLED or CRUSADE scores to quantify bleeding risk and guide therapy.
- Patient Assessment: Comprehensive evaluation of patient history, comorbid conditions, and concomitant medications is essential.

## 63.17   Antiplatelet Therapy Modifications

Choice of P2Y12 Inhibitor:

- Clopidogrel: Often favored in high bleeding risk patients due to its lower bleeding risk profile compared to prasugrel and ticagrelor.
- Ticagrelor: May be considered, but with caution, as it carries an intermediate bleeding risk.
- Prasugrel: Generally avoided in high bleeding risk patients due to increased hemorrhagic complications.

Aspirin Monotherapy: In patients with very high bleeding risk or significant contraindications to DAPT, aspirin monotherapy may be considered after careful evaluation. However, this approach may increase the risk of stent thrombosis and should be reserved for exceptional cases.

## 63.18   Duration of Dual Antiplatelet Therapy

- Shortened DAPT Duration: Recent guidelines allow for a shorter duration of DAPT (e.g., 3–6 months) in high bleeding risk patients, particularly with the use of newer-generation drug-eluting stents that have lower rates of stent thrombosis.
- De-escalation Strategies: Transitioning from a potent P2Y12 inhibitor to clopidogrel after an initial period may reduce bleeding without significantly increasing ischemic risk.

## 63.19   Anticoagulant Therapy Adjustments

- Reduced Dosing: Consider lower doses of anticoagulants like UFH during PCI, guided by ACT measurements.
- Avoid GPIs: Omit routine use of GPIs unless absolutely necessary, as they significantly increase bleeding risk.
- Bivalirudin Use: May be advantageous due to its reversible action and lower bleeding risk compared to UFH with GPIs.

## 63.20   Bleeding Management Protocols

- Preparedness: Have protocols in place for the prompt recognition and management of bleeding complications.
- Transfusion Strategies: Judicious use of blood transfusions, balancing the risks of anemia and transfusion-related complications.

## 63.21   Post-reperfusion Care

After reperfusion, comprehensive post-procedural management is crucial to address potential complications and prevent recurrent events. Mandatory assessment of left ventricular function should be conducted to stratify the risk of heart failure and other adverse outcomes. Echocardiography is the preferred modality for evaluating ventricular performance and detecting mechanical complications.

If ongoing ischemia persists after reperfusion attempts, guidelines recommend follow-up angiography to assess for residual stenosis or reocclusion. For patients with multivessel disease who are stable and not in cardiogenic shock, complete revascularization during the same hospital admission is advised. This approach has been shown to improve long-term outcomes but may pose increased risks in patients with hemodynamic instability or shock.

Secondary Prevention Measures Long-term management following STEMI is aimed at reducing recurrent ischemic events, preventing heart failure, and improving survival.

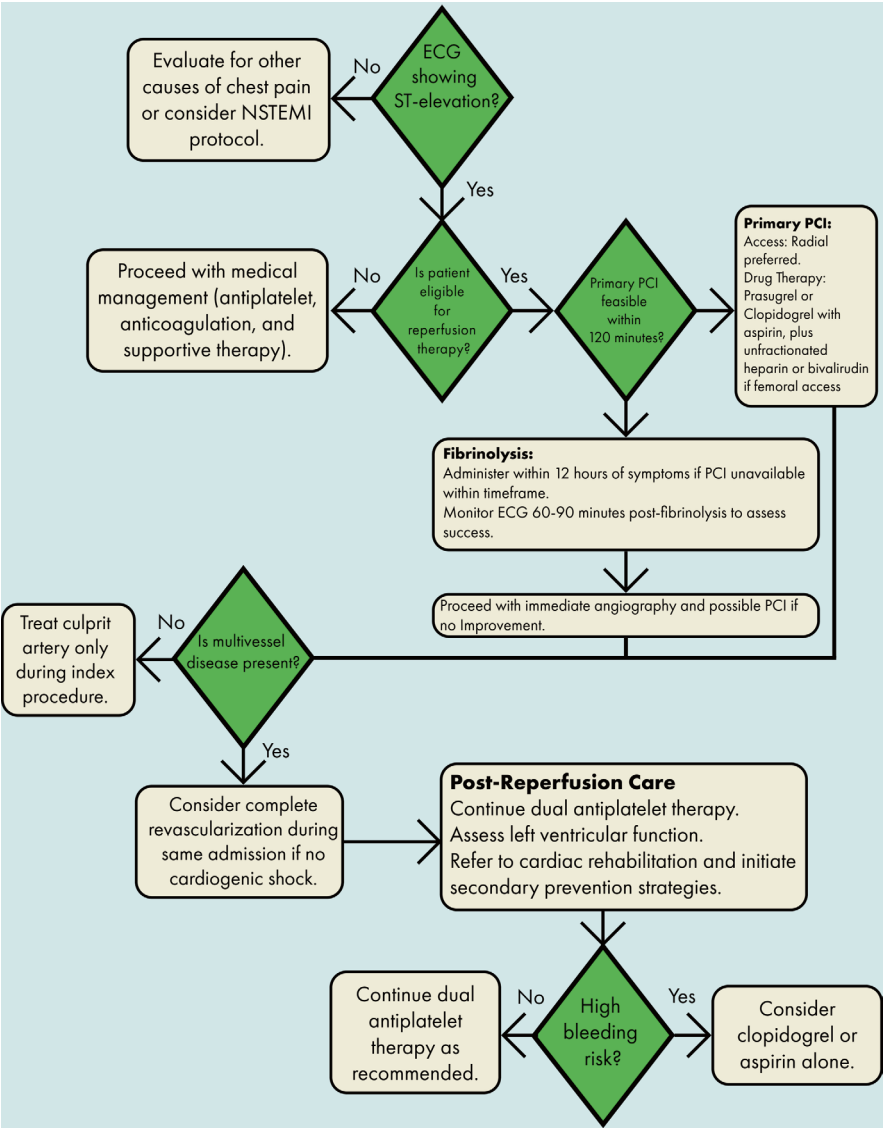Evidence-based pharmacologic and lifestyle interventions form the cornerstone of secondary prevention:

- Beta-blockers: Recommended unless contraindicated, to reduce myocardial oxygen demand, prevent arrhythmias, and improve survival.
- ACE inhibitors/ARBs/ARNI: Initiated early, particularly in patients with LV dysfunction, diabetes, hypertension, or anterior MI, to improve ventricular remodeling and long-term outcomes.

- Statins: High-intensity statin therapy (e.g., atorvastatin 40–80 mg, rosuvastatin 20–40 mg) should be started as soon as possible to achieve LDL-C reduction and plaque stabilization.
- Mineralocorticoid receptor antagonists: Indicated in patients with LV ejection fraction ≤40% with heart failure symptoms or diabetes, provided renal function and potassium levels are adequate.
- Lifestyle Modifications: Smoking cessation, dietary changes (low-salt, low-saturated fat), weight control, and structured exercise or cardiac rehabilitation programs.
- Follow-up: Regular outpatient follow-up for optimization of therapy, adherence monitoring, and risk factor control.

## 63.22   Conclusion

Managing STEMI requires a multifaceted approach that begins with rapid recognition and immediate initiation of evidence-based interventions. Early administration of aspirin and prompt determination of reperfusion eligibility are critical initial steps. The choice between primary PCI and fibrinolysis depends on timing, availability, and patient-specific factors. Antithrombotic therapy must be tailored to balance efficacy and bleeding risk. Post-reperfusion care, including left ventricular function assessment and consideration of complete revascularization, plays a pivotal role in optimizing outcomes.

## Algorithm 63.1: Approach to STEMI in the ICU



Evaluate for other causes of chest pain or consider NSTEMI protocol. ← No — ECG showing ST-elevation?

Yes ↓

Proceed with medical management (antiplatelet, anticoagulation, and supportive therapy). ← No — Is patient eligible for reperfusion therapy? — Yes → Primary PCI feasible within 120 minutes? → **Primary PCI:** Access: Radial preferred. Drug Therapy: Prasugrel or Clopidogrel with aspirin, plus unfractionated heparin or bivalirudin if femoral access

**Fibrinolysis:** Administer within 12 hours of symptoms if PCI unavailable within timeframe. Monitor ECG 60-90 minutes post-fibrinolysis to assess success.

Proceed with immediate angiography and possible PCI if no Improvement.

Treat culprit artery only during index procedure. ← No — Is multivessel disease present?

Yes ↓

Consider complete revascularization during same admission if no cardiogenic shock. → **Post-Reperfusion Care** Continue dual antiplatelet therapy. Assess left ventricular function. Refer to cardiac rehabilitation and initiate secondary prevention strategies.

↓

Continue dual antiplatelet therapy as recommended. ← No — High bleeding risk? — Yes → Consider clopidogrel or aspirin alone.

# Bibliography

1. Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction–executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1999 Guidelines for the Management of Patients With Acute Myocardial Infarction). Circulation. 2004;110(5):588–636.
2. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, et al. ESC guidelines for the management of acute coronary syndromes. Eur Heart J. 2023;44(38):3720–826.