2013 ACCF/AHA Guideline for the Management of Patients with ST-Elevation Myocardial Infarction (STEMI). A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines

About the Guideline

- This guideline was developed by the American College of Cardiology Foundation (ACCF) and the American Heart Association (AHA) task force on practice guidelines. The scope focuses on management of patients with ST-elevation myocardial infarction (STEMI). It serves as an update to the versions published in 2007 and 2009.
- Despite decreasing rates of STEMI over time, acute coronary syndrome (ACS), as a syndrome including STEMI, NSTEMI, and unstable angina, contributes to significant morbidity and mortality in the United States.
- STEMI is defined as a clinical syndrome of myocardial ischemia in association with persistent electrocardiographic (ECG) ST elevation (in the absence of left ventricular [LV] hypertrophy or left bundle-branch block [LBBB]) with subsequent release of biomarkers of myocardial necrosis (O'Gara et al., 2013).
- This reference serves to summarize the above clinical practice guideline and does not include updates made since that time.

Key Clinical Considerations

Community preparedness and system goals for reperfusion therapy.

The ACCF/AHA makes the following recommendations:

- Communities should have a system of care in place directing the assessment and management of patients with STEMI. These systems should be evaluated continuously for quality improvements.
- The following system of care is recommended:
    - 12-lead ECG with first medical contact (FMC) in those with symptoms suggestive of STEMI
    - Reperfusion therapy for all patients with STEMI and onset of symptoms **within 12 hours**
        - Primary percutaneous coronary intervention (PCI)
            - EMS should transport those with STEMI to PCI-capable hospital with goal time from FMC to intervention of 90 minutes or less.
            - Patients arriving at a non-PCI capable hospital should be transferred immediately to a PCI-capable facility with a FMC to intervention time of 120 minutes or less.
                - If unable to transport to PCI-capable facility in less than 120 minutes, fibrinolytic therapy should be administered in patients with STEMI within 30 minutes of hospital arrival at non-PCI capable facility.
                - Reperfusion therapy (primary PCI if possible) is reasonable for patients with STEMI and onset of symptoms in prior **12 to 24 hours** if clinical or ECG findings suggestive of ongoing ischemia (O'Gara et al., 2013).

STEMI and Out-of-Hospital Cardiac Arrest

The ACCF/AHA makes the following recommendations:

- Therapeutic hypothermia
  - Initiate as soon as feasible in comatose patients with ventricular fibrillation (VF) related cardiac arrest or pulseless ventricular tachycardia (VT); including those patients that undergo primary PCI.
- Perform immediate angiography and PCI in resuscitated out-of-hospital cardiac arrest with STEMI on initial ECG.

Reperfusion at a PCI-capable hospital

The ACCF/AHA makes the following recommendations:

- Primary PCI should be performed on the following clinical populations:
  - STEMI and ischemic symptoms less than 12 hours
  - STEMI and ischemic symptoms less than 12 hours with contraindications to fibrinolytic treatment regardless of time from FMC to PCI-capable hospital
  - STEMI and cardiogenic shock or acute severe heart failure, regardless of time delay
- Reasonable to consider primary PCI in those with STEMI and clinical or ECG evidence of ongoing ischemia between 12 to 24 hours of symptom onset.
- Recommendations ***against*** PCI for:
  - Non-infarct artery during primary PCI in hemodynamically stable patients with STEMI
- During primary PCI, the following interventions are acceptable for patients with STEMI:
  - Manual aspiration thrombectomy
  - Placement of drug-eluting stent (DES)
    - Note: patient selected for DES must comply with dual anti-platelet therapy for 1 year; non-compliance leads to high risk of re-thrombosis
  - Placement of bare metal stent (BMS)
    - First line in the following clinical scenarios:
      - High bleeding risk
      - Those unable to comply with 1-year dual anti-platelet therapy
      - Anticipated invasive or surgical procedure in next year
- Adjunct pharmacologic treatments with primary PCI:
  - Aspirin (ASA) 162 mg to 325 mg as a one-time dose given before primary PCI and 81 mg to 325 mg PO daily; 81 mg PO daily is the preferred dose to be continued indefinitely
  - P2Y 12 inhibitors: loading dose followed by daily maintenance for up to 12 months in addition to ASA in those that receive a stent during PCI
    - Clopidogrel: 600 mg loading dose, then 75 mg/day
    - Prasugrel: 60 mg loading dose, then 10 mg daily
      - Should not be given to patients with a history of CVA or TIA
    - Ticagrelor: 180 mg loading dose, then 90 mg BID
  - Intravenous GP IIb/IIIa receptor antagonist: reasonable to consider at time of primary PCI in patients receiving unfractionated heparin (regardless of stenting or clopidogrel pre-treatment), or in pre-catheterization setting with planned PCI
    - Abciximab 0.25 mg/kg IV bolus, then 0.125 mcg/kg/min (maximum 10 mcg/min)
      - May be reasonable to consider intracoronary administration for those undergoing PCI
    - Tirofiban (high dose bolus) 25 mcg/kg IV bolus, then 0.15 mcg/kg/min
      - Reduce dose by 50% for creatinine clearance (CrCl) less than 30 ml/min

        - Eptifibatide (double bolus) 180 mcg/kg IV bolus, then 2 mcg/kg/min; followed by a second 180 mcg/kg bolus 10 min after the first bolus
            - Reduce dose by 50% for CrCl less than 30 ml/min
            - Avoid in those on hemodialysis
    - Anticoagulation therapy
        - Unfractionated heparin (UFH): titrated to therapeutic levels for patient's undergoing primary PCI
            - Higher bolus in those with no planned GP IIb/IIIa administration
        - Bivalirudin with or without prior treatment with UFH
            - Preferred in patients at high risk of bleeding in place of UFH and a GP IIb/IIIa receptor antagonist
            - Dose adjustment for renal insufficiency
        - Fondaparinux should not be used as sole anticoagulant in primary PCI due to risk of catheter thrombosis

Reperfusion at a Non-PCI-Capable Hospital
The ACCF/AHA makes the following recommendations:
Fibrinolytic therapy

- Fibrinolytic therapy should be administered for patients with STEMI and greater than 120-minute delay from FMC to primary PCI in the following cases if no contraindications:
    - STEMI and ischemic symptoms for less than 12 hours
    - STEMI and clinical or ECG evidence of ongoing ischemia within 12-24 hours of symptom onset and high suspicion for large area of infarct or hemodynamic instability
- NOT recommended for ST depression unless high clinical suspicion for posterior (inferobasal) MI or ST elevation in lead aVR

Adjunct pharmacologic treatment for patients with STEMI receiving fibrinolytic therapy:

- Aspirin 162 mg to 325 mg loading dose, then 81 mg to 325 mg daily (81 mg preferred), to be continued indefinitely
- Clopidogrel:
    - 300 mg loading dose for patients 75 years of age or younger;
    - No loading dose in those over 75 years of age
        - consider a 75 mg dose
    - followed by 75 mg daily for at least 14 days and up to a year
- Anticoagulation:
    - Recommended for minimum of 48 hours, preferred for duration of hospitalization, up to 8 days, or until revascularization
        - UFH: weight-based IV bolus and infusion to goal activated partial prothrombin time of 1.5 to 2.0 times control
        - Enoxaparin: weight, age, CrCl-based dosing; initial IV bolus then subcutaneous injection 15 minutes following bolus
        - Fondaparinux: initial 2.5 mg IV dose, followed by 2.5 mg daily subcutaneous injection beginning in 24 hours (if CrCl greater than 30 ml/min)

Assess clinically for reperfusion following fibrinolysis.

- Evaluate ECG and clinical symptoms for reperfusion arrhythmias.

Transfer to PCI capable facility for patients with STEMI following fibrinolysis treatment for coronary angiography:

- Immediately: for cardiogenic shock or acute, severe heart failure
- Urgent: for those with high clinical suspicion for failed reperfusion or re-occlusion
- Within 24 hours, but not within first 2-3 hours

Delayed Invasive Management

The ACCF/AHA makes the following recommendations:

Coronary angiography with revascularization in those with STEMI who did not receive reperfusion therapy or who were managed with fibrinolytics and the following conditions (O'Gara et al. 2013):

1. Cardiogenic shock or acute heart failure after initial presentation
2. Intermediate or high-risk findings on pre-discharge noninvasive ischemic testing
3. Spontaneous or easily provoked myocardial ischemia
4. Failed reperfusion or re-occlusion after fibrinolytic therapy
5. Stable after successful fibrinolysis between 3 and 24 hours

PCI to infarct artery with clinically and anatomically significant stenosis should be performed in those with STEMI who received fibrinolytic therapy or who did not receive reperfusion and the following conditions (O'Gara et al., 2013):

1. Cardiogenic shock or acute severe heart failure
2. Intermediate or high-risk findings on pre-discharge noninvasive ischemic testing
3. Spontaneous or easily provoked myocardial ischemia
4. Failed reperfusion or re-occlusion following fibrinolytic therapy
5. Stable patients after successful fibrinolysis, between 3 and 24 hours
6. Stable patients more than 24 hours after successful fibrinolysis

Not recommended: delayed PCI of a totally occluded infarct artery more than 24 hours after STEMI in a clinically stable patient.

PCI of non-infarct artery before hospital discharge:

Reasonable to perform separate from primary PCI in those with:

- spontaneous symptoms of myocardial ischemia
- intermediate or high-risk findings on pre-discharge noninvasive ischemic testing

Adjunct pharmacologic treatment for patients with STEMI and delayed PCI following fibrinolytic therapy:

- Aspirin
  - 162 mg to 325 mg loading dose with fibrinolytic agent
  - 81 mg to 325 mg daily (81 mg preferred) to be continued indefinitely
- $P2Y_{12}$ receptor inhibitors
  - Clopidogrel
    - If loading dose given with fibrinolytic therapy:
      - No further loading dose, continue 75 mg daily
    - If PCI performed in 24 hours or less after fibrinolytic therapy:
      - 300 mg loading dose prior to or at time of PCI if no previous loading dose given
      - Maintenance: 75 mg daily
        - at least 1 year with placement of DES

        - at least 30 days and up to 1 year with placement of BMS
    - If PCI performed more than 24 hours after fibrinolytic therapy:
        - 600 mg loading dose before or at time of PCI if no previous loading dose given
        - Maintenance: 75 mg daily
            - at least 1 year with placement of DES
            - at least 30 days and up to 1 year with placement of BMS
- Prasugrel
    - As alternative to clopidogrel
    - if PCI performed more than 24 hours after fibrinolytic therapy with fibrin split agent or more than 48 hours after non-fibrin split agent:
        - 60 mg at time of PCI (if no prior loading dose of clopidogrel)
        - Maintenance: 10 mg daily
            - at least 1 year with placement of DES
            - at least 30 days and up to 1 year with placement of BMS
    - Contraindicated in patients with prior stroke or TIA
- Anticoagulation
    - UFH: continue through PCI at therapeutically indicated doses
    - Enoxaparin: continue through PCI
        - No additional dosing needed if last dose within 8 hours prior to PCI
        - 0.3 mg/kg IV bolus if last dose 8 to 12 hours prior to PCI
        - weight, age, creatinine-based dosing; initial IV bolus then subcutaneous injection 15 minutes following bolus
    - Fondaparinux: NOT recommended as sole agent of anticoagulation secondary to risk of catheter thrombosis; additional anticoagulant with anti-IIa activity should be administered

Coronary artery bypass graft (CABG) surgery

The ACCF/AHA makes the following recommendations:

- Urgent CABG in patients with STEMI anatomically unsuitable for PCI and ongoing ischemia, recurrent ischemia, cardiogenic shock, severe heart failure, or other high-risk indications
    - Mechanical circulatory support recommended in those who are hemodynamically unstable
- CABG within 6 hours of symptom onset in those with STEMI but no sign of cardiogenic shock and not candidate for PCI or fibrinolytic therapy
- Recommended in those with STEMI undergoing repair of “mechanical deficits”
- Recommendations in relation to anti-platelet therapy:
    - ASA should not be withheld prior to urgent CABG
    - If possible, discontinue clopidogrel or ticagrelor at least 24 hours prior to urgent on-pump CABG
        - Urgent off pump CABG may be considered less than 24 hours of discontinuation if benefit of revascularization outweighs the risk of bleeding
        - Urgent CABG within 5 days of clopidogrel or ticagrelor or 7 days of prasugrel administration if benefit of revascularization outweighs risk of bleeding
    - Discontinue short-acting infusions of GP IIB/IIIa receptor antagonist at least 2 to 4 hours prior to urgent CABG
    - Abciximab should be discontinued at least 12 hours prior to surgery

Routine Medical Therapies

The ACCF/AHA makes the following recommendations:

Medications:

- Beta-receptor antagonists – initiate within first 24 hours in patients with STEMI and continue during and after hospitalization if no contraindication
    - Oral dose for all patients if no contraindications
    - IV for refractory HTN or ongoing ischemia
- ACE inhibitors – within 24 hours
    - All patients with anterior infarction, post-MI LV dysfunction or heart failure
    - Routinely in all patients with no contraindications
- Angiotensin II receptor blockers (ARB)
    - Patients intolerant of ACE inhibitors
- Statins
    - All patients if no contraindications
    - High intensity dosing recommended
        - Example: Atorvastatin 80 mg
- Nitroglycerin
    - In patients with ongoing chest pain
    - In patients with hypertension (HTN) and heart failure
- Oxygen
    - Indicated in patients with clinically significant hypoxemia (oxygen saturation less than 90%)
    - Heart failure
    - Respiratory symptoms, dyspnea
- Morphine
    - Indicated in those with pain, anxiety or pulmonary edema

Complications following STEMI

The ACCF/AHA makes the following recommendations:

- Cardiogenic shock
    - In pump failure following STEMI, emergency revascularization with PCI or CABG indicated despite time from initial MI
    - In those unable to undergo PCI or CABG, fibrinolytic therapy is recommended
    - Consider intra-aortic balloon pump for those with cardiogenic shock refractory to pharmacologic modalities
    - LV assist devices may be considered but at time of publication, there was not sufficient evidence to make a strong recommendation
- Electrical complications
    - Ventricular arrhythmias
        - Implantable cardioverter defibrillator (ICD) therapy
            - ICD indicated before discharge in those with sustained VT/VF more than 48 hours after STEMI
            - rule out transient/reversible ischemia, re-infarction or metabolic derangements as etiology of VT/VF
    - Bradycardia, AV block, intraventricular conduction deficits
        - Temporary pacing recommended in those with symptomatic bradyarrhythmias refractory to pharmacologic interventions

- Pericarditis
  - Treatment recommendations
    - Aspirin, higher doses indicated
    - Consider acetaminophen, colchicine, narcotic analgesics if aspirin ineffective
  - Potentially harmful pharmacologic agents: glucocorticoids, non-steroidal anti-inflammatories
- Thromboembolic and bleeding related complications
  - Anticoagulation with vitamin K antagonist recommended in the following patients with STEMI:
    - atrial fibrillation and CHADS2 score of 2 or more
    - mechanical heart valve
    - venous thromboembolism
    - hypercoagulable disorder
    - asymptomatic LV mural thrombus
    - consider in anterior apical akinesis or dyskinesis
  - Consider lower target international normalized ratio (e.g., 2.0 – 2.5) in those on dual anti-platelet therapy
  - Minimize duration of "triple antithrombotic therapy" with aspirin, vitamin K antagonist, and a $P2Y_{12}$ receptor inhibitor to reduce risk of bleeding (O'Gara et al., 2013)

Risk Assessment following STEMI

The ACCF/AHA makes the following recommendations:

- Non-invasive testing prior to discharge
  - Perform prior to discharge following STEMI in those who did not undergo coronary angiography and no high-risk features warranting coronary angiography
  - Consider in the following clinical situations:
    - Non-infarct artery stenosis identified on coronary angiography to evaluate clinical significance of defect
    - For guidance/tolerance of post-discharge exercise program
- Assessment of LV function: evaluate on all patients with STEMI
- Assessment of risk for sudden cardiac death: if initial LVEF reduced (less than 40%), re-evaluate 40 or more days after discharge to best determine need for ICD

Recommendations related to Post-Hospitalization Plan of Care

The ACCF/AHA makes the following recommendations:

- System-based programs should be in place to facilitate effective discharge and coordinate outpatient care to prevent hospital re-admissions.
- In all patients with STEMI:
  - Plan of Care
    - A post-hospital plan of care should be developed with a focus on educating patient on importance of medication adherence, regular follow-up with healthcare providers, dietary and exercise adherence (lifestyle modifications) and compliance with recommendations for secondary prevention of CV disease.
  - Smoking cessation: patients should be counseled on smoking cessation and avoidance of second hand smoke for secondary prevention of CV disease
  - Cardiac rehabilitation: exercise based cardiac rehabilitation and secondary prevention programs recommended in all patients with STEMI.

Reference

O'Gara, P. T., Kushner, F. G., Ascheim, D. D., Casey, D. E., Jr, Chung, M. K., de Lemos, J. A., Ettinger, S. M., Fang, J. C., Fesmire, F. M., Franklin, B. A., Granger, C. B., Krumholz, H. M., Linderbaum, J. A., Morrow, D. A., Newby, L. K., Ornato, J. P., Ou, N., Radford, M. J., Tamis-Holland, J. E., Tommaso, C. L., … American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines (2013). 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*, *127*(4), e362–e425. https://doi.org/10.1161/CIR.0b013e3182742cf6