

Part 9: Acute Coronary Syndromes

Web-based Integrated 2010 & 2015 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Key Words: acute coronary syndrome | electrocardiogram | fibrinolytics | myocardial infarction

ST-segment elevation | unstable angina | non-ST-segment elevation

1 Highlights

The 2015 Guidelines Update marks a change in the scope of the AHA guidelines for the evaluation and management of ACS. Starting with this update, recommendations will be limited to the prehospital and emergency department phases of care. In-hospital care is addressed by guidelines for the management of myocardial infarction published jointly by the AHA and the American College of Cardiology Foundation.

Summary of Key Issues and Major Changes

Key issues with major changes in the 2015 Guidelines Update recommendations for ACS include the following:

- Prehospital ECG acquisition and interpretation
- Choosing a reperfusion strategy when prehospital fibrinolysis is available
- Choosing a reperfusion strategy at a non-PCI-capable hospital
- Troponin to identify patients who can be safely discharged from the emergency department
- Interventions that may or may not be of benefit if given before hospital arrival

Prehospital ECG Acquisition and Interpretation

2015 (New): Prehospital 12-lead ECG should be acquired early for patients with possible ACS.

2015 (New): Trained nonphysicians may perform ECG interpretation to determine whether or not the tracing shows evidence of STEMI.

2015 (Updated): Computer-assisted ECG interpretation may be used in conjunction with interpretation by a physician or trained provider to recognize STEMI.

2015 (Updated): Prehospital notification of the receiving hospital and/or prehospital activation of the catheterization laboratory should occur for all patients with a STEMI identified on prehospital ECG.

2010 (Old): If providers are not trained to interpret the 12-lead ECG, field transmission of the ECG or a computer report to the receiving hospital was recommended.

2010 (Old): Advance notification should be provided to the receiving hospital for patients identified as having STEMI.

Why: A 12-lead ECG is inexpensive, is easy to perform, and can rapidly provide evidence of acute ST elevation. Concern that nonphysician interpretation of ECGs could lead to either overdiagnosis with a resulting overuse of resources or, alternately, underdiagnosis, which could result in a delay to treatment, has inhibited expansion of ECG programs to EMS systems. Similar concerns existed with computer interpretation of ECGs. A review of the literature shows that when fibrinolysis is not given in the prehospital setting, early hospital notification of the impending arrival of a patient with ST elevation or prehospital activation of the catheterization laboratory reduces time to reperfusion and reduces morbidity and mortality. Because it may take time for the inexperienced provider to develop skill with 12-lead ECG interpretation, computer interpretation can be expected to increase the accuracy of interpretation when used in conjunction with trained nonphysician interpretation.

Reperfusion

2015 (New): Where prehospital fibrinolysis is available as part of the STEMI system of care and direct transport to a PCI center is available, prehospital triage and transport directly to a PCI center may be preferred because it results in a small relative decrease in the incidence of intracranial hemorrhage. There is, however, no evidence of mortality benefit of one therapy over the other.

2015 (New): In adult patients presenting with STEMI in the emergency department of a non-PCI-capable hospital, we recommend immediate transfer without fibrinolysis from the initial facility to a PCI center, instead of immediate fibrinolysis at the initial hospital with transfer only for ischemia-driven PCI.

2015 (New): When STEMI patients cannot be transferred to a PCI-capable hospital in a timely manner, fibrinolytic therapy with routine transfer for angiography (see below) may be an acceptable alternative to immediate transfer to primary PCI.

2015 (New): When fibrinolytic therapy is administered to a STEMI patient in a non-PCI-capable hospital, it may be reasonable to transport all postfibrinolysis patients for early routine angiography in the first 3 to 6 hours and up to 24 hours rather than transport postfibrinolysis patients only when they require ischemia-guided angiography.

2010 (Old): Transfer of high-risk patients who have received primary reperfusion with fibrinolytic therapy is reasonable.

Why: Fibrinolysis has been the standard of care for STEMI for more than 30 years. In the past 15 years, PPCI has become more readily available in most parts of North America and has been shown to modestly improve outcomes, compared with fibrinolysis, when PPCI can be provided in a timely manner by experienced practitioners. However, when there is a delay to PPCI, depending on the length of that delay, immediate fibrinolysis may overcome any additional benefits of PCI. Direct transfer to a PCI-capable hospital compared with prehospital fibrinolysis does not produce any difference in mortality, but transfer for PPCI does result in a small relative decrease in the incidence of intracranial hemorrhage. A fresh look at the evidence has allowed stratification of treatment recommendations according to time from *symptom onset* and anticipated delay to PPCI, and has enabled recommendations specifically for clinicians at non-PCI-capable hospitals. Immediate PCI after treating with fibrinolysis provides no added benefit, but routine angiography within the first 24 hours after giving fibrinolysis does reduce the incidence of reinfarction.

Troponin to Identify Patients Who Can Be Safely Discharged From the Emergency Department

2015 (New): High-sensitivity troponin T and troponin I alone measured at 0 and 2 hours (without performing clinical risk stratification) should not be used to exclude the diagnosis of ACS, but high-sensitivity troponin I measurements that are less than the 99th percentile, measured at 0 and 2 hours, may be used together with low-risk stratification (Thrombolysis in Myocardial Infarction [TIMI] score of 0 or 1, or low risk per Vancouver rule) to predict a less than 1% chance of 30-day major adverse cardiac event (MACE). Also, negative troponin I or troponin T measurements at 0 and between 3 and 6 hours may be used together with very low-risk stratification (TIMI score of 0, low risk score per Vancouver rule, North American Chest Pain score of 0 and age less than 50 years, or low-risk HEART score) to predict a less than 1% chance of 30-day MACE.

2010 (Old): If biomarkers are initially negative within 6 hours of symptom onset, it was recommended that biomarkers should be remeasured between 6 to 12 hours after symptom onset.

Why: Relying on a negative troponin test result, either alone or in combination with *unstructured* risk assessment, results in an unacceptably high rate of MACE at 30 days. However, predictions based on negative troponin test results, combined with *structured* risk assessment, carry a risk of less than 1% of MACE at 30 days.

Other Interventions

When a medication reduces morbidity or mortality, prehospital compared with hospital administration of that medication allows the drug to begin its work sooner and may further decrease morbidity or mortality. However, when urban EMS response and transport times are short, the opportunity for beneficial drug effect may not be great. Moreover, adding medications increases the complexity of prehospital care, which may in turn produce negative effects.

- Adenosine diphosphate inhibition for hospital patients with suspected STEMI has been recommended for many years. Administration of an adenosine diphosphate inhibitor in the prehospital setting provides neither additional benefit nor harm compared with waiting to administer it in the hospital.
- Unfractionated heparin (UFH) administered to patients with STEMI in the prehospital setting has not been shown to provide additional benefits to giving it in the hospital. In systems where prehospital administration of UFH already occurs, it is reasonable to continue to use it. Where it is not already used in the prehospital setting, it is just as reasonable to wait to give UFH until hospital arrival.
- Before the 2010 recommendations, oxygen was routinely administered to all patients with suspected ACS regardless of oxygen saturation or respiratory condition. In 2010, weak evidence of no benefit and possible harm prompted a recommendation that supplementary oxygen was not needed for patients with ACS who had an oxyhemoglobin saturation of 94% or greater (i.e., no hypoxemia) and no evidence of respiratory distress. Further evidence that the routine administration of supplementary oxygen may be harmful, supported by a multicenter randomized controlled trial published since the 2015 systematic review, strengthens the recommendation that oxygen be withheld from patients with possible ACS who have a normal oxygen saturation (ie, who are without hypoxemia).
- For STEMI patients, prehospital administration of UFH or bivalirudin is reasonable.
- For suspected STEMI patients who are being transferred for PPCI, enoxaparin is a reasonable alternative to UFH.

2 Introduction - Updated

These Web-based Integrated Guidelines incorporate the relevant recommendations from 2010 and the new or updated recommendations from 2015.

Clinicians often struggle with uncertainty and complexity in deciding which course of treatment will likely lead to an optimal outcome for an individual patient. Scientific research provides information on how patient populations have responded to treatment regimens, and this information, combined with a knowledge of the individual patient, can help guide the clinician's decisions.

The recommendations in the *2015 American Heart Association (AHA) Guidelines Update for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC)* are based on an extensive evidence review process that was begun by the International Liaison Committee on Resuscitation (ILCOR) after the publication of the *ILCOR 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations*^{1,2} and was completed in February 2015.^{3,4}

In this in-depth evidence review process, ILCOR examined topics and then generated a prioritized list of questions for systematic review. Questions were first formulated in PICO (population, intervention, comparator, outcome) format,⁵ and then a search for relevant articles was performed. The evidence was evaluated by the ILCOR task forces by using the standardized methodologic approach proposed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group.⁶

The quality of the evidence was categorized based on the study methodologies and the 5 core GRADE domains of risk of bias, inconsistency, indirectness, imprecision, and other considerations (including publication bias). Then, where possible, consensus-based treatment recommendations were created.

To create this *2015 AHA Guidelines Update for CPR and ECC*, the AHA formed 15 writing groups, with careful attention to avoid conflicts of interest, to assess the ILCOR treatment recommendations, and to write AHA treatment recommendations by using the AHA Class of Recommendation and Level of Evidence (LOE) system. The recommendations made in the *2015 Guidelines Update for CPR and ECC* are informed by the ILCOR recommendations and GRADE classification, in the context of the delivery of medical care in North America. In the online version of this publication, live links are provided so the reader can connect directly to the systematic reviews on the Scientific Evidence Evaluation and Review System (SEERS) website. These links are indicated

by a superscript combination of letters and numbers (eg, ACS 873).

This 2015 Guidelines Update offers recommendations for the care of patients with acute coronary syndromes (ACS). The recommendations in this Web-based Integrated Guidelines include issues that were reviewed in 2015 as well as the recommendations from the the 2010 Guidelines that are still relevant.

The ILCOR ACS Task Force did not review areas in which it found a paucity of new evidence between 2010 and 2015; therefore, the 2010 Guidelines for these unreviewed areas remain current. For example, acetylsalicylic acid administration has been shown to be of benefit in ACS and was recommended by the 2010 Guidelines.⁷ Acetylsalicylic acid was not reviewed by the ACS Task Force in 2015, so the recommendations from 2010 should be used. (Note: The First Aid section of this 2015 Guidelines Update makes recommendations on acetylsalicylic acid administration by nonmedical personnel—see “[Part 15: First Aid](#)”). The recommendations that were not reviewed in 2015 will either be reviewed and included in future *AHA Guidelines for CPR and ECC* or will be in the most recent ACC/AHA Guidelines.⁸⁻¹⁰

A table of recommendations made in this update, as well as the recommendations made in “Part 10: Acute Coronary Syndromes” of the 2010 Guidelines,⁷ can be found in the Appendix.

The 2015 Guidelines for ACS are directed toward practitioners who provide care for patients with suspected ACS from the time of first medical contact until disposition from the emergency department (ED). Care providers during this time may include emergency medical service (EMS) dispatchers, first responders, EMT-Bs, paramedics, nurses, physicians, and other independent practitioners.

3 Methodology - Updated

ILCOR performed 18 systematic reviews (14 based on meta-analyses) on more than 110 relevant studies that span 40 years. Based on these reviews, the ACS Writing Group assessed the evidence and assigned an LOE by using AHA definitions. The LOE for a given intervention supports the class or “strength” of recommendation that the writing group assigned. This update uses the newest AHA Class of Recommendation and LOE classification system, which contains modifications to the Class III recommendation and introduces LOE B-R (randomized studies) and B-NR (nonrandomized studies), as well as LOE C-LD (limited data) and LOE C-EO (consensus of expert opinion). For further information, see “[Part 2: Evidence Evaluation and Management of Conflicts of Interest](#).”

4 Patient and Healthcare Provider Recognition of ACS

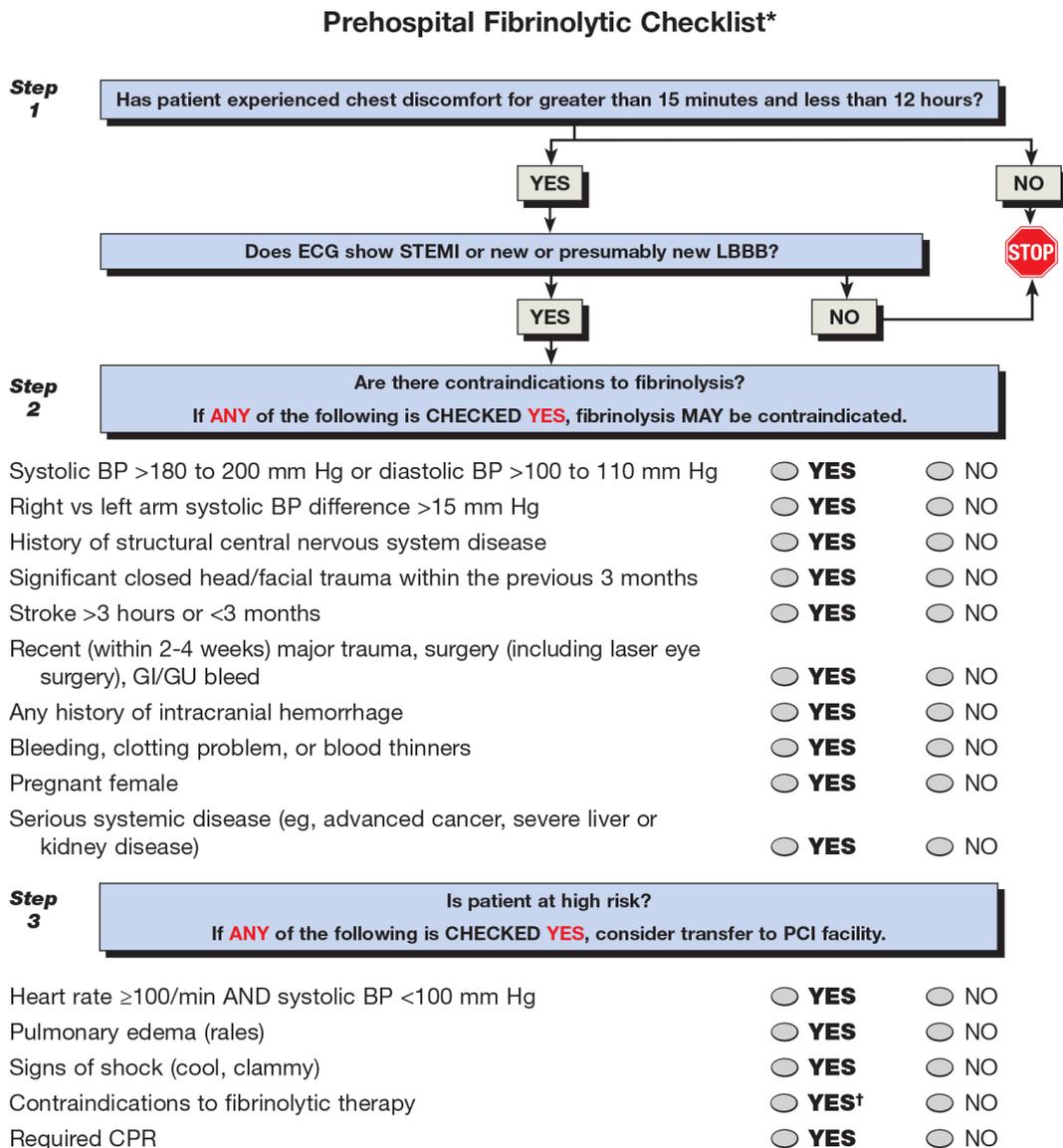
Prompt diagnosis and treatment offers the greatest potential benefit for myocardial salvage in the first hours of STEMI; and early, focused management of unstable angina and NSTEMI reduces adverse events and improves outcome.¹¹ Thus, it is imperative that healthcare providers recognize patients with potential ACS in order to initiate the evaluation, appropriate triage, and management as expeditiously as possible; in the case of STEMI, this recognition also allows for prompt notification of the receiving hospital and preparation for emergent reperfusion therapy. Potential delays to therapy occur during 3 intervals: from onset of symptoms to patient recognition, during prehospital transport, and during emergency department (ED) evaluation.

Patient-based delay in recognition of ACS and activation of the emergency medical services (EMS) system often constitutes the longest period of delay to treatment.¹² With respect to the prehospital recognition of ACS, numerous issues have been identified as independent factors for prehospital treatment delay (ie, symptom-to-door time), including older age,¹³ racial and ethnic minorities,^{14,15} female gender,¹⁶ lower socioeconomic status,^{17,18} and solitary living arrangements.^{14,19}

Hospital-based delays in ACS recognition range from nonclassical patient presentations and other confounding diagnostic issues to provider misinterpretation of patient data and inefficient in-hospital system of care.^{16,20-23}

Symptoms of ACS may be used in combination with other important information (biomarkers, risk factors, ECG, and other diagnostic tests) in making triage and some treatment decisions in the out-of-hospital and ED settings. The symptoms of AMI may be more intense than angina and most often persist for longer periods of time (eg, longer than 15–20 minutes). The classic symptom associated with ACS is chest discomfort, but symptoms may also include discomfort in other areas of the upper body, shortness of breath, sweating, nausea, vomiting, and dizziness. Most often the patient will note chest or upper body discomfort and dyspnea as the predominant presenting symptoms accompanied by diaphoresis, nausea, vomiting, and dizziness.²⁴⁻²⁶ Isolated diaphoresis, nausea, vomiting, or dizziness are unusual predominant presenting symptoms.²⁷ Atypical or unusual symptoms are more common in women, the elderly, and diabetic patients.²⁸⁻³⁰ The physical examination of the patient with ACS is often normal.

Figure 1: Prehospital Fibrinolytic Checklist



*Contraindications for fibrinolytic use in STEMI are viewed as advisory for clinical decision making and may not be all-inclusive or definitive. These contraindications are consistent with the 2004 ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction.

[†]Consider transport to primary PCI facility as destination hospital.

Prehospital fibrinolytic checklist. Adapted from Antman EM, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of Patients with Acute Myocardial Infarction). *Circulation*. 2004;110:e82-e292, with permission from Lippincott Williams & Wilkins. Copyright 2004, American Heart Association.

(Figure 1). Prehospital Fibrinolytic Checklist. Adapted from Antman EM, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of Patients with Acute Myocardial Infarction). *Circulation*. 2004;110:e82-e292, with permission from Lippincott Williams & Wilkins. Copyright 2004, American Heart Association.

Public education campaigns increase patient awareness and knowledge of the symptoms of ACS, yet have only transient effects on time to presentation.^{31,32} For patients at risk for ACS (and for their families), primary care physicians and other healthcare providers should consider discussing the appropriate use of aspirin and activation of EMS system. Furthermore, an awareness of the location of the nearest hospital that offers 24-hour

emergency cardiovascular care can also be included in this discussion. Previous guidelines have recommended that the patient, family member, or companion activate the EMS system rather than call their physician or drive to the hospital if chest discomfort is unimproved or worsening 5 minutes after taking 1 nitroglycerin treatment.³³

5 Initial EMS Care

Half the patients who die of ACS do so before reaching the hospital. VF or pulseless VT is the precipitating cardiac arrest rhythm in most of these deaths,^{34,35} and it is most likely to develop in the early phase of ACS evolution.³⁶ Communities should develop programs to respond to cardiac emergencies that include the prompt recognition of ACS symptoms by patients and their companions as well as by healthcare and public safety providers and early activation of the EMS system. Additional features of such a program include high-quality CPR for patients in cardiac arrest (see [Part 5: "Adult Basic Life Support"](#)) and rapid access to and use of an automated external defibrillator (AED) through community AED programs (see [Part 6: "Electrical Therapies"](#)).³⁷ Emergency dispatch center personnel should be educated in the provision of CPR instructions for lay rescuers before the arrival of EMS. EMS providers should be trained to respond to cardiovascular emergencies, including ACS and its acute complications.

Emergency dispatch center personnel can provide instructions to the patient or caller before EMS arrival.

Because aspirin should be administered as soon as possible after symptom onset to patients with suspected ACS, it is reasonable for EMS dispatchers to instruct patients with no history of aspirin allergy and without signs of active or recent gastrointestinal bleeding to chew an aspirin (160 to 325 mg) while awaiting the arrival of EMS providers.³⁸⁻⁴³ ***(Class IIa, LOE C)***

EMS providers should be familiar with the presentation of ACS and trained to determine the time of symptom onset. EMS providers should monitor vital signs and cardiac rhythm and be prepared to provide CPR and defibrillation if needed.

EMS providers administer oxygen during the initial assessment of patients with suspected ACS. However, there is insufficient evidence to support its routine use in uncomplicated ACS.

If the patient is dyspneic, hypoxemic, or has obvious signs of heart failure, providers should titrate therapy, based on monitoring of oxyhemoglobin saturation, to ≥94%.⁴⁴ ***(Class I, LOE C)***

EMS providers should administer nonenteric aspirin (160* to 325* mg). ***(Class I, LOE B)***
Class I, LOE C)

The patient should chew the aspirin tablet to hasten absorption.^{38,45-47} EMS providers should administer up to 3 nitroglycerin doses (tablets or spray) at intervals of 3 to 5 minutes. Nitrates in all forms are contraindicated in patients with initial systolic blood pressure <90 mm Hg or ≥30 mm Hg below baseline and in patients with right ventricular infarction.⁴⁸⁻⁵⁰ Caution is advised in patients with known inferior wall STEMI, and a right-sided ECG should be performed to evaluate RV infarction. Administer nitrates with extreme caution, if at all, to patients with inferior STEMI and suspected right ventricular (RV) involvement because these patients require adequate RV preload. Nitrates are contraindicated when patients have taken a phosphodiesterase-5 (PDE-5) inhibitor within 24 hours (48 hours for tadalafil).⁵¹

Morphine is indicated in STEMI when chest discomfort is unresponsive to nitrates. ***(Class I, LOE C)***

Morphine should be used with caution in unstable angina (UA)/NSTEMI due to an association with increased mortality in a large registry.⁵² ***(Class IIa, LOE C)***

The efficacy of other analgesics is unknown.

6 Diagnostic Interventions in ACS - Updated

6.1 Prehospital ECG and Prehospital STEMI Activation of the Catheterization Laboratory - Updated [ACS 873](#) [ACS 336](#)

Prehospital 12-lead ECGs speed the diagnosis, shorten the time to reperfusion (fibrinolytics⁵³⁻⁶⁰ or primary percutaneous coronary intervention [PPCI]⁶¹⁻⁶⁸). EMS personnel should routinely acquire a 12-lead electrocardiogram (ECG) as soon as possible for all patients exhibiting signs and symptoms of ACS. The ECG may be transmitted for remote interpretation by a physician or screened for STEMI by properly trained paramedics, with or without the assistance of computer-interpretation.

Prehospital acquisition of 12-lead electrocardiograms (ECGs) has been recommended by the AHA Guidelines for CPR and Emergency Cardiovascular Care since 2000. The 2015 ILCOR systematic review examined whether acquisition of a prehospital ECG with transmission of the ECG to the hospital, notification of the hospital of the need for fibrinolysis, or activation of the catheterization laboratory changes any major outcome.

6.1.1 2015 Evidence Summary

Obtaining an ECG early in the assessment of patients with possible ACS ensures that dynamic ECG changes suggestive of cardiac ischemia and ACS will be identified, even if they normalize before initial treatment.⁶⁹

An early ECG may also enable ST elevation myocardial infarction (STEMI) to be recognized earlier. Acquiring a prehospital ECG and determining the presence of STEMI effectively makes the prehospital provider the first medical contact. The prehospital ECG can reliably enable identification of STEMI before arrival at the hospital,⁷⁰ but if notification of the receiving facility does not occur, any benefit to prehospital STEMI recognition is lost.

Prehospital ECG acquisition coupled with hospital notification if STEMI is identified consistently reduces the time to reperfusion in-hospital (first medical contact-to-balloon time, first medical contact-to-needle time, door-to-balloon time, door-to-needle time).⁷¹ To reduce time to STEMI reperfusion in-hospital, rapid transport and early treatment must occur in parallel with hospital preparation for the arriving patient.

Prehospital ECGs reduce the time to reperfusion with fibrinolytic therapy and also reduce the time to primary percutaneous coronary intervention (PPCI) and facilitate triage of STEMI patients to specific hospitals.⁴ Prehospital activation of the catheterization laboratory (as opposed to delaying cardiac catheterization laboratory activation until the patient arrives at the hospital) is independently associated with improved times to PPCI and reduced mortality.⁴

Prehospital ECG acquisition and hospital notification reduce mortality by 32% when PPCI is the reperfusion strategy (benefit is accentuated when prehospital activation occurs) and by 24% when ED fibrinolysis is the reperfusion strategy.⁴

6.1.2 2015 Recommendations - Updated

Prehospital 12-lead ECG should be acquired early for patients with possible ACS. (Class I, LOE B-NR)

Prehospital notification of the receiving hospital (if fibrinolysis is the likely reperfusion strategy) and/or prehospital activation of the catheterization laboratory should occur for all patients with a recognized STEMI on prehospital ECG. (Class I, LOE B-NR)

Implementation of 12-lead ECG diagnostic programs with concurrent medically-directed quality assurance is recommended. (Class I, LOE B)

Prehospital personnel can accurately identify ST-segment elevation from the 12-lead ECG.^{55,58,72-85}

If providers are not trained to interpret the 12-lead ECG, field transmission of the ECG or a computer report to the receiving hospital is recommended. (Class I, LOE B)

6.2 ED Evaluation and Risk Stratification (Figure 1, Boxes 3 and 4)

6.2.1 Focused Assessment and ECG Risk Stratification

ED providers should quickly assess patients with possible ACS. Ideally within 10 minutes of ED arrival providers should obtain a targeted history while a monitor is attached to the patient and a 12-lead ECG is obtained (if not done in the prehospital setting).⁸⁶ The evaluation should focus on chest discomfort, associated signs and symptoms, prior cardiac history, risk factors for ACS, and historical features that may preclude the use of fibrinolytics or other therapies.

This initial evaluation must be efficient because if the patient has STEMI, the goals of reperfusion are to administer fibrinolytics within 30 minutes of arrival (30-minute interval “door-to-drug”) or to provide PCI within 90 minutes of arrival (90-minute interval “door-to-balloon”). (Class I, LOE A)

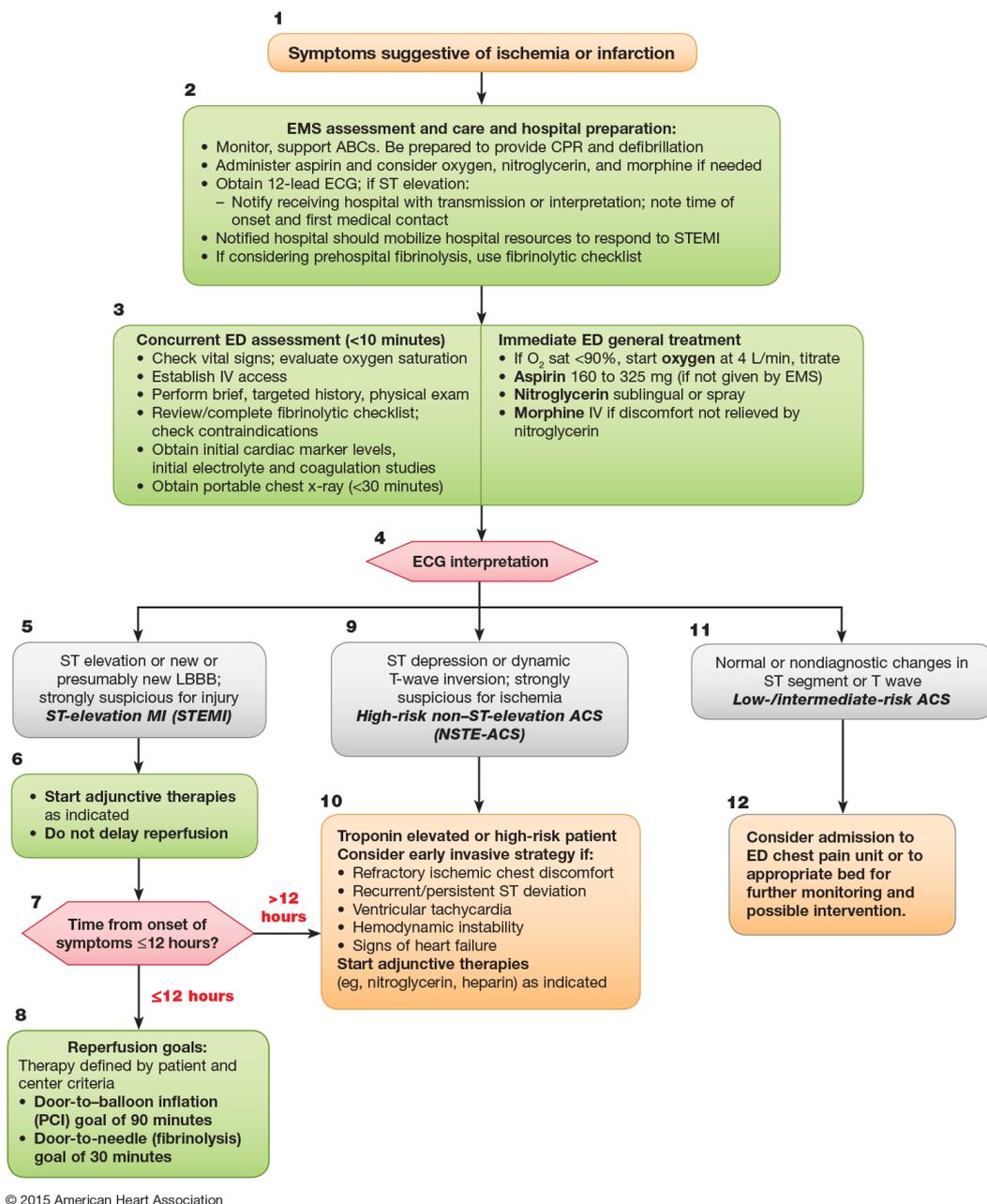
Potential delay during the in-hospital evaluation period may occur from door to data, from data (ECG) to decision, and from decision to drug (or PCI). These 4 major points of in-hospital therapy are commonly referred to as the “4 D’s.”⁸⁷ All providers must focus on minimizing delays at each of these points. Prehospital transport time constitutes only 5% of delay to treatment time; ED evaluation constitutes 25% to 33% of this delay.^{88,87-90}

The physical examination is performed to aid diagnosis, rule out other causes of the patient’s symptoms, and evaluate the patient for complications related to ACS. Although the presence of clinical signs and symptoms may increase suspicion of ACS, evidence does not support the use of any single sign or combination of clinical signs and symptoms alone to confirm the diagnosis.^{24-26,91}

When the patient presents with symptoms and signs of potential ACS, the clinician uses ECG findings (Figure 2 : Acute Coronary Syndromes, Box 4) to classify the patient into 1 of 3 groups:

Figure 2: Acute Coronary Syndromes Algorithm - 2015 Update

Acute Coronary Syndromes Algorithm—2015 Update



1. ST-segment elevation or presumed new LBBB (Box 5) is characterized by ST-segment elevation in 2 or more contiguous leads and is classified as *ST-segment elevation MI (STEMI)*. Threshold values for ST-segment elevation consistent with STEMI are J-point elevation 0.2 mV (2 mm) in leads V2 and V3 and 0.1 mV (1 mm) in all other leads (men ≥40 years old); J-point elevation 0.25 mV (2.5 mm) in leads V2 and V3 and 0.1 mV (1 mm) in all other leads (men <40 years old); J-point elevation 0.15 mV (1.5 mm) in leads V2 and V3 and 0.1 mV (1 mm) in all other leads (women).⁹²

2. Ischemic ST-segment depression >0.5 mm (0.05 mV) or dynamic T-wave inversion with pain or discomfort (Box 9) is classified as UA/NSTEMI. Nonpersistent or transient ST-segment elevation ≥0.5 mm for <20 minutes is also included in this category. Threshold values for ST-segment depression consistent with ischemia are J-point depression 0.05 mV (-.5 mm) in leads V2 and V3 and -0.1 mV (-1 mm) in all other leads (men and women).⁹²

3. The nondiagnostic ECG with either normal or minimally abnormal (ie, nonspecific ST-segment or T-wave changes, Box 13). This ECG is nondiagnostic and inconclusive for ischemia, requiring further risk stratification. This classification includes patients with normal ECGs and those with ST-segment deviation of <0.5 mm (0.05

mV) or T-wave inversion of ≥ 0.2 mV. This category of ECG is termed *nondiagnostic*.

The interpretation of the 12-lead ECG is a key step in this process, allowing not only for this classification but also the selection of the most appropriate diagnostic and management strategies.

6.2.2 Cardiac Biomarkers

Serial cardiac biomarkers are often obtained during evaluation of patients suspected of ACS. Cardiac troponin is the preferred biomarker and is more sensitive than creatine kinase isoenzyme (CK-MB). Cardiac troponins are useful in diagnosis, risk stratification, and determination of prognosis. An elevated level of *troponin* correlates with an increased risk of death, and greater elevations predict greater risk of adverse outcome.⁹³

Clinicians should take into account the timing of symptom onset and the sensitivity, precision, and institutional norms of the assay, as well as the release kinetics and clearance of the measured biomarker.

A diagnosis of myocardial infarction can be made when clinical symptoms or new ECG abnormalities are consistent with ischemia and one biomarker is elevated above the 99th percentile of the upper reference limit (URL) using a test with optimal precision defined as a CV $\leq 10\%$.

There is insufficient evidence to support the use of troponin point-of-care testing (POCT) either in or out of hospital. There is also insufficient evidence to support the use of myoglobin, β -natriuretic peptide (BNP), NT-proBNP, D-dimer, C-reactive protein, ischemia-modified albumin pregnancy-associated plasma protein A (PAPP-A) or interleukin-6 in isolation.

6.2.3 STEMI (Figure 1, Boxes 5 Through 8)

Patients with STEMI usually have complete occlusion of an epicardial coronary artery. The primary goal of initial treatment is early reperfusion therapy through administration of fibrinolytics (pharmacological reperfusion) or PPCI (mechanical reperfusion). Providers should rapidly identify patients with STEMI and quickly screen them for indications and contraindications to fibrinolytic therapy and PCI. Patients who are ineligible for fibrinolytic therapy should be considered for transfer to a PCI facility regardless of delay.

Within a STEMI system of care, the first physician who encounters a patient with STEMI determines the need and strategy (fibrinolytic or PPCI) for reperfusion therapy (see Table 1: ST-Segment Elevation or New or Presumably New LBBB: Evaluation for Reperfusion).

If the patient meets the criteria for fibrinolytic therapy, a door-to-needle time (initiation of fibrinolytic agent) (Class I, LOE A)

Routine consultation with a cardiologist or another physician is not recommended except in equivocal or uncertain cases.^{94,95}

Consultation delays therapy and is associated with increased hospital mortality rates. (Class III, LOE B)

Table 1: 2010 - ST-Segment Elevation or New or Presumably New LBBB: Evaluation for Reperfusion

Open table in a [new window](#)

ST-Segment Elevation or New or Presumably New LBBB: Evaluation for Reperfusion

Step 1: Assess time and risk

Time since onset of symptoms

Risk of STEMI	
Risk of fibrinolysis	
Time required to transport to skilled PCI catheterization suite	
Step 2: Select reperfusion (fibrinolysis or invasive) strategy	
<i>Note:</i> If presentation <3 hours and no delay for PCI, then no preference for either strategy.	
<p>Fibrinolysis is generally preferred if:</p> <ul style="list-style-type: none"> • Early presentation (≤3 hours from symptom onset) • Invasive strategy is not an option (eg, lack of access to skilled PCI facility or difficult vascular access) or would be delayed <ul style="list-style-type: none"> ○ - Medical contact-to-balloon or door-to-balloon >90 minutes ○ - (Door-to-balloon) minus (door-to-needle) is >1 hour • No contraindications to fibrinolysis 	<p>An invasive strategy is generally preferred if:</p> <ul style="list-style-type: none"> • Late presentation (symptom onset >3 hours ago) • Skilled PCI facility available with surgical backup • Medical contact-to-balloon or door-to-balloon <90 minutes • (Door-to-balloon) minus (door-to-needle) is <1 hour • Contraindications to fibrinolysis, including increased risk of bleeding and ICH • High risk from STEMI (CHF, Killip class is ≥3) • Diagnosis of STEMI is in doubt
<ul style="list-style-type: none"> • Modified from ACC/AHA 2004 Update Recommendations.[reference id="4607" range="" /] 	

6.2.4 UA and NSTEMI (Figure 1, Boxes 9 Through 12)

Unstable angina (UA) and NSTEMI are difficult to distinguish initially. These patients usually have a partially or intermittently occluding thrombus. Both ACS syndromes may present with similar symptoms and ECG. Clinical features can correlate with the dynamic nature of clot formation and degradation (eg, waxing and waning clinical symptoms). The ECG will demonstrate a range of findings short of diagnostic ST-segment deviation; these ECG presentations include normal, minimal nonspecific ST-segment/T-wave changes, and significant ST-segment depression and T-wave inversions.

An elevated biomarker separates NSTEMI from UA and has incremental value in addition to the ECG. Elevation of cardiac troponin indicates increased risk for major adverse cardiac events and benefit from an invasive strategy. Cardiac troponins indicate myocardial necrosis, although numerous conditions other than ACS may cause elevated biomarkers (eg, myocarditis, heart failure, and pulmonary embolism).

Management strategies for UA/NSTEMI include antiplatelet, antithrombin, and antianginal therapy and are based on risk stratification. Fibrinolysis is contraindicated in this heterogeneous group of patients and may be harmful; an invasive strategy is indicated in patients with positive biomarkers or unstable clinical features.

6.2.4.1 The Process of Risk Stratification

Diagnosis of ACS and risk stratification become an integrated process in patients presenting to an acute care setting with possible ACS and an initially nondiagnostic evaluation. This nondiagnostic evaluation includes a normal or nondiagnostic 12-lead ECG and normal serum cardiac biomarker concentrations. The majority of these patients will not be experiencing an ACS, but many may have underlying CAD or other clinical features putting them at subsequent risk for major adverse cardiac events over the course of a few days to several months.

A major goal of the risk stratification process is to identify those patients who do not appear to have high-risk features on initial assessment but are found, through the course of the diagnostic process, to have ACS and clinically significant CAD. This strategy allows physicians to target patients who would benefit from guideline-based ACS therapies while avoiding unnecessary procedural and pharmacological risks (eg, anticoagulation therapy and invasive cardiac catheterization) in patients with low risk for major adverse cardiac events.

Although the diagnosis of ACS is important and will help to guide immediate therapy, the estimation of risk for major adverse cardiac events in the immediate, short-term, and long-term time frames helps the physician determine the urgency in completing the diagnostic workup not just for ACS but also for CAD. Many patients can be managed in the outpatient setting once it is determined that they are at very low risk for short-term (30 days) major adverse cardiac events.

6.2.4.1.1 Braunwald Risk Stratification

ACC/AHA Guidelines recommend that all patients be risk stratified for the selection of an initial management strategy and site of care.⁸⁸ A well-recognized approach is the one initially proposed and later refined by Braunwald and colleagues and published in ACC/AHA Guidelines on the Management of Patients With Unstable Angina and Non-ST Segment Elevation MI.⁹⁶⁻¹⁰⁰ This approach is based on a combination of historical, clinical, laboratory, and ECG variables and answers two questions: what is the likelihood that signs and symptoms represent ACS secondary to obstructive CAD, and what is the likelihood of an adverse clinical outcome?

Table 2¹⁰¹ is a modified version of Braunwald and colleagues' approach updated over several publications.^{98,100,102} Patients are initially risk-stratified according to the likelihood that symptoms are due to unstable CAD. Patients at intermediate or high risk for CAD are further classified by their risk of major adverse cardiac events. This second classification is useful for prospectively identifying patients at intermediate or high risk who can benefit from an invasive strategy and more aggressive pharmacology with antiplatelet and antithrombin agents. Other risk stratification schemes include the TIMI, GRACE, and PURSUIT risk scores developed for short- and longer-term risk assessment.¹⁰³⁻¹⁰⁷ Stratification tools cannot be used to determine discharge from the ED.

Table 2: 2010 - Likelihood That Signs and Symptoms Represent ACS Secondary to CAD

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Likelihood That Signs and Symptoms Represent ACS Secondary to CAD			
Feature	High Likelihood <i>Any of the following:</i>	Intermediate Likelihood <i>Absence of high-likelihood features and presence of any of the following:</i>	Low Likelihood <i>Absence of high- or intermediate-likelihood features but may have the following:</i>
History	Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina; known history of CAD including MI	Chest or left arm pain or discomfort as chief symptom; age >70 years; male sex; diabetes mellitus	Probable ischemic symptoms in absence of any intermediate-likelihood characteristics; recent cocaine use

Feature	High Likelihood <i>Any of the following:</i>	Intermediate Likelihood <i>Absence of high-likelihood features and presence of any of the following:</i>	Low Likelihood <i>Absence of high- or intermediate-likelihood features but may have the following:</i>
Examination	Transient MR murmur, hypotension, diaphoresis, pulmonary edema, or rales	Extracardiac vascular disease	Chest discomfort reproduced by palpation
ECG	New or presumably new transient ST-segment deviation (≥ 1 mm) or T-wave inversion in multiple precordial leads	Fixed Q waves ST depression 0.5 to 1 mm or T-wave inversion >1 mm	T-wave flattening or inversion <1 mm in leads with dominant R waves Normal ECG
Cardiac markers	Elevated cardiac TnI, TnT, or CK-MB	Normal	Normal

- CAD indicates coronary artery disease; CK-MB, MB fraction of creatine kinase; ECG, electrocardiogram; MI, myocardial infarction; MR, mitral regurgitation; TnI, troponin I; and TnT, troponin T.

Modified from Braunwald E, et al. *Unstable Angina: Diagnosis and Management*. 1994;3-1-AHCPR Publication No 94-0602:1-154. In the public domain.[reference id="4732" range="" /]

6.2.4.1.2 TIMI Risk Score

Recommendations concerning TIMI Risk Scores were not reviewed in 2015. Please refer to the [2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes](#) or the [2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction](#) for information on this topic.

6.2.5 Indicators for Early Invasive Strategies

Risk stratification (Figure 2, Boxes 9, 13, 14, 15) helps the clinician identify patients with non–ST-elevation ACS who should be managed with an early invasive strategy versus a selectively invasive one. Early coronary angiography may allow the clinician to determine whether patients are appropriate candidates for revascularization with PCI or coronary artery bypass grafting (CABG).

The 2007 Focused Update of the ACC/AHA/SCAI 2005 Guideline Update for Percutaneous Coronary Intervention contains the following recommendations related to the selection of early invasive PCI versus conservative strategies.

1. An early invasive PCI strategy is indicated for patients with non–ST-elevation ACS who have no serious comorbidity and who have coronary lesions amenable to PCI and an elevated risk for clinical events. (Class I, LOE A)

(See Table 3 and Section 3.3 of the ACC/AHA 2007 UA/NSTEMI Guidelines).

2. An early invasive strategy (ie, diagnostic angiography with intent to perform revascularization) is indicated in non–ST-elevation ACS patients who have refractory angina or hemodynamic or electric instability (without serious comorbidities or contraindications to such procedures). (Class I, LOE B)

3. In initially stabilized patients, an initially conservative (ie, a selectively invasive) strategy may be considered as a treatment strategy for non–ST-elevation ACS patients (without serious comorbidities or contraindications to such procedures) who have an elevated risk for clinical events including those with abnormal troponin elevations. (Class IIb, LOE B)

4. The decision to implement an initial conservative (versus initial invasive) strategy in these patients may be made by considering physician and patient preference. (Class IIb, LOE C)

Table 3: 2010 - Selection of Initial Treatment Strategy for Patients With Non-ST-Elevation ACS: Invasive Versus Conservative Strategy

Open table in a [new window](#)

Selection of Initial Treatment Strategy for Patients With Non-ST-Elevation ACS: Invasive Versus Conservative Strategy

Preferred Strategy

Patient Characteristics

Invasive	<ul style="list-style-type: none"> • Recurrent angina or ischemia at rest or with low-level activities despite intensive medical therapy • Elevated cardiac biomarkers (TnT or TnI) • New or presumably new ST-segment depression • Signs or symptoms of HF or new or worsening mitral regurgitation • High-risk findings from noninvasive testing • Hemodynamic instability • Sustained ventricular tachycardia • PCI within 6 months • Prior CABG • High-risk score (eg, TIMI, GRACE) • Reduced LV function (LVEF less than 40%)
Conservative	<ul style="list-style-type: none"> • Low-risk score (eg, TIMI, GRACE) • Patient or physician preference in absence of high-risk features
<ul style="list-style-type: none"> • CABG indicates coronary artery bypass graft surgery; GRACE, Global Registry of Acute Coronary Events; HF, heart failure; LV, left ventricular; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention; TIMI, Thrombolysis in Myocardial Infarction; TnI, troponin I; and TnT, troponin T. • ?* Adapted from the ACC/AHA 2007 UA/NSTEMI Guidelines. 	

6.2.6 Normal or Nondiagnostic ECG Changes (Figure 1, Boxes 13 Through 17)

The majority of patients with normal or nondiagnostic ECGs do not have ACS. Patients in this category with ACS are most often at low or intermediate risk. The physician's goal involves risk stratification (see above) to provide appropriate diagnostic or treatment strategies for an individual patient. These strategies then target patients at increased risk for benefit while avoiding risk (eg, anticoagulation therapy and invasive cardiac catheterization) in patients with low or minimal risk.

6.2.6.1 The Chest Pain Unit Model

Chest pain observation protocols may be employed in a dedicated space (ie, a physical chest pain unit [CPU]) or throughout an ED/hospital (ie, virtual CPU). These chest pain observation protocols are a rapid system of patient

assessment that should generally include a history and physical examination, a period of observation, serial electrocardiography, and serial measurement of serum cardiac markers. In selected patients, an evaluation for inducible myocardial ischemia or anatomic coronary disease after AMI is excluded when indicated. Eleven randomized trials¹⁰⁸⁻¹¹⁸ suggest that these protocols may be used to improve accuracy in identifying patients requiring inpatient admission or further diagnostic testing and, thereby, reduce length of stay, rate of hospital admission, and health care costs while improving quality of life measures.

In patients with suspicion for ACS, normal initial biomarkers, and nonischemic ECG, chest pain observation protocols may be recommended as a safe and effective strategy for evaluating patients in the ED. (Class I, LOE A)

There is no direct evidence demonstrating that CPUs/observation protocols reduce adverse cardiovascular outcomes, including mortality for patients presenting with possible ACS, normal serum cardiac biomarkers, and a nondiagnostic ECG.

6.2.6.2 Advanced Testing to Detect Coronary Ischemia and CAD

For ED/CPU patients who are suspected of having ACS, have nonischemic ECG's and negative biomarkers, a noninvasive test for inducible myocardial ischemia or anatomic evaluation of the coronary arteries (eg, computed tomography [CT] angiography, cardiac magnetic resonance, myocardial perfusion imaging, stress echocardiography) can be useful in identifying patients suitable for discharge from the ED. (Class IIa, LOE B)

This strategy may be considered to increase diagnostic accuracy for ACS thereby decreasing costs, length of stay, time to diagnosis, and can provide valuable short-term and long-term prognostic information of future major cardiac events.

Myocardial perfusion scintigraphy (MPS) has a high negative predictive value (NPV) for ruling out ACS; 99% in patients presenting to the ED with acute chest pain, nondiagnostic ECG, and negative cardiac markers.

MPS can also be used for risk stratification, especially in low- to intermediate-likelihood of cardiac events according to traditional cardiac markers.¹¹⁹⁻¹²² (Class IIa, LOE B)

MPS is best utilized in patients with an intermediate probability or LOE of risk stratification.

The use of multidetector computed tomography (MDCT) angiography (64-slice scanner) after presentation to the ED with chest discomfort, a nondiagnostic ECG, and negative cardiac biomarkers has also been demonstrated to have high sensitivity and specificity for CAD and ACS.^{123,124}

The use of MDCT angiography for selected low-risk patients can be useful to allow for safe early discharge from the ED.¹²⁵⁻¹²⁷ (Class IIa, LOE B)

It is reasonable to consider both the exposure to radiation and iodinated contrast agents when using MDCT angiography and myocardial perfusion imaging. Little evidence is available to support the use of MRI in this patient population.

6.2.6.3 Safety of Discharge and Risk of Major Adverse Cardiac Events After Discharge From the ED/CPU

The final step in the CPU risk-stratification process is the decision to discharge or admit the patient. No simple clinical decision rule is adequate and appropriate to identify ED chest discomfort patients with suspected ACS who can be safely discharged from the ED.¹²⁸

The use of inpatient-derived risk scoring systems are useful for prognosis* but are not recommended to

identify patients who may be safely discharged from the ED. (Class I, LOE A; **Class III, LOE C*)**

The Bayesian process of serial assignment of pretest risk, diagnostic testing, and reclassification into post-test risk levels based on the test results is the most reliable method to identify patients at the lowest risk for short term major adverse cardiac events and those patients in need of further evaluation for underlying CAD.

Patients at low and intermediate clinical risk for ACS who have remained stable in the CPU and have negative serial ECGs, serial cardiac biomarker measurements, and noninvasive physiological or anatomic testing for ACS have very low rates of major adverse cardiac events at 30 days from ED discharge.¹²⁹⁻¹³³ Patients younger than 40 years-of-age with nonclassical presentations and no significant past medical history have very low short-term rates of major adverse cardiac events when serial biomarkers and 12-lead ECGs are normal. These patients may be discharged directly from the ED/CPU if appropriate outpatient testing can be arranged within 72 hours.^{88,129-131,133-135} Any system that attempts to facilitate outpatient testing should include mechanisms to ensure patient access to outpatient clinics and testing facilities and should consider nonmedical barriers to discharge from the ED that may require inpatient admission.

6.3 Computer-Assisted ECG STEMI Interpretation - Updated ACS 559

The identification of STEMI in patients with suspected STEMI is often made on clinical grounds in combination with ECG findings as interpreted by a physician. The 2015 ILCOR systematic review addressed whether computer-assisted ECG interpretation improves identification of STEMI while minimizing unnecessary intervention.

6.3.1 2015 Evidence Summary

Studies examined both underdiagnosis (false-negative results) and overdiagnosis (false-positive results)^{136,137} or overdiagnosis alone¹³⁸⁻¹⁴² by computer ECG interpretation. There was wide variation in the proportion of false-positive results (0% to 42%) and of false-negative results (22% to 42%).

These variations in accuracy seemed to occur because different ECG machines use different algorithms and because the computer interpretations are compared variously with interpretation by cardiologists, emergency physicians, and discharge diagnosis of STEMI. Moreover, the sensitivity and specificity of the test will differ depending on the prevalence of STEMI.

Both studies that examined false-negative results suggest that computer interpretation of ECG tracing produces unacceptably high rates of false-negative results in the identification of STEMI. A few studies show that computer interpretation can produce an unacceptably high rate of false-positive diagnoses. Interpretation by trained personnel in conjunction with computer interpretation may lower the rate of false results obtained when using computer interpretation alone.

6.3.2 2015 Recommendations - New

Because of high false-negative rates, we recommend that computer-assisted ECG interpretation not be used as a sole means to diagnose STEMI. (Class III: Harm, LOE B-NR)

We recommend that computer-assisted ECG interpretation may be used in conjunction with physician or trained provider interpretation to recognize STEMI. (Class IIb, LOE C-LD)

6.4 Nonphysician STEMI ECG Interpretation - Updated ACS 884

When physicians are not present or not available to interpret an ECG, other methods for interpretation must be used so that timely patient care is not adversely affected. The 2015 ILCOR systematic review examined whether nonphysicians such as paramedics and nurses could identify STEMI on an ECG so that earlier identification of STEMI could be made with acceptable rates of either underdiagnosis (false-negative results) or overdiagnosis (false-positive results).

6.4.1 2015 Evidence Summary

Three observational studies compared the diagnostic accuracy of the interpretation of ECGs as either STEMI or No STEMI by physicians and paramedics.¹⁴³⁻¹⁴⁵ While the studies used different methods to adjudicate the diagnosis, including World Health Organization criteria,¹⁴³ discharge diagnosis,¹⁴⁴ and catheterization laboratory activation,¹⁴⁵ all 3 studies showed a fairly high rate of agreement between physician and paramedic rates of distinguishing STEMI from No STEMI.

Overidentification of STEMI may have a significant adverse effect on resource utilization. An additional 6 studies examined the accuracy of paramedic identification of STEMI and reported false-positive rates (patients incorrectly diagnosed with STEMI by paramedics when no STEMI was present) ranging from 8% to 40%.^{139,146-150} One study reported that transmission of the ECG to the ED for emergency physician interpretation, compared with paramedic interpretation alone, improves the positive predictive value of the prehospital 12-lead ECG for triage and therapeutic decision making.¹⁴⁶ The time from hospital arrival to percutaneous coronary intervention (PCI) with balloon inflation was significantly shorter if EMS activated the catheterization laboratory than if the laboratory was activated by hospital staff^{147,148,150} or if the patient was directly admitted to the catheterization laboratory.¹⁴⁹

6.4.2 2015 Recommendation - New

While transmission of the prehospital ECG to the ED physician may improve positive predictive value (PPV) and therapeutic decision-making regarding adult patients with suspected STEMI, if transmission is not performed, it may be reasonable for trained nonphysician ECG interpretation to be used as the basis for decision-making, including activation of the catheterization laboratory, administration of fibrinolysis, and selection of destination hospital. (Class IIa, LOE B-NR)

6.5 Biomarkers in ACS - Updated [ACS 737](#)

Cardiac troponin measurement, along with the ECG, is an integral part of the evaluation of patients with signs and symptoms suspicious for ACS. The detection of an elevated troponin (Tn) above the 99th percentile upper reference limit is highly sensitive and specific for myocardial necrosis, and is required in the universal definition of myocardial infarction (MI).¹⁵¹

Contemporary troponin assays are termed “high-sensitivity” (hs) if they are able to detect measurable troponin levels even in healthy individuals, with a threshold of detection of 0.006 ng/ml for hs-cTnI and 0.005 for hs-cTnT. Positive results are an order of magnitude higher than the threshold for detection and are usually defined as exceeding the 99th percentile of values with a coefficient of variation of less than 10%.¹⁵²

More than 8 million patients are evaluated for potential ischemic chest pain in US EDs each year, with troponin measurement serving as one of the crucial diagnostic tests.¹⁵³ Because of this vast number of patients with potential ischemic chest pain, it is highly desirable to find some combination of diagnostic testing that can reliably identify patients who are not experiencing ischemia and can be safely discharged from the ED.

The 2015 ILCOR systematic review examined whether a negative troponin test could be used to identify patients at low risk for ACS when they did not have signs of STEMI, ischemia, or changes on the ECG that could mask signs of acute ischemia or MI.

The clinician should bear in mind that unstable angina can present without any objective data of myocardial ischemic injury (ie, with normal ECG and normal troponin), in which case the initial diagnosis depends solely on the patient’s clinical history and the clinician’s interpretation and judgment.

6.5.1 2015 Evidence Summary

Two observational studies used troponin (cTnI, cTnT, or hscTnT) measured at 0 and 2 hours to assess whether patients could be safely discharged from the ED.^{154,155} In these studies, 2.5% to 7.8% of patients with ACS had (false-) negative tests. That is, ACS would have been missed in 2.5% to 7.8% of the patients studied. With an unstructured risk assessment used in addition to the troponin testing, 2.3% of patients identified as being at low risk have a major adverse cardiac event (MACE) on 30-day follow-up. A formal risk assessment instrument was not used in either of these 2 studies.

Six additional observational studies combined troponin testing (using cTnI, cTnT, hs-cTnI, or hs-cTnT) with use

of clinical decision rules such as TIMI, Vancouver, North American, or HEART. The proportion of false-negative results among patients with 30-day MACE ranged from 0% to 1.2%.¹⁵⁶⁻¹⁶¹ When the age cutoff for low-risk patients was increased from 50 years to 60 years for the North American Chest Pain Rule, the proportion of false-negative results rose from 0% to 1.1%.¹⁵⁹ Because the rules were used in combination with different troponin measurements, and each test identified 99% of patients with ACS as defined by 30-day MACE, it was difficult to directly compare rule or assay performance. One study¹⁵⁸ identified 1 additional ACS patient by using the Vancouver rule when the hs-cTnI was used instead of the cTnI.

6.5.2 2015 Recommendations - New

We recommend against using hs-cTnT and cTnI alone measured at 0 and 2 hours (without performing clinical risk stratification) to identify patients at low risk for ACS. (Class III: Harm, LOE B-NR)

We recommend that hs-cTnI measurements that are less than the 99th percentile, measured at 0 and 2 hours, may be used together with low-risk stratification (TIMI score of 0 or 1 or low risk per Vancouver rule) to predict a less than 1% chance of 30-day MACE. (Class IIa, LOE B-NR)

We recommend that negative cTnI or cTnT measurements at 0 and between 3 and 6 hours may be used together with very low-risk stratification (TIMI score of 0, low-risk score per Vancouver rule, North American Chest Pain score of 0 and age less than 50 years, or low-risk HEART score) to predict a less than 1% chance of 30-day MACE. (Class IIa, LOE B-NR)

7 Therapeutic Interventions in ACS - Updated

Several initial therapeutic measures are appropriate for all patients with suspected ACS in the ED setting. These include continuous cardiac monitoring, establishment of intravenous (IV) access, and consideration of several medications discussed below.

7.1 ADP Inhibition: Adjunctive Therapy in Patients With Suspected STEMI—ADP Inhibitors - Updated [ACS 335](#)

The 2015 ILCOR systematic review addressed the clinical impact of the timing of administration of adenosine diphosphate (ADP) inhibition in the treatment of patients with suspected STEMI. The relative merit of early prehospital as compared with hospital administration of ADP inhibition as a general treatment strategy was assessed. Differences between individual ADP inhibitors were not examined.

The preferred reperfusion strategy for patients with STEMI is identification and restoration of normal flow in the infarct-related artery using primary percutaneous intervention. The use of potent dual antiplatelet therapy in STEMI patients undergoing PPCI is associated with improved clinical outcomes as well as lower rates of acute stent thrombosis.^{162,163} Given the short time from first medical contact to balloon inflation, treatment with oral ADP inhibitors in a prehospital setting has the potential to enhance platelet inhibition and improve procedural and clinical outcomes after PCI.

7.1.1 2015 Evidence Summary

Three randomized controlled trials (RCTs)¹⁶⁴⁻¹⁶⁶ showed no additional benefit to the outcome of 30-day mortality and no additional benefit or harm with respect to major bleeding with prehospital administration compared with in-hospital administration of an ADP-receptor antagonist.

7.1.2 2015 Recommendation - New

In patients with suspected STEMI intending to undergo PPCI, initiation of ADP inhibition may be reasonable in either the prehospital or in-hospital setting. (Class IIb, LOE C-LD)

7.2 Prehospital Anticoagulants Versus None in STEMI - Updated [ACS 562](#)

In patients with suspected STEMI, anticoagulation is standard treatment recommended by the American College

of Cardiology Foundation/AHA Guidelines.^{9,10} The 2015 ILCOR systematic review sought to determine if any important outcome measure was affected if an anticoagulant was administered prehospital compared with whether that same anticoagulant was administered in-hospital.

7.2.1 2015 Evidence Summary

A single nonrandomized, case-control study found that while flow rates were higher in an infarct-related artery when heparin and aspirin were administered in the prehospital setting versus the ED, there was no significant difference in death, PCI success rate, major bleeding, or stroke.¹⁶⁷

7.2.2 2015 Recommendations - New

While there seems to be neither benefit nor harm to administering heparin to patients with suspected STEMI before their arrival at the hospital, prehospital administration of medication adds complexity to patient care.

We recommend that EMS systems that do not currently administer heparin to suspected STEMI patients do not add this treatment, whereas those that do administer it may continue their current practice.

(Class IIb, LOE B-NR)

In suspected STEMI patients for whom there is a planned PCI reperfusion strategy, administration of unfractionated heparin (UFH) can occur either in the prehospital or in-hospital setting.

(Class IIb, LOE B-NR)

7.3 Prehospital Anticoagulation for STEMI - Updated [ACS 568](#)

The 2015 ILCOR systematic review examined whether the prehospital administration of an anticoagulant such as bivalirudin, dalteparin, enoxaparin, or fondaparinux instead of UFH, in suspected STEMI patients who are transferred for PPCI, changes any major outcome.

7.3.1 2015 Evidence Summary

One RCT provided evidence in patients transferred for PCI for STEMI that there was no significant difference between prehospital bivalirudin compared with prehospital UFH with respect to 30-day mortality, stroke, or reinfarction. However, this same study did demonstrate a decreased incidence of major bleeding with bivalirudin.¹⁶⁸ Another study (this one a non-RCT) also demonstrated no difference between prehospital bivalirudin compared with prehospital UFH with respect to 30-day mortality, stroke, and reinfarction. In contrast to the RCT, this study did not find a difference in major bleeding.¹⁶⁹

Although stent thrombosis was not considered as an a priori outcome, bivalirudin was strongly associated with the risk of acute stent thrombosis (relative risk, 6.11; 95% confidence interval, 1.37–27.24).¹⁶⁸ Such association is also consistently reported in other published in-hospital studies and meta-analyses of this agent in patients undergoing PCI.¹⁷⁰⁻¹⁷² While the benefit of bivalirudin over UFH alone in reducing bleeding complications has been shown, this benefit may be offset by the risk of stent thrombosis.

We have identified 1 RCT¹⁷³ enrolling 910 patients transferred for PPCI for STEMI that showed no significant difference between prehospital enoxaparin compared with prehospital UFH with respect to 30-day mortality, stroke, reinfarction, or major bleeding.

It is important to consider the results of the comparison between anticoagulants given in prehospital versus in-hospital settings in STEMI patients. Only UFH has been evaluated directly in this setting, and because there is no clear evidence of benefit, we are not recommending that EMS systems implement anticoagulant administration in the prehospital setting.

7.3.2 2015 Recommendations - New

It may be reasonable to consider the prehospital administration of UFH in STEMI patients or the prehospital administration of bivalirudin in STEMI patients who are at increased risk of bleeding. (Class IIb, LOE B-R)

In systems in which UFH is currently administered in the prehospital setting for patients with suspected STEMI who are being transferred for PPCI, it is reasonable to consider prehospital administration of enoxaparin as an alternative to UFH. (Class IIa, LOE B-R)

7.4 Routine Supplementary Oxygen Therapy in Patients Suspected of ACS - Updated [ACS 887](#)

The 2010 AHA Guidelines for CPR and ECC noted that there was insufficient evidence to recommend the routine use of oxygen therapy in patients who had an uncomplicated ACS without signs of hypoxemia or heart failure and that older literature suggested harm with supplementary oxygen administration in uncomplicated ACS without demonstrated need for supplementary oxygen.^{174,175} The 2010 Guidelines, however, did recommend that oxygen be administered to patients with breathlessness, signs of heart failure, shock, or an oxygen saturation less than 94%.⁷

In 2015, the ILCOR systematic review specifically addressed the use of oxygen as an adjunctive medication in the treatment of patients who had normal oxygen saturation but had suspected ACS. The 2 treatment approaches (either providing or withholding oxygen) were compared with respect to outcomes: rate of death, infarction size, resolution of chest pain, and ECG abnormality resolution. The new recommendation in this 2015 Guidelines Update applies only to the use of oxygen for patients suspected of ACS who have normal oxygen saturations.

7.5 Adjunctive Therapy in Patients Suspected of ACS: Oxygen - Updated

Respiratory compromise, manifested by oxygen desaturation, can occur during ACS, most often as a result of either acute pulmonary edema or chronic pulmonary disease. Supplementary oxygen has previously been considered standard therapy for the patient suspected of ACS, even in patients with normal oxygen saturation. The rationale for oxygen therapy was a belief that maximization of oxygen saturation may improve delivery of oxygen to the tissues and thus reduce the ischemic process and related negative outcomes. In other patient groups, such as resuscitated cardiac arrest patients, hyperoxia has been associated with worse outcomes as compared with normoxia.¹⁷⁶⁻¹⁷⁸

7.5.1 2015 Evidence Summary

There is limited evidence regarding the use of supplementary oxygen therapy in suspected ACS patients with normal oxygen saturation. The practice of administering oxygen to all patients regardless of their oxygen saturation is based on both rational conjecture and research performed before the current reperfusion era in acute cardiac care.¹⁷⁴ More recent study of this issue is also limited,^{179,180} although 2 trials addressing this question are in progress or are recently completed. The AVOID trial,¹⁸¹ a multicentered prospective RCT published since the 2015 ILCOR systematic review, compared oxygen administration with no oxygen administration in suspected STEMI patients without respiratory compromise. When oxygen was administered, the patients experienced increased myocardial injury at presentation and larger infarction size at 6 months. Reinfarction and the incidence of cardiac arrhythmias were also increased in the oxygen therapy group.¹⁸¹ Because this study was published after the ILCOR systematic review, it was not considered in our treatment recommendation.

There is no evidence that withholding supplementary oxygen therapy in normoxic patients suspected of ACS affects the rate of death and/or resolution of chest pain; there is only a very low level of evidence that withholding supplementary oxygen reduces infarction size, and there is no evidence that withholding supplementary oxygen therapy affects the resolution of ECG abnormality.^{174,175,179,180}

7.5.2 2015 Recommendation - Updated

The provision of supplementary oxygen to patients with suspected ACS who are normoxic has not been shown to reduce mortality or hasten the resolution of chest pain. Withholding supplementary oxygen in these patients has been shown to minimally reduce infarct size.

The usefulness of supplementary oxygen therapy has not been established in normoxic patients. In the prehospital, ED, and hospital settings, the withholding of supplementary oxygen therapy in normoxic patients with suspected or confirmed acute coronary syndrome may be considered. (Class IIb, LOE C-LD)

7.6 Aspirin and Nonsteroidal Anti-Inflammatory Drugs

Early administration of aspirin (acetylsalicylic acid [ASA]), has been associated with decreased mortality rates in several clinical trials.^{38,40,182,183} Multiple studies support the safety of aspirin administration.

Therefore, unless the patient has a known aspirin allergy or active gastrointestinal hemorrhage, nonenteric aspirin should be given as soon as possible to all patients with suspected ACS. (Class I, LOE A)

Aspirin produces a rapid clinical antiplatelet effect with near-total inhibition of thromboxane A₂ production. It reduces coronary reocclusion and recurrent ischemic events after fibrinolytic therapy. Aspirin alone reduced death from AMI in the Second International Study of Infarct Survival (ISIS-2), and its effect was additive to that of streptokinase.⁴⁰ Aspirin was found to substantially reduce vascular events in all patients with AMI, and in high-risk patients it reduced nonfatal AMI and vascular death.¹⁸⁴ Aspirin is also effective in patients with NSTEMI. The recommended dose is 160 to 325 mg. Chewable or soluble aspirin is absorbed more quickly than swallowed tablets.^{185,186}

Aspirin suppositories (300 mg) are safe and can be considered for patients with severe nausea, vomiting, or disorders of the upper gastrointestinal tract.

Other nonsteroidal anti-inflammatory medications (NSAIDs) are contraindicated and should be discontinued in patients who are taking these medications. NSAIDs (except for aspirin), both nonselective as well as COX-2 selective agents, should not be administered during hospitalization for STEMI because of the increased risk of mortality, reinfarction, hypertension, heart failure, and myocardial rupture associated with their use. (Class III, LOE C)

(Research related to this recommendation statements can be found in the linked references.¹⁸⁷⁻¹⁸⁹)

7.7 Nitroglycerin (or Glyceryl Trinitrate)

Nitroglycerin has beneficial hemodynamic effects, including dilation of the coronary arteries (particularly in the region of plaque disruption), the peripheral arterial bed, and venous capacitance vessels. The treatment benefits of nitroglycerin are limited, however, and no conclusive evidence has been shown to support the routine use of IV, oral, or topical nitrate therapy in patients with AMI.¹⁹⁰ With this in mind, these agents should be carefully considered, especially in the patient with low blood pressure and when their use would preclude the use of other agents known to be beneficial, such as angiotensin-converting enzyme (ACE) inhibitors.

Patients with ischemic discomfort should receive up to 3 doses of sublingual or aerosol nitroglycerin at 3- to 5-minute intervals until pain is relieved or low blood pressure limits its use. (Class I, LOE B)

Topical nitrates are acceptable alternatives for patients who require anti-anginal therapy but who are hemodynamically stable and do not have ongoing refractory ischemic symptoms. Parenteral formulations, rather than long acting oral preparations, can be used acutely to enable titration in patients with obvious ACS, objective test abnormality, and ongoing discomfort. In patients with recurrent ischemia, nitrates are indicated in the first 24 to 48 hours.

The use of nitrates in patients with hypotension (SBP (Class III, LOE C)

Caution is advised in patients with known inferior wall STEMI, and a right-sided ECG should be performed to evaluate RV infarction. Administer nitrates with extreme caution, if at all, to patients with inferior-wall MI and suspected right ventricular (RV) involvement because these patients require adequate RV preload. Nitroglycerin should not be administered to patients who had taken a phosphodiesterase inhibitor (eg, sildenafil) for erectile dysfunction within 24 hours (48 hours if tadalafil use).

Relief of chest discomfort with nitroglycerin is neither sensitive nor specific for ACS; gastrointestinal etiologies as well as other causes of chest discomfort can “respond” to nitroglycerin administration.^{25,191-193}

7.8 Analgesia

Providers should administer analgesics, such as intravenous morphine, for chest discomfort unresponsive to nitrates. Morphine is the preferred analgesic for patients with STEMI. (Class I, LOE C)

However, analysis of retrospective registry data raised a question about the potentially adverse effects of morphine in patients with UA/NSTEMI.⁵² As a result, the ACC AHA UA/NSTEMI writing group reduced morphine use to a **Class IIa** recommendation for that patient population.⁸⁸

8 Reperfusion Decisions in STEMI Patients - Updated

Acute reperfusion therapy using PPCI or fibrinolytic therapy in patients with STEMI restores flow in the infarct-related artery, limits infarct size, and translates into early mortality benefit that is sustained over the next decade.^{194,195} While optimal fibrinolysis restores normal coronary flow (TIMI 3) in 50% to 60% of subjects, PPCI is able to achieve restored flow in >90% of subjects. The patency rates achieved with PPCI translates into reduced mortality and reinfarction rates as compared to fibrinolytic therapy.¹⁹⁶ This benefit is even greater in patients presenting with cardiogenic shock. PPCI also results in a decreased risk of intracranial hemorrhage and stroke, making it the reperfusion strategy of choice in the elderly and those at risk for bleeding complications.

The 2010 ILCOR systematic review addressed the use of reperfusion therapy, including fibrinolysis and PPCI, in patients with STEMI who present initially to non-PCI-capable hospitals. The *2015 AHA Guidelines Update for CPR and ECC* examines the most appropriate reperfusion therapy in STEMI patients presenting to non-PCI-capable hospitals as well as the need for hospital transfer for PCI, or ischemiaguided (ie, rescue) coronary angiography and/or PCI.

In summary, for patients presenting within 12 hours of symptom onset and electrocardiographic findings consistent with STEMI, reperfusion should be initiated as soon as possible – independent of the method chosen. (Class I, LOE A)

8.1 Fibrinolytics & Percutaneous Coronary Intervention (PCI) Overview

A cooperative and interdisciplinary effort between emergency medicine and cardiology, as well as among the EMS agencies, the catheterization laboratory, and the CCU, has the potential to reduce markedly the door-to-therapy time in STEMI patients and therefore limit delays in providing this time-sensitive treatment. Prior agreement between the ED and cardiovascular physicians at institutions with invasive capability must be obtained so that consideration of PCI does not introduce further delays in fibrinolytic drug administration; such cooperation can limit additional delays in the administration of fibrinolytic agents in patients who are considered for PCI in AMI.

A systems of care approach involving a reperfusion team or “STEMI alert” system mobilizes hospital-based resources, optimizing the approach to the patient. This system, whether activated by data gathered in the ED or prehospital-based information, has the potential to offer time-sensitive therapies in a rapid fashion to these ill patients.

8.1.1 Fibrinolytics

Early fibrinolytic therapy is a well-established treatment modality for patients with STEMI who present within 12 hours of the onset of symptoms and who lack contraindications to its use.^{195,197-200}

Patients are evaluated for risk and benefit; for absolute and relative contraindications to therapy (see Table 4).

Table 4: 2010 - Fibrinolytic Therapy

Open table in a [new window](#)

Fibrinolytic Therapy

Contraindications and cautions for fibrinolytic use in STEMI from ACC/AHA 2004 Guideline Update*

Absolute Contraindications

- Any prior intracranial hemorrhage
- Known structural cerebral vascular lesion (eg, AVM)
- Known malignant intracranial neoplasm (primary or metastatic)
- Ischemic stroke within 3 months EXCEPT acute ischemic stroke within 3 hours
- Suspected aortic dissection
- Active bleeding or bleeding diathesis (excluding menses)
- Significant closed head trauma or facial trauma within 3 months

Relative Contraindications

- History of chronic, severe, poorly controlled hypertension
- Severe uncontrolled hypertension on presentation (SBP >180 mm Hg or DBP >110 mm Hg)[‡]
- History of prior ischemic stroke >3 months, dementia, or known intracranial pathology not covered in contraindications
- Traumatic or prolonged (>10 minutes) CPR or major surgery (<3 weeks)
- Recent (within 2 to 4 weeks) internal bleeding
- Noncompressible vascular punctures
- For streptokinase/anistreplase: prior exposure (>5 days ago) or prior allergic reaction to these agents
- Pregnancy
- Active peptic ulcer
- Current use of anticoagulants: the higher the INR, the higher the risk of bleeding

- CPR, cardiopulmonary resuscitation; AVM indicates arteriovenous malformation; SBP, systolic blood pressure; DBP, diastolic blood pressure; INR, International Normalized Ratio.

- [?]* Viewed as advisory for clinical decision making and may not be all-inclusive or definitive.

- [?]† Could be an absolute contraindication in low-risk patients with myocardial infarction.

If fibrinolysis is chosen for reperfusion, the ED physician should administer fibrinolytics to eligible patients as early as possible according to a predetermined process of care developed by the ED and cardiology staff. (Class I, LOE A)

Patients with STEMI presenting at later times in the myocardial infarction evolution are much less likely to benefit from fibrinolysis.

In fact, fibrinolytic therapy is generally not recommended for patients presenting between 12 and 24 hours after onset of symptoms based on the results of the LATE and EMERAS trials,^{201,202} unless continuing ischemic pain is present with continuing ST-segment elevation. (Class IIb, LOE B)

Fibrinolytic therapy should not be administered* to patients who present greater than 24 hours after the onset of symptoms. (*Class III, LOE B)

8.1.1.1 Risks of Fibrinolytic Therapy

Physicians who administer fibrinolytic agents must be aware of the indications, contraindications, benefits, and major risks of administration so that they are able to weigh the net clinical benefit for each patient (see Table 4).^{203,202} This net clinical benefit requires integration of relative and absolute contraindications versus overall potential clinical gain.

Patients who present early after symptom onset with extensive ECG changes (consistent with a large AMI) and a low risk of intracranial bleeding receive the greatest benefit from fibrinolytic therapy.¹⁹⁷ Patients who have symptoms highly suggestive of ACS and ECG findings consistent with LBBB are also appropriate candidates for intervention because they have the highest mortality rate when LBBB is due to extensive AMI. Inferior wall STEMI also benefits from fibrinolysis, yet the magnitude of this outcome improvement is markedly less robust. More extensive inferior STEMI presentations, of course, demonstrate more robust benefit when undergoing fibrinolysis; inferior wall STEMI with RV involvement is such an example. Fibrinolytics have been shown to be beneficial across a spectrum of patient subgroups with comorbidities such as previous MI, diabetes, tachycardia, and hypotension.¹⁹⁷ Although superior to placebo, the lack of efficacy in the setting of cardiogenic shock makes referral for PPCI an optimal strategy in this setting.

Although older patients (>75 years) have a higher risk of death, their absolute benefit appears to be similar to that of younger patients. The incidence of stroke does increase with advancing age,^{204,205} reducing the relative benefit of fibrinolytic therapy. Older age is the most important baseline variable predicting nonhemorrhagic stroke.²⁰⁵ Although 1 large trial reported lower early and 1-year mortality rates with accelerated administration of tissue plasminogen activator (rtPA) in patients <85 years of age,²⁰⁶ a retrospective analysis found no specific survival advantage and possible risk for patients >75 years of age.²⁰⁷

8.1.1.1.1 Intracranial Hemorrhage

Fibrinolytic therapy is associated with a small but definite increase in the risk of hemorrhagic stroke, which contributes to increased mortality.¹⁹⁷ More intensive fibrinolytic regimens using rtPA (alteplase) and heparin pose a greater risk than streptokinase and aspirin.^{208,209} Clinical factors that may help risk-stratify patients at the time of presentation are age (≥65 years), low body weight (<70 kg), hypertension on presentation (>180/110 mm Hg), and use of rtPA. The number of risk factors can be used to estimate the frequency of stroke, which ranges from 0.25% with no risk factors to 2.5% with 3 risk factors.²⁰² Several risk factor estimates are available for use by clinicians, including Simoons,²⁰² the Co-Operative Cardiovascular Project,²¹⁰ and the In-Time 2 trial.²¹¹

8.1.2 Percutaneous Coronary Intervention (PCI)

Coronary angioplasty with or without stent placement is the treatment of choice for the management of STEMI when it can be performed effectively with a door-to-balloon time 75 PCIs per year) at a skilled PCI facility (performing >200 PCIs annually, of which at least 36 are primary PCI for STEMI).^{33,212,213}
(Class I, LOE A)

Primary PCI (PPCI) may also be offered to patients presenting to non-PCI centers when prompt transfer can result in an effective balloon time of <90 minutes from first medical contact as a systems goal.²¹⁴ The TRANSFER AMI trial supports the transfer of high-risk patients who receive fibrinolysis in a non-PCI center to a PCI center within 6 hours of presentation to receive routine early PCI.²¹⁵

Primary PCI performed at a high-volume center within 90 minutes of first medical contact by an experienced operator that maintains an appropriate expert status is reasonable, as it improves morbidity and mortality as compared with immediate fibrinolysis ((Class I, LOE A)

For those patients with a contraindication to fibrinolysis, PCI is recommended despite the delay, rather than foregoing reperfusion therapy. (Class I, LOE A)

For those STEMI patients presenting in shock, PCI (or CABG) is the preferred reperfusion treatment. Fibrinolysis should only be considered in consultation with the cardiologist if there is a substantial delay to PCI.

8.2 Prehospital Fibrinolysis, Hospital Fibrinolysis, and Prehospital Triage to PCI Center - Updated ACS 338 ACS 341

Prehospital fibrinolysis requires a sophisticated system of provider expertise, well-established protocols, comprehensive training programs, medical oversight, and quality assurance.⁴ In many European systems, a physician provides prehospital fibrinolysis, but nonphysicians can also safely administer fibrinolytics.²¹⁶ The 2015 ILCOR systematic review evaluated whether prehospital fibrinolysis is preferred to reperfusion in-hospital where the prehospital fibrinolysis expertise, education, and system support exists.

8.2.1 2015 Evidence Summary

Prehospital fibrinolysis will achieve earlier treatment as compared with ED fibrinolysis. Where transport times are more than 30 to 60 minutes, the time advantage conferred by prehospital fibrinolysis provides a mortality benefit.⁴ This benefit from prehospital fibrinolysis was found consistently by 3 RCTs performed more than 20 years ago.²¹⁷⁻²¹⁹ However, these studies were performed at a time when hospital fibrinolytic administration typically took well in excess of 60 minutes. It is not clear the extent to which that mortality benefit would be maintained today when the hospital time to fibrinolytic treatment is typically considerably shorter than it was 20 years ago. The only recent evidence for this therapy comes from a non-RCT that confirms a small mortality benefit to prehospital fibrinolysis.²²⁰ When transport times are shorter than 30 to 60 minutes, the mortality benefit from administering fibrinolytics before hospital arrival may be lost and may no longer outweigh the relative complexity of providing this therapy outside of a hospital.

However, PPCI is generally preferred to in-hospital fibrinolysis for STEMI reperfusion.²²¹ Prehospital providers can transport STEMI patients directly to PCI centers, and activation of the team before arrival allows the team to assemble and prepare in parallel with transport. Several studies in the past 15 years have compared transport directly for PPCI with prehospital fibrinolysis and found no mortality benefit of either therapy, although the relatively rare harm from intracranial hemorrhage is greater with fibrinolysis.²²²⁻²²⁵

8.2.2 2015 Recommendations - Updated

Where prehospital fibrinolysis is available as part of a STEMI system of care, and in-hospital fibrinolysis is the alternative treatment strategy, it is reasonable to administer prehospital fibrinolysis when transport times are more than 30 minutes. (Class IIa, LOE B-R)

It is strongly recommended that systems which administer fibrinolytics in the prehospital setting include the following features: protocols using fibrinolytic checklists, 12-lead ECG acquisition and interpretation, experience in advanced life support, communication with the receiving institution, medical director with training and experience in STEMI management, and continuous quality improvement. (Class I, LOE C)

Where prehospital fibrinolysis is available as part of the STEMI system of care and direct transport to a PCI center is available, prehospital triage and transport directly to a PCI center may be preferred because of the small relative decrease in the incidence of intracranial hemorrhage without evidence of mortality benefit to either therapy. (Class IIb, LOE B-R)

If PCI is the chosen method of reperfusion for the prehospital STEMI patient, it is reasonable to transport patients directly to the nearest PCI facility, bypassing closer EDs as necessary, in systems where time intervals between first medical contact and balloon times are (Class IIa, LOE B)

8.3 ED Fibrinolysis and Immediate PCI Versus Immediate PCI Alone - Updated [ACS 882](#)

Delays in the performance of PPCI are commonly observed in clinical practice. In many regions, the delay arises because of the relative paucity of dedicated PPCI centers, resulting in the need for prolonged transfer times. In this context, combining the availability and ease of administration of fibrinolytic with the downstream certainty of mechanical reperfusion with facilitated PCI was an attractive concept, with its promise of both restoring early flow to the infarct-related artery while addressing the concerns of pharmacologic failure and need for rescue. This was counterbalanced by the concern for a heightened risk of bleeding complications and detrimental procedural outcomes in this prothrombotic milieu.

The 2015 ILCOR systematic review addressed the merits for reperfusion in STEMI patients with a strategy of initial fibrinolysis followed by immediate PCI versus immediate PCI alone.

8.3.1 2015 Evidence Summary

A number of randomized clinical trials have addressed clinical outcomes after initial treatment with a half- or full-dose fibrinolytic agent followed by dedicated immediate PCI compared with immediate PCI alone.

The studies showed no benefit to mortality,²²⁶⁻²³⁰ nonfatal MI,²²⁶⁻²³⁰ or target vessel revascularization²²⁶⁻²²⁹ when fibrinolytic administration is combined with immediate PCI as compared with immediate PCI alone.

The studies did, however, identify harm from intracranial hemorrhage²²⁶⁻²²⁸ or major bleeding²²⁶⁻²³⁰ when fibrinolytic administration is combined with immediate PCI versus immediate PCI alone.

8.3.2 2015 Recommendation - New

In the treatment of patients with suspected STEMI, the combined application of fibrinolytic therapy followed by immediate PCI (as contrasted with immediate PCI alone) is not recommended. (Class III: Harm, LOE B-R)

8.4 Delayed PCI Versus Fibrinolysis Stratified by Time From Symptom Onset - Updated [ACS 337](#)

Although the overall survivability benefits of reperfusion therapy are time dependent, the loss of efficacy caused by delay is more pronounced with fibrinolysis than with PCI.²³¹ The success of PCI in achieving TIMI-3 flow in the early hours after STEMI does not change with time, whereas the ability of fibrinolytic therapy to achieve TIMI-3 flow decreases significantly with increasing ischemic time.²³² In this context, the choice of reperfusion therapy for a STEMI patient when access to PCI is delayed is a challenging one. The clinician has to weigh the advantages of immediate fibrinolysis, which includes ease of administration and potential to open the infarct-related artery in a timely manner versus the limitations of fibrinolysis, which include the risk of intracranial hemorrhage and bleeding and the time sensitivity of the intervention's efficacy to open the infarct-related artery. Thus, total ischemic time is an important variable in weighing the merits of delayed PCI versus immediate fibrinolysis.

In the 2010 AHA Guidelines for CPR and ECC,⁷ the recommendations were directed at patients in whom PCI could not be accomplished within 90 minutes of first medical contact.

The 2015 ILCOR systematic review compared the relative benefits of immediate fibrinolysis versus primary but delayed PCI in treating STEMI patients, stratifying patients by time from initial medical contact.

8.4.1 2015 Evidence Summary

In STEMI patients presenting less than 2 hours after symptom onset in whom immediate PPCI will delay treatment 60 to 160 minutes compared with fibrinolysis, 2 RCTs (combined into a single analysis) using an outcome of 30-day mortality²³³ and 1 RCT using an outcome of 5-year mortality showed greater harm with delayed PPCI compared with fibrinolysis.²³⁴ No differences were found to incidence of reinfarction²³³ or severe

bleeding.²³⁵

For STEMI patients presenting 2 to 6 hours after symptom onset in whom PPCI will delay treatment 60 to 160 minutes compared with fibrinolysis, 2 RCTs using an outcome of 1-year mortality²³³ and 1 RCT using an outcome of 5-year mortality showed no benefit of delayed PPCI over fibrinolysis.²³⁴ There was also no difference in the incidence of reinfarction,²³³ but 1 RCT²³⁵ showed more severe bleeding with fibrinolysis as compared with delayed PPCI.

In STEMI patients presenting 3 to 12 hours after symptom onset in whom PPCI will delay treatment 60 to 120 minutes as compared with fibrinolysis, 1 RCT²³⁶ using a 30-day mortality outcome showed that delayed PPCI conferred a benefit as compared with immediate fibrinolysis.

A reanalysis of the raw data from 16 RCTs²³⁷ has suggested that the acceptable fibrinolysis to PPCI delay varies depending on the patient's baseline risk and delay to presentation. A pragmatic simplification of the formula derived in the analysis has been suggested in an editorial²³⁸ associated with the publication of the analysis: Patients older than 65 years and all patients in Killip class greater than 1 should be treated with PPCI. Patients older than 65 years in Killip class 1 should have PPCI unless delay is greater than 35 minutes.

8.4.2 2015 Recommendations - Updated

The following recommendations are not in conflict with, and do not replace, the 2013 ACC/AHA STEMI Guidelines, which are endorsed by this ACS Writing Group. These 2015 Guidelines Update recommendations are derived from a different set of studies that examined the interval between *symptom onset* and reperfusion, rather than the interval between *first medical contact* and reperfusion. The symptom onset interval is appropriate to consider when time of symptom onset is known. However, time from symptom onset may be difficult to ascertain or may be unreliable. When time from symptom onset is uncertain, it is appropriate to follow the ACC/AHA STEMI Guidelines recommendation that PPCI is the preferred reperfusion strategy when time from symptom onset is less than 12 hours and time to PPCI from first medical contact in these patients is anticipated to be less than 120 minutes.

Regardless of whether time of symptom onset is known, the interval between first medical contact and reperfusion should not exceed 120 minutes. (Class I, LOE C-EO)

In STEMI patients presenting within 2 hours of symptom onset, immediate fibrinolysis rather than PPCI may be considered when the expected delay to PPCI is more than 60 minutes. (Class IIb, LOE C-LD)

In STEMI patients presenting within 2 to 3 hours after symptom onset, either immediate fibrinolysis or PPCI involving a possible delay of 60 to 120 minutes might be reasonable. (Class IIb, LOE C-LD)

In STEMI patients presenting within 3 to 12 hours after symptom onset, performance of PPCI involving a possible delay of up to 120 minutes may be considered rather than initial fibrinolysis.

(Class IIb, LOE C-LD)

It is acknowledged that fibrinolysis becomes significantly less effective more than 6 hours after symptom onset, and thus a longer delay to PPCI may be the better option for patients more than 6 hours after symptom onset.

In STEMI patients, when delay from first medical contact to PPCI is anticipated to exceed 120 minutes, a strategy of immediate fibrinolysis followed by routine early (within 3 to 24 hours) angiography and PCI if indicated may be reasonable for patients with STEMI. (Class IIb, LOE B-R)

8.5 Interfacility Transfer

Hospital and ED protocols should clearly identify criteria for expeditious transfer of patients to PCI facilities.

These include patients who are ineligible for fibrinolytic therapy or who are in cardiogenic shock. (Class I, LOE C)

(Research related to this recommendation statements can be found in the linked references.²³⁹⁾

A door-to-departure time <30 minutes is recommended by ACC/AHA Guidelines.³³

Transfer of high-risk patients who have received primary reperfusion with fibrinolytic therapy is reasonable. (Class IIa, LOE B)

(Research related to this recommendation statements can be found in the linked references.^{215,240)}

8.6 Reperfusion Therapy for STEMI in Non-PCI-Capable Hospitals - Updated [ACS 332](#) [ACS 334](#) [ACS 779](#)

The rapid restoration of perfusion in the infarct-related coronary artery, using either fibrinolytic therapy or PPCI, provides the opportunity for an optimal outcome.

Fibrinolytic therapy unequivocally improves survival in patients presenting with STEMI and has widespread availability.²⁴¹ STEMI patients with contraindications to fibrinolytic therapy and who are in cardiogenic shock are not appropriate candidates for this form of reperfusion therapy.²⁴² PPCI is superior to fibrinolytic therapy in the management of STEMI,²⁴³ because PPCI also improves survival rates and enhances other important outcomes in the STEMI patient. However, this form of reperfusion therapy is not widely available.

The superiority of PPCI over fibrinolytic therapy is not absolute. For STEMI patients presenting to a non-PCI-capable hospital, the decision to administer fibrinolytic therapy at the initial facility as compared with immediate-transfer PPCI requires consideration of several factors, including the location of the MI, patient age, the duration of STEMI at time of initial ED presentation, time required to complete transfer for and performance of PPCI, and the abilities of the PPCI cardiologist and hospital.²⁴³ Furthermore, the hemodynamic status of the patient is important; specifically, patients in cardiogenic shock are most appropriately managed with PPCI.²⁴²

8.6.1 2015 Evidence Summary

8.6.1.1 Fibrinolysis Versus Transfer for PPCI - Updated

In a non-PCI-capable hospital, the choice of reperfusion therapy in the STEMI patient is either immediate fibrinolytic therapy or transfer for PPCI; the time required for transfer of the patient to a PCI-capable hospital must be considered in making the choice. Comparison studies showed benefit of immediate transfer to a PCI center with respect to 30-day mortality, stroke, and/or reinfarction.^{236,244-250} There was no difference in major hemorrhage.^{246,249}

8.6.1.2 Fibrinolysis and Routine Transfer for Angiography Versus Immediate Transfer for PPCI - Updated

When immediate fibrinolysis in a non-PCI-capable hospital followed by routine transfer for angiography was compared with immediate transfer to a PCI center for PPCI, 3 studies showed no benefit to 30-day mortality, stroke, and/or reinfarction and no difference in the rates of intracranial hemorrhage or major bleeding.^{223,251,252}

8.6.1.3 Fibrinolysis and Routine Transfer for Angiography Versus No Routine Transfer: 30-Day Mortality - Updated

In patients who received a fibrinolytic agent for STEMI in a non-PCI-capable hospital, studies comparing either routine transfer for angiography at 3 to 6 hours and up to 24 hours or no transfer except for ischemia-driven PCI (rescue PCI) in the first 24 hours showed no benefit with respect to 30-day mortality^{223,250,253-257} or 1-year mortality.^{223,253,254,257-259}

8.6.1.4 Fibrinolysis and Routine Transfer for Angiography Versus No Routine Transfer: Intracranial Hemorrhage or Major Bleeding - Updated

In patients who received a fibrinolytic agent for STEMI in a non-PCI-capable hospital, studies comparing either routine transfer for angiography at 3 to 6 hours and up to 24 hours or no transfer except for ischemia-driven PCI (rescue PCI) in the first 24 hours demonstrated no difference in incidence of intracranial hemorrhage,^{223,253-257} major bleeding,^{223,253-257} or stroke.^{250,253,255,257}

8.6.1.5 Fibrinolysis and Routine Transfer for Angiography Versus No Routine Transfer: Reinfarction - Updated

When immediate fibrinolysis for STEMI was followed by routine transfer for angiography at 3 to 6 hours and up to 24 hours as compared with no transfer except for ischemia-driven PCI (rescue PCI) in the first 24 hours, a decrease in the rate of reinfarction was demonstrated.^{223,250,253-257}

8.6.2 2015 Recommendations - New

In adult patients presenting with STEMI in the ED of a non-PCI-capable hospital, we recommend immediate transfer without fibrinolysis from the initial facility to a PCI center instead of immediate fibrinolysis at the initial hospital with transfer only for ischemia-driven PCI. (Class I, LOE B-R)

When STEMI patients cannot be transferred to a PCI-capable hospital in a timely manner, fibrinolytic therapy with routine transfer for angiography may be an acceptable alternative to immediate transfer to PPCI. (Class IIb, LOE C-LD)

When fibrinolytic therapy is administered to a STEMI patient in a non-PCI-capable hospital, it may be reasonable to transport all postfibrinolysis patients for early routine angiography in the first 3 to 6 hours and up to 24 hours rather than transport postfibrinolysis patients only when they require ischemia-guided angiography. (Class IIb, LOE B-R)

It is recognized that there may be practical and logistical circumstances, including geographic limitations, where transfer for angiography within 24 hours is difficult or impossible. In these cases, the small but measurable decrease in reinfarction rates may not justify a prolonged or difficult transfer.

9 Hospital Reperfusion Decisions After ROSC - Updated

9.1 PCI After ROSC With and Without ST Elevation - Updated [ACS 340](#) [ACS 885](#)

In 2010, the ILCOR systematic review combined ST-elevation and non-ST-elevation patients after ROSC. However, the *2010 AHA Guidelines for CPR and ECC* did make separate recommendations for each of these distinct groups of patients, recommending emergency coronary angiography for ST-elevation patients after ROSC, while supporting the consideration of coronary angiography for non-ST-elevation patients after ROSC.

The 2015 ILCOR systematic review examined whether immediate coronary angiography (angiography performed within 24 hours after ROSC) for patients with and without ST elevation after cardiac arrest improved outcomes.

9.1.1 2015 Evidence Summary

Evidence regarding the timing of coronary angiography immediately after cardiac arrest (defined variously, but within 24 hours) is limited to observational studies.

Aggregated data from 15 studies of 3800 patients having ST elevation on ECG after ROSC after cardiac arrest demonstrated a benefit of immediate coronary angiography, favoring survival to hospital discharge,²⁶⁰⁻²⁷⁴ while 9 of these studies enrolling a total of 2819 patients also demonstrated a benefit favoring neurologically favorable outcomes.^{260-262,265,267-269,272,275}

In patients without ST elevation on initial postarrest ECG, 2 studies demonstrated a benefit favoring improved survival to hospital discharge and improved neurologically favorable outcome when patients received immediate coronary angiography.^{260,265}

In these studies, the decision to undertake the intervention was influenced by a variety of factors such as patient age, duration of CPR, hemodynamic instability, presenting cardiac rhythm, neurologic status upon hospital arrival, and perceived likelihood of cardiac etiology.

9.1.2 2015 Recommendations - Updated

Coronary angiography should be performed emergently (rather than later in the hospital stay or not at all) for OHCA patients with suspected cardiac etiology of arrest and ST elevation on ECG. (Class I, LOE B-NR)

Emergency coronary angiography is reasonable for select (eg, electrically or hemodynamically unstable) adult patients who are comatose after OHCA of suspected cardiac origin but without ST elevation on ECG. (Class IIa, LOE B-NR)

It is reasonable to include cardiac catheterization and coronary angiography in standardized post-cardiac arrest protocols as part of an overall strategy to improve neurologically intact survival in this patient group (Class IIa, LOE B) and appropriate treatment of ACS or STEMI, including PCI or fibrinolysis, should be initiated regardless of coma. (Class I, LOE B)

Angiography and/or PCI need not preclude or delay other therapeutic strategies including therapeutic hypothermia. (Class IIa, LOE B)

Coronary angiography is reasonable in post-cardiac arrest patients where coronary angiography is indicated regardless of whether the patient is comatose or awake. (Class IIa, LOE C-LD)

A 12-lead ECG should be performed as soon as possible after ROSC. (Class I, LOE A)

10 Complicated Acute Myocardial Infarction (AMI)

10.1 Cardiogenic Shock, LV Failure, and Congestive Heart Failure

Infarction of ~40% of the LV myocardium usually results in cardiogenic shock and carries a high mortality rate. Of those who developed shock,²⁷⁶ patients with ST-segment elevation developed shock significantly earlier than patients without ST-segment elevation. Cardiogenic shock and congestive heart failure are not contraindications to fibrinolysis, but PCI is preferred if the patient is at a facility with PCI capabilities. Based on the results of the SHOCK trial ACC/AHA guidelines note that PPCI is reasonable in those who develop shock within 36 hours of symptom onset and who are suitable candidates for revascularization that can be performed within 18 hours of the onset of shock.⁸⁸ Although the benefits in the SHOCK trial were observed only in patients >75 years of age, selected elderly patients also appear to benefit from this strategy. The guidelines also support the use of hemodynamic support with intra-aortic balloon counterpulsation (IABP) in this setting as part of aggressive medical treatment. The IABP works synergistically with fibrinolytic agents in this setting, and the benefits observed with early revascularization strategy in the SHOCK trial were also obtained in the setting of IABP support. The use of PPCI for patients with cardiogenic shock has increased over time and contributes to the observed decrease in hospital mortality.^{277,278} The majority of survivors following cardiogenic shock experience a good quality of life, and the early mortality benefit with revascularization is sustained over time.²⁷⁹⁻²⁸¹

In hospitals without PCI facilities, fibrinolytic administration needs to be considered with prompt transfer to a tertiary care facility where adjunct PCI can be performed if cardiogenic shock or ongoing ischemia ensues.²⁸² The ACC/AHA STEMI guidelines recommend a door-to-departure time of <30 minutes for transfer to a PCI-capable center.⁸⁸

10.2 Right Ventricular (RV) Infarction

RV infarction or ischemia may occur in up to 50% of patients with inferior wall MI. The clinician should suspect RV infarction in patients with inferior wall infarction, hypotension, and clear lung fields. In patients with inferior wall infarction, obtain an ECG with right-sided leads. ST-segment elevation (>1 mm) in lead V4R is sensitive (sensitivity, 88%; specificity, 78%; diagnostic accuracy, 83%) for RV infarction and is a strong predictor of increased in-hospital complications and mortality.²⁸³

The in-hospital mortality rate of patients with RV dysfunction is 25% to 30%, and these patients should be routinely considered for reperfusion therapy. Fibrinolytic therapy reduces the incidence of RV dysfunction.²⁸⁴ Similarly PCI is an alternative for patients with RV infarction and is preferred for patients in shock. Patients with shock caused by RV failure have a mortality rate similar to that for patients with shock due to LV failure.

Patients with RV dysfunction and acute infarction are dependent on maintenance of RV “filling” pressure (RV end-diastolic pressure) to maintain cardiac output.²⁸⁵ Thus, nitrates, diuretics, and other vasodilators (ACE inhibitors) should be avoided because severe hypotension may result. Hypotension is initially treated with an IV fluid bolus.

11 ACE Inhibitors in the Prehospital Setting

Despite multiple studies that have shown a benefit of ACE inhibitors and ARBs in patients with a myocardial infarction when therapy is started during the first 24 hours of the index hospitalization, no trial specifically evaluates patients in the ED or prehospital settings. An older randomized trial showed a reduction in mortality with an increased risk of hypotension in patients treated soon after presentation in the inpatient setting.¹⁹⁰ Several trials showed a reduction in the rate of heart failure and mortality in patients treated soon after fibrinolysis,²⁸⁶⁻²⁸⁸ and several others showed no benefit with the early or prehospital use of angiotensin converting enzyme.^{287,289,290}

In conclusion, although ACE inhibitors and ARBs have been shown to reduce long-term risk of mortality in patients suffering an AMI, there is insufficient evidence to support the routine initiation of ACE inhibitors and ARBs in the prehospital or ED setting. (Class IIb, LOE C)

Other recommendations concerning ACE Inhibitors in the hospital setting were not reviewed in 2015. Please refer to the [2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes](#) or the [2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction](#) for information on this topic.

12 Management of Arrhythmias

This section discusses management of arrhythmias during acute ischemia and infarction.

12.1 Ventricular Rhythm Disturbances

Treatment of ventricular arrhythmias during and after AMI has been a controversial topic for three decades. Primary VF accounts for the majority of early deaths during AMI.²⁹¹⁻²⁹³ The incidence of primary VF is highest during the first 4 hours after onset of symptoms^{36,294-296} but remains an important contributor to mortality during the first 24 hours. Secondary VF occurring in the setting of CHF or cardiogenic shock can also contribute to death from AMI. VF is a less common cause of death in the hospital setting with the use of fibrinolytics and percutaneous revascularization as early reperfusion strategies. Broad use of β -blockers also contributes significantly in the reduction of VF incidence in the after AMI.

Although prophylaxis with lidocaine reduces the incidence of VF, an analysis of data from ISIS-3 and a meta-analysis suggest that lidocaine increased all-cause mortality rates.²⁹⁷

Thus, the practice of prophylactic administration of lidocaine is not recommended. (Class III, LOE A)

Sotalol has not been adequately studied. (Class IIb, LOE C)

Amiodarone in a single RCT did not appear to improve survival in low doses and may increase mortality in high doses when used early in patients with suspected myocardial infarction.²⁹⁸ (Class IIb, LOE C)

Twenty published studies including 14 RCTs and 4 meta-analyses/reviews provide no good evidence that prophylactic antiarrhythmics improve outcomes (survival to discharge, 30/60 day mortality) and despite a documented decrease in the incidence of malignant ventricular arrhythmias, they may cause harm.

Therefore prophylactic antiarrhythmics are not recommended for patients with suspected ACS or myocardial infarction in the prehospital or ED. (Class III, LOE A)

Routine IV administration of β -blockers to patients without hemodynamic or electric contraindications is associated with a reduced incidence of primary VF. (Class IIb, LOE C)

Low serum potassium, but not magnesium, has been associated with ventricular arrhythmias.

It is prudent clinical practice to maintain serum potassium >4 mEq/L and magnesium >2 mEq/L. (Class IIB, LOE A)

Routine administration of magnesium to patients with MI has no significant clinical mortality benefit, particularly in patients receiving fibrinolytic therapy.¹⁹⁰ ISIS-4 enrolled >58 000 patients and showed a trend toward increased mortality rates when magnesium was given in-hospital for primary prophylaxis to patients within the first 4 hours of known or suspected AMI.

Following an episode of VF, there is no conclusive data to support the use of lidocaine or any particular strategy for preventing VF recurrence. Further management of ventricular rhythm disturbances is discussed in [Part 7: Adult Advanced Cardiovascular Life Support](#).

13 Authorship and Disclosures

13.1 2015 Writing Team

Robert E. O'Connor, Chair; Abdulaziz S. Alali; William J. Brady; Chris A. Ghaemmaghami; Venu Menon; Michelle Welsford; Michael Shuster

Table 5: 2015 - Part 9: Acute Coronary Syndromes: 2015 Guidelines Update Writing Group Disclosures

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Part 9: Acute Coronary Syndromes: 2015 Guidelines Update Writing Group Disclosures								
Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honorary	Expert Witness	Ownership Interest	Consultant/Advisory Board	Other
Robert E. O'Connor	University of Virginia	None	None	None	None	None	None	None
Abdulaziz S. Al Ali	McMaster University	None	None	None	None	None	None	None
William J. Brady	University of Virginia	Siemens Medical Diagnostics*	None	None	Medicolegal consulting*	None	EvidenceCare†	None
Chris A. Ghaemmaghami	University of Virginia	None	None	None	None	None	None	None
Venu Menon	Cleveland Clinic	Astra Zeneca*	None	None	None	None	Astra Zeneca*; Takeda Pharmaceuticals†	None
Michelle Welsford	Centre for Paramedic Education and Research	None	None	None	None	None	None	None
Consultant								
Michael Shuster	Mineral Springs Hospital	None	None	None	None	None	American Heart Association†	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition. *Modest. †Significant.

13.2 2010 Writing Team

Robert E. O'Connor, Chair; William Brady; Steven C. Brooks; Deborah Diercks; Jonathan Egan; Chris Ghaemmaghami; Venu Menon; Brian J. O'Neil; Andrew H. Travers; Demetris Yannopoulos

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
William Brady	University of Virginia	None	None	None	None	None	*Expert Witness: If contacted by attorneys, I will consider reviewing cases under litigation/potentially under litigation. I am not affiliated with any agency or business entity in this regard. When paid, the money is paid to my department at the University of Virginia—I can then use the money for professional issues and/or receive a certain amount in my personal pay check from the University.
Steven C. Brooks	University of Toronto—Clinician-Scientist	None	None	None	None	None	None

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Brian J. O'Neil	Wayne State, Associate Chair	†Medivance Corporation, Zoll Circulation, Heartscan Technologies	* Somanetics Corp	Speakers bureau † Sanofi-Aventis, Bristol Meyer Squibb * Glaxo-Smith Kline; Medivance Corp; Heartscan Technologies Honoraria* Heartscan Technologies	None	Advisory board- * Heartscan Technologies; *Zoll Circulation	Expert witness- † Seimien Huckabay law offices
Andrew H. Travers	Emergency Health Services—Provincial Medical Director; Dalhousie University—Associate Professor; QE-II Hospital—Attending Physician	None	None	None	None	None	None
Demetris Yannopoulos	University of Minnesota—Intercardiologist	None	None	None	None	None	None

- This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be “significant” if (a) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be “modest” if it is less than “significant” under the preceding definition
- ?* Modest.
- ?† Significant.

14 Footnotes

The American Heart Association requests that this document be cited as follows:

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