Part 9: Acute Coronary Syndromes

2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations

Robert E. O’Connor, Co-Chair*; Leo Bossaert, Co-Chair*; Hans-Richard Arntz; Steven C. Brooks; Deborah Diercks; Gilson Feitosa-Filho; Jerry P. Nolan; Terry L. Vanden Hoek; Darren L. Walters; Aaron Wong; Michelle Welsford; Karen Woolfrey; on behalf of the Acute Coronary Syndrome Chapter Collaborators

Note From the Writing Group: Throughout this article, the reader will notice combinations of superscripted letters and numbers (eg, “Chest Pain Observation Units ACS-005A*”). These callouts are hyperlinked to evidence-based worksheets, which were used in the development of this article. An appendix of worksheets, applicable to this article, is located at the end of the text. The worksheets are available in PDF format and are open access.

The International Liaison Committee on Resuscitation (ILCOR) ACS-MI Task Force included expert reviewers from Africa, Asia, Australia, Europe, North America, and South America. These experts reviewed 25 topics related to the acute initial management of acute coronary syndrome (ACS), which was further categorized as unstable angina, non-ST-elevation MI (UA/NSTEMI) and ST-elevation MI (STEMI). Topics were identified based on previous recommendations, emerging science, and clinical importance, using an iterative writing process involving all Task Force members. The Task Force reviewed the evidence specifically related to diagnosis and treatment of ACS in the out-of-hospital setting and the first hours of care in the in-hospital setting, typically in the emergency department (ED). The evidence review took place over several years, with ongoing refinement of recommendations being made as new evidence was published. The purpose of the review was to generate current, evidence-based treatment recommendations for healthcare providers who serve as the initial point of contact for patients with signs and symptoms suggestive of ACS.

The following is a summary of the most important changes in recommendations for diagnosis and treatment of ACS since the last ILCOR review in 2005.1,2

- The history and physical examination, initial ECG, and initial serum biomarkers, even when used in combination, cannot be used to reliably exclude ACS in the prehospital and ED settings.
- In contrast, chest pain observation protocols are useful in identifying patients with suspected ACS and patients who require admission or may be referred for provocative testing for coronary artery disease (CAD) to identify reversible ischemia. Such strategies also reduce cost by reducing unnecessary hospital admissions and improve patient safety through more accurate identification of NSTEMI and STEMI.
- The acquisition of a prehospital 12-lead ECG is essential for the diagnosis of STEMI patients before hospital arrival and should be used in conjunction with pre-arrival hospital notification and concurrent activation of the catheter laboratory.
- Nonphysicians can be trained to independently interpret 12-lead ECGs for the purpose of identifying patients with STEMI, provided that appropriate and reliable STEMI criteria are used. This skill is of particular value in the prehospital setting where paramedics may independently identify STEMI, thus mitigating over-reliance on ECG transmission.
- Computer-assisted ECG interpretation can be used to increase diagnostic accuracy of STEMI diagnosis when used alone or in combination with ECG interpretation by a trained healthcare provider.
- STEMI systems of care can be implemented to improve the time to treatment. The following measures have been shown to reduce the time to primary percutaneous coronary intervention (PPCI): institutional commitment, use of a team-based approach, arranging single-call activation of the catheterization laboratory by the emergency physician or prehospital provider, requiring the catheterization laboratory to be ready in 20 minutes, having an experienced cardiologist always available, and providing real-time data feedback.
- Intravenous (IV) β-blockers should not be given routinely in the ED or prehospital setting, but may be useful in a subset of patients with hypertension or tachycardia in the setting of ACS.

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The routine use of high-flow supplemental oxygen in ACS is not recommended. Instead, oxygen administration should be guided by arterial oxygen saturation.

Reinforce the need for time targets for reperfusion beginning from the time of first medical contact (FMC). The clinical circumstances that favor fibrinolysis and PCI are discussed, including the role of prehospital fibrinolytics.

The prophylactic use of antiarrhythmics is discouraged.

Angiography and percutaneous coronary intervention (PCI) may be considered in patients with out-of-hospital cardiac arrest (OHCA) and return of spontaneous circulation (ROSC). It may also be acceptable to perform angiography in selected patients, despite the absence of ST-segment elevation on the ECG or prior clinical findings such as chest pain.

Despite progress in diagnostic and therapeutic strategies, numerous knowledge gaps have been identified during the discussions. These gaps include:

- Much of the research concerning the care of the patient with ACS has been conducted on in-hospital populations rather than specifically in the ED or out-of-hospital settings. By definition, extending the conclusions from such research to the early ED management or the out-of-hospital setting requires extrapolation.
- Strategies for improving layperson recognition of ACS and shortening time to diagnosis in vulnerable populations.
- The value of emergency dispatcher-initiated bystander administration of aspirin.
- Accurate decision rules for the early identification of patients with and without ACS in the prehospital and the ED settings.
- Feasibility of widespread paramedic interpretation of prehospital 12-lead ECGs versus reliance on transmission or computer interpretation.
- Impact on mortality of systems of care strategies designed to expedite reperfusion.
- The role of reperfusion including PCI in post–cardiac arrest care following either prehospital or in-hospital cardiac arrest, in the presence or absence of STEMI.
- The sensitivity and specificity of newer biomarkers for the detection of ACS.
- Is high-dose oxygen harmful in the setting of ACS?
- What is the role of analgesia and anxiolysis in patients with ACS?
- Optimal timing of platelet inhibition and anticoagulation in the prehospital and ED setting.
- While the time goals for reperfusion begin with first medical contact, time from symptom onset may be preferred, yet precise identification of this time point has been elusive.

The American Heart Association and the American College of Cardiology, the European Society of Cardiology, and others have developed comprehensive guidelines for the in-hospital management of patients with STEMI and UA/NSTEMI, and the reader is referred to these guidelines for more detailed recommendations regarding the care of patients with ACS.3–6 The ILCOR CoSTR statements are intended to supplement these other resources by having a specific focus on the initial evaluation and treatment in the prehospital and ED phases of care. It is envisioned that these CoSTR documents will be used to develop treatment guidelines to assist providers during the initial acute phase of care.

The prognostic and diagnostic use of the signs and symptoms of ACS, cardiac markers, and 12-lead ECG can have enormous impact on the initial impression and management of patients with suspected ACS. As such, it is important to evaluate the sensitivity, specificity, and clinical impact of various diagnostic strategies in ACS through a comprehensive evidence-based process.

The 12-lead ECG in the ED and out-of-hospital settings is central to the initial triage of patients with possible ACS. Neither signs and symptoms nor cardiac markers alone are sufficiently sensitive to diagnose AMI or ischemia in the prehospital setting or the first 4 to 6 hours in the ED.

### Diagnostic Tests in ACS

#### Risk Stratification

**Demographic Factors**

For patients with ACS, we evaluated whether any specific demographic factors (eg, age, sex, race, weight) were associated with delayed treatment and classified these delays according to whether they occurred before or after hospital arrival.

**Consensus on Science**

**Prehospital Treatment Delay.** Thirty-five studies (LOE P178; LOE P39–40) showed that demographic factors, such as older age, nonwhite race, female gender, income, socioeconomic status, and living alone are independent factors for prehospital treatment delay (symptom-to-door time).

**In-Hospital Treatment Delay.** Nineteen studies (LOE P28; LOE P39,10,14,19,29,39,42,55–62; LOE 563–65) showed that demographic factors, such as older age, female gender, income, socioeconomic status, and living alone are independent factors for in-hospital treatment delay (door-to-balloon, door-to-needle, or door-to-reperfusion time).

As many studies analyzed more than one demographic factor for prediction of treatment delay, and one factor may predict delay while another factor was not found to be independent for prediction of delay, 8 studies were mixed in identifying factors associated with treatment delays (LOE P2), 13,17,20,24,25,36,40,41,44–54.

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Five studies indicated that older age, female gender, income, and living alone did not show any association with prehospital delay times (LOE P2, 13,17,20,24,25,36,40,41). As many studies analyzed more than one demographic factor for prediction of treatment delay, and one factor may predict delay while another factor was not found to be independent for prediction of delay, 8 studies were mixed in identifying factors associated with treatment delays (LOE P2, 13,17,20,24,25,36,40,41).

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these factors include older age, racial and ethnic minorities, female gender, low socioeconomic status and residing alone. Providers should be trained to expeditiously identify patients with ACS irrespective of age, gender, socioeconomic status, or living arrangements.

Accuracy of History and Physical Examination for Diagnosing ACS

In patients with suspected ACS in various settings (eg, prehospital, emergency or in-hospital), do specific historical factors, physical examination findings, and test results, compared with normal, increase the accuracy of diagnosis of ACS and MI?

Consensus on Science: Prognosis and Clinical Impact

In 34 studies (LOE 171,83,92; LOE 224,67–70,84,87,94,95,100; LOE 3 to 5)103 and extrapolations from 27 other studies (LOE 181) found the sign of tenderness to chest wall palpation useful in ruling out a diagnosis of AMI. Studies showed that computer-interpreted electrocardiography or field-transmitted electrocardiography can be applied if no adequate interpretation of the prehospital ECG is available on site (LOE D111,112).

Treatment Recommendation

In patients with suspected ACS, a 12-lead-ECG should be acquired and interpreted by prehospital or emergency providers as soon as possible after first patient contact. The interpretation should be used in conjunction with the clinical signs and presentation for diagnosis and triage, including destination decisions and activation of the cardiac catheterization laboratory. If interpretation of the prehospital ECG is not available on site, field-transmission of the ECG for expert interpretation may be reasonable.

Diagnosis of STEMI by Nonphysicians

In patients with suspected ACS in the prehospital, ED, or in-hospital settings, can nonphysicians (eg, paramedics and nurses) accurately diagnose STEMI when compared to physicians?
Consensus on Science

Eight observational studies reported paramedics can diagnose STEMI in the prehospital setting without transmission of a 12-lead ECG for physician consultation (LOE D3113–115; LOE D4116–119; LOE D5120). The limited evidence available about paramedic false-negative diagnostic decisions, including decisions not to obtain a 12-lead ECG, may affect paramedics’ true overall diagnostic accuracy.

Eight observational studies reported that nurses can diagnose STEMI in the context of nurse-initiated fibrinolysis programs (LOE D3121; LOE D4116.122–124; LOE D5125–127). The literature largely describes the ability of nurses to avoid false-positive diagnosis in fibrinolysis programs without substantial evidence about false-negative decisions, which may affect true overall diagnostic accuracy.

Treatment Recommendations

It is reasonable for paramedics and nurses to identify STEMI on a 12-lead ECG independently as long as there is a mandatory program of initial training and ongoing concurrent medical oversight of all ECG interpretations.

Computer-Assisted ECG InterpretationACS-008A

In patients with suspected ACS, does the use of computer-assisted ECG interpretation, compared with standard diagnostic techniques (emergency physicians), increase accuracy of diagnosis (eg, of NSTEMI/STEMI)?

Consensus on Science

Two studies found evidence of improved diagnostic accuracy with the use of computerized ECG interpretation (LOE D5,128,129) Eight studies either found no effect or equivocal effect of the use of computerized ECG interpretation on diagnostic accuracy (LOE 1111,130–132; LOE D5133–136). Two studies found evidence that the use of computerized ECG interpretation decreased diagnostic accuracy (LOE D1).137,138 Three studies showed computer ECG interpretation relating to ACS to be reliable (LOE D1137, LOE 1111,110). The “gold standard” used most commonly was expert “electrocardiographer” review, although four studies used validated clinical diagnosis as the gold standard (LOE D1,110). Two studies reported a higher specificity for the computer-interpretation (identifying true negatives), while the physicians had a higher sensitivity (identifying true positives) (LOE 1111, LOE D1131). Two studies found that computer interpretation had a greater influence on nonexpert subject performance in interpreting ECGs than it did on more expert interpretation (LOE D1137; LOE D5135; LOE D5133).

Treatment Recommendation

Prehospital ECG interpretation should be augmented with computer interpretation. Computer interpretation of the ECG may increase the specificity of diagnosis of STEMI, especially for clinicians less experienced in reading ECGs. The benefit of computer interpretation is dependent on accuracy, and therefore computer-assisted ECG interpretation should not replace, but may be used as an adjunct to, interpretation by an experienced clinician. The computer interpretation should be considered in the clinical context.

Diagnostic and Prognostic Test Characteristics of Cardiac Biomarkers for ACS

Protein Markers of Coronary IschemiaACS-013B

In patients with suspected ACS in various settings (eg, prehospital, emergency, or in-hospital), do abnormal protein markers compared with normal levels allow the clinician to accurately diagnose acute coronary ischemia?

Consensus on Science

Eight studies supported cardiac troponin testing alone in the diagnosis of AMI, when serum testing was drawn at least 6 hours from time of symptom onset or ED presentation, or drawn serially (LOE D2139–141; LOE D3142; LOE D4143–146). No studies showed adequate sensitivity of cardiac troponin testing outside of the ED or short-stay cardiac unit (LOE 2147; LOE 4148–150) including the ICU (LOE 4).151 Four studies showed increased sensitivity of new sensitive troponin assays compared with conventional troponin assays and supported their use to diagnose AMI (LOE D2152,153; LOE D3154; LOE D4155). Nine studies supported multimarker testing (CK-MB, ischemia-modified albumin or myoglobin) in combination with cardiac troponin in the diagnosis of AMI (LOE D2139,141,153,156–158; LOE D4155,156,159).

There were heterogeneous data on the use of troponin point-of-care testing (POCT) in the diagnosis of ACS: 5 studies supported the use of troponin POCT (LOE D2145; LOE D4155,160–163), and 5 studies opposed the use of troponin POCT in the ED and cardiac short-stay units (LOE D3164; LOE D4165–168). Two studies opposed the use of troponin POCT in the prehospital setting (LOE D4),148,149 and 1 opposed the use of troponin POCT in the outpatient clinic setting (LOE D2).147

Treatment Recommendations

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

All patients presenting to the ED with symptoms suspicious of cardiac ischemia should have cardiac biomarker testing as part of an initial evaluation. A cardiac-specific troponin is the preferred biomarker. For patients who present within 6 hours of symptom onset suggestive of cardiac ischemia with negative cardiac troponin initially, it is recommended that a troponin level be remeasured between 6 and 12 hours after symptom onset. It is reasonable to use highly sensitive cardiac troponin assays, defined as having a 10% coefficient of variation at the 99th percentile, to evaluate patients with symptoms suspicious of cardiac ischemia. Multimarker evaluation with CK-MB or myoglobin in conjunction with troponin in patients with symptoms suspicious of cardiac ischemia may be considered to improve the sensitivity of diagnosing AMI.

There is no evidence to support the use of troponin POCT in isolation as a primary test in the prehospital setting to evaluate patients with symptoms suspicious of cardiac ischemia.

There is insufficient evidence to support the use of myoglobin, brain natriuretic peptide (BNP), NT-proBNP, D-dimer, C-reactive protein, ischemia-modified albumin

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pregnancy-associated plasma protein A (PAPP-A), and/or interleukin-6 in isolation as primary tests to evaluate patients with symptoms suspicious for cardiac ischemia.

**Prognosis for Discharge Versus Admission**

In patients with suspected ACS, does the presence of any specific factors (eg, history, examination, ECG, and/or biomarkers) or combination into a specific clinical decision rule compared with standard care increase accuracy of prediction of prognosis (eg, decision rule for early discharge)?

**Consensus on Science Statements**

There are no randomized controlled studies addressing clinical decision rules for ACS in the prehospital or ED settings. Existing studies do not adequately address the question because they are heterogeneous (LOE P1).169 There is not a single published clinical decision rule which is adequate and appropriate for identifying ED chest pain patients who can be safely discharged home from the ED (LOE P1).169

Younger patients with no history of previous ischemic heart disease, atypical presentations, negative serial biomarkers, and a nondiagnostic 12-lead ECGs have a very low short-term rate of adverse events. Five studies demonstrated that younger patients with no history of previous ischemic heart disease, atypical presentations, negative serial biomarkers, and nondiagnostic 12-lead ECGs have a very low short-term rate of adverse events (LOE P2).88,170–175 One study demonstrated that older patients are evaluated less effectively and the subset of older patients who can be safely discharged from the ED are less easily identified than younger patients (LOE P2).88

Five studies demonstrated that the combined use of serial biomarkers and ECGs in selected patients (ie, low risk, sensation-free, and clinically stable) can assist in the identification of a subset of patients who can be safely discharged from the ED (LOE P2).88,170–175 This study demonstrated that older patients demonstrate higher rates of ACS diagnosis and adverse outcome.

Nine studies demonstrated that scoring systems derived from in-patient populations (eg, TIMI Risk Score or Goldman Criteria) are not appropriate for ED use and do not assist in the identification of patients who can be safely discharged from the ED (LOE P1176,177; LOE P3178–184).

**Treatment Recommendations**

None of the currently reported clinical decision rules should be used to select ED chest pain patients who can be safely discharged from the ED. Patients <40 years of age with non-classical presentations and lacking significant past medical history, who have normal serial biomarkers and 12-lead ECGs, have a very low short-term event rate.

**Chest Pain Observation Units**

In patients with suspected ACS, does the use of chest pain observation units (CPUs), compared with not using them, increase accuracy of diagnosis and safely identify patients who require admission or specific management of CAD?

CPUs have been developed to assess patients with chest pain and normal initial biomarkers and non-ischemic ECG. The elements that define a CPU vary depending on the characteristics of the individual organizations and the clinical context in which the unit is sited (eg, ED versus in-patient environment versus dedicated site).

Components of the CPU are typically a protocol or pathway based care strategy, dedicated physical space/infrastructure and staffing, use of an accelerated risk-stratification protocol comprising

- Measurement of serial biomarkers of acute infarction (eg, troponin or CK-MB)
- Serial ECG or continuous ECG monitoring
- A period of observation (6 hours)
- Integration with more advanced diagnostic testing (eg, exercise stress test, myocardial perfusion scan)

**Consensus on Science**

Eleven studies of patients with chest pain and normal initial biomarkers and nondiagnostic ECGs demonstrated that CPUs result in reduced length of stay, hospital admissions, quality of life measures, and healthcare costs (LOE 1).185–195 One large case-control multicenter study showed that care in CPUs did not reduce the proportion of patients with chest pain admitted to hospital and may have increased ED attendances when implemented across a healthcare system (LOE 2).196 Fifty-five studies from many healthcare settings demonstrate that CPUs enable evaluation of patients systematically, with a short length of stay, high diagnostic accuracy, and a low event rate at follow-up (LOE 4).197–246

**Imaging Techniques**

**Imaging Techniques and Diagnosis**

In patients with suspected ACS, does the use of specific imaging techniques (eg, CT angiography, MRI, nuclear, echocardiography), compared with not using them, increase accuracy of diagnosis (eg, of ACS).
Consensus on Science

Data from 1 study (LOE D2)\(^{247}\) documented a sensitivity of 89% and a specificity of 77% for detection of ACS when myocardial perfusion imaging was used in adults presenting to the ED with chest pain, a nondiagnostic ECG, and negative cardiac biomarkers. Supportive evidence was also provided by 4 other studies (LOE D4)\(^{217,248-250}\) for adults presenting to the ED with chest pain.

Data from 2 studies showed high sensitivity (95%) and specificity (90%) for detection of ACS in adults who received multidetector CT angiography (MDCT, 64-slice scanner) after presentation to the ED with chest pain, a nondiagnostic ECG, and negative cardiac biomarkers (LOE D2).\(^{251,252}\) This finding was also supported by 4 studies (LOE D4).\(^{198,217,253,254}\)

Data from 1 study documented sensitivity 93% and specificity 66% when rest echocardiography is used for detection of ACS in low-risk patients who presented to the ED with chest pain, a nondiagnostic ECG, and negative cardiac biomarkers (LOE D2).\(^{247}\) Supportive evidence was also provided by one prospective cohort study (LOE D4).\(^{250}\) One prospective study provided similar estimates including specificity of 95% and positive predictive value of 81% for exercise stress echo in the same population (LOE D4).\(^{248}\)

Data from 2 studies documented high sensitivity (85%), specificity (84%), and negative predictive value (95%) for the diagnosis of ACS in adult patients who received MRI within 24 hours of presentation to the ED with chest pain after a nondiagnostic ECG and negative cardiac biomarkers (LOE D4).\(^{255,256}\)

Treatment Recommendations

A noninvasive test (CT angiography, cardiac MR, myocardial perfusion imaging, and echocardiography) may be considered in selected patients who present to the ED with chest pain and initial nondiagnostic conventional work-ups.

It is reasonable to consider both the exposure to radiation and iodinated contrast when utilizing MDCT and myocardial perfusion imaging.

Imaging Techniques and Outcome\(^{ACS-006-2A, ACS-006-2B}\)

In patients with suspected ACS, does the use of specific imaging techniques (eg, CT angiography, MRI, nuclear, or echocardiography), compared with not using them, improve outcome (survival, length of ED stay, hospital admission rate, cost)?

Consensus on Science Statements

Data from 2 studies of low-risk ED patients with an initial negative work-up of ACS with negative cardiac enzymes and non diagnostic ECGs, who received SPECT perfusion imaging, demonstrated low rates of cardiac events, reduced costs, and reduced length of stay (LOE 4).\(^{215,249}\)

Data from 3 studies of 64-slice MDCT utilized within 24 hours in adult patients presenting to the ED with chest pain, showed that the procedure decreases time to diagnosis, reduces costs, reduces length of stay, is predictive of major adverse events, and can lead to safe discharge from the ED (LOE 1\(^{257}\); LOE 4\(^{258,259}\)).

Data from 5 studies of echocardiography performed in adult ED patients presenting with chest pain, negative cardiac enzymes, and non-diagnostic ECG’s demonstrated decreased mean length of stay and reduced costs and predicted a low cardiovascular event rate (LOE 1\(^{260}\); LOE 4\(^{261-264}\)).

Treatment Recommendations

Based on studies which investigated limited numbers of selected individuals, patients presenting to the ED with suspected ACS and having a negative initial work-up, including a nondiagnostic ECG and negative cardiac biomarkers, an evaluation with a noninvasive test (CT angiography, myocardial perfusion imaging, or stress echocardiography) may be considered. In selected groups these noninvasive tests may decrease costs, length of stay, and time to diagnosis and may provide valuable short-term and long-term prognostic information of future major cardiac events. There are insufficient data to assess impact on mortality.

Initial Therapeutic Interventions

Few studies have been published that directly address out-of-hospital or ED interventions for ACS. In some situations, extrapolation from in-hospital evidence was needed to provide some guidance for out-of-hospital and early ED management.

Oxygen Therapy

Supplemental Oxygen\(^{ACS-015}\)

In patients with suspected ACS in various settings (eg, prehospital, emergency or in-hospital) and normal oxygen saturations, does the use of supplemental oxygen, compared with room air, improve outcomes (eg, chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

Consensus on Science

One study reported improvement in ST changes if oxygen was given to 17 patients with myocardial infarction (LOE 4).\(^{265}\) One LOE 1 trial\(^{266}\) conducted before the introduction of reperfusion therapy reported that the amount of aspartate aminotransferase released in the circulation was higher in patients who received oxygen therapy. Ventricular tachycardia (VT) and mortality was not significantly different in the two groups. Another LOE 1 study\(^{267}\) involving myocardial infarction patients treated with streptokinase showed no impact of oxygen on the occurrence of VT. Severe hypoxemia occurred less often in patients given oxygen therapy. One LOE 1 study\(^{268}\) found that studies were small and lacked statistical power to detect a true influence on clinical outcomes. The review found no definite proof of a harmful effect of oxygen therapy; however, there is absolutely no evidence that oxygen was beneficial to patients with myocardial infarction unless complicated by hypoxemia.

Treatment Recommendations

There is insufficient evidence to support or refute the empirical use of high-flow oxygen therapy in patients with uncomplicated AMI without signs of hypoxemia and/or heart failure. There are insufficient data to support or refute the fact that high-flow oxygen therapy might be harmful in this setting. In addition, there is lack of evidence to suggest that low flow oxygen is of any benefit in patients with normal oxygen saturation levels.

Oxygen therapy should be initiated if breathlessness, hypoxemia, or signs of heart failure or shock are present.
Noninvasive monitoring of oxygen saturation may be used to decide on the need for oxygen administration.

**ACS and Nitroglycerin**

In patients with suspected ACS/STEMI in the ED and prehospital settings, does the use of nitroglycerin, compared with no nitroglycerin, improve outcome (eg, chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

**Consensus on Science**

Despite multiple studies performed in the pre-reperfusion era that have shown a benefit of early nitroglycerin administration in patients with a myocardial infarction, no trial specifically evaluated patients in the ED or prehospital settings. The greatest reduction in infarct size was noted in those treated within 3 hours of symptom onset in 3 studies of patients treated in the intensive care unit (ICU) (LOE 5). In addition, 2 trials suggested that concomitant treatment of nitroglycerin and fibrinolytics may impair reperfusion (LOE 2). One study of patients with NSTEMI showed a reduction in myocardial infarction size in those treated with diltiazem compared with intravenous glyceryl trinitrate (LOE 1). There is insufficient evidence to determine the benefit or harm of initiating nitroglycerin treatment in the prehospital setting or ED.

**Treatment Recommendations**

Although it is reasonable to consider the early administration of nitroglycerin in selected patients without contraindications, insufficient evidence exists to support or refute the routine administration of nitroglycerin in the ED or prehospital setting in patients with a suspected ACS. There may be some benefit if nitroglycerin administration results in pain relief.

**Analgesics and Sedation**

The worksheet on the topic of Analgesics and Sedation was not completed for the 2010 International Consensus Conference, but the task force felt the topic was important to the care of patients with ACS. As a result, this topic was reviewed by the task force, and they developed the summary of science and treatment recommendations.

In patients with suspected ACS/STEMI in the ED and prehospital settings, does the use of analgesic and/or sedation, (including NSAIDs, opiates, and benzodiazepines) compared with no analgesia or sedation, improve outcome (eg, chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

**Consensus on Science**

One study suggested increased mortality and myocardial infarction rates associated with the use of intravenous morphine in patients presenting with high-risk NSTEMI (LOE 4). One study demonstrated that the early use of lorazepam with nitroglycerin was more effective than nitroglycerin alone and appears to be safe in relieving cocaine-associated chest pain (LOE 1). One study was neutral when diazepam was compared with placebo on the end points of tachyarrhythmias, self-assessed anxiety, or other symptoms in undifferentiated patients with AMI (LOE 1).

One analysis of case control and cohort studies studying patient exposure to NSAIDs (LOE 1) and a large analysis of clinical trials randomizing patients to Cox inhibitors over placebo (LOE 1) revealed an increased risk for developing myocardial infarction with use of NSAIDs. The risk appeared most consistent with rofecoxib, and was less consistently observed with celecoxib, naprosyn, ibuprofen, and diclofenac. One study suggested increased harm with the initiation or continuation of NSAID (except aspirin) in patients with suspected ACS (LOE 4).

**Treatment Recommendations**

Morphine should be administered intravenously and titrated to pain relief in patients with STEMI. Morphine may be considered for pain relief in subjects with suspected NSTEMI. Some form of analgesia should be considered for patients with active chest discomfort. While anxiolytics may be administered to patients with ACS to alleviate apprehension and anxiety, there is no evidence that anxiolytics facilitate ECG resolution, reduce infarct size, or decrease mortality in undifferentiated patients with suspected ACS. Lorazepam with nitroglycerin may be considered to alleviate pain in patients with cocaine-associated chest pain. NSAIDs should not be administered and may be harmful in subjects with suspected ACS. Patients with suspected ACS who are taking NSAIDs should have them discontinued when feasible.

**Aspirin (Acetylsalicylic Acid)**

**Timing of Aspirin Administration**

In patients with suspected ACS, does dispatcher guided administration of aspirin by bystanders before arrival of EMS, compared with later administration of aspirin by paramedic or ED staff, improve outcome?

**Consensus on Science**

There was no clear evidence to support or refute the use of prehospital or EMS dispatch directed (versus hospital administered) aspirin. One study found that aspirin, given before fibrinolysis, increased long-term survival (LOE 1). One study showed a benefit in STEMI patients with a decrease in in-hospital complications and 7- and 30-day mortality when given prehospital (LOE 4). There was clear evidence that aspirin is associated with a reduction in long-term mortality, which is greatest when the aspirin is administered in the first 4 hours of after an event. One study showed no benefit with administration within the first 4 hours of symptoms, compared with later administration (LOE 1). Two other studies showed that the potential benefit from early aspirin administration outweighs potential harm (LOE 1).

**Treatment Recommendations**

Despite limited direct evidence to support or refute the practice, it may be reasonable to consider EMS or dispatcher-guided bystander aspirin administration, provided an adequate history to exclude a true allergy or a bleeding disorder, can be obtained.
Clopidogrel and Other Platelet ADP-Receptor Antagonists

**Clopidogrel (and Similar Drugs)**

In patients with non–ST-elevation ACS (NSTE ACS), STEMI managed with fibrinolysis, and STEMI managed with PCI, in prehospital and ED settings, does the use of clopidogrel or newer oral antiplatelet agents (prasugrel, ticagrelor) compared with standard management (eg, no prehospital or ED use of clopidogrel or compared to clopidogrel or new thienopyridines), improve outcome (eg, chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 day mortality)?

**Consensus on Science**

**Clopidogrel.** Seven studies (LOE 1286–289; LOE 2290,291 LOE 3292) documented consistent improvement, and 1 study (LOE 5)293 was neutral in demonstrating benefit in the combined event rate of cardiovascular mortality, nonfatal infarction, nonfatal stroke, and overall mortality. There was a small increase in major bleeding when clopidogrel was administered by providers in the ED or hospital to patients with non–ST-elevation ACS.

Six studies documented consistent improvement in combined event rate of cardiovascular mortality, nonfatal infarction, and nonfatal stroke, with a resultant small increase in major bleeding when clopidogrel was administered by providers in the ED or prehospital to patients <75 years with STEMI managed with fibrinolysis (LOE 1294–297; LOE 3298,299).

Five studies documented improvement in combined event rate (cardiovascular mortality, nonfatal infarction, and nonfatal stroke) and mortality with a resultant small increase in major bleeding when clopidogrel was administered by ED, hospital and/or prehospital providers to patients with STEMI managed by PCI (LOE 2300,301; LOE 3298,299; LOE 5300).

There was little evidence on the use of a loading dose of clopidogrel in patients ≥75 years of age treated by PCI, and they were excluded from studies if treated with fibrinolysis.

**Prasugrel.** There was no direct evidence of use of prasugrel in the ED or prehospital setting for non-ST-elevation ACS. Extrapolating evidence from an in-hospital setting, 5 studies (LOE 5)302–306 documented improvement and 1 study (LOE 1)307 documented no benefit in combined event rate (cardiovascular mortality, nonfatal infarction, and nonfatal stroke) or mortality, but with a resultant increase in major bleeding when prasugrel (compared to clopidogrel) was administered after angiography to patients with non-ST-elevation ACS and stenoses suitable for PCI.

There was no direct or indirect evidence of benefit or risk of prasugrel administered by hospital, ED, or prehospital providers to patients with STEMI managed with fibrinolysis. There was no direct evidence of the use of prasugrel in the ED or prehospital setting for patients with STEMI ACS. There was no direct evidence of the use of prasugrel in the ED or prehospital setting for patients with STEMI ACS managed with PCI. Six studies demonstrated small improvements in combined event rate (cardiovascular mortality, nonfatal infarction, and nonfatal stroke) and/or mortality when prasugrel compared with clopidogrel was administered in the hospital setting before, during, or after angiography to patients with STEMI managed with PCI (LOE 5).302–306,308

Posthoc exploratory analysis of a randomized control trial in STEMI and non–ST-elevation ACS patients treated by PCI identified risk factors associated with a higher rate of bleeding complications with prasugrel: patients ≥75 years of age, history of stroke or transient ischemic attack (TIA), and body weight less than 60 kg (LOE 5).302

**Ticagrelor.** One study documented improvement in overall mortality and combined event rates (death from vascular causes, MI, or stroke) with a marginal increase in bleeding and an increase in dyspnea when ticagrelor, given by in-hospital providers to patients with high-risk non-ST elevation ACS, was compared with clopidogrel (LOE 1).309 There was no direct or indirect evidence of benefit or risk of ticagrelor administered by hospital, ED, or prehospital providers to patients with STEMI managed with fibrinolysis. One study documented improvement in overall mortality and combined event rates (death from vascular causes, MI, or stroke) with a marginal increase in bleeding and an increase in dyspnea when ticagrelor was administered compared to clopidogrel by in-hospital providers to patients with STEMI managed by PCI (LOE 1).309

**Treatment Recommendations**

**Clopidogrel.** Administration of clopidogrel in addition to standard care (aspirin, anticoagulants, and/or reperfusion) for patients determined to have moderate to high-risk non-ST elevation ACS and STEMI is recommended. The ideal oral loading dose of clopidogrel in patients <75 years of age is dependent on the planned approach: 600 mg in a planned invasive strategy; or 300 mg in a planned noninvasive strategy or together with fibrinolysis. The ideal dose in patients ≥75 years of age has not yet been delineated, but may range from 75 to 600 mg.

**Prasugrel.** Prasugrel may be administered after angiography to patients with NSTEMI presenting with stenoses amenable to PCI. ED or prehospital administration of clopidogrel should be withheld even in patients who are not at high risk for bleeding (age <75 years, no history of previous stroke or TIA, and body weight >60 kg), pending consideration of prasugrel administration following angiography. In patients who are at high risk for bleeding with planned PCI, prasugrel (60 mg oral loading dose) may be substituted for clopidogrel for patients determined to have STEMI less than 12 hours after the initial symptoms. Prasugrel is not recommended in STEMI patients receiving fibrinolysis.

**Ticagrelor.** Administration of ticagrelor (180-mg oral loading dose) in addition to standard care (aspirin, anticoagulants, and/or reperfusion) determined to have non-ST-elevation ACS or STEMI managed with early invasive strategy by hospital personnel may be an option instead of clopidogrel. The risks and/or benefits of ticagrelor in STEMI patients managed with fibrinolysis is unknown.

**Combination.** The risks and/or benefits of combining these agents (clopidogrel, prasugrel, and/or ticagrelor) for loading and maintenance dosing has not been sufficiently determined.

**Heparins**

**Anticoagulants and Non–ST-Elevation ACS**

In patients with suspected non–ST-elevation myocardial infarction in the prehospital and ED setting, does the use of new anticoagulants (ie, pentasaccharide, enoxaparin, bivalirudin),
compared with standard management (placebo, unfractionated heparin [UFH], other anticoagulant, or no anticoagulant), improve outcomes (eg, mortality, reinfarction, revascularization, bleeding, stroke)?

**Consensus on Science**

Twenty-two studies demonstrated improved combined end points (death, MI, revascularization) with an increase in the proportion of patients with bleeding complications when enoxaparin was administered in-hospital rather than UFH in patients with AMI (LOE 1;310–320; LOE 2;321–326; LOE 5;327–329).

Four randomized, controlled trials (RCTs, LOE 1),330–332,333 3 meta-analyses (LOE 1),334–336 6 nonrandomized control trials (LOE 2 to 4),337–344 and 5 additional studies (LOE 4 to 5)345–349 did not demonstrate a difference for outcomes among in-hospital patients given enoxaparin compared with UFH.

One RCT (LOE 1),350 3 nonrandomized control studies (LOE 2),351–353 and 2 additional studies (LOE 5)354,355 demonstrated improved combined end points (death, MI, revascularization) without increased bleeding when fondaparinux, compared with UFH, was administered in-hospital in patients with AMI. Three studies did not demonstrate a difference in outcomes for fondaparinux compared with UFH when given in-hospital (LOE 2;356,357; LOE 5;358). One RCT indicated fondaparinux may lead to excess catheter thrombosis when used as part of an invasive approach without the use of adjunctive medications (LOE 1).350

Twenty-eight studies (LOE 1;359–364; LOE 2 to 4;365–375; LOE 5;376–386) did not demonstrate a difference in combined outcomes for major adverse cardiac events but did demonstrate less bleeding for bivalirudin administered in-hospital compared with UFH.

**Treatment Recommendations**

For patients with non–ST-elevation ACS managed with a planned initial conservative approach, either fondaparinux or enoxaparin are reasonable alternatives to UFH. For patients with non–ST-elevation ACS managed with a planned invasive approach, either enoxaparin or UFH are reasonable choices. Bivalirudin may be considered as an alternative, but does not appear to offer an advantage over UFH. Fondaparinux may be used in the setting of PCI, but requires co-administration of UFH and does not appear to offer an advantage over UFH alone.

For patients with non–ST-elevation ACS and renal insufficiency, bivalirudin or UFH may be considered. For patients with non–ST-elevation ACS and increased bleeding risk, where anticoagulant therapy is not contraindicated, fondaparinux or bivalirudin are reasonable, and UFH may be considered. There is no specific evidence for or against anticoagulant use in non–ST-elevation ACS in the prehospital setting. There is currently insufficient evidence on other anticoagulants to make recommendations.

**Anticoagulants and STEMI Treated With Fibrinolysis**

In patients with suspected STEMI in the prehospital and ED setting treated with fibrinolysis, does the use of new anticoagulants (ie, pentasaccharide, enoxaparin, bivalirudin), compared with standard management (placebo, unfractionated heparin, other anticoagulant, or no anticoagulant), improve outcomes (eg, mortality, reinfarction, revascularization, bleeding, or stroke)?

**Consensus on Science**

**Enoxaparin.** For patients with STEMI to be treated with fibrinolysis, 17 studies supported enoxaparin over UFH (LOE 1;336,387–393; LOE 2;394,395,396; LOE 4;397; LOE 5;398,399–401) Twelve other studies were neutral comparing enoxaparin and UFH.402–411

**Other LMWH.** There were 2 neutral meta-analyses of dalteparin, nadroparin, reviparin, and fondaparinux (LOE 1,412 1 dalteparin supporting study using a surrogate end point (LOE 1),413 3 neutral studies of LOE 1414 for nandroparin415 and reviparin416,417,418

**Bivalirudin.** Two studies did not demonstrate a significant difference in outcomes with bivalirudin (LOE 1;422,423).

**Treatment Recommendations**

Enoxaparin: For patients with STEMI managed with fibrinolysis, it is reasonable to administer enoxaparin instead of UFH. For prehospital patients with STEMI managed with fibrinolysis, adjunctive enoxaparin instead of UFH may be considered. Patients initially treated with enoxaparin should not be switched to UFH and vice versa to avoid increased bleeding risk.

Fondaparinux: May be considered in the hospital for patients treated specifically with non–fibrin-specific thrombolitics (ie, streptokinase), provided the creatinine level is <3 mg/dL.

Other LMWH or bivalirudin: There are insufficient data to recommend other LMWH or bivalirudin over UFH in patients treated with fibrinolysis in STEMI.

**Anticoagulants and STEMI Treated With PCI**

In patients with suspected STEMI in the prehospital and ED setting to be treated with PCI, does the use of new anticoagulants (ie, pentasaccharide, enoxaparin, bivalirudin), compared with standard management (placebo, unfractionated heparin, other anticoagulant, or no anticoagulant), improve outcomes (eg, mortality, reinfarction, revascularization, bleeding, or stroke)?

**Consensus on Science**

**Bivalirudin.** Two studies resulted in less bleeding and a short- and long-term reduction in cardiac events and overall mortality with bivalirudin compared with UFH plus a glycoprotein inhibitor in patients with STEMI and planned PCI...
Two case series also resulted in fewer cardiac events and less bleeding (LOE 4). One study demonstrated better outcome of patients with cardiogenic shock if treated with or without a glycoprotein IIb/IIIa inhibitor, compared with UFH plus a glycoprotein IIb/IIIa inhibitor (LOE 4). One study with prehospital initiation of bivalirudin versus UFH showed no difference (LOE 3). One analysis showed no difference when bivalirudin and UFH were compared for PCI (LOE 5). In 2 studies of bivalirudin versus UFH, outcomes were similar (LOE 2; LOE 4).

Enoxaparin. Three studies of PCI after fibrinolysis resulted in favorable outcome when enoxaparin was compared with UFH (LOE 4). Eight other studies showed no benefit using enoxaparin compared with UFH (LOE 2). One analysis of NSTEMI patients documented fewer acute cardiovascular events and less bleeding using fondaparinux and PCI compared with other antithrombins (LOE 5). Thrombus formation on catheter material in patients on fondaparinux required the addition of UFH during PCI.

Other LMWH. One nonrandomized study compared dalteparin with UFH in STEMI patients undergoing PCI and showed a neutral result (LOE 2).

Treatment Recommendations
For patients with STEMI undergoing contemporary PCI, enoxaparin may be considered a safe and effective alternative to UFH. To avoid increased bleeding risk, patients initially treated with enoxaparin should not be switched to UFH and vice versa.

In comparison with UFH, fondaparinux reduces the bleeding risk in STEMI patients undergoing PCI. There is an increased risk of catheter thrombi with fondaparinux alone; additional UFH (50 to 100 U/kg BW bolus) may help to avoid this complication, but using these 2 agents is not recommended over UFH alone. The dose of fondaparinux and enoxaparin requires adjustment in patients with renal impairment.

Bivalirudin may be superior to UFH plus glycoprotein IIb/IIIa inhibitors with respect to bleeding and reduces adverse cardiac events and mortality in STEMI patients undergoing PCI. An increased rate of stent thromboses has been observed with bivalirudin within the first 24 hours after PCI.

There are insufficient data to recommend other LMWH than enoxaparin for antithrombin treatment in STEMI patients undergoing PCI.

Glycoprotein IIb/IIIa Inhibitors
In patients with suspected ACS/MI in prehospital and ED settings, does the use of glycoprotein IIb/IIIa inhibitors, compared with standard management, improve outcomes (eg, chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

Conclusions on Science
Twelve larger randomized studies and metaanalyses (LOE 1) and 2 smaller randomized studies consistently reported better clinical outcome with use of glycoprotein IIb/IIIa inhibitors compared with placebo. This result was supported by many studies which consistently reported better outcomes with upstream or early use of glycoprotein IIb/IIIa inhibitor compared with deferred treatment or other strategies (LOE 1). There were 12 studies with neutral outcomes/evidence (LOE 1). Seven LOE 1 studies showed worse outcomes, or at least more bleeding and need for transfusion without clinical advantage, with glycoprotein IIb/IIIa inhibitors compared with standard/alternative procedures. In most of the supporting, as well as neutral and opposing, studies a higher rate of (major) bleedings has been observed.

Treatment Recommendations
There were insufficient data to support the routine use of glycoprotein IIb/IIIa inhibitors in patients with suspected STEMI or NSTE-ACS in the prehospital or ED settings. For selected high-risk patients with NSTE-ACS, abciximab, eptifibatide, or tirofiban administration may be acceptable, provided PCI is planned. There is an increased bleeding risk with routine glycoprotein IIb/IIIa inhibitors when used with heparins. Alternatives for anticoagulation and antiplatelet treatment might be considered instead.

Reperfusion Strategies
In the majority of patients, STEMI occurs as the result of a recent acute occlusion of a major epicardial coronary artery due to the disruption of atherosclerotic plaque and thrombus formation. Strategies aimed at restoring myocardial perfusion are an important part of the management of these patients. Restoring coronary blood flow and myocardial perfusion either by pharmacologic (fibrinolytics) and/or mechanical therapy (PCI) has been demonstrated to improve outcomes in patients presenting within 12 hours of symptom onset and later other patients group such as those with cardiogenic shock. There is evidence that prehospital fibrinolysis reduces delay to treatment, especially in rural areas with long transit times. In these settings prehospital fibrinolysis is a reasonable treatment strategy.

Out-of-Hospital Fibrinolytics for STEMI
Prehospital Fibrinolytics for STEMI
In patients with STEMI in the prehospital setting, does the use of prehospital fibrinolytics, compared with in-hospital fibrinolytics, improve outcomes (eg, chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

Conclusions on Science
Nineteen studies demonstrated significantly reduced time to treatment when fibrinolytics were given to patients with STEMI in the prehospital setting by either physicians,
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randomized trial demonstrated that early revascularization
related directly to risk status of the patient, with those at high
ranged between 82 and 122 minutes. The benefit was corre-
varied among the separate trials in this meta-analysis and

LOE 3511–513).  

grams, and quality assurance programs, under medical
and should be administered by paramedics, nurses, or doctors
started as soon as possible, ideally in the prehospital setting,
if fibrinolysis is chosen as the reperfusion strategy, it should be
in a timely manner, at a capable center, by an experienced
interventionalist, PPCI may be superior to fibrinolysis. Ap-
lication of PPCI has been limited by access to catheter
laboratory facilities and appropriately skilled clinicians. Fi-
bринolytic therapy is a widely available reperfusion strategy
may be used if delays to PPCI are anticipated. Both
treatment strategies are well established and have been the
subject of large randomized multicenter trials over the last 2
decades.

Choice of Reperfusion Strategy in the Hospital

PPCI Versus Fibrinolytic Therapy for STEMIACS-025B
In patients with suspected STEMI in the ED setting, does the
use of PPCI compared with fibrinolytic therapy, improve outcome (eg, arrhythmias, infarct size, ECG resolution, sur-
vival to discharge, 30/60 days mortality)?

PPCI is an effective reperfusion strategy. When provided
in a timely manner, at a capable center, by an experienced
interventionalist, PPCI may be superior to fibrinolysis. Ap-
lication of PPCI has been limited by access to catheter
laboratory facilities and appropriately skilled clinicians. Fi-
bринolytic therapy is a widely available reperfusion strategy
and may be used if delays to PPCI are anticipated. Both
treatment strategies are well established and have been the
subject of large randomized multicenter trials over the last 2
decades.

Consensus on Science
For patients admitted to hospital with PCI facilities, evidence
from 2 studies demonstrated that PPCI conferred clinical
benefit compared with fibrinolysis both in terms of mortality and morbidity (reinfarction/stroke) for the majority of pa-
tients (LOE 1).517,518 The evidence from 2 studies was scant
for additional benefit of PCI over fibrinolysis for specific
subgroups such as post CABG patients or patients with renal
failure (LOE 1519; LOE 3520).

For patients admitted to hospital without PCI facilities, 2
studies showed benefit associated with transferring patients
for PPCI versus on-site fibrinolysis in terms of reinfarction and stroke and a trend to a lower mortality in the PPCI group
(LOE 2).521,522 The average time from randomization to PCI
varied among the separate trials in this meta-analysis and
ranged between 82 and 122 minutes. The benefit was corre-
lated directly to risk status of the patient, with those at high
risk benefiting more from transfer.

For patients with cardiogenic shock, evidence from 1
randomized trial demonstrated that early revascularization
improves survival at 6 months (LOE 1).523 The survival
benefit was seen mainly in patients less than 75 years of age.

Data from registries 524 and a meta-analysis from previ-
ously published studies 525 highlight the variability in PCI-
related time delay (between 40 and 179 minutes), that
mitigated the benefit of mechanical intervention over fibrin-
olysis (LOE 3524,525). This variability was influenced by
several factors including age, symptom duration, and location
of infarction. Similarly 1 study showed that the benefit of PCI
over fibrinolytic therapy is offset when PCI is carried out in
low-volume PCI centers (LOE 1).526

Treatment Recommendations

For patients presenting within 12 hours of symptom onset
and with ECG findings consistent with STEMI, reperfusion
should be initiated as soon as possible independently of the
method chosen. The benefit of mechanical intervention over
fibrinolysis varies considerably depending on the patient’s
condition and the duration of PCI-related delays. For those
patients with a contraindication to fibrinolysis, PCI should
still be pursued despite the delay, rather than offering no
reperfusion therapy.

For those STEMI patients presenting in shock, PCI (or
coronary artery bypass surgery) is the preferred reperfusion
treatment. Fibrinolysis should only be considered if there is a
substantial delay to PCI.

Combined PCI and Fibrinolysis

Fibrinolitics and Immediate PCI (Facilitated PCI) Versus
Immediate PCIACS-025A, ACS-025B

In patients with suspected STEMI in the ED and prehospital
settings, does the use of fibrinolitics and immediate PCI,
compared with immediate PCI, improve outcome (eg, chest
pain resolution, infarct size, ECG resolution, survival to
discharge, 30/60 days mortality)?

Fibrinolitics and PCI may be used in a variety of combi-
nations to restore coronary blood flow and myocardial per-
fusion. There are several ways in which the 2 therapies can be
combined. There is some lack of uniformity in the nomen-
clature used to describe these regimes. In this analysis,
facilitated PCI is used to describe PCI performed immedi-
ately after fibrinolysis, a pharmaco-invasive strategy refers to
PCI performed routinely 2 to 6 hours after fibrinolysis, and
rescue PCI is defined as PCI performed for a failed reperfu-
son (as evidenced by <50% resolution of ST-segment
elavation at 60 to 90 minutes post-lytic). These strategies are
distinct from a routine PCI approach where the angiography
and intervention is performed more than 12 hours after
successful fibrinolysis.
**Consensus on Science**

Twelve studies demonstrated poorer outcome with routine PCI shortly after fibrinolysis (LOE 1481,527,528,529,532 LOE 2533, LOE 5534,535). Most of these studies have been performed in recent years. Eleven studies supported a facilitated PCI strategy (LOE 153; LOE 2464,539,541 LOE 3542,544; LOE 5545,547). Thirty studies show no benefit of PPCI over fibrinolysis (LOE 1405,491,548–554; LOE 2555–560; LOE 5561,561–566,567–574).

**Treatment Recommendations**

The routine use of fibrinolysis-facilitated PPCI, compared with PPCI, is not recommended in patients with suspected STEMI. It is reasonable to perform angiography and possible PCI in patients with failed fibrinolysis according to clinical signs and/or insufficient ST-segment resolution.

**Additional Medical Therapy**

Several additional medical therapies have been proposed for ACS patients with the goal of reducing complications from myocardial ischemia, major adverse cardiac events, and ultimately long-term survival. Therapeutic options include antiarrhythmics, β-blockers, angiotensin-converting enzyme (ACE) inhibitors, and HMG-CoA reductase inhibitors (statins). The bulk of data available to determine the usefulness of these therapies has not been derived from patients in the prehospital or ED settings. Traditional preventive interventions usually start with the first admission with a confirmed diagnosis, survival to discharge, 30/60 days mortality?

**Antiarrhythmics**

**Prophylactic AntiarrhythmicsACS-021B**

In patients with suspected ACS/MI in prehospital and ED settings, does the use of prophylactic antiarrhythmics, compared with standard management (ie, no prehospital and ED use of β-blockers), improve outcome (eg, arrhythmias, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

**Consensus on Science**

Evidence from 3 studies suggested a reduction in ventricular fibrillation (VF), which was not statistically significant; however, there was no improvement in survival to hospital discharge (LOE 1575,577; LOE 4578). The studies had heterogeneous clinical protocols, and most were underpowered. Twelve studies showed no improvement in suppression of ventricular arrhythmias (LOE 1579,588; LOE 2589; LOE 4590). The studies showed no improvement in survival to hospital discharge. Four studies showed worsening of arrhythmias and the potential for harm (LOE 1584,591,592; LOE 2593).

Lidocaine is the antiarrhythmic drug that has been studied most extensively in this clinical setting. The majority of the evidence suggests lidocaine is not associated with improved clinical outcomes. There were 3 studies supporting arrhythmia suppression with lidocaine; however, no clinical benefit was shown (LOE 1575,577; LOE 4578). There were 8 studies that were neutral for demonstrating arrhythmia suppression with lidocaine (LOE 1581,583,586–588; LOE 2589,593; LOE 4590. There were 2 studies that showed harm (LOE 1).580,592

One trial showed a statistically significant benefit in decreasing the incidence of VT using sotalol (LOE 1).594 Three studies were neutral with respect to tocainide and disopyramide (LOE 1).585,586 mexilitine (LOE 1),579 and tocainamide (LOE 1).585 One study showed harm with amiodarone (LOE 1)584 and 1 trial (LOE 1)591 showed harm with a variety of drugs, including β-blockers.

**Treatment Recommendations**

Prophylactic antiarrhythmics are not recommended for patients with suspected ACS or myocardial infarction.

**β-BlockersACS-023A**

In patients with suspected ACS/MI in prehospital and ED settings, does the use of β-blockers, compared with standard management (ie, no prehospital and ED use of β-blockers), improve outcome (eg, arrhythmias, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

Studies of β-blockers are heterogenous with respect to the time of β-blocker administration. There is a paucity of data on the administration of β-blockers in the prehospital or early ED settings (ie, within the first hour of a suspected ACS).

Eight studies showed no advantage for IV β-blockers on mortality, infarct size, prevention of arrhythmias, or reinfarction (LOE 1).595–602 None of the papers reviewed showed that β-blockers caused irreversible harm when given early in the development of suspected ACS. One study showed a statistically significant reduction in 6-week mortality in a subgroup of low-risk (ie, Killip Class I) patients (LOE 1).596 Other studies (LOE 1) have shown reduced mortality603,604 and decreased infarct size605,606,607 with early IV β-blocker use.

Four studies showed that early β-blocker administration helped prevent dangerous arrhythmias, (LOE 1)608,609,608 while 2 studies showed a prevention of reinfarction but increased incidence of cardiogenic shock (LOE 1).604,608 Many of the β-blocker trials in the early 1980s were small and had wide confidence intervals. One study suggested that the earlier IV β-blockers were administered, the greater the reduction in infarct size and mortality (LOE 3).610

**Treatment Recommendations**

For patients with ACS, there is no evidence to support the routine administration of IV β-blockers in the prehospital setting or during initial assessment in the ED. It may be reasonable to administer IV β-blockers in specific situations, such as severe hypertension or tachycardia, in patients without contraindications. Starting oral β-blockers at low doses is recommended once the patient’s condition has been stabilized.

**Angiotensin Converting Enzyme Inhibitors**

**Angiotensin Converting Enzyme (ACE) Inhibitors and Angiotensin Receptor Blockers (ARBs)ACS-024**

In patients with suspected ACS/MI in prehospital and ED settings, does the use of ACE inhibitors or ARBs, compared with standard management (ie, no prehospital and ED use of ACE inhibitors), improve outcome (eg, infarct size, survival to discharge, 30/60 days mortality)?
Consensus on Science
Despite multiple studies that have shown a benefit for ACE inhibitors and ARBs in patients with a myocardial infarction, no trial specifically evaluated patients in the ED or prehospital settings. One randomized trial showed a reduction in mortality for patients treated with ACE inhibitors soon after presentation, despite causing some hypotension (LOE 1).611 Three randomized trials showed a reduction in the rate of heart failure and mortality in patients treated soon after fibrinolysis (LOE 1).612–614 One study (LOE 1)613 failed to show a benefit with the use of ACE inhibitors within 1 hour of reperfusion and 2 meta-analyses (LOE 1)615,616 documented no benefit with ACE inhibitor administration.

Treatment Recommendations
ACE inhibitors and ARBs reduce mortality in patients with AMI; however, there is insufficient evidence to support the routine initiation of ACE inhibitors and ARBs in the prehospital or ED setting in patients with a myocardial infarction.

HMG CoA Reductase Inhibitors (Statins)
A & B StatinsACS-024B
In patients with suspected ACS/MI in prehospital and ED settings, does the use of statins, compared with standard management (ie, no prehospital and ED use of statins), improve outcome (eg, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

Consensus on Science
Nineteen studies documented a reduction in short- and long-term major adverse cardiovascular events after intensive treatment with statins within the first 24 hours after hospital admission for patients with ACS (LOE 1617–622; LOE 2623–635). Multiple studies reported consistently reduced short-term mortality and reduced incidence of death and nonfatal myocardial infarction during the 30-day follow-up with continued statin treatment or early initiation of this treatment, compared with discontinuation of statins at hospital admission of ACS patients (LOE 3636; LOE 4637–645). Some of the studies also report the reduction in markers of myocardial necrosis or inflammation in statin treatment in patient groups undergoing PCI. One meta-analysis (LOE 1)646 and 2 other studies (LOE 4)647,648 were neutral with regard to death and nonfatal myocardial infarction during the 30-day follow-up. There were no reports on the risk or safety considerations of early initiation of statin treatment in ACS.

Treatment Recommendations
Intensive statin treatment should be considered early after onset of an ACS event (eg, immediately after hospital admission) in patients presenting with ACS unless contraindicated (eg, by proven intolerance). Pre-existing statin therapy should be continued in patients presenting with an ACS.

Healthcare System Interventions for ACS
Several systems-related strategies have been developed to improve quality of care for patients with ACS and reduce reperfusion delays for patients with STEMI. Strategies exist for patients identified in the prehospital setting and in the ED. These strategies focus on the use of prehospital 12-lead ECG and time-saving strategies to facilitate early diagnosis and rapid treatment for patients with STEMI.

12-Lead Out-of-Hospital ECG and Advance ED Notification
Prehospital ECGsACS-026B
In patients with suspected ACS/MI in prehospital setting, does the use of prehospital ECG and advance ED notification, compared with no prehospital ECG, improve outcome (eg, arrhythmias, infarct size, ECG resolution, survival to discharge, 30/60 days mortality)?

Consensus on Science
Eight studies demonstrated a reduction in the door-to-needle time interval ranging from 20 to 60 minutes when physician- or paramedic-interpreted prehospital 12-lead ECG was used to evaluate patients with suspected AMI who are then treated with a fibrinolytic (LOE 1649–652; LOE 2116,117,653,654).

Eight studies demonstrated a reduction in the reperfusion delay (with varied time interval definitions) ranging from 15 to 65 minutes in patients treated with PCI (LOE 2655–658; LOE 3112,659,660; LOE 4661).

Two studies suggested that the time saved by using prehospital ECGs was dependent on advanced hospital notification of an incoming STEMI patient and activation of the catheterization team before the patient’s arrival (LOE 2).655,660 When comparing the door-to-reperfusion time for patients with a prehospital ECG and prehospital activation to patients with no prehospital ECG, the mean door-to-reperfusion interval was reduced by more than 30 minutes.660

Two nonrandomized trials reported no significant reductions in mortality with the use of prehospital ECGs (LOE 2).117,657 In one of these studies in-hospital all-cause mortality was 15.6% in a group of STEMI patients brought by EMS to the ED without prehospital ECGs, and 8.4% for patients who had a prehospital ECG and were brought directly to the critical care unit for fibrinolysis.117 The study was not powered to detect a mortality difference. The second study reported an 11% in-hospital mortality for STEMI patients brought by EMS without a prehospital ECG versus 5% in those with a prehospital ECG.657

Treatment Recommendations
Prehospital 12-lead ECGs facilitate earlier diagnosis of STEMI and provide the opportunity for rapid prehospital reperfusion or for rapid triage of patients to awaiting institutions able to provide such reperfusion. EMS personnel should acquire a prehospital 12-lead ECG on all patients exhibiting signs and symptoms of ACS and provide advance notification to receiving institutions for patients diagnosed with STEMI. Advance notification may be achieved with direct transmission of the ECG or with interpretation of the ECG by prehospital personnel. Advance notification should prompt preparations at the receiving institution for rapid reperfusion of the arriving STEMI patient.

Improving Systems of Care for ACSACS-009A
In patients with suspected STEMI, do any specific techniques improve STEMI system or process of care, compared with...
standard management, to improve time to treatment and clinical outcome?

Consensus on Science

Emergency Physician or Prehospital Activation of the Catheterization Laboratory Team. Two studies suggested an association between the ability of emergency physicians to activate the catheterization laboratory team and decreased door-to-balloon time interval (LOE 5).662,663 Twelve studies demonstrated that emergency physician activation of the catheterization laboratory was associated with significant reductions in door-to-balloon time intervals (20 to 68 minutes) (LOE 2664–666; LOE 3667–673; LOE 5663,674). False-positive activation rate in these studies ranged from 0% to 15%.674,663–673

Prehospital Activation of the Catheterization Laboratory. Seven studies demonstrated the effectiveness of prehospital activation on reducing door-to-balloon time intervals (22 to 69 minutes) (LOE 2656,675; LOE 3676,677; LOE 4660,678). The studies were variable in their implementation and all had significant limitations. False-positive activation of the catheterization laboratory was not assessed by any of the studies.

Single Call to a Central Page Operator. One qualitative survey suggested an association between single call to a central page operator and reduced reperfusion delay (LOE 5).679 There were no studies that investigated the effect of this specific technique in isolation.

Real-Time Data Feedback. Four studies demonstrated a positive impact of feedback on reducing the door-to-balloon interval (10 to 54 minutes) (LOE 3667,671; LOE 5679,680). These studies were heterogeneous and had significant limitations.

Institutional Commitment. Two qualitative studies suggested that senior management commitment and leadership was crucial to improving treatment of STEMI. However, no other studies proved this relationship (LOE 5).681,682

Team Based Approach. One qualitative study suggested a team-based approach led to improvements in STEMI systems of care (LOE 5).681 However, no other studies proved this relationship empirically.

Expecting the Catheterization Laboratory Staff to Arrive in 20 Minutes. One study established an association between hospitals that expect the catheterization team to arrive in 20 minutes and having decreased door-to-balloon time (LOE 5).679 However, no studies have investigated the impact of implementing this specific technique in isolation. One study used this specific expectation of arrival of catheterization laboratory staff along with other methods as part of a quality improvement initiative (LOE 3).667 Another study evaluated the outcomes of patients that presented during peak hours compared with off-peak hours and found decreased door-to-balloon time intervals among patients who presented when the catheterization laboratory team was in house (LOE 5).683

Having an Interventional Cardiologist Immediately Available at the Hospital. One study demonstrated an association between having an interventional cardiologist always at the hospital and decreased door to balloon times of 8.2 minutes (LOE 5).670 No studies have investigated the impact of implementing this specific technique on reperfusion delay. No studies demonstrated direct effect on mortality or other outcomes data.

Treatment Recommendations

Hospitals should implement prehospital activation of the catheterization laboratory for patients with suspected STEMI who arrive by EMS and should implement first-physician-contact activation of the catheterization laboratory for patients suspected of having STEMI arriving by other means. Hospitals may implement additional institution-specific techniques to improve STEMI systems of care; however there is little evidence to support their widespread implementation. These techniques include:

- Arranging single-call activation of the catheterization laboratory
- Requiring the catheterization laboratory to be ready in 20 minutes
- Having the interventional cardiologist immediately available at the hospital
- Providing real-time data feedback
- Fostering the commitment of senior management
- Encouraging a team-based approach

Out-of-Hospital Triage for PCI

In patients with ST-elevation identified on prehospital ECG, does the use of direct transport to PPCi, compared with transport to the closest hospital, improve outcomes (mortality, left ventricular function, re-infarction, or stroke) as compared with other standard strategies?

Consensus on Science

Two studies suggested that transportation of STEMI patients diagnosed by paramedics directly to PCI centers for PPCi as part of a coordinated regional response to STEMI reduced in-hospital mortality when compared with historical controls with a strategy of transportation to the closest hospital for fibrinolysis (LOE 3684; LOE 5685).

Four studies failed to show that a strategy of prehospital diagnosis and direct transportation for PCI was any better than prehospital fibrinolysis followed by early PCI in patients with STEMI (in systems involving the presence of physicians in mobile intensive care units) in reducing the composite outcome of death, nonfatal reinfarction, and nonfatal stroke at 30 days (LOE 1562,686,687; LOE 4555).

Three studies suggested a benefit of prehospital fibrinolysis (when coupled with an early invasive strategy) over that of PCI for patients presenting early after the onset of chest pain (less than 2 hours) and in certain clinical subsets (<65 years-of-age, anterior STEMI) in reduction of mortality (LOE 1688; LOE 4525,689).

Six studies comparing interfacility transfer for PPCi with on-site ED fibrinolysis in STEMI patients diagnosed in the ED demonstrated improved outcomes, including the triple end point of death, reinfarction, and stroke at 30 days; and outcomes for 30-day survival alone and reinfarction alone supported the strategy of direct transport for PPCi over fibrinolysis (LOE 5).521,530,690–693

Eleven studies demonstrated improved outcomes for patients diagnosed with STEMI in the prehospital setting and brought directly to PCI centers for PPCi compared with STEMI patients diagnosed in the ED of a non-PCI hospital who were transferred for PPCi (LOE 4115,676,678,694–700; LOE 5685). Clinical outcomes that were reported to improve with
diversion for PPCI in this group included left ventricular function, in-hospital mortality, long-term mortality, and a triple end point of death, reinfarction, or stroke at 30 days.

Thirteen studies suggested equivalent outcomes between a strategy of transfer for PPCI and of fibrinolysis in the prehospital or hospital setting, particularly in patients presenting early after the onset of chest pain (<2 hours) and in certain clinical subsets (<65 years-of-age, anterior STEMI) (LOE 2657,677; LOE 4405,450,456,487,701–707; LOE 5525).

Treatment Recommendations
It is reasonable to consider direct transport to PCI capable facilities for PPCI for patients diagnosed with STEMI by EMS in the prehospital setting, bypassing closer EDs as necessary, in systems where time intervals between first medical contact and balloon time are brief. In patients presenting early after the onset of chest pain (<2 hours) and in certain clinical subsets (<65 years-of-age, anterior STEMI), prehospital fibrinolysis may offer similar outcomes compared to PPCI.

PCI Following ROSC
In patients with ROSC after cardiac arrest, does the routine use of PCI, compared with standard management (without PCI), improve outcomes (eg, survival, rearrest, etc)?

There is evidence of underlying ischemic heart disease in the majority of patients who have an out-of-hospital cardiac arrest (OHCA). Acute coronary artery occlusion is known to be the precipitating factor in many of these patients. While coronary artery occlusion after cardiac arrest is associated with ECG ST-elevation or left bundle branch block (LBBB), it can also occur in the absence of these findings. Fibrinolysis in setting of OHCA is addressed in Part 8: “Advanced Life Support.”

Consensus on Science
One study suggested that cardiac angiography and PCI, when used as part of a standardized advanced post–cardiac arrest protocol, may be associated with improved survival to hospital discharge when compared with no standardized protocol (LOE 3).708 Sixteen studies suggested that percutaneous intervention (PCI) was feasible following ROSC (LOE 3708–724). These studies demonstrated that successful PCI versus no PCI may be associated with improved cardiac ejection fraction and survival,724 and coronary angiography may be favorably associated with neurologically intact survival.725 In most of the patients in these studies, immediate angiography and PPCI were performed.

Evidence from 2 studies suggested that outcomes after angiography and PCI vary considerably depending on patient-related factors (LOE 4).709,711 The survival in patients who had witnessed VF-arrests of short durations, STEMI, and with recovery of consciousness was as high as 95% to 100%. One study showed that therapeutic hypothermia in combination with PPCI was feasible and safe in patients resuscitated after cardiac arrest (LOE 4).725 One study compared PCI with fibrinolysis and demonstrated no difference in functional neurologic recovery or survival at 6 months in patients with ROSC after cardiac arrest (LOE 4).726

Two additional retrospective case series (LOE 4726,727) compared outcomes of PCI in patients with and without cardiac arrest. One study compared 20 post–cardiac arrest patients who underwent PCI and mild hypothermia with a control group of 70 patients who underwent mild hypothermia without PCI. There was no difference in the rate of arrhythmias (the primary end point) or other adverse events between the 2 groups.277 In the other retrospective study728 of 948 STEMI patients without cardiogenic shock treated by PPCI, 20 were post–cardiac arrest. There was no difference in one-month mortality between the non-arrest (cardiogenic shock) group and the post–cardiac arrest group, but non-cardiac mortality was higher in the post–cardiac arrest group.728

Recent publications provide additional information about the survival and functional outcome of patients who have PCI following ROSC after cardiac arrest. One retrospective series (LOE 4729) of 98 post–cardiac arrest patients who had ECG evidence of STEMI and underwent emergent angiography included 59 patients who were unresponsive. The survival rate to discharge (and proportion of these with full neurological recovery) was 64% (92%) overall and 44% (88%) among the initially unresponsive patients.729 In a prospective observational registry (LOE 3729) of out-of-hospital cardiac arrest patients, (the Parisean Regional Out of hospital Cardiac Arrest Trial [PROCAT]), 435 patients had no obvious extracardiac cause and all underwent immediate coronary angiography, followed by PCI if indicated. At least one significant coronary artery lesion was found in 128 (96%) of 134 patients with STEMI on the ECG and in 176 (58%) of 301 patients without STEMI. In patients with a significant coronary lesion, PCI was successful in 99 of the 128 STEMI patients and in 78 of the 176 patients with other ECG patterns. Hospital survival was 40%. Multivariate analysis showed successful PCI to be an independent predictor of survival, regardless of the post-resuscitation ECG (odds ratio 2.06; 95% CI 1.16–3.66).730

Treatment Recommendations
In OHCA patients with STEMI or new LBBB on ECG following ROSC, early angiography and PPCI should be considered. It is reasonable to perform early angiography and PPCI in selected patients despite the absence of ST-segment elevation on the ECG or prior clinical findings, such as chest pain, if coronary ischemia is considered the likely cause on clinical grounds. Out-of-hospital cardiac arrest patient are often initially comatose but this should not be a contraindication to consider immediate angiography and PCI. It may be reasonable to include cardiac catheterization in a standardized post–cardiac-arrest protocol as part of an overall strategy to improve neurologically intact survival in this patient group. Therapeutic hypothermia is recommended in combination with primary PCI, and should be started as early as possible, preferably before initiation of PCI.

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## Disclosures

### CoSTR Part 9: Writing Group Disclosures

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<tr>
<th>Writing Group Member</th>
<th>Employment</th>
<th>Research Grant</th>
<th>Other Research Support</th>
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<th>Ownership Interest</th>
<th>Consultant/ Advisory Board</th>
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</tr>
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<tbody>
<tr>
<td>Robert E. O’Connor</td>
<td>University of Virginia Health System: Professor and Chair of Emergency Medicine</td>
<td>None</td>
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<td>None</td>
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<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Leo Bossaert</td>
<td>University of Antwerp—Professor</td>
<td>None</td>
<td>None</td>
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</tr>
<tr>
<td>Hans-Richard Arntz</td>
<td>Charité Medical University, Berlin, Germany—Consultant</td>
<td>*Sanofi-Aventis; *Boehringer</td>
<td>None</td>
<td>*Sanofi Aventis; *Boehringer; *Daiichi-Sankyo</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Steven C. Brooks</td>
<td>University of Toronto—Assistant Professor; St. Michael’s Hospital—Clinician-Scientist; Sunnybrook Health Sciences Centre—Emergency Physician and Clinician-Scientist</td>
<td>*$5000 CDN one time grant for the completion of a systematic review comparing direct transportation to a PCI centre versus transportation to the closest hospital for patients with STEMI diagnosed by EMS personnel in pre-hospital setting. Peer-reviewed grant awarded by the Canadian Association of Emergency Physicians</td>
<td>None</td>
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<tr>
<td>Deborah Diercks</td>
<td>University of California, Davis Medical Center—Professor</td>
<td>None</td>
<td>None</td>
<td>*Sanofi-Aventis; *Bristol Myers Squibb</td>
<td>None</td>
<td>*Sanofi-Aventis; *Bristol Myers Squibb; *Heartscape; *Schering Plough; *Beckman Coulter; *Nanosphere; *Astellas</td>
<td>None</td>
</tr>
<tr>
<td>Gilson Feitosa-Filho</td>
<td>Hospital Aliança—Cardiologist; Escola Bahiana de Medicina e Saúde Pública—Professor; Hospital Santa Izabel-Santa Casa de Misericórdia da Bahia—Cardiologist</td>
<td>None</td>
<td>None</td>
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</tr>
<tr>
<td>Jerry P. Nolan</td>
<td>Royal United Hospital NHS Trust: Consultant in Anaesthesia and Intensive Care Medicine; Editor-in-Chief Resuscitation</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Terry L. Vanden Hoek</td>
<td>The University of Chicago—Associate Professor</td>
<td>None</td>
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<tr>
<td>Darren Walters</td>
<td>Queensland Health–Director of Cardiology</td>
<td>*Merck Sharp and Dohme; *CSL; *Medtronic</td>
<td>*Medtronic Biosensors; *Merck; *GSK; *AstraZeneca; *Johnson &amp; Johnson; *Abbott Vascular; *Boston Scientific</td>
<td>None</td>
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</tr>
<tr>
<td>Michelle Welsford</td>
<td>Hamilton Health Sciences Medical Director, CPER</td>
<td>None</td>
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</tr>
<tr>
<td>Karen Woolfrey</td>
<td>University of Toronto/Sunnybrook Health Science Centre Director, Royal College Emergency Medicine Program and Postgraduate Program Coordinator</td>
<td>None</td>
<td>None</td>
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<td>None</td>
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<tr>
<td>Aaron Wong</td>
<td>National Heart Centre-Senior Consultant</td>
<td>None</td>
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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.

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<tr>
<td>William J. Brady</td>
<td>University of Virginia, Charlottesville, VA–Professor &amp; Vice Chair of Emerg. Med.</td>
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<tr>
<td>Teresa R. Camp-Rogers</td>
<td>VCU Healthsystem Emergency Medicine Residency Resident</td>
<td>None</td>
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<tr>
<td>Marc J. Claeys</td>
<td>University hospital–Professor-Physician</td>
<td>*National coordinator of PLATO trial (AstraZeneca)</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>*Member of advisory board Eli Lilly Bieneux: advising marketing of prasugrel</td>
<td>None</td>
</tr>
<tr>
<td>Alan M. Craig</td>
<td>Toronto Emergency Medical Services: Municipal agency providing EMS Deputy EMS Chief</td>
<td>None</td>
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<tr>
<td>Russell Denman</td>
<td>Q Health; Cardiologist</td>
<td>None</td>
<td>None</td>
<td>*Asia Pacific Heart Rhythm meeting Beijing 2009-$1000 plus travel expenses</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Judith Finn</td>
<td>University of Western Australia-Professor</td>
<td>†Multiple National Health and Medical Research Grants (NHWRS), National Heart Foundation Australia and State Government grants of &gt;$10,000 since 1999. No money came to me—all came to my University to employ research staff and meet research expenses. No grants were directly related to any topic on which I am undertaking a Worksheet</td>
<td>None</td>
<td>*$1000 from the Japanese Resuscitation Council to speak at the JRC Conference in Osaka in 2009</td>
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<td>Chris Ghaemmaghami</td>
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<tr>
<td>Ian Jacobs</td>
<td>University of Western Australia Academic Teaching/Research—Professor; AHA Evaluation of evidence works for C2010—Work Sheet Expert</td>
<td>†Chief investigator on numerous grants awarded by: a) National Health and Medical Research Council b) The Department of Health-Western Australia c) The National Heart Foundation of Australia These funds are awarded to the University of Western Australia and none are used to provide any direct or indirect salary or other financial support</td>
<td>†Funds are received into the Discipline of Emergency Medicine—University of Western Australia from the Ambulance Service—Western Australia and Laerdal (Australia) to maintain the Cardiac Arrest Registry for Western Australia. Our role is to independently maintain, analyze and report outcomes of CA in Western Australia. I oversee the operation of the registry and reporting of outcomes. These funds are not used in any way to provide any direct or indirect salary or other financial support</td>
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<td>Michael C. Kurz</td>
<td>Virginia Commonwealth University Health System: Academic Hospital—Assistant Professor</td>
<td>†Co-investigator for NIH RCI grant “Health information Prescriptions for ED/Observation Patients (HP-009).” Money comes to my institution. Grant is pending, stated for decision in September, 2009. *Co-investigator for NETT Hub at VCUHS ($38000). Money comes to institution</td>
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<td>Dawn Yin Lim</td>
<td>Toronto Hospitals’ Postgraduate Payroll Association Emergency Medicine Resident</td>
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<td>Venu Menon</td>
<td>Cleveland Clinic Hospital Director CCU</td>
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<td>Patrick Meybohm</td>
<td>University Hospital Schleswig-Holstein, Campus Kiel, Germany: Medical doctor, Dept of Anesthesiology—Anesthetist</td>
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<td>Peter T. Morley</td>
<td>Royal Melbourne Hospital; Hospital Director of Medical Education University of Melbourne University Clinical Dean, Royal Melbourne Hospital AHA Not for profit organization Evidence Evaluation Expert</td>
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<td>Dirk Mueller</td>
<td>Charité University Hospital Physician</td>
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<td>Hiroshi Nonogi</td>
<td>National CV Center the Government Hosp. Japan; Director Division of Cardiology</td>
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<tr>
<td>Brian J. O’Neil</td>
<td>Self employed</td>
<td>*SanofiAventis, Bristol Myers Squibb</td>
<td>None</td>
<td>†(Bristol Myers Squibb, GlaxoSmithKline)</td>
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<td>Joseph P. Ornato</td>
<td>Virginia Commonwealth University: Academic health center-Prof/Chair of Emergency Medicine</td>
<td>None</td>
<td>None</td>
<td>*Grand Rounds hospital presentations-funded by educational grant from Bristol-Myers-Squibb Sanofi</td>
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<td>Julian J. Owen</td>
<td>Hamilton Health Sciences-Emergency Medicine Resident Physician</td>
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<td>Valeria Rac</td>
<td>St Michael’s Hospital, University of Toronto Rescu, Keenan Research Centre, Li Ka Shing Knowledge Institute Postdoctoral Fellow</td>
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<td>Hiromi Seo</td>
<td>Kochi Medical School Hospital-Professor</td>
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<tr>
<td>Kimberly A. Skelding</td>
<td>Geisinger Med. Center, Interventional Cardiologist</td>
<td>None</td>
<td>None</td>
<td>*Medtronic; *Society for Cardiovascular Angio &amp; Interventions; *HMG Communications</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Christian Spaulding</td>
<td>Assistance Publique Hôpitaux de Paris–Director, Cardiac Catheterization Laboratory; Paris-Descartes University–Professor of Cardiology</td>
<td>None</td>
<td>None</td>
<td><em>Cardis, Johnson &amp; Johnson: participation to 7 workshops or sponsored symposiums in 2008 and 2009. Total amount paid: 6000 euros. Topic: drug eluting stents, no relationship with the guidelines Abbott Vascular: participation to four workshops or sponsored symposiums in 2008 and 2009. Total amount paid: 4000 euros. Topics: drug eluting stents, primary angioplasty, no relationship with the guidelines. The topic of my talk was on the safety of drug eluting stents. In 2009, I received 4224 euros from Lilly for 2 symposiums on acute MI and for a board on 8B IIIA Inhibitors. The aim of this board was the future of resper</em> in management of ACS. My talks were on the declining rate of AMI and the increasing rate of primary angioplasty compared to thrombolytic therapy in France</td>
<td>None</td>
<td>*Cardis, Johnson &amp; Johnson: advisory board on drug eluting stents. 3500 euros in 2008 and 3000 euros in 2009</td>
<td>*Member of an advisory board for the French government on coronary angioplasty and drug eluting stents, focused on the financing by the French Ministry of Health. Received 2500 euros in 2008 and 1500 euros in 2009</td>
</tr>
<tr>
<td>Nico R. Van de Veire</td>
<td>Leiden University Medical Center–Cardiologist</td>
<td>None</td>
<td>None</td>
<td>*Boston Scientific; -Medtronic; -GE Cardiac Ultrasound; -Philips Cardiac Ultrasound</td>
<td>None</td>
<td>*Biotronik advisory board</td>
<td>None</td>
</tr>
<tr>
<td>Hirotsuki Yokoyama</td>
<td>National Cardiovascular Center Cardiology</td>
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This table represents the relationships of worksheet collaborators that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all worksheet collaborators 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.
### Task Force WS ID PICO Title Short Title Authors URL

**ACS ACS-005A** In patients with suspected ACS (P), does the use of chest pain observation units (O), compared with not using them (C), improve accuracy of to safely identify patients who require admission or specific management of CAD (O)?

Demographic factors

Patrick Meybohm, Aaron Wong

[http://circ.ahajournals.org/site/C2010/ACS-005A.pdf](http://circ.ahajournals.org/site/C2010/ACS-005A.pdf)

**ACS ACS-003B** In patients with suspected ACS (P), does the presence of any specific demographic factors (eg. age, sex, race, weight) (I), compared with their absence (O), improve accuracy of prediction of delayed treatment (O)?

Timing of aspirin administration

Brian J. O’Neil

[http://circ.ahajournals.org/site/C2010/ACS-003B.pdf](http://circ.ahajournals.org/site/C2010/ACS-003B.pdf)

**ACS ACS-006-1A** In patients with suspected ACS (P), does the use of specific imaging techniques (eg. CT angiography/MRI/nuclear testing/ECG) (I), compared with not using them (O), increase accuracy of diagnosis of ACS (O)?

Imaging techniques and diagnosis

Julian J. Owen, Karen Woolfrey


**ACS ACS-006-1B** In patients with suspected ACS (P), does the use of specific imaging techniques (eg. CT angiography/MRI/nuclear testing/ECG) (I), compared with not using them (O), increase accuracy of diagnosis of ACS (O)?

Imaging techniques and diagnosis

Hiroshi Nonogi


**ACS ACS-006-2A** In patients with suspected ACS (P), does the use of specific imaging techniques (eg. CT angiography/MRI/nuclear testing/ECG) (I), compared with not using them (O), improve outcome (eg. size of infarct, LV function, survival) (O)?

Imaging techniques and outcome

Julian J. Owen, Karen Woolfrey


**ACS ACS-006-2B** In patients with suspected ACS (P), does the use of specific imaging techniques (eg. CT angiography/MRI/nuclear testing/ECG) (I), compared with not using them (O), improve outcome (eg. size of infarct, LV function, survival) (O)?

Imaging techniques and outcome

Hiroshi Nonogi


**ACS ACS-007B** In patients with suspected ACS in the prehospital, emergency department or in-hospital settings (P), can non-physicians (eg. paramedics and nurses) (I) accurately diagnose STEMI (O), when compared to physicians (O)?

Diagnosis of STEMI by non-physicians

Alan M. Craig

[http://circ.ahajournals.org/site/C2010/ACS-007B.pdf](http://circ.ahajournals.org/site/C2010/ACS-007B.pdf)

**ACS ACS-008A** In patients with suspected ACS (P), does the use of computer-assisted ECG interpretation (I), compared with standard diagnostic techniques (emergency physicians) (C), increase accuracy of diagnosis (eg. of NSTE/STEMI) (O)?

Computer-assisted ECG interpretation

Judith Finn

[http://circ.ahajournals.org/site/C2010/ACS-008A.pdf](http://circ.ahajournals.org/site/C2010/ACS-008A.pdf)

**ACS ACS-009A** In patients with suspected ACS (P), do any specific techniques (I), improve ACS/MI system or process of care compared with standard management (C), to improve time to treatment and clinical outcome (O)?

Improving systems of care for ACS

Teresa R. Camp-Rogers, Michael C. Kurz

[http://circ.ahajournals.org/site/C2010/ACS-009A.pdf](http://circ.ahajournals.org/site/C2010/ACS-009A.pdf)

**ACS ACS-010A** In patients with ROSC after cardiac arrest (P), does the routine use of PCI (I), compared with standard management (without PCI) (C), improve outcomes (eg. TBD survival/re-arrest/etc) (O)?

PCI following ROSC

Terry Vandenberg

[http://circ.ahajournals.org/site/C2010/ACS-010A.pdf](http://circ.ahajournals.org/site/C2010/ACS-010A.pdf)

**ACS ACS-010B** In patients with ROSC after cardiac arrest (P), does the routine use of PCI (I), compared with standard management (without PCI) (C), improve outcomes (eg. TBD survival/re-arrest/etc) (O)?

PCI following ROSC

Darren L. Walters

[http://circ.ahajournals.org/site/C2010/ACS-010B.pdf](http://circ.ahajournals.org/site/C2010/ACS-010B.pdf)

**ACS ACS-011** In patients with suspected ACS in various settings (eg. prehospital, emergency or in-hospital) (P), do specific historical factors, physical examination findings and test results (I), compared with normal (C), improve accuracy of diagnosis ACS and MI (O)?

Accuracy history and PE for diagnosing ACS and MI

Hans-Richard Arntz, Peter T. Morley, Darren L. Walters


**ACS ACS-013B** In patients with suspected ACS in various settings (eg. prehospital, emergency or in-hospital) (P), do abnormal protein markers, compared with normal levels (C) allow the clinician to accurately diagnose acute coronary ischemia? (O)?

Protein makers of coronary ischemia

Steve Lin, Hironori Yokoyama


**ACS ACS-014** In patients with suspected ACS in various settings (eg. prehospital or emergency) (P), does the use of prehospital or emergency 12 lead ECG (I), compared with other diagnostic techniques (C), increase sensitivity and specificity of diagnosis of ACS/MI (O)?

12 lead ECG

Marc J. Claey, Dirk Mueller

[http://circ.ahajournals.org/site/C2010/ACS-014.pdf](http://circ.ahajournals.org/site/C2010/ACS-014.pdf)

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<tr>
<td>ACS</td>
<td>ACS-015</td>
<td>In patients with suspected ACS in various settings (eg. prehospital, emergency or in-hospital) and normal oxygen saturations (P), does the use of supplemental oxygen (I), compared with room air (C), improve outcomes (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Supplemental oxygen</td>
<td>Kimberly A. Skedinger, Nico R. Van de Veire</td>
<td><a href="http://circ.ahajournals.org/site/C2010/ACS-015.pdf">http://circ.ahajournals.org/site/C2010/ACS-015.pdf</a></td>
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<td>ACS</td>
<td>ACS-017-1</td>
<td>In patients with suspected STElevation myocardial infarction in the prehospital and emergency department setting (P) treated with fibrinolysis, does the use of new anticoagulants ie. pentasaccharide, enoxaparin, bivalirudin (I), compared with standard management (unfractionated heparin) (C), improve outcome (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Anticoagulants and STEMI</td>
<td>Hans-Richard Arntz, Michelle Welsford</td>
<td><a href="http://circ.ahajournals.org/site/C2010/ACS-017-1.pdf">http://circ.ahajournals.org/site/C2010/ACS-017-1.pdf</a></td>
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<td>ACS</td>
<td>ACS-017-2</td>
<td>In patients with suspected ST-elevation myocardial infarction in the prehospital and emergency department setting (P) to be treated with primary PCI, does the use of new anticoagulants ie. pentasaccharide, enoxaparin, bivalirudin (I), compared with standard management (unfractionated heparin) (C), improve outcome (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Anticoagulants plus PCI</td>
<td>Hans-Richard Arntz, Michelle Welsford</td>
<td><a href="http://circ.ahajournals.org/site/C2010/ACS-017-2.pdf">http://circ.ahajournals.org/site/C2010/ACS-017-2.pdf</a></td>
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<td>ACS</td>
<td>ACS-017-3</td>
<td>In patients with suspected non-ST-elevation ACS in prehospital and emergency department settings (P), does the use of new anticoagulants ie. pentasaccharide, enoxaparin, bivalirudin (I), compared with standard management (unfractionated heparin or other anticoagulant (C), improve outcome (eg. mortality, reinfarction, bleeding) (O)?</td>
<td>Anticoagulants and non ST-elevation ACS</td>
<td>Hans-Richard Arntz, Michelle Welsford</td>
<td><a href="http://circ.ahajournals.org/site/C2010/ACS-017-3.pdf">http://circ.ahajournals.org/site/C2010/ACS-017-3.pdf</a></td>
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<td>ACS</td>
<td>ACS-018B</td>
<td>In patients with STEMI in the prehospital setting (P), does the use of prehospital fibrinolysis (I), compared with in-hospital fibrinolysis (C), improve outcome (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Prehospital fibrinolysis for STEMI</td>
<td>Dirk Mueller, Valeria Rac</td>
<td><a href="http://circ.ahajournals.org/site/C2010/ACS-018B.pdf">http://circ.ahajournals.org/site/C2010/ACS-018B.pdf</a></td>
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<td>ACS</td>
<td>ACS-019A</td>
<td>In patients with non-ST elevation ACS/STEMI and fibrinolytic/ suspected STEMI and PCI in prehospital and emergency department settings (P), does the use of clopidogrel (I) compared with standard management (ie. no prehospital or ED use of clopidogrel (C) or new thienopyridines, prasugrel) (I) compared to clopidogrel (C), improve outcome (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Clopidogrel and similar drugs and non-ST elevation ACS</td>
<td>Michelle Welsford</td>
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<td>ACS</td>
<td>ACS-019B</td>
<td>In patients with non-ST elevation ACS/STEMI and fibrinolytic/ suspected STEMI and PCI in prehospital and emergency department settings (P), does the use of clopidogrel (I) compared with standard management (ie. no prehospital or ED use of clopidogrel (C) or new thienopyridines, prasugrel) (I) compared to clopidogrel (C), improve outcome (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Clopidogrel and similar drugs and non-ST elevation ACS</td>
<td>Ian Jacobs, Christian Spaulding</td>
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<td>ACS</td>
<td>ACS-020</td>
<td>In patients with suspected ACS/MI in prehospital and emergency department settings (P), does the use of IB IIIA inhibitors (I), compared with standard management (C), improve outcome (eg. chest pain resolution, infarct size, ECG resolution, survival to discharge, 30/60 d mortality) (O)?</td>
<td>IB IIIA inhibitors</td>
<td>Hans-Richard Arntz, Venu Menon</td>
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<td>ACS</td>
<td>ACS-021A</td>
<td>In patients with suspected ACS/MI in prehospital and emergency department settings (P), does the use of Prophylactic Antiarrhythmics (I), compared with standard management (ie. no Prophylactic Antiarrhythmics (C), improve outcome (eg.arrhythmias, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Prophylactic Antiarrhythmics</td>
<td>Joseph P. Ornato, Peter T. Morley</td>
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<td>ACS</td>
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<td>In patients with suspected ACS/MI in prehospital and emergency department settings (P), does the use of Prophylactic Antiarrhythmics (I), compared with standard management (ie. no Prophylactic Antiarrhythmics (C), improve outcome (eg.arrhythmias, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Prophylactic Antiarrhythmics</td>
<td>Russell Denman</td>
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<td>ACS</td>
<td>ACS-022A</td>
<td>In patients with suspected ACS/MI in prehospital and emergency department settings (P), does the use of ACE inhibitors (I), compared with standard management (ie. no prehospital and emergency department use of ACE inhibitors) (C), improve outcome (eg. infarct size, survival to discharge, 30/60 d mortality) (O)?</td>
<td>ACE inhibitors</td>
<td>Deborah Diercks</td>
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<td>ACS</td>
<td>ACS-023A</td>
<td>In patients with suspected ACS/MI in prehospital and emergency department settings (P), does the use of beta-blockers (I), compared with standard management (ie. no prehospital and emergency department use of beta-blockers) (C), improve outcome (eg. arrhythmias, survival to discharge, 30/60 d mortality) (O)?</td>
<td>Beta-blockers</td>
<td>Gibson Felicia Felho, Daan Yee Lim</td>
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Key Words: acute coronary syndrome ■ fibrinolysis ■ non-ST-segment elevation acute coronary syndromes ■ percutaneous coronary intervention ■ STEMI