



General

Guideline Title

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS).

Bibliographic Source(s)

Davis T, Bluhm J, Burke R, Iqbal Q, Kim K, Kokoszka M, Larson T, Puppala V, Setterlund L, Vuong K, Zwank M. Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2012 Nov. 91 p. [159 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Institute for Clinical Systems Improvement (ICSI). Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2011 Nov. 85 p.

Regulatory Alert

FDA Warning/Regulatory Alert

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- [August 31, 2016 – Opioid pain and cough medicines combined with benzodiazepines](#) : A U.S. Food and Drug Administration (FDA) review has found that the growing combined use of opioid medicines with benzodiazepines or other drugs that depress the central nervous system (CNS) has resulted in serious side effects, including slowed or difficult breathing and deaths. FDA is adding Boxed Warnings to the drug labeling of prescription opioid pain and prescription opioid cough medicines and benzodiazepines.
- [March 22, 2016 – Opioid pain medicines](#) : The U.S. Food and Drug Administration (FDA) is warning about several safety issues with the entire class of opioid pain medicines. These safety risks are potentially harmful interactions with numerous other medications, problems with the adrenal glands, and decreased sex hormone levels. They are requiring changes to the labels of all opioid drugs to warn about these risks.

Recommendations

Major Recommendations

Note from the National Guideline Clearinghouse (NGC) and the Institute for Clinical Systems Improvement (ICSI): For a description of what has changed since the previous version of this guidance, refer to [Summary of Changes Report – November 2012](#) [redacted]. In addition, ICSI has made a decision to transition to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system. This document is in transition to the GRADE methodology. Transition steps incorporating GRADE methodology for this document include the following:

- Priority placed upon available systematic reviews in literature searches.
- All existing Class A (randomized controlled trials [RCTs]) studies have been considered as high quality evidence unless specified differently by a work group member.
- All existing Class B, C and D studies have been considered as low quality evidence unless specified differently by a work group member.
- All existing Class M and R studies are identified by study design versus assigning a quality of evidence. Refer to Crosswalk between ICSI Evidence Grading System and GRADE (see below in the "Definitions" section).
- All new literature considered by the work group for this revision has been assessed using GRADE methodology.

The recommendations for diagnosis and treatment of chest pain and acute coronary syndrome (ACS) are presented in the form of 7 algorithms with 126 components, accompanied by detailed annotations. Algorithms are provided in the [original guideline document](#) [redacted] for Chest Pain Screening; Emergency Intervention; ST-Segment Elevation Myocardial Infarction (STEMI); Acute Myocardial Infarction Complications; Special Workup; Non-Cardiac Causes; and Clinic Evaluation. Clinical highlights and selected annotations (numbered to correspond with the algorithm) follow.

Class of evidence (Low Quality, Moderate Quality, High Quality, Meta-analysis, Systematic Review, Decision Analysis, Cost-Effectiveness Analysis, Guideline, and Reference) definitions are provided at the end of the "Major Recommendations" field.

Clinical Highlights

- On initial contact with the health care system, high-risk patients need to be identified quickly and referred to an emergency department via the 911 system. (*Annotations #1, 2, 4, 5, 6; Aim #1*)
- Patients whose chest pain symptoms are suggestive of serious illness need immediate assessment in a monitored area and early therapy to include an immediate electrocardiogram (ECG), intravenous access, oxygen, aspirin, and other appropriate medical therapies. (*Annotations #20 and 30; Aims #1 and 3*)
- Triage and management of patients with chest pain and unstable angina should be based on a validated risk assessment system and clinical findings. (*Annotation #39*)
- Patients with low-risk symptoms could be evaluated as outpatients. (*Annotations #39, 49, 50*)
- Thrombolysis for ST-elevation, myocardial infarction (MI) or left bundle branch block (LBBB) should be instituted within 30 to 60 minutes of arrival, or angiogram/primary percutaneous coronary intervention (PCI) should be performed within 90 minutes of arrival, with a target of less than 60 minutes. High-risk patients initially treated at non-PCI-capable facilities who cannot be transferred for PCI within 90 minutes should receive thrombolysis followed by as-soon-as-possible transfer to a PCI-capable facility. (*Annotations #54, 55, 58, 59, 60, 61; Aim #2*)
- Recommend use of the following medications: P2Y12 inhibitor and aspirin (or P2Y12 inhibitor alone if aspirin allergic) at admission. Avoid P2Y12 inhibitor if cardiac surgery is anticipated. Use beta-blockers whenever possible and/or angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blockers at 24 hours if stable, nitrates (when indicated), and statins whenever possible. (*Annotations #22, 65, 67; Aim #3*)
- Recommend use of cardiac rehabilitation. (*Annotations #76, 78*)

Chest Pain Screening Algorithm Annotations

1. Initial Contact with Complaint of "Chest Pain/Discomfort" in Person or via Telephone
Initial presentation may be in person or on the phone, etc.

Definitions:

Chest: Upper abdomen, chest, upper back, throat, jaw, shoulders, upper arms

Pain: "Discomfort" or other abnormal sensation such as "gas," "indigestion," "fullness," "pressure," "tightness," or "heaviness"
[Low Quality Evidence]

2. Initial Evaluation by Triage Indicates Elevated Risk?

Triage should move patients with suspicious symptoms forward (especially diabetic and middle-aged or older) to immediate ECG and

prompt clinician assessment (with expedited cardiac enzymes if appropriate). Triage staff should be systematically trained to recognize chest pain and cardiovascular risk indicators.

Reception and other staff should bring all complaints of chest pain and breathlessness to medical personnel for further evaluation, especially when:

- Patient is currently having symptoms
- Interviewer senses distress
- Symptoms have been present for less than eight weeks (or are getting worse)
- Patient feels the pain was at least moderate
- Other symptoms of ill health are present (e.g., shortness of breath, weakness, sweating, nausea)
- Patient requests an immediate opportunity to discuss the symptoms with medical personnel

[Low Quality Evidence]

4. Brief Screening History by Medical Personnel

Angina, typical angina, atypical angina, atypical chest pain, and non-cardiac chest pain are not consistently defined and used in medical practice. Sometimes they are used to describe a symptom complex; at other times they are used to describe an etiology. For the purposes of this guideline, the following definitions will be used to categorize the patient's chest pain or discomfort as a symptom complex and not an etiology:

Typical angina - pain or discomfort that is 1) substernal, 2) provoked by exercise and/or emotion, and 3) relieved by rest and/or nitroglycerin.

Atypical angina - pain or discomfort that has two of the three features listed for typical angina.

Nonanginal chest pain - pain or discomfort that has one or none of the three features listed for typical angina.

It should be emphasized that patients with nonanginal chest pain may still be at risk for acute myocardial infarction (AMI) or ACS. Several serious illnesses are included in the differential diagnosis of chest pain. Assessment of these illnesses requires office or emergency department evaluation. The initial phone interview is limited to determining the timing and location of the initial office or emergency department evaluation.

The risk of immediate adverse outcome is a function of the time course of the chest pain. If the symptoms have been stable for more than two weeks, the risk of an immediate adverse outcome is low. The phone history should stress symptoms suggestive of life-threatening illnesses and the time course of the symptoms.

High-Risk Symptoms

Symptoms suggestive of a high risk of immediate adverse outcome include, but are not limited to:

- Severe or ongoing pain
- Pain lasting 20 minutes or more
- New pain at rest or with minimal activity
- Severe dyspnea
- Loss of consciousness

[Guideline]

The interviewer may use his/her discretion with respect to the need to obtain further history for such symptoms or to refer to a physician.

All patients with high-risk chest pain symptoms should be instructed on the proper use of 911.

The interviewer must use his or her judgment. This guideline focuses on serious complaints that the interviewer feels may signify a serious illness. Chest pain that is not high risk in the judgment of the interviewer (e.g., a young person with chest wall pain) may be evaluated in the office.

Teach medical triage personnel to appropriately conduct the brief screening history.

6. High-Risk Symptom(s) Present within Last Two Days

Patients who have had high-risk symptom(s) within the previous two days are at the highest risk and should enter the 911 system. The interviewer may judge the need for ambulance transport and office or emergency department evaluation for patients who call hours or days

after transient symptoms resolve.

8. High-Risk Symptom(s) Present between Three Days and Two Weeks

Patients who have had high-risk symptom(s) within the previous two weeks but not the previous two days may be safely evaluated in either a properly equipped office or the emergency department (ED).

Emergency Intervention Algorithm Annotations

19. Ambulance Transport to Emergency Department; Obtain Electrocardiogram En Route if Able; Aspirin if Possible

A patient complaining of chest pain suggestive of serious etiology should be transported via ambulance with advanced cardiac life support capabilities whether he/she is being transported from home or outpatient clinic to the emergency department.

Systems exist that allow 12 lead ECGs to be obtained by ambulance personnel en route to the ED. If available, this should be done and the EKG transmitted to the ED physician. This may allow more rapid identification of patients with STEMI, hastening definitive management. Similarly, if not given prior to the arrival of the ambulance personnel, 324 mg chewable aspirin should be given to patients who do not have a serious allergy.

Patients who are critically ill or unstable should be taken to a hospital capable of performing cardiac catheterization and cardiac surgery unless this would lead to excessive transport time. Plans for triage of a critically ill patient to a tertiary care institution should be part of every community hospital plan.

If a patient is seen in a clinic or physician's office complaining of chest pain suggesting a serious condition, the patient must be transported to the emergency department as soon as possible. Attempts should be made to stabilize the patient as well as possible prior to transport. The referring physician must call the receiving physician and send copies of all medical records pertaining to the current illness [*Low Quality Evidence*], [*Guideline*].

Each community should develop a STEMI protocol for care that includes a process for prehospital identification and activation, destination protocols for STEMI receiving centers, and ongoing multidisciplinary team meetings involving emergency medical services personnel, representatives from non-PCI capable hospitals and referral centers, and representatives from PCI capable hospitals to evaluate data, discuss outcomes, and work on quality improvement.

20. On Arrival in Emergency Department, Immediate Monitoring, Oxygen, IV Access, Cardiac Markers, Portable Chest X-Ray Recommendation:

- Cardiac markers, such as troponin I or T should be evaluated on arrival [*Low Quality Evidence*].

On arrival in the emergency department, an immediate ECG should be obtained if not previously done. A loading dose of 324 mg aspirin should be given, preferably chewed, if not received pre-hospital (for palatability, consider using four 81 mg chewable tablets). Oxygen should be started via nasal cannula, cardiac monitoring initiated and the treating physician called for.

The emergency department physician should also be called to the patient's bedside urgently. On arrival, the physician should perform a brief initial assessment based on vitals, brief historical information, and physical examination. Institution of stabilizing therapy (including chewable aspirin, nitroglycerin and morphine for suspect anginal pain) prior to completing history or physical is appropriate and often necessary at this level.

Troponin I or T have proven to be very sensitive and specific for myocardial injury, as well as predictive of short-term risk for MI or death [*Low Quality Evidence*]. A newer highly sensitive troponin I assay (hsTnI) has been adopted by many hospitals. While both conventional troponin and highly sensitive assays show similar sensitivity and specificity, hsTnI has been shown to have the best performance characteristics [*Low Quality Evidence*]. Creatine kinase-MB should no longer be used as the primary marker for MI.

The use of troponin can present diagnostic challenges in subgroups of patients where it may be chronically elevated or when the initial troponin measure and a subsequent measure both reflect tiny elevations of the biomarker in the setting of non-ischemic cardiac conditions. As with any diagnostic test, the interpretation of an abnormal serum troponin is dependent upon the clinical setting in which the myocardial injury occurred. It is appropriate to measure serial troponin values on arrival and after at least three hours of observation. A diagnosis of ACS can be established when the change in troponin value is significant in the appropriate clinical setting. Significant change is generally considered a second troponin greater than the 99th percentile [*Low Quality Evidence*].

Other diagnostic testing such as brain natriuretic peptide and chest x-ray may add value to the patient evaluation.

[*Low Quality Evidence*], [*Guideline*]

21. Electrocardiogram Positive for ST-segment Elevation?

The recognition of coronary artery disease and evaluation of its severity cannot be adequately carried out without an ECG. The early performance of an ECG following arrival at the emergency department is therefore critical. When patients have new or typical chest pain presumably new ST-segment elevation of greater than 1 mm in two or more contiguous limb leads, or equal to 2 mm or more in precordial leads, they should be considered to have AMI. Patients with new or presumably new LBBB should be treated similarly to those with ST-segment elevation. Although some patients with LBBB will prove not to have AMI, thrombolytic therapy of patients with LBBB is nevertheless associated with a reduction in patient mortality.

Large studies establish the high positive predictive value of new ST-segment elevation, which has been subsequently used for entry in a number of very large clinical trials [*High Quality Evidence*].

The mortality benefit of acute thrombolytic reperfusion therapy has been firmly established in such patients. Pooled data from the available large trials have also demonstrated that patients with LBBB have a significant reduction in mortality with thrombolytic therapy [*High Quality Evidence*].

It should be recognized that not all patients with LBBB will in fact have MI. Their apparent mortality advantage with thrombolytic therapy reflects the very high risk of those patients with LBBB who do have acute infarction [*Low Quality Evidence*].

Regardless of ST elevation, consider cardiology consultation early.

22. Early Therapy

Recommendations:

- Immediately treat with aspirin or P2Y12 inhibitor loading dose and oxygen to keep saturations >90% and keep patient in a monitored area of the emergency department where critical care interventions can be completed.

Aspirin reduces mortality, reinfarction and stroke, and the addition of unfractionated heparin (UFH), low-molecular-weight heparin (LMWH) or Xa inhibitors to aspirin improves outcomes (decrease risk of death and MI). In eligible patients, beta-blockers reduce mortality, reinfarction and stroke. Although no mortality benefit has been shown with the use of nitroglycerin, it is still appropriate for relief of ischemic pain [*Guideline*].

Therapy for AMI has been the subject of multiple large randomized trials, many with a primary endpoint of patient mortality. Clinicians caring for patients with AMI should be familiar with the available definitive evidence.

[*Guideline*], [*High Quality Evidence*], [*Meta-analysis*], [*Low Quality Evidence*]

P2Y12 Inhibitors

For STEMI and primary PCI, a loading dose of a P2Y12 inhibitor should be given as soon as possible or before the PCI.*

For STEMI patients undergoing non-primary PCI, the following regimens are recommended:

- If the patient has received fibrinolytic therapy and has been given clopidogrel, clopidogrel should be continued as the P2Y12 inhibitor of choice.
- If the patient received fibrinolytic therapy without a P2Y12 inhibitor, a loading dose of clopidogrel should be given as the P2Y12 inhibitor of choice.
- If the patient did not receive fibrinolytic therapy, either a loading dose of clopidogrel or ticagrelor should be given, or once the coronary anatomy is known and PCI is planned, a loading dose of prasugrel should be given promptly and no later than one hour after PCI.

*Prasugrel is not recommended to be used in patients with a prior history of stroke or transient ischemic attack (TIA), or who are >75 years of age due to increased risk of bleeding except in high-risk situations (diabetes mellitus or prior MI history).

If the patient requires revascularization and a coronary artery bypass graft (CABG) is planned, it is recommended to withhold clopidogrel and ticagrelor for at least five days and prasugrel for at least seven days if possible to decrease the risk of excess bleeding.

In March 2010, the Food and Drug Administration (FDA) issued a new boxed warning to the product label of clopidogrel bisulfate to warn about patients who do not effectively metabolize the drug and therefore may not receive the full benefits of the drug. Specifically, the purpose is to:

- Warn about reduced effectiveness in patients who are poor metabolizers of clopidogrel – poor metabolizers do not effectively convert clopidogrel to its active form in the body.

- Inform health care professionals that tests are available to identify genetic differences in CYP2C19 function.
- Advise health care professionals to consider use of other anti-platelet medications or alternative dosing strategies for clopidogrel bisulfate in patients identified as poor metabolizers.

See the [FDA Web site](#) .

In response to both FDA warnings (2009 and 2010), the American College of Cardiology issued statements pointing to the lack of definitive data to guide endorsement of a specific treatment strategy, noting that clinical trials are currently under way to help address the matter.

Anticoagulants

In STEMI patients undergoing primary PCI, intravenous UFH should be started before and continued throughout to maintain therapeutic activated clotting time (ACT) levels. Bivalirudin may be an alternative anticoagulant during the PCI, especially if patient is at high risk for bleeding [*Low Quality Evidence*].

Data supports the use of LMWH, or the Xa inhibitor fondaparinux as alternatives to intravenous UFH.

In high-risk patients, early administration of subcutaneous LMWH or intravenous UFH with aspirin and/or P2Y12 inhibitor is associated with a decrease in the incidence of AMI and ischemia.

Enoxaparin has been shown to have a moderate benefit over intravenous UFH in decreasing the rate of death, MI and recurrent ischemia. A meta-analysis of two trials showed a statistically significant reduction by 20% in the rate of death and MI [*High Quality Evidence*].

Enoxaparin should be used with caution in patients with renal insufficiency.

Switching patients from UFH to enoxaparin or vice versa at the time of referral to tertiary care institutions has been shown to increase adverse events. Hence, start and maintain the patient on a single drug continuously during transfer and treatment at referring and referral institutions [*High Quality Evidence*].

Fondaparinux, a selective Xa inhibitor, may also be used. Maintenance dosing with fondaparinux should be continued for the duration of the hospitalization, up to eight days [*High Quality Evidence*]. Fondaparinux appears to reduce all-cause mortality at 30 days with the effect becoming more significant at 180 days when compared to UFH and LMWH in ACS. It has been associated with a decreased risk of major and minor bleeding when compared to enoxaparin [*Systematic Review*].

Due to risk of catheter thrombosis, do not use fondaparinux as the sole anticoagulant to support PCI. Administer an additional anticoagulant with anti-IIa activity (UFH, bivalirudin, argatroban).

Fondaparinux has a long elimination half-life and there is no antidote for reversal; therefore, patients who may require rapid reversal are not candidates for this therapy. Fondaparinux is contraindicated in patients with a creatinine clearance (CrCl) <30 mL/min.

For additional information about LMWH/fondaparinux or heparin-induced thrombocytopenia, please refer to the NGC summary of the [ICSI Antithrombotic Therapy Supplement](#).

Beta-blockers

Beta-blockers have been a cornerstone of ACS therapy. The Chinese Cardiac Study 2 (CCS2), also called the Clopidogrel and Metoprolol for Myocardial Infarction Trial (COMMIT), demonstrated no overall benefit from early administration of intravenous metoprolol in STEMI patients receiving medical therapy +/- thrombolysis [*High Quality Evidence*]. In this population with no primary or delayed angioplasty, post-hoc analysis revealed a survival advantage with reduced ventricular tachycardia/ventricular fibrillation if the presenting systolic blood pressure was over 120 mmHg, no benefit if the blood pressure was 100-120 mmHg, and significant mortality attributed to the development of cardiogenic shock if the blood pressure was under 100 mmHg. Exercise caution in administering intravenous beta-blocker until after revascularization and stabilization of the patient's blood pressure. Avoid intravenous beta-blockers in Killip III/IV patients. Hypertensive and tachycardic patients may benefit from early ancillary intravenous beta-blocker therapy [*Low Quality Evidence*]. Beta-blocker therapy remains indicated for NSTEMI and unstable angina unless hypotension, shock, heart block or other contraindication is present.

Initiate beta-blockers early, in the absence of any contraindications. In high-risk patients, they should be given initially intravenously, followed by the oral route with a goal target resting heart rate of 50-60 beats per minute. Patients with low to intermediate risk may start out with oral therapy. The duration of benefit is uncertain. A meta-analysis of double-blinded randomized trials in patients with evolving MI showed a 13% reduction in risk progression to AMI. Other multiple randomized trials in coronary artery disease patients have shown a

decrease in mortality and/or morbidity rates.

Beta-blockers should be used in most patients with STEMI. They remain underutilized in patients with chronic obstructive pulmonary disease and diabetes mellitus where definite benefit has been demonstrated. Patients with low blood pressure or heart failure, or who were recently hemodynamically unstable, should be started on the lowest dose. Caution should be used in patients with reactive airway disease. A cardioselective beta-blocker such as metoprolol may be preferred in patients with reactive airway disease.

Indications for not starting a beta-blocker are:

- History of intolerance or adverse drug reaction to beta-blockers
- Symptomatic bradycardia or advanced heart block (excluding treatment by pacemaker)
- Evidence of fluid overload or volume depletion
- Recent treatment with an intravenous positive inotropic agent (e.g., digoxin, nesiritide and others)
- Suspected cocaine ingestion (completely avoid beta-blockers in cocaine-induced STEMI because there is a risk of exacerbating coronary spasm)
- Cardiogenic shock [*High Quality Evidence*]

Consider intravenous esmolol if concerned about potential adverse effects of beta-blockers.

Nitroglycerin

ISIS-4 and GISSI-3 failed to show a benefit of nitroglycerin on reduction of mortality in AMI.

Nitroglycerin should be given sublingually to relieve ischemic symptoms. If symptoms are ongoing or recurrent despite the administration of intravenous beta-blockers, intravenous nitroglycerin can be initiated.

Nitroglycerin is contraindicated in patients who are hypotensive, have documented severe aortic stenosis, have hypertrophic cardiomyopathy, or who have received sildenafil or vardenafil within the previous 24 hours or tadalafil in the previous 48 hours [*Guideline*].

Glycoprotein (GP) IIb/IIIa Inhibitors

GP IIb/IIIa inhibitors may be started at the time of primary PCI but the usefulness in starting prior to the catheterization laboratory is uncertain.

Contraindications to GP IIb/IIIa inhibitors include active or recent bleeding in the last 30 days, history of intracranial hemorrhage, recent stroke in previous 30 days, uncontrolled hypertension (greater than 200/100 mmHg), major surgery within the previous six weeks, aortic dissection, acute pericarditis, or platelet count less than 100,000 mm³ (eptifibatid is contraindicated in patients who are dialysis dependent).

[*Guideline*], [*High Quality Evidence*], [*Moderate Quality Evidence*]

24. Vital Signs Compromised?

In the critically ill patient whose vitals are compromised (i.e., cardiac arrest, tachyarrhythmias, severe bradycardia, shock, or hypotension), the Advanced Cardiac Life Support guideline developed by the American Heart Association should be followed [*Low Quality Evidence*], [*Guideline*].

25. Initiate Advanced Cardiac Life-Support Protocols

The American Heart Association Advanced Cardiac Life Support guideline provides the most recent protocols for initial management of patients whose vital signs are compromised.

26. Symptoms Suggest Possibility of Acute Cardiovascular Syndrome?

The symptoms that suggest ACS are, in order of importance:

1. Chest pain description (see Annotation #4 above, "Brief Screening History by Medical Personnel")
2. History or evidence of ischemic heart disease
3. Age, gender, comorbidities (atypical presentation in female, elderly, and diabetic)
4. Presence of cardiac risk factors

The description of the patient's chest pain or discomfort is the most critical part of the history. Although multiple other features of the chest pain may be incorporated into an experienced clinician's judgment, the clinician should ultimately attempt to classify the patient as having

typical angina, atypical angina, or nonanginal chest pain as described in Annotation #4, "Brief Screening History by Medical Personnel" of the Chest Pain Screening algorithm.

Additionally clinicians should be alert for signs, symptoms and medical history that suggest other serious acute cardiovascular syndromes where prompt intervention is necessary such as aortic dissection and cardiac tamponade.

These may include:

- Abrupt or instantaneous onset
- Pain that is severe in intensity
- Pain that has a ripping, tearing, stabbing or sharp quality
- Chest pain accompanied by back or abdominal pain
- Pain worsened with inspiration, coughing, position changes, or swallowing
- Tachypnea or severe shortness of breath
- Focal neurologic deficit
- New murmur consistent with aortic regurgitation
- Pericardial friction rub
- Connective tissue disease such as Marfan syndrome
- Known aortic valve disease
- Known thoracic or aortic aneurysm
- Recent MI
- Recent cardiovascular procedure

[Guideline], [Low Quality Evidence]

27. Chest Pain Not Related to Acute Cardiovascular Syndrome But Indicative of Other Serious Diagnosis?

Pulmonary embolus, expanding pneumothorax or serious gastrointestinal pathology are all potentially life threatening and may closely mimic presentations of an ACS. Further, the presence or absence of reproducible chest wall pain does not preclude the possibility of a more serious underlying cause.

In evaluating a patient with chest pain, it is important to keep in mind the entire differential diagnosis, including non-cardiac causes. Missed or misdiagnosis may have serious implications, both in regards to medico-legal issues and resource utilization.

[Low Quality Evidence]

30. Expedited Aortic Imaging

- Computerized tomography angiogram is generally the quickest and most readily available diagnostic test.
- Transesophageal echocardiogram with a biplane probe is equally diagnostic and preferable in patients with renal insufficiency or allergy to contrast dye.
- Magnetic resonance imaging remains the most accurate test but requires a stable patient. Magnetic resonance imaging should be avoided if a type A dissection is suspected.

A careful comparison of magnetic resonance imaging and transesophageal echocardiography has been published elsewhere *[Low Quality Evidence]*.

31. Any High-Risk Features for Aortic Dissection?

- Clinical findings of ischemia involving several organ systems
- Pain typically "tearing" or "ripping"
- Pain radiation from chest to back, hips and lower extremities
- Common findings: hypertension, cardiac murmurs, systolic bruits, diminished or absent pulses
- Chest x-ray – abnormalities around aortic knob, increased diameter of ascending aorta
- Blood pressure discrepancy between right and left arm

32. Cardiovascular Surgical Consultation

- Surgical intervention for symptomatic thoracic aneurysms and proximal (type A; ascending aorta) dissections *[Low Quality Evidence]*.
- Control blood pressure with esmolol or labetalol drips +/- nitroprusside.

33. Aortic Dissection Present?

The imaging procedure should establish the presence or absence of an aneurysm and the presence or absence, and location, of a dissection.

34. Definitive Management

- Distal (type B; distal to left subclavian artery) aortic dissections generally appropriate for pharmacological therapy
 - IV beta-blocker (esmolol or labetalol) +/- nitroprusside to control heart rate and blood pressure along with appropriate pain management
 - Consider surgery if therapy not effective

35. Symptoms, Signs Suggest Pericardial Disease?

- Chest pain worsened with inspiration, coughing, position changes or swallowing
- Pericardial friction rub
- ECG – ST-T changes
- Etiology – infectious, neoplastic, metabolic, inflammatory autoimmune disorders, post-MI (Dressler's syndrome)
- Drug related – hydralazine, procainamide, isoniazid, phenytoin, doxorubicin
- Consider blunt trauma, postop

36. Tamponade?

- Chest pressure and shortness of breath
- Exam – elevated jugular venous pressure, hypotension, tachypnea, narrow pulse pressure, pulsus paradoxus greater than 20 mm Hg
- ECG may reveal electrical alternans
- Chest x-ray – normal or enlarged cardiac silhouette
- Echocardiogram diagnostic test of choice
- Pericardial space typically contains 50 cc of fluid, with chronic accumulation may contain up to 2,000 cc
- With acute, rapid accumulation, overt tamponade may develop with as little as 150 cc

37. Pericardiocentesis – Prefer Echocardiogram-Directed

- Echocardiogram-directed apical pericardiocentesis procedure of choice
- Subxiphoid approach if echocardiogram not available and patient unstable

[Low Quality Evidence]

38. Admit Critical Care Unit/Monitored Bed

The patient should be observed in a critical care unit/monitored bed setting.

39. Risk Assessment/Consider Repeat Electrocardiogram if Ongoing Chest Discomfort

Recommendations:

- The patients with suspected ACS should undergo early and follow-up risk assessment based on history, exam, ECGs, biomarkers *[quality of evidence high, recommendations strong]*, *[Low Quality Evidence]*, *[Guideline]*
- Serial ECGs are indicated at 15-30 minute intervals if suspicion for ACS is high, the patient has ongoing chest discomfort and original ECG is non-diagnostic.

There are a variety of risk assessment criteria for patients presenting with chest pain and suspected ACS. This section will focus on risk assessment for chest pain symptoms and subsequent risk assessment for those with suspected or documented ACS.

For patients with continuing chest discomfort highly suggestive of ACS, serial ECGs, initially at 15-30 minute intervals, should be strongly considered to evaluate for development of ST shift or other evolution. There is a wealth of evidence that any dynamic ECG changes portend both diagnostic and prognostic value in evaluation and treatment of patients with suspected ACS. In addition, dynamic ECGs call for more aggressive medical therapy and timing of invasive coronary evaluation in the emergency department for possible evolving STEMI not seen on initial ECG.

Patients who are deemed low risk by American College of Cardiology Foundation (ACCF)/American Heart Association (AHA) guideline criteria may be safely evaluated as outpatients. These will include some patients with mild symptoms, which may reflect non-compliance with medications, increasing activity, emotional stress or other exacerbating factors. Patients with a low likelihood of coronary artery disease on the basis of chest pain description, age, gender and risk factor assessment, and patients at intermediate likelihood may be initially medically treated and risk stratified with non-invasive testing.

Patients who are intermediate risk by the guideline criteria need definitive emergency department assessment and may be most suitable for admission to an observation or chest pain unit. Patients with intermediate risk symptoms should undergo risk stratification with assessment of cardiac biomarkers, repetitive ECG assessment and ultimately cardiac imaging and stress testing.

Patients who fulfill high-risk criteria should be admitted to the hospital and treated with aggressive medical therapy and early invasive

coronary evaluation. A large number of studies have confirmed this risk and support a strategy of hospitalization and subsequent risk assessment for ACS [*High Quality Evidence*], [*Guideline*], [*Low Quality Evidence*].

Complete certainty of the etiology of a patient's chest pain is difficult to achieve by an evaluation and commonly cannot be attained in the emergency department. It is therefore vitally important to assess risk in order to safely and yet cost effectively triage chest pain patients.

Diagnosis and risk assessment of patients with suspected ACS is a continuous process that includes clinical observation for recurrent symptoms, hemodynamic features, dynamic ECG and biomarkers data.

For patients with unstable coronary artery disease and/or an ACS, it is important to use objective risk assessment criteria for purposes of triage (critical care unit, monitored bed or immediate catheterization lab referral). There are a number of ways to risk stratify patients with unstable coronary disease. The initial examination in the emergency department often provides insight into the patient's risk. An astute clinician can often assess risk from the physical examination and laboratory assessment.

A variety of risk factors for short-term risk of death or non-fatal MI have been determined. They include accelerated tempo of ischemic symptoms in the preceding 48 hours, prolonged (greater than 20 minutes) ongoing rest angina, pulmonary congestion, mitral insufficiency, S3 heart sound, hypotension, excessive brady- or tachycardia, age over 75, dynamic, even 0.5 mm ST deviation, new LBBB, paroxysmal sustained ventricular tachycardia, and elevated markers of myonecrosis [*Guideline*]. Many risk calculators are available for health care providers for rapid and easy risk calculation. One of the most popular risk assessment tools – the TIMI (thrombolysis in MI) risk score – displayed a potent predictive gradient of short-term risk of about 10 times magnitude between the lowest and the highest risk patients [*Low Quality Evidence*]. Health care providers are encouraged to use this calculator to obtain an objective risk assessment of short-term patient's risk.

40. Echocardiogram; Discharge?/Consider Treatment

- Pericarditis without tamponade – obtain echocardiogram
- Non-steroidal anti-inflammatory drugs (NSAIDs), aspirin or colchicine and close follow-up [*High Quality Evidence*]

41. High Risk

High-risk ACS patients, as determined by TIMI risk score of equal or higher than three, require a high level of care with close monitoring and intravenous access for the initiation of intravenous medications including UFH/LMWH, beta-blockers, and nitroglycerin. These therapies should be started in the emergency department setting. Hospitalization usually requires an intensive care unit setting or competent nursing in a monitored bed setting [*Guideline*].

42. Early Therapy for High-Risk Patients

See Annotation #22, "Early Therapy," for general recommendations for aspirin, P2Y12 inhibitors, nitrates, oxygen, beta-blockers, anticoagulation and GP IIb/IIIa inhibitors.

An early invasive strategy involves diagnostic catheterization within 24 to 48 hours, followed by PCI or CABG if warranted.

For patients where an initial invasive strategy is planned, it is recommended to give a loading dose of clopidogrel or prasugrel as soon as possible prior to PCI, in addition to aspirin. If clopidogrel is not given before PCI, prasugrel or ticagrelor may be added at the time of PCI. Cardiology may elect to add a GP IIb/IIIa inhibitor in some patients. Treatment with a P2Y12 inhibitor should be continued for at least 12 months unless contraindicated. If the risk of bleeding outweighs the benefit, early discontinuation of P2Y12 inhibitor therapy may be considered specifically in patients not treated with an implantation of a drug-eluting coronary stent. A GP IIb/IIIa inhibitor may be omitted if the patient has been on bivalirudin as the anticoagulant and P2Y12 inhibitor has been given at least six hours prior to the PCI [*Guideline*].

If an initial non-invasive (conservative) strategy is planned, a loading dose of P2Y12 inhibitor (clopidogrel or ticagrelor) should be given in addition to aspirin as soon as possible. The P2Y12 inhibitor should be continued for at least one month and ideally up to 12 months. A GP IIb/IIIa inhibitor may be added to the regimen of aspirin, P2Y12 inhibitor and anticoagulant therapy before diagnostic angiography in patients who fail initial conservative management (recurrent ischemia/heart failure/arrhythmias). If coronary disease is found on angiography, the patient should be continued on aspirin indefinitely and a P2Y12 inhibitor for up to one year if possible. UFH should be continued for 48 hours or LMWH or fondaparinux should be continued for duration of hospitalization up to a maximum of eight days.

When an initial conservative management is planned, GP IIb/IIIa inhibitors may be considered in high-risk unstable angina (UA)/non-ST elevation myocardial infarction (NSTEMI) patients in addition to aspirin and a P2Y12 inhibitor prior to PCI if the risk of bleeding is low. GP IIb/IIIa inhibitors are not recommended to be added to aspirin and P2Y12 inhibitor if the risk of bleeding is high [*Guideline*].

If diagnostic angiography is not required in patients initially managed conservatively, the patient should undergo stress testing. If after stress testing the patient is found to be of low risk, the patient should be continued on aspirin indefinitely, and P2Y12 inhibitor should be continued

for a minimum of one month and preferably up to one year. UFH should be continued for 48 hours, or LMWH or fondaparinux should be continued for duration of hospitalization up to a maximum of eight days.

44. Perform Catheterization within 24 to 48 Hours

Recommendation:

- Perform angiography within the first 24 hours for patients diagnosed with high-risk ACS and any patients who are unstable or having recurrent symptoms [*Systematic Review*].

An early invasive strategy is beneficial in many patients with NSTEMI or high-risk UA, especially when coupled with aggressive adjunctive medical therapy. Certainly the aggressive anticoagulation and antiplatelet agents should be utilized when there are recurrent symptoms and no ability to proceed to early angiography, such as a weather-related delay or the catheterization lab is not available. However, in patients who become unstable or have recurrent symptoms, the delay for angiography and percutaneous coronary revascularization should be minimized.

Contraindications to GP IIb/IIIa inhibitors include active or recent bleeding in the last 30 days, history of intracranial hemorrhage, recent stroke in previous 30 days, uncontrolled hypertension (greater than 200/100 mm Hg), major surgery within the previous six weeks, aortic dissection, acute pericarditis, or platelet count less than 100,000 mm³ (eptifibatide is contraindicated in patients who are dialysis dependent) [*Guideline*], [*High Quality Evidence*].

In patients with UA/NSTEMI in whom an initial invasive procedure is selected, it is reasonable to omit upstream GP IIb/IIIa before angiography if bivalirudin is selected as the anticoagulant and a loading dose of P2Y₁₂ inhibitor was administered at least six hours prior to PCI. Bivalirudin alone as compared with heparin plus GP IIb/IIIa has similar rates of major adverse cardiac events, lower minor bleeding complications and similar net adverse cardiac events [*Moderate Quality Evidence*].

An analysis of invasive therapy in high-risk, predominantly biomarker positive patients has shown 25% reduction of all-cause mortality and 17% reduction of recurrent non-fatal MI for early invasive therapy compared with conservative therapy at a mean follow-up of two years [*Systematic Review*].

45. Intermediate Risk

It is difficult to predict which patients truly have an ACS after the initial evaluation in the emergency department. As the short-term risk of a significant cardiac event may be 10% [*Guideline*], it is imperative to treat each patient according to protocol during the evaluation process. The work group recommends a standardized approach or critical pathway approach to these patients that strives to fully diagnose and risk stratify. These patients should be observed in the emergency department for at least three hours [*Low Quality Evidence*] or admitted to a chest pain unit or observation unit where serial troponin biomarkers and ECG assessment can be obtained. It is crucial to perform serial clinical reassessments during the observation period to determine if the symptoms have worsened or the initial baseline risk category assessment remains accurate. Many of these patients should undergo cardiac imaging and stress testing assessment, and some may require outpatient referral to a cardiologist for subsequent evaluation and management. It may be appropriate to consider diagnostic catheterization in certain subgroups of these patients [*Guideline*].

46. Early Therapy for Intermediate-Risk Patients

See Annotation #22, "Early Therapy," and Annotation #42, "Early Therapy for High-Risk Patients."

47. Admit to Chest Pain Unit or Monitored Bed

If the patient's risk assessment is not clearly in a high- or low-risk category, and the institution has an emergency department-based chest pain observation unit, admit to the chest pain unit or a monitored bed. Otherwise, management using a critical pathway for unstable angina with a similar protocol on a monitored bed unit is recommended.

A chest pain unit critical pathway provides monitoring capabilities, a dedicated nurse, serial cardiac markers (markers should be negative for at least three hours from admission to the emergency department), and a post-observation stress test prior to final triage decision. Generally, after successful completion of the evaluation, patients can be classified as low-risk and safely followed up as outpatients in the next few days. In the case of a positive or indeterminate lab test, ECG or stress/imaging test, or if there is recurrent chest pain during the observation period, a patient should be considered high risk and managed accordingly.

If a patient requires repeated doses of nitroglycerin and/or intravenous nitroglycerin or paste, or requires beta-blockade for pain control, assess the patient to high risk [*Guideline*].

Refer to Annotation #39, "Risk Assessment/Consider Repeat Electrocardiogram if Ongoing Chest Discomfort," above for more information on risk stratification.

48. Patient Has Positive: Markers? Electrocardiogram Changes? Unstable Dysrhythmias?

If a patient develops recurrent chest discomfort during the observation period, the patient should be considered having failed the observation unit intervention and should be considered high risk. Admit to a monitored bed or an intensive care unit setting. If the serial cardiac markers, troponin T or I on the second blood draw are positive, or the patient develops new or dynamic ST-T wave changes, the patient should also be considered high risk. If a patient develops an unstable dysrhythmia (e.g., ventricular tachycardia or multifocal premature ventricular complexes, etc.), he/she should also be considered high risk and admitted.

Most patients in this category will have an uneventful observation period and should undergo an endpoint stress test. This can be done after two negative troponins prior to patient discharge in a patient in whom symptoms have resolved, or can be arranged for within 72 hours after discharge. The choice of a treadmill exercise test utilizing the Bruce treadmill score should be preferred in all patients who can walk and have an interpretable ECG. In some instances additional imaging may be beneficial. If the patient is unable to walk, a pharmacologic stress test should be considered. Patients needing continued beta-blockade may be candidates for nuclear imaging instead of standard treadmill stress testing. Patients can also be considered for coronary computed tomographic angiography (CCTA). [*High Quality Evidence*], [*Low Quality Evidence*].

49. Low Risk

Patients with a history of brief episodes of chest pain (less than 20 minutes) but suggestive of accelerating and/or class three or four angina should be considered low risk if indeed an ECG can be obtained during the chest pain episodes. If, however, an ECG cannot be obtained during a chest pain episode or other atypical features are present, the patient may be managed as intermediate risk and evaluated in a cardiac observation unit.

50. Discharge to Outpatient Management

If the diagnosis is low-risk UA, a follow-up appointment, preferably with a cardiologist, should be done. Otherwise, a follow-up with a primary care physician may also be appropriate. These appointments should occur within one to three days. If the chest pain is considered stable angina and nonanginal chest pain, an arrangement for follow-up with a primary care physician should be arranged in the near future. The primary care physician may want to follow the clinical evaluation algorithm provided within the original guideline document.

51. Patient Has Abnormal Functional Test or Coronary Computed Tomographic Angiography (CCTA)?

If patient has an abnormal stress test without recurrence of signs of ACS, refer him/her as an outpatient for cardiology consultation. If a patient has recurrence of more persistent symptoms at rest or signs of escalating angina, consider him/her to be high risk within this ACS guideline.

Some patients may be anxious for more immediate evaluation by cardiology if they have an abnormal functional stress test or CCTA. Patients can be reassured that outpatient consultation with cardiology is appropriate. Patients should all be counseled to seek immediate evaluation with any recurrence of anginal symptoms [*Guideline*].

ST-Elevation Myocardial Infarction (STEMI) Algorithm Annotations

53. ST-Segment Elevation on Electrocardiogram

About 40% of patients with AMI present with ST-segment elevation. They can be treated with thrombolytics or with emergency coronary angiography and PCI. Patients presenting with chest pain but no ST-segment elevation may be triaged to the telemetry unit if they are hemodynamically stable and pain-free.

AMIs are divided into two categories: those causing ST-segment elevation (transmural) and those not causing ST-segment elevation (non-transmural or subendocardial). Infarctions associated with ST-segment elevations will be positively affected by early thrombolytic therapy. There is no question that if unable to get to a PCI-capable facility in <90 minutes, patients with anterior MIs and those who present very early (less than four to six hours after onset of symptoms) benefit tremendously from any thrombolytic agent, and both in-hospital and late mortality are significantly reduced [*Low Quality Evidence*].

Facilities without PCI capabilities should activate their established processes and criteria for transfer for immediate PCI.

54. Percutaneous Coronary Intervention-Capable Facility?

The major distinction among hospitals in regard to STEMI management is between PCI-capable hospitals, which are STEMI receiving centers, and non-PCI-capable hospitals, which are STEMI referring centers. Both types of facilities need to develop multidisciplinary STEMI systems of care that include prehospital identification and activation, emergency medical services, transfer and destination protocols [*Guideline*].

55. Emergency Coronary Angiography

Recommendation:

- If experienced interventional cardiologists and rapid deployment of PCI are available, prioritize PCI over thrombolysis, as PCI has been demonstrated to be more effective in opening acutely occluded arteries [*Guideline*].

Time to open artery is critical to effective primary PCI. Current ACC/AHA guidelines suggest that institutions wishing to apply primary PCI for STEMI should achieve a median door-to-balloon time of 90 minutes or less. The ACC/AHA Consensus Panels have set a 60-minute median door-to-balloon time as the benchmark for top-performing institutions [*Guideline*].

Institutions that cannot meet the recommended treatment times should consider preferential use of intravenous thrombolytic therapy. *These institutions should have a predetermined plan for treating patients who present with contraindication to thrombolytics.*

Aspirin, anti-platelet/clopidogrel or prasugrel, UFH/LMWH/fondaparinux, nitrates and beta-blockers should be administered early to these patients, unless contraindicated [*High Quality Evidence*].

Primary PCI may also play a role in the treatment of NSTEMI/refractory angina pectoris if angina symptoms fail to resolve within an hour of instituting aggressive anti-anginal therapy with aspirin, prasugrel, UFH, LMWH, beta-blockers and GP IIb/IIIa inhibitors, or serial ECG or echocardiogram suggest a large amount of myocardium at risk.

For centers that have demonstrated high success rates and low complication rates, this strategy is at least equal in efficacy to that of initial thrombolytic therapy, especially for those patients at high risk of mortality, and may be considered in thrombolytic candidates, as well as in patients with thrombolytic contraindications. It is the preferred therapy for cardiogenic shock. Immediate transfer of patients to an institution capable of treating this condition is indicated for the presentation or development of cardiogenic shock [*Low Quality Evidence*].

Current ACC/AHA guidelines recommend treating the culprit vessel when feasible and deferring surgical- or PCI-based revascularization of other vessels until the patient has stabilized and the clinically most appropriate strategy determined [*High Quality Evidence*].

58. Percutaneous Coronary Intervention (PCI) Available within 90 Minutes?

Recommendations:

- Systems should be in place to transfer patient with STEMI or high-risk features to angiography within 90 minutes wherever possible [*High Quality Evidence*].
- When PCI is not available within 90 minutes, employ a strategy of early thrombolytics prior to transfer [*Guideline*].

The medical evidence is clear that the more rapidly reperfusion is obtained in ACS, the better the outcomes that are obtained. ACC/AHA standards call for door-to-needle time for initiation of fibrinolytic therapy within 30 minutes or that door-to-balloon time for PCI is kept under 90 minutes [*Guideline*]. They state further "because there is not considered to be a threshold effect for the benefit of shorter times to reperfusion, these goals should not be understood as 'ideal' times but the longest times that should be considered acceptable." In the 2009 focused updates, this standard was left in place, although "the writing groups continue to believe the focus should be on developing systems of care to increase the number of patients with timely access to primary PCI rather than extending the acceptable window for door to balloon time." A recent study of 43,801 patients reinforced this, showing a continuous non-linear increase in in-hospital mortality with any delay in reperfusion time [*High Quality Evidence*]. The practical standard in care should be an "as-soon-as-possible" one.

Whichever strategy – fibrinolytic or PCI – is employed will be affected by both facility and patient factors. However "for facilities that can offer PCI, the literature suggests that this approach is superior to pharmacologic reperfusion." This is primarily due to reduction in the rate of non-fatal recurrent MI. The 22 randomized clinical trials that were reviewed in the ACC/AHA guidelines demonstrated that, compared to fibrinolytics, patients treated with PCI experienced "lower short term mortality rates, less nonfatal reinfarction and less hemorrhagic stroke." However there was an increase in major bleeding risk. The difference was even more pronounced among high-risk patients such as those with cardiogenic shock, severe heart failure, or electrical instability.

Patients who are best suited for fibrinolysis alone include "those who present early after symptom with a low bleeding risk." Patients who may benefit the most from immediate transfer for PCI include high-risk patients, those with high bleeding risk and patients presenting more than four hours after symptom onset.

In facilities that do not offer PCI but must transfer the patient to another center, generally fibrinolysis can be offered more quickly. If the transfer cannot be accomplished so that the door-to-balloon time is less than 90 minutes, the differences in outcomes are reduced and fibrinolysis may be preferred [*Guideline*]. Consultation with cardiology at the tertiary care center may be indicated to determine the best strategy in these situations.

59. High-Risk Patient?

Patients at high risk of AMI complications include those with extensive ST-segment elevation; new-onset LBBB; previous MI; Killip class II

or III; left ventricular ejection fraction 35% or less; systolic blood pressure less than 100, heart rate >100 beats per minute (bpm) and patients with diabetes.

60. Thrombolytics Followed by Rapid Transfer to PCI-Capable Facility

Studies have addressed the best management of high-risk patients with AMI initially treated at non-PCI capable facilities. The CARESS-in-AMI trial [*High Quality Evidence*] studied 600 STEMI patients <75 years with high-risk features. Patients treated with thrombolytics followed by immediate transfer to a PCI facility had a significantly lower primary outcome measure (all-cause mortality, reinfarction and refractory myocardial ischemia) with no increase in major bleeding compared to delayed transfer for rescue PCI as indicated (4.4% versus 10.7%, P=0.004). Similarly, the TRANSFER-AMI trial [*Guideline*] followed 1,059 patients randomized to either standard rescue PCI strategy or "pharmacointensive" care (thrombolysis followed by immediate transfer for PCI). The primary endpoints of the trial were a 30-day composite of the first occurrence death, reinfarction, recurrent ischemia, new or worsening heart failure, and cardiogenic shock. The pharmacointensive group reached primary endpoints 11.0% of the time, compared to 17.2% of the rescue PCI group (P=0.004).

61. Thrombolytics

Recommendation:

- Thrombolytics should be administered early in the course of AMI if a catheterization lab with experienced personnel is not readily available [*Guideline*].

Indications for Thrombolytics

- ST-segment elevation of 1 mm or more in two or more contiguous limb leads or
 - ST-segment elevation of 2 mm or more in precordial leads or
 - New or presumably new LBBB; ST-segment depression of 2 mm or more in V₁V₂ (true posterior infarction), and anginal chest pain between 30 minutes and 12 hours in duration that is unrelieved with nitroglycerin

[*High Quality Evidence*], [*Low Quality Evidence*]

Low patient weight has been identified as an ongoing risk factor for significant intracranial hemorrhage (ICH) when thrombolytics are administered. It is imperative to accurately estimate the weight of patients with AMI to determine the proper dose of thrombolytic to minimize the risk of intracranial hemorrhage.

Single-bolus agents, such as tenecteplase, simplify administration; however, patient weight remains important in calculating dose.

The use of any particular thrombolytic agent is very controversial and continuously being reassessed [*Guideline*]. It is recommended that each facility/institution that is non-PCI-capable develop a protocol on a specific thrombolytic agent and dose, and administration prior to transferring the patient to a PCI-capable facility.

Refer to the original guideline document for additional information on thrombolytic administration and common causes of delay in initiation of thrombolytics.

62. Was Thrombolysis Successful at Reperfusion?

Recurrent or ongoing symptoms following treatment with thrombolytics is an indication for PCI. Rescue PCI refers to PCI within 12 hours after failed fibrinolysis for patients with continuing or recurrent myocardial ischemia. Thrombolytic failure may be evident by failure of ST-elevation to resolve within 30 to 60 minutes of thrombolytic therapy and usually includes persistent symptoms. Guidelines for time from arrival to balloon inflation are not established for this complex subset of patients, but rescue PCI should be accomplished within 90 to 120 minutes of thrombolytic failure if possible.

According to the ACC/AHA guidelines for patients with STEMI [*Guideline*]:

Rescue PCI should be performed in patients less than 75 years old with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care.

Perform rescue PCI in patients with symptom onset within 12 hours and severe congestive heart failure (CHF) and/or pulmonary edema (Killip class 3).

Consider rescue PCI for patients with one or more of the following:

- a. Hemodynamic or electrical instability
- b. Persistent ischemic symptoms

Given the uncertainty surrounding this issue, the work group suggests contemplation of cardiology consultation to aid in properly treating these patients.

63. Cardiology Consultation for High-Risk Patients (if Not Already Obtained)

Angiography should be performed for patients at increased risk as defined in Emergency Intervention Algorithm, Annotation #39, "Risk Assessment/Consider Repeat Electrocardiogram if Ongoing Chest Discomfort," above.

Trials (collectively FRISC II and TACTICS-TIMI 18) suggest an early invasive approach.

- Early diagnostic coronary angiography and appropriate PCI or CABG within 48 hours of presentation is recommended if STEMI is present.

Consider coronary artery bypass graft for patients with left main, three-vessel or two-vessel disease with left anterior descending coronary artery involvement and demonstration of ischemia or for patients who would not receive the ideal benefit from PCI. Pharmacologic or stress test imaging may be helpful if myocardial viability is uncertain and revascularization is considered.

Consider PCI for patients with acceptable anatomy in whom its prognostic effect has been most clearly demonstrated: significant residual ischemia, CABG candidacy and failure of maximal medical therapy (two of three medications) to control angina or contraindications to medications.

65. Admit to Critical Care Unit

Patients who present with acute ST-segment elevation, hemodynamic instability, or both should be considered for admit to the critical care unit. Reconsider the early use of adjunctive medications. Once the issue of surgery is clarified, consider the early use of P2Y12 inhibitor for those in whom PCI is planned. (See Emergency Intervention Algorithm.) A critical care unit admission order set is included in the original guideline document.

67. Critical Care Unit Care: Chronic Adjunctive Medications/Phase One Cardiac Rehabilitation

A protocol should be in place to guide routine orders for continuous monitoring, oxygen delivery, intravenous access therapy, activity, laboratory and diagnostic tests, diet, and medications.

The following medications are recommended:

- Aspirin should be continued. Aspirin has been shown to reduce reinfarction and mortality long term and should be continued whenever possible. Use of NSAIDs and cyclooxygenase (COX)-2 inhibitors may reduce the cardioprotective benefits of aspirin [Reference].
- P2Y12 inhibitors (clopidogrel/prasugrel/ticagrelor). For patients with allergies to aspirin, P2Y12 inhibitors may be used alone and continued indefinitely. For patients undergoing a bare metal stent or drug-eluting stent, a P2Y12 inhibitor should be continued for at least 12 months.

For patients who present with UA, NSTEMI or STEMI without revascularization who are not at high risk for bleeding, clopidogrel/ticagrelor should be continued for at least one year.

If the morbidity risk due to bleeding outweighs the benefit of P2Y12 inhibitor therapy, early discontinuation should be considered. If a P2Y12 inhibitor is given and a coronary artery bypass surgery is planned, clopidogrel and ticagrelor should be held for at least five days and prasugrel for at least seven days prior to surgery due to increased risk of perioperative bleeding. Prasugrel is not recommended as part of dual antiplatelet therapy in patients with a history of stroke or transient ischemic attack (TIA) due to the increased risk of bleeding.

In November 2009 the FDA issued a statement advising prescribers that in patients taking clopidogrel to avoid selected proton pump inhibitors (PPIs) and other drugs (e.g., cimetidine, esomeprazole, fluoxetine, fluconazole, ketoconazole) that inhibit CYP2C19.

See the [FDA Web site](#) .

Though the FDA issued a warning, post-hoc analysis of two recent studies [Low Quality Evidence] did not confirm these adverse cardiovascular outcomes. The ACC/AHA issued a statement that suggested that additional clinical studies are needed before a formal recommendation could be made [Guideline]. Additional management guidelines on this topic are being prepared by the ACC/AHA.

After a consensus-building discussion, the ICSI Antithrombotic work group recommends:

- Risks and benefits of concomitant clopidogrel and PPI use must be carefully evaluated and documented on an individual patient basis.

- Discontinue PPI if there is no strong indication for one.
- Consider H2 blockers (famotidine, nizatidine and ranitidine).
- Pantoprazole does not inhibit CYP2C19 and is a reasonable option. However, this has not been shown to be significant in clinical trials [*Low Quality Evidence*].
- Beta-blockers*. Beta-blockers reduce mortality, readmission, and reinfarction for both coronary artery disease and CHF. They should be instituted and/or continued whenever possible. Patients who have clinical contraindications for beta-blockers in the hospital should be reconsidered for beta-blocker therapy after discharge [*High Quality Evidence*]. Prescribing beta-blockers for AMI patients is a Centers for Medicare and Medicaid Services (CMS)/The Joint Commission quality measure.
*Shown in large clinical trials to reduce infarction mortality in all MIs.
- Statins: Patients diagnosed with ACS should be treated with statins. Statins may reduce recurrent ischemic event after ACS, all-cause mortality and revascularization [*Systematic Review*], [*Low Quality Evidence*], [*Moderate Quality Evidence*]. Patients should be started on statins regardless of baseline low-density lipoprotein (LDL). Higher baseline LDL level at the time of ACS will draw more benefits from statin therapy than lower LDL levels [*Low Quality Evidence*].

For more information on statins, see the NGC summary of the ICSI guideline [Lipid Management in Adults](#).

- ACE inhibitors*. ACE inhibitors are indicated (angiotensin receptor blockers if ACE inhibitors aren't tolerated – in addition to beta-blockers, when possible) for most patients following AMI to reduce mortality and morbidity associated with large infarcts with significant left ventricular dysfunction, to reduce adverse ventricular remodeling that may result in further reduction in ejection fraction, and for potential reduction of future MI and stroke. Consider hydralazine/isosorbide dinitrate if intolerant to ACE inhibitors or angiotensin receptor blockers or either drug is contraindicated.
*Shown in large clinical trials to reduce infarction mortality in all MIs.
- Calcium channel blockers may be useful for control of blood pressure and ischemic pain when beta-blockers are contraindicated but should be avoided in patients with decreased left ventricular function or heart failure. The short-acting dihydropyridine calcium channel blockers (e.g., nifedipine) may be associated with increased risk and should be avoided in acute ischemic syndromes.
- Oral nitrates may benefit selected patients with postinfarction angina or CHF.
- Low-molecular-weight heparin has been shown to be superior to UFH in patients without ST-segment elevation and can preferentially be used in subcutaneous dosing (e.g., enoxaparin sodium 1 mg/kg every 12 hours). UFH/LMWH may be continued for two to four days or maintained until conversion to warfarin is completed. If UFH is used, the dose should be regulated to maintain an activated partial thromboplastin time of 50 to 75 seconds.
- Warfarin therapy may be initiated in certain clinical situations (e.g., postinfarction CHF or anterior MI with high risk of left ventricular thrombus) as soon as clinical stability is achieved and invasive diagnostic studies are completed. The usual target international normalized ratio is 2.0 to 3.0.
- Oral antiarrhythmics are not recommended, especially when left ventricular function is reduced. Flecainide acetate and sotalol hydrochloride should be avoided in patients with significant structural heart disease unless clearly indicated on the basis of electrophysiologic study for the suppression of life-threatening ventricular arrhythmias. Beta-blockers are the current drug of choice when tolerated. Routine use of amiodarone hydrochloride in post-MI patients with non-sustained ventricular ectopy has not been shown to reduce mortality.
- Tobacco cessation should be addressed as soon as possible for patients who smoke or use tobacco products.
- Glycemic control. Tight control of blood glucose in patients with diabetes is recommended. Patients with diabetes mellitus have greater short-term and long-term mortality after AMI than patients without diabetes [*Low Quality Evidence*]. Diabetes is also an independent predictor of mortality following other ACSs [*Low Quality Evidence*]. Even in patients without a previous diagnosis of diabetes, hyperglycemia on admission for an AMI is associated with higher mortality than those without elevations of glucose. Recent studies [*High Quality Evidence*] have important limitations in terms of the efficacy of glycemic control in patients with an AMI. Whether control of glycemia is sufficient to reduce morbidity and mortality is not proven at this time. Given the lack of convincing evidence, the glucose targets during an AMI are not clearly defined. Previously, the ACC/AHA guidelines for STEMI recommended an insulin infusion to "normalize" blood glucose in patients with both uncomplicated and complicated courses. The 2009 Focused Update recommends that it is reasonable to use an insulin-based regimen to achieve and maintain glucose levels less than 180 mg/dL while avoiding hypoglycemia for patients with STEMI with either a complicated or uncomplicated course [*Guideline*].

Phase One Cardiac Rehabilitation

With shortened length of stay, teachable moments may be limited. As a result, timely initiation of education on lifestyle modification is crucial. Phase one cardiac rehabilitation should begin as soon as the patient is stable and pain-free. Goals are to minimize harmful effects of immobilization, assess the hemodynamic response to exercise, manage the psychosocial issues of cardiac disease, and educate the patient

and family about lifestyle modification including:

- Tobacco cessation
- Dietary instruction including a heart healthy diet
- Manageable exercise regimen

68. Complications?

Arrhythmic complications include sinus bradycardia, Möbitz I block (Wenckebach), Möbitz II block, complete heart block or asystole, premature ventricular contractions (PVC), ventricular tachycardia, ventricular fibrillation, accelerated idioventricular rhythm, and supraventricular arrhythmias (atrial flutter, atrial fibrillation, and supraventricular tachycardia). Ischemic complications include postinfarction angina. Mechanical complications include papillary muscle dysfunction, rupture with significant mitral regurgitation, ventricular septal rupture, myocardial rupture, right ventricular infarction, pericarditis with or without tamponade, left ventricular dysfunction, and aneurysm formation [*Low Quality Evidence*].

69. See Acute Myocardial Infarction Complications Algorithm

Transfer to a PCI-capable facility any patients with post-MI complications such as those outlined above.

70. Transfer to Post-Critical Care Unit Care

Patients should be transferred from the critical care unit to the telemetry or step-down unit when they are pain-free, hemodynamically stable, and meet the institution's protocol for admission to the telemetry unit (usually 12 to 24 hours after MI). Discontinuation of cardiac monitoring should be considered for patients who attain electrical stability (usually within three days of infarction).

72. Risk Stratification

Assessment of ejection fraction is important in predicting prognosis. Most patients should undergo echocardiography or other assessment of left ventricular ejection fraction. As a treadmill test is not useful for predicting recurrence of AMI, consider angiography when ST-segment depression or angina appear early in treatment. Consider pharmacologic stress testing if the patient is unable to exercise. If the ECG is not interpretable, consider stress imaging (nuclear or echocardiographic).

Patient with no high-risk indications following thrombolytics therapy may be stratified non-invasively into low, medium, and high risk.

Some clinicians may elect to measure multiple cardiac biomarkers in patients with MI. This may especially be helpful when risk stratification is not available by other clinical evidence. One study demonstrated the utility of cardiac troponins, C-reactive protein and B-type natriuretic peptide (BNP) measurements. This work demonstrated that patients with elevations of all three cardiac biomarkers had significantly higher risks of recurrent MI and death than those with only two or one elevated. There was a progressive step-wise increase in risk going from one abnormality to two abnormalities to elevations of all three biomarkers [*Cost-Effective Analysis*], [*Guideline*], [*Systematic Review*], [*Low Quality Evidence*].

BNP is a cardiac neurohormone released upon ventricular myocyte stretch as proBNP, which is enzymatically cleaved to the N-terminal proBNP (NT-proBNP) and, subsequently, to BNP. A number of prospective studies and large data sets have documented its prognostic value, independent of conventional risk factors for mortality in patients with stable and unstable coronary syndromes [*Low Quality Evidence*].

When measured at first patient contact or during the hospital stay or follow-up, the natriuretic peptides are strong predictors of both short- and long-term mortality in patients with STEMI and UA/NSTEMI [*Low Quality Evidence*].

Increasing levels of NT-proBNP are associated with proportionally higher short- and long-term mortality rates at one year. Prognostic value was independent of a previous history of heart failure (HF) and of clinical or laboratory signs of left ventricular dysfunction on admission or during hospital stay [*Low Quality Evidence*]. Moreover, the prognostic significance of an elevated BNP appears to be independent of echocardiographic findings [*Low Quality Evidence*].

Measurement of BNP or NT-proBNP may be considered to supplement assessment of global risk in patients with suspected ACS. However, further studies are needed to determine optimal treatment of elevated levels of natriuretic peptides [*Guideline*].

73. High-Risk Patient?

Patients who are at increased risk for adverse prognosis after AMI and who are also candidates for short-term intervention include those with a large amount of myocardial necrosis (ejection fraction less than 40%), residual ischemia (angina during hospitalization or exercise testing), electrical instability (greater than 10 PVC/hr), left main or three-vessel coronary artery disease, limited exercise tolerance, or rales/crackles in more than one-third of lung fields.

The following factors increase long-term risk:

- Age 70 years or greater
- Previous infarction
- Anterior-wall MI
- Hypotension and sinus tachycardia
- Diabetes
- Female gender
- Continued smoking
- Atrial fibrillation
- Heart failure

Patients able to exercise more than four metabolic equivalents (METs) had less than a 2% subsequent incidence of death or MI within one year compared with 18% for those in the high-risk group [*Moderate Quality Evidence*].

74. Secondary Prevention and Risk Factor Modification

Modification of risk factors, such as high lipid levels, hypertension and smoking, significantly reduces subsequent cardiovascular mortality. Document risk factor counseling in the medical record in a consistent manner. Many health systems invoke a "care plan" or "critical pathway" approach with flow sheets. Ongoing patient monitoring and feedback are important. Continue the patient's adjunctive therapy (aspirin plus a P2Y12 inhibitor [if patient managed by PCI] or a P2Y12 inhibitor alone if aspirin allergic, beta-blockers, warfarin for large anterior infarctions, ACE inhibitors/angiotensin receptor blockers, and statins).

Efforts targeted at exercise (as an adjunct, in the management of other risk factors), lipid management, hypertension control, and smoking cessation can reduce cardiovascular mortality, improve functional capacity, attenuate myocardial ischemia, retard the progression and foster the reversal of coronary atherosclerosis, and reduce the risk of further coronary events [*High Quality Evidence*].

The Cooperative Cardiovascular Project has documented a discrepancy between risk factor counseling documentation and actual practice during hospital stays of patients with MI. Therefore, documentation of smoking cessation counseling has become one of 13 indicators judged to be representative of quality care by the Cooperative Cardiovascular Project steering committee [*Low Quality Evidence*].

1. Smoking cessation is clearly linked to mortality and morbidity after MI.
2. Aggressive treatment of dyslipidemia can reduce subsequent myocardial ischemia.
3. Hypertension control will reduce recurrent cardiac events.
4. Exercise alone is only modestly effective for secondary prevention.
5. A case management system may be more effective than usual care in long-lasting risk factor modification.
6. Initiate depression screening and medical management when appropriate.

Teaching must be done when the patient is ready, and ideally is based on patient-derived learning priorities. Teaching moments may be best taken advantage of by a team approach involving physician and nursing staff during the hospital stay. Ongoing outpatient follow-up and progress feedback are important for patient adherence [*Low Quality Evidence*].

Depression affects one in four AMI patients, and delay in treatment of depression is associated with poorer outcomes [*Low Quality Evidence*], [*High Quality Evidence*]. The SADHART trial [*Low Quality Evidence*] suggested a benefit from the early diagnosis and treatment of depression in AMI patients. Depression associated with MI is underdiagnosed, and referral for treatment initiation is inefficient. The Patient Health Questionnaire 9 (PHQ-9) is a validated tool for the rapid diagnosis of moderate and severe depression. A score of 15 or higher indicates moderate depression and a score of 20 or higher indicates severe depression. Refer to the NGC summary of the ICSI guideline [Adult Depression in Primary Care](#) for additional information.

75. Discharge

Complete and document the following before discharge:

- Patient education that includes discharge diagnosis, medical regimen, lifestyle modification issues, and functional limitation (including resumption of sexual activity and driving)
- Scheduling of a follow-up appointment with the primary care physician
- Targeting a return-to-work date. Patients with sedentary jobs often return to work in two to three weeks. More physically demanding jobs often can be resumed in four to six weeks unless significant ischemia is present.

Patients are commonly discharged in less than three days following successful primary PCI with evidence of complete or near complete salvage of threatened myocardium. Though patients should avoid strenuous exertion for several weeks during the stent healing phase, many such patients may return to sedentary or only moderately active work activities within days of discharge.

Most patients with uncomplicated MI should be discharged within five days. Patients undergoing primary PCI who are at low risk with an uncomplicated course may be discharged on the third day. Early reperfusion and definitive angiography revealing little or no residual injury or disease has increasingly demonstrated improved myocardial salvage and enhanced patient stability. Discharge may be individualized according to the degree of salvage and stability. In many centers some patients are safely discharged within 24 hours when salvage is nearly complete [*Low Quality Evidence*].

76. Phase Two Cardiac Rehabilitation — if Available

Outpatient cardiac rehabilitation/secondary prevention programs are recommended for patients diagnosed with STEMI or NSTEMI. Of particular concern are those patients who carry a moderate or high risk or have multiple modifiable risk factors for coronary artery disease and for whom supervised exercise training is deemed appropriate.

There are exceptions to this recommendation, which include patient-oriented barriers, provider-oriented criteria (such as a patient who is deemed to have a high-risk condition or contraindication to exercise), or health care system barriers (such as patient who resides a significant distance from a program) [*Guideline*]. However, age, gender, race or socioeconomic status should not limit participation in a cardiac rehabilitation or secondary prevention program [*Low Quality Evidence*].

Home exercise training programs have been shown to be beneficial in certain low-risk patient groups but lack the valuable elements of education and group interaction [*High Quality Evidence*].

Certain patients felt to be at higher risk of complications post-discharge are more likely to require monitoring during exercise in the immediate post-discharge period. There is strong evidence to suggest that cardiac rehabilitation programs have been shown to decrease mortality rates in all populations, including younger, more selective populations as well as the socioeconomically and clinically diverse, older population (age 65 and older) [*Moderate Quality Evidence*].

The U.S. Public Health Service described Phase Two cardiac rehabilitation as a "comprehensive, long-term program including medical evaluation, prescribed exercise, cardiac risk factor modification, education and counseling. Phase Two refers to outpatient, medically supervised programs that are typically initiated one to three weeks after hospital discharge and provide appropriate ECG monitoring." In the past, the main emphasis was exercise based, but today the focus includes risk factor modification, education, and counseling.

Research shows that a cardiac rehabilitation program based on regular exercise and education focused on risk factor reduction is both efficient and effective in altering the course of coronary heart disease [*Low Quality Evidence*]. The initial outpatient phase includes a comprehensive evaluation, education and treatment for outpatients who have experienced a cardiac-related event. Phase Two patients are monitored with continuous ECG, blood pressure, heart rate and subjective Rating of Perceived Exertion. For certain patients, referral to a Phase Two program may facilitate earlier hospital discharge by providing emotional support in the outpatient hospital setting.

Services delivered by a cardiac rehabilitation program may be considered "reasonable and necessary" for up to 36 sessions, and patients typically participate two to three times per week for 12 to 18 weeks [*Reference*].

Program Requirements

A cardiac rehabilitation program should include evaluation and assessment of modifiable cardiovascular risk factors, development of individualized interventions, and communication with other health care providers. Submeasures should include the following individualized assessments:

1. Tobacco use
2. Blood pressure control
3. Lipid control
4. Physical activity habits
5. Weight management
6. Diabetes management
7. Presence or absence of depression
8. Exercise capacity
9. Adherence to preventive medications

[*Guideline*]

Additional Goals of Phase Two Rehabilitation

- Increase exercise tolerance and endurance to enable patient to perform activities of daily living, at a level that resumes or exceeds their previous level of function

- Improve quality of life
- Improve psychological well-being and provide emotional support
- Provide educational support and resources

Education Topics

- Anatomy and physiology of the heart
- Nutrition
- Heart disease risk factors and modification
- Stress reduction
- Emotional aspects of heart disease
- Cardiac medications
- Aerobic exercise and exercise progression
- Cardiac signs and symptoms

Exercise Prescription

An exercise prescription will be developed, taking into consideration the following factors:

- Patient's past medical history
- Recent cardiac or pulmonary event with symptomatology, interventions, estimated ejection fraction, complications in recovery process
- Risk factor identification
- Current medications, oxygen use
- Past exercise history
- Exercise history since cardiac event
- Orthopedic impairments
- Barriers to learning
- Vocational and leisure time activities

An exercise prescription consists of:

Mode – The emphasis is aerobic exercise – continuous activity for 30 to 40 minutes, using large muscle groups. Options include treadmill, stationary bike, recumbent bike, Airdyne® bike, NuStep®, elliptical machine, upper body ergometer, hall walking and chair aerobics. Pure isometric exercise should be minimized because it may result in left ventricular decompensation in patients with poor left ventricular function.

Frequency – Two to three times per week supervised in rehab and additional home exercise program daily.

Duration – A goal of 30 to 40 minutes total including five-minute warm-up and five-minute cool-down.

Intensity – Initial exercise intensity will be based on diagnosis and previous exercise history. If patient is just beginning an exercise program, initial training will usually range from two-three METs (e.g., two-three miles per hour, 0% grade on treadmill, or 25 to 50 watts on bicycle). In patients with an angina threshold of two-three METs, exercise training may not be appropriate.

Progression – A gradual increase of 0.5-1.0 METs will be prescribed as tolerated with a MET goal established individually at initial evaluation session.

Exercise Tolerance and Assessment Tools

Exercise tolerance will be assessed by monitoring heart rate response, blood pressure response and Borg Rating of Perceived Exertion, with desired level being 11 to 13.

Exercise heart rate – Taking into consideration the above information, an exercise heart rate guideline will be calculated. This applies to patients who are not taking a beta-blocker and who have been shown to tolerate the exercise heart rate without ischemia.

- Age-adjusted maximum heart rate multiplied by 60% to 75%
- Age-adjusted multiplied by 60% to 80% if approved by physician
- 20 to 30 above resting heart rate
- Graded stress test

Monitoring rate of perceived exertion is very useful. This is advantageous for many reasons: it is unaffected by negative chronotropic medications, unlike heart rate monitoring; it is quite reproducible across age, gender and cultural origin; and lastly, it only requires patient attunement to symptoms [*Low Quality Evidence*].

Monitoring METs – Monitoring is determined by the patient's post-MI exercise tolerance test and/or in rehabilitation and is highly individual.

77. Chronic Adjunctive Medications/Outpatient Management

Recommendation:

- The following medications should be considered for therapy:
 1. Aspirin should be administered indefinitely unless contraindicated or not tolerated.
 2. P2Y12 inhibitor for 12 months should be given to patients following placement of drug-eluting stents.
 3. Beta-blockers should be administered indefinitely in all patients who have had a MI unless contraindicated.
 4. Patients who do not receive a beta-blocker during the first 24 hours because of early contraindications should be reevaluated for use of beta-blocker.
 5. Angiotensin-converting enzyme inhibitors should be administered to all patients with a history of AMI. The benefit is greater if the left ventricular ejection fraction is less than 40%.
 6. Statins should be administered to all patients with ACS unless contraindicated. For all patients with ACS, the LDL goal should be <100 mg/dL with the option of <70 mg/dL for very high risk patients.
(See the NGC summary of the ICSI [Lipid Management in Adults](#) guideline.)
 7. Consider oral nitrates for patients with ongoing angina.

Continue the use of enteric-coated aspirin or aspirin plus a P2Y12 inhibitor when indicated. Beta-blocker use following MI has been shown to reduce ischemia, prevent arrhythmias and reinfarction, and improve survival. Patients with large anterior infarctions may benefit from therapeutic warfarin therapy (international normalized ratio 2-3), usually for 3 months to reduce risk of systemic emboli.

Most patients should be receiving a statin (or alternative lipid-lowering medication if intolerant to statins) at discharge from the hospital. Lipid-lowering therapy should be considered for patients who have undergone PCI or CABG and patients whose LDL lipoprotein cholesterol level is 70 mg/dL or greater. Calcium channel blockers should be considered only for patients with NSTEMI who cannot take beta-blockers and patients without congestive heart failure or decreased left ventricular ejection fraction. Oral nitrates should be considered for patients with ongoing ischemia [*Low Quality Evidence*].

78. Phase Three/Phase Four Cardiac Rehabilitation if Appropriate

Phase Three Cardiac Rehabilitation

Phase Three is a maintenance program based on the continuation of a heart healthy lifestyle. The program is designed for patients who have completed a Phase Two cardiac rehabilitation program or for individuals with a cardiac history or significant cardiac risk factors. Patients are not continually monitored by ECG, but spot check ECG and daily blood pressures and heart rates are recorded. Trained staff, when available, continues to provide support and education for risk factor modification and exercise progression. Warm-up, aerobic exercise, stretching, and strength training (when appropriate) are included in Phase Three.

Phase Four Cardiac Rehabilitation

Phase Four cardiac rehabilitation begins after the desired functional capacity has been attained (usually greater than or equal to eight METs) and/or maximal oxygen uptake (VO₂max) has reached a plateau. Maintenance is the principal goal. The exercise prescription should continue as at the end of Phase Three unless angina or exercise intolerance develops, either of which requires cessation of exercise and urgent medical attention.

Acute Myocardial Infarction Complications Algorithm Annotations

81. Arrhythmic Complication(s)?

Arrhythmic complications including sinus bradycardia, Möbitz I (Wenckebach), premature ventricular complexes, accelerated idioventricular rhythm, and supraventricular arrhythmias (transient atrial flutter, atrial fibrillation, supraventricular tachycardia, and hemodynamic instability) are generally benign and may require symptomatic therapy. Transient Möbitz II block with MI may be treated symptomatically. Permanent pacing is indicated for persistent and symptomatic second- and third-degree atrioventricular block [*Low Quality Evidence*].

CMS — Covered Indications for Defibrillators

1. Documented episode of cardiac arrest due to ventricular fibrillation (VF), not due to transient or reversible cause
2. Documented sustained ventricular tachyarrhythmia, either spontaneous or induced by an electrophysiology study, not associated with an AMI and not due to transient or reversible cause
3. Documented familial or inherited conditions with a high risk of life-threatening ventricular tachyarrhythmia, such as long QT syndrome

or hypertrophic cardiomyopathy

4. Coronary artery disease with documented prior MI, ejection fraction less than 35%, and inducible sustained ventricular tachyarrhythmia or ventricular fibrillation at electrophysiology study
5. Documented prior MI, ejection fraction less than or equal to 30%, and QRS duration of greater than 120 msec (the patient must not have New York Heart Association [NYHA] Class IV heart failure, shock, CABG, PCI, MI within three months or a need for coronary revascularization or predicted survival less than one year)
6. Patients with dilated cardiomyopathy, documented prior MI, NYHA Class II and III heart failure, and left ventricular ejection fraction less than or equal to 35% for longer than nine months

Additional indications may be found at the [CMS Web site](#) .

82. Treat Arrhythmic Complication(s)

Refer to the original guideline document for more information on treatment of arrhythmic complications, including atrioventricular/bundle branch blocks, ventricular arrhythmias, accelerated idioventricular rhythm, and supraventricular arrhythmias.

83. Ischemic Complication(s)?

Ischemic complications include postinfarction angina.

84. Treat Ischemic Complication(s)

Treatment of postinfarction angina should be correlated with ECG changes, if possible. Optimal therapy consists of beta-blockers and long-acting nitrates. If beta-blockers are not tolerated or are ineffective and left ventricular function is not significantly depressed, a calcium channel blocker may be used. Early coronary angiography should be considered. Angina after MI may be confused with pericarditis. Aneurysm formation should be a consideration.

85. Mechanical Complication(s)?

Monitor patients for mechanical complications during hospital care and counsel patients to seek immediate emergency room care for symptoms of complications after discharge.

Mechanical complications may include papillary muscle dysfunction or rupture with significant mitral regurgitation, ventricular septal rupture, myocardial rupture, right ventricular infarction, pericarditis with or without tamponade, left ventricular dysfunction, and aneurysm formation.

86. Treat Mechanical Complication(s)

Papillary muscle dysfunction is evidenced by the murmur of mitral regurgitation, typically within five days of infarction.

Papillary muscle rupture may occur within 10 days of the event. Findings include development of sudden CHF or pulmonary edema, often but not always accompanied by a new holosystolic apical murmur. Diagnosis is verified by echocardiography. Stabilization is achieved by one or more of the following: aggressive use of diuretics and vasodilators, insertion of a Swan-Ganz catheter, and insertion of an intra-aortic balloon pump. Because of the high mortality rate with this complication, urgent surgical repair is indicated.

Ventricular septal rupture occurs within one week of infarction and results in left-to-right shunting and subsequent hemodynamic deterioration. Ventricular septal rupture is suggested by the presence of a new, harsh, holosystolic murmur that is loudest along the lower left sternal border; this may be accompanied by a thrill. Patients may also have symptoms of right-sided heart failure with right ventricular PO_2 step-up and may have less pulmonary congestion than patients with papillary muscle rupture. The diagnosis is confirmed by two-dimensional echocardiography. Patients are best stabilized by vasodilator therapy, insertion of a Swan-Ganz catheter or an intra-aortic balloon pump, or all of these. Because of the high mortality rate, urgent surgical repair is indicated.

Myocardial rupture is a common cause of sudden death after AMI. Symptoms or findings include emesis, persistent restlessness, anxiety, and persistent ST-wave elevation on ECG. Rupture usually occurs within five to seven days of MI. Left ventricular free-wall rupture leads to hemopericardium and subsequent death from tamponade. Contained rupture may result in formation of a pseudoaneurysm. Surgical resection is recommended.

Right ventricular infarction is suspected in patients with inferior infarction complicated by low cardiac output, hypotension, oliguria, jugular venous distention, and clear lung fields without radiographic evidence of pulmonary venous congestion. Infarction can be confirmed by ECG findings (ST-segment elevation in right precordial leads V_4R through V_6R in the presence of inferior ST-elevation), two-dimensional echocardiography, or pulmonary artery catheter demonstrating a disproportionate elevation of right atrial pressure compared with pulmonary capillary wedge pressure. Treatment consists of intravascular volume expansion and use of inotropic agents; if the patient loses sinus rhythm, temporary pacing to re-establish atrioventricular synchrony should be considered. Agents that reduce right ventricular preload, such as nitroglycerin, diuretics, and large doses of morphine, should be avoided. ACE inhibitors and beta-blockers may require dose

reduction or discontinuation with milder presentation of right ventricular dysfunction post-MI [*Systematic Review*], [*Low Quality Evidence*].

Post-MI pericarditis can be early (occurring within 72 to 96 hours after AMI) or occasionally delayed (typically occurring weeks after MI); the latter is called Dressler's syndrome. Early pericarditis is suspected in patients with pericardial friction rub, usually heard on the second or third day after AMI, and chest pain that may extend to the back, neck, or shoulders that is intensified by movement and respiration and relieved by sitting up or leaning forward. Treatment consists of anti-inflammatory agents and reassurance. Echocardiography to assess for possible incomplete myocardial rupture should be considered. It is important to emphasize to the patient that the recurrent pain is not the result of recurrent infarction. Risk of hemopericardium is increased in patients receiving anticoagulants; development of a pericardial effusion can be detected by close clinical observation and echocardiography [*Low Quality Evidence*].

Dressler's syndrome is characterized by an increase in erythrocyte sedimentation rate, leukocytosis, and more frequent pleural and pericardial effusions than in early pericarditis. The incidence of Dressler's syndrome is roughly 1% to 3% of AMI patients. Because of the increased incidence of pericardial effusion, anticoagulation should be used with caution. Treatment for pericardial effusion with impending tamponade is pericardiocentesis, preferably guided by echocardiography [*Low Quality Evidence*].

Risk of developing left ventricular dysfunction and subsequent heart failure is greatly increased in patients with more extensive MI. Restricted diastolic filling patterns on echocardiography may predict subsequent clinical heart failure.

Refer to the original guideline document for more information.

Special Workup Algorithm Annotations

91. Symptoms, Arterial Blood Gases, Chest X-Ray Suggest Pulmonary Embolus?

- Symptoms may include dyspnea, tachypnea, pleuritic chest pain.
- Physical findings extremely variable, may include fever, wheezing
- ECG - non-specific ST-T changes
- Chest x-ray - normal, pleural effusion, wedge-shaped infiltrate
- Arterial blood gases - abnormal A-a gradient

93. Symptoms, Arterial Blood Gases, Chest X-Ray Suggest Pneumothorax?

- Idiopathic or spontaneous pneumothorax - sudden onset of pleuritic chest pain and dyspnea (pleuritic pain more prominent with small pneumothorax, dyspnea with large)
- Arterial blood gases may be abnormal

94. Consider Chest Tube and Hospitalization

- Pneumothorax greater than 10% to 20% usually requires chest tube
 - Primary pneumothorax - occurs in otherwise healthy people (idiopathic most frequently in tall young males, catamenial associated with endometriosis and menses) [*Low Quality Evidence*]
 - Secondary pneumothorax - chronic obstructive pulmonary disease (COPD), asthma, pneumonia, cystic fibrosis [*Low Quality Evidence*]
- Outpatient treatment possible if progression unlikely and patient reliable
 - Catheter aspiration followed by several hours of observation
 - Indwelling catheter attached to Heimlich valve
- Inpatient treatment if pneumothorax is secondary or significant symptoms
- Reabsorption slow - 1.25% per day

Non-Cardiac Causes Algorithm Annotations

98. Reproducible Chest Pain Tenderness on Exam, No Increase in Troponin or Change in ST Segment on ECG

The examination should also target potential non-cardiac causes for the patient's symptoms such as prominent murmurs (endocarditis), pericardial friction rub (pericarditis), fever and abnormal lung sounds, pneumonia, reproducible chest pain after palpation (musculoskeletal) [*Low Quality Evidence*].

99. Symptoms, Signs, Chest X-Ray Suggest Pleural or Parenchymal Pulmonary Disease?

Patients with pulmonary or pleural disease frequently have a presenting complaint of chest pain with or without shortness of breath. A detailed history, physical examination, ECG, chest x-ray, and laboratory evaluation typically will often suggest the diagnosis. Differential diagnoses include COPD, asthma, infectious processes, and malignancies. Specific management of these diagnoses is beyond the scope of

this guideline.

100. Evaluate for Observation or Admission

Disposition decisions are largely dependent on the patient's stability. The initial treatment must be directed toward treating any instability and searching for the etiology of the symptoms. Pulse, blood pressure, respirations, and level of consciousness must be assessed. Other factors that need to be considered are age, general state of health and immunocompetency, and reliability. If a patient is labile or unstable, or at risk of becoming unstable, admit the patient [*Low Quality Evidence*].

101. Symptoms and Signs Suggest Chest Wall/Costochondritis?

Costochondritis (Tietze's syndrome, intercostal muscular strain) can present with chest pain. If not adequately addressed, the patient will present repeatedly for chest pain evaluation. It is essential that this opportunity for teaching be maximized [*Low Quality Evidence*].

102. Aspirin, Acetaminophen, Chest Wall Rest and Graded Return to Activity/Adjunctive Treatments to Be Considered

It should not be assumed that because this particular episode of chest pain has been attributed to a non-cardiac cause that the patient should therefore be treated with agents that increase cardiovascular risk. Several authors have raised concerns about the safety and efficacy of non-steroidal drugs even in a healthy population [*Low Quality Evidence*]. Thus, the work group recommends aspirin, acetaminophen, topical strategies including cold and heat, gentle stretching and avoidance of lifting more than 10 lbs. for 48 hours as initial interventions. If the pain is localized over a joint, topical NSAIDs such as diclofenac (Voltaren gel, Flector patch) can be effective. These agents have limited systemic absorption estimated at 6%, so provide a greatly reduced renal risk as compared to systemically used NSAIDs. If the region is over a muscular area, then topical Lidoderm patch can offer partial day relief.

If the pain is of a chronic nature, in addition to being referred back to their primary care physician, the patient can be offered gabapentin or other medications used to treat neuropathic pain such as tricyclic antidepressants, selective serotonin reuptake inhibitors (SSRIs), or serotonin-norepinephrine reuptake inhibitors (SNRIs). Muscle relaxation agents such as cyclobenzaprine, tizanidine, baclofen or benzodiazepines are not only ineffective but may predispose patient towards increased medication usage (see the NGC summary of the ICSI guideline [Assessment and Management of Chronic Pain](#)).

Essential non-pharmacologic pain management techniques should not be overlooked. The impact of sleep hygiene, adequate daily aerobic exercise, physical therapy and desensitization techniques are essential to regaining full function (see the NGC summary of the ICSI guideline [Assessment and Management of Chronic Pain](#)).

103. Consider Gastrointestinal Diagnosis?

Gastrointestinal disorders are sometimes perceived by the patient as chest pain. Once the clinician is confident that no intra-thoracic processes are the cause of the discomfort, a gastrointestinal diagnosis should be considered.

104. Gastrointestinal Evaluation

Commonly history, physical examination, and a laboratory evaluation will suggest a gastrointestinal diagnosis. Further evaluation of this is beyond the scope of this guideline.

105. Reconsider Differential Diagnosis

If the clinician, after initial evaluation and work-up, does not arrive at a likely working diagnosis, he/she may have to go back and reconsider the entire differential diagnosis a second time in order to make certain that no serious condition has been missed. The clinician may then have to redirect his/her search for a diagnosis to conditions of the thoracic spine and thoracic nerves. Other considerations are somatization and anxiety disorders. These may be more or less obvious after careful consideration.

Differential diagnoses of thoracic spine and thoracic neuralgias include metastatic malignancy, multiple myeloma, arthritic processes, ankylosing spondylitis, osteomyelitis, kyphoscoliosis, and herpes zoster.

Atypical chest pain associated with mitral valve prolapse is a poorly understood symptom [*Low Quality Evidence*].

Clinic Evaluation Algorithm Annotations

107. Initial Focused Assessment for High-Risk History, Physical Examination, and Other Findings

History should include characterization of pain, exacerbating or relieving factors, associated symptoms, and risk factors for coronary disease. Physical examination should include careful cardiovascular and pulmonary examination, peripheral vascular examination, and evaluation for hypertension and hypercholesterolemia. Lab studies may include resting ECG, chest x-ray, hemoglobin, and others if clinically indicated [*Low Quality Evidence*].

The patient's description of pain and the history of previous coronary disease are by far the most important parts of the history.

Carotid bruits, peripheral vascular disease, and xanthomas on physical examination suggest a higher likelihood of coronary disease. The resting ECG may show evidence of previous infarction.

Direct provider education toward completing the history evaluation.

High-risk symptoms on initial presentation include:

History

- Severe or ongoing pain
- Pain lasting 20 minutes or more
- New pain at rest or with minimal activity
- Severe dyspnea
- Loss of consciousness

Physical Findings

- Hypotension or other signs of underperfusion
- Tachycardia or bradycardia
- Pulmonary edema, cyanosis

ECG Findings

- ST elevation greater than 1 mm on two contiguous leads suggesting AMI
- New ST or T wave changes
- ST depression greater than 1 mm at rest
- New LBBB

109. Initiate Emergency Interventions and Transfer to Emergency Department as Appropriate

Initiate emergency intervention as appropriate and transfer the patient as soon as possible for further emergency intervention.

A patient complaining of chest pain should immediately be placed on a cardiac monitor. Vital signs should be taken, intravenous access started, oxygen administered, and immediate ECG taken. Institution of stabilizing therapy (including nitroglycerin and chewable aspirin for suspect anginal pain) prior to the completion of the history or physical is appropriate and often necessary at this level [*Guideline*].

110. Coronary Artery Disease Diagnosis Secure?

When the clinical setting and history suggest typical angina pectoris (substernal pain provoked by exertion and relieved by nitroglycerin or rest), the physician is very likely correct in assuming an ischemic coronary syndrome. Treatment and prognostic evaluation may proceed as outlined in the NGC summary of the ICSI guideline [Stable Coronary Artery Disease](#).

111. Refer to the NGC Summary of the ICSI Guideline [Stable Coronary Artery Disease](#)

Typical angina pectoris, if stable for 60 days and without evidence of recent MI, may be treated under the NGC summary of the ICSI guideline [Stable Coronary Artery Disease](#).

112. Ischemic Heart Pain Possible?

When coronary disease is of intermediate probability, a stress test may contribute supplemental information. When coronary disease is unlikely based on highly atypical symptoms and low prevalence of coronary disease among the population to which the patient belongs, stress testing may be misleading.

113. Select Stress Test or Consider Cardiology Referral

Choose the best type of cardiac stress test based on:

- The resting cardiogram
- The patient's ability to walk
- Local expertise

114. Can Patient Walk?

For patients who cannot exercise, consider pharmacologic stress and imaging test (with adenosine, dipyridamole, or dobutamine). Physical exercise is the most physiologic form of cardiovascular stress. If one doubts how far a patient will be able to walk, it might still be worthwhile to attempt treadmill exercise. The occasional patient with orthopedic restriction may be able to perform bicycle ergometry [*Low Quality Evidence*].

116. Resting Electrocardiogram Interpretable for Ischemic Changes?

Marked resting ECG abnormalities, such as LBBB, left ventricular hypertrophy with repolarization abnormality, ventricular pre-excitation, or ventricular paced rhythm, render the exercise ECG uninterpretable for ischemic changes. Patients with less than 1 mm resting ST depression may undergo standard ECG stress testing, provided the clinician realizes that further ST depression with exercise has minimal diagnostic significance. It is recommended that patients who are on digoxin undergo imaging studies since digoxin can produce abnormal ST segment depression. A stable abnormality with exercise is reassuring [*Guideline*], [*Low Quality Evidence*].

117. Do Exercise Imaging Study

When the resting ECG is markedly abnormal, use an exercise imaging test (stress echocardiogram, stress radionuclear perfusion, or stress radionuclear ventriculogram) [*Low Quality Evidence*].

118. Do Treadmill Stress Test

Use the Bruce protocol, modified if need be for debilitated patients. Adequacy of exercise and myocardial challenge is generally accepted as achieving greater than or equal to 85% of age-predicted maximum heart rate. The Bruce protocol, because of extensive use and long-term follow-up, provides the most reliable prognostic information [*Guideline*], [*Low Quality Evidence*].

119. Is Test Strongly Positive?

Stress testing may be strongly positive and suggest a moderate to high risk of cardiovascular events as indicated by the Duke treadmill score, which is based upon the Bruce protocol.

A stress test predicts the patient's prognosis and provides evidence of the presence or absence of coronary artery disease. Of these two types of information, the first, establishing the patient's prognosis, is the more reliable.

Treadmill findings which signify a poor prognosis are:

- Poor exercise tolerance
- Hypotension
- Marked ST abnormality at a low workload

Conversely, good exercise tolerance to a high heart rate and blood pressure signifies a good prognosis, even if the exercise ECG is somewhat abnormal (for example, a patient who walks nine minutes and has 1 mm of asymptomatic ST depression.)

Mark et al. (Duke treadmill score) validated an easy-to-use treadmill score which stratifies high-, intermediate-, and low-risk patients. The Duke treadmill score was developed from a retrospective study of 2,842 inpatients. It was prospectively tested on an outpatient population of 613 patients with an endpoint of patient mortality. Consequently, it is well validated and the best measurement for the prognostic interpretation of treadmill tests.

A Duke score of greater than or equal to five is generally accepted as a passing score, and such patients may be discharged to home with follow-up within 72 hours.

[*High Quality Evidence*], [*Low Quality Evidence*]

Unless advanced age, comorbidity, or patient preference suggests medical treatment, high-risk patients should be considered for revascularization. Patients identified as high risk by treadmill testing often have left ventricular dysfunction, left main coronary stenosis, or other serious coronary disease. Revascularization may offer a better prognosis [*Low Quality Evidence*], [*High Quality Evidence*].

121. Is Test Positive But Low Risk?

A stress cardiogram may be positive but without features that signify a poor prognosis as noted above. For example, a 65-year-old man with atypical angina and 1 mm ST depression at 10 minutes has a good prognosis even though he has coronary disease.

123. Is Test Equivocal?

Because of resting abnormality, limited exercise performance, limited heart rate, or minor exercise abnormalities, the test may not be clearly normal or abnormal, yet high-risk treadmill findings are absent [*Low Quality Evidence*].

125. Test Is Normal

A normal test may confirm the clinical impression of non-cardiac symptoms. Refer to cardiology if symptoms are worrisome despite a normal stress test.

Compared with the prognostic information contained in a stress test, the diagnostic information is more variable. The physician must consider:

1. How to estimate the pretest likelihood of coronary disease based upon the patient's age, sex, and description of chest pain. If pretest likelihood is very high or very low, a test of intermediate predictive value, such as treadmill stress testing, may be misleading [*Low Quality Evidence*]. Refer to the table "Percent Prevalence of Angiographic Coronary Disease," in the original guideline document.
2. How abnormal are the exercise findings?
Greater than 1 mm flat or 1.5 mm upsloping ST depression measured 80 msec after the J point occurring with a normal resting ECG is considered a positive test. However, "positive" is not all-or-nothing. Downsloping ST depression, greater degrees of ST depression, persistent ST depression, and ST depression at a low workload are "more positive." Conversely, upsloping ST depression, ST depression at a high workload, and rapidly resolving ST depression are "less positive."
3. How good is the test itself? Is exercise challenge adequate, heart rate high enough? Resting abnormality present?
4. The natural history of a coronary plaque. A non-obstructive plaque may become active, provoking unstable symptoms by platelet emboli or vasoconstriction, yet not impair exercise coronary flow. A normal test isn't reassuring if the symptoms are worrisome.
5. What is the diagnostic goal? Absolute certainty for airline pilots? Reasonable reassurance?

Despite the complexities of interpretation, stress testing is a valuable tool in the evaluation of a patient with chest pain. Clinical judgment is paramount.

[*Low Quality Evidence*]

Definitions:

Following a review of several evidence rating and recommendation writing systems, the Institute for Clinical System Improvement (ICSI) has made a decision to transition to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system.

Crosswalk between ICSI Evidence Grading System and GRADE

ICSI GRADE System	Previous ICSI System	
High, if no limitation	Class A:	Randomized, controlled trial
Low	Class B:	[observational]
		Cohort study
Low	Class C:	[observational]
		Non-randomized trial with concurrent or historical controls
Low		Case-control study
Low		Population-based descriptive study
*Low		Study of sensitivity and specificity of a diagnostic test
*Following individual study review, may be elevated to Moderate or High depending upon study design		
Low	Class D:	[observational]
		Cross-sectional study
		Case series
		Case report
Meta-analysis	Class M:	Meta-analysis
Systematic Review		Systematic review
Decision Analysis		Decision analysis
Cost-Effectiveness Analysis		Cost-effectiveness analysis

ICSI GRADE System	Previous ICSI System	
Low	Class R:	Consensus statement
Low		Consensus report
Low		Narrative review
Guideline	Class R:	Guideline
Low	Class X:	Medical opinion

Evidence Definitions

High Quality Evidence = Further research is very unlikely to change confidence in the estimate of effect.

Moderate Quality Evidence = Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.

Low Quality Evidence = Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate or any estimate of effect is very uncertain.

In addition to evidence that is graded and used to formulate recommendations, additional pieces of literature will be used to inform the reader of other topics of interest. This literature is not given an evidence grade and is instead identified as a Reference throughout the document.

Clinical Algorithm(s)

The following detailed and annotated clinical algorithms are provided in the [original guideline document](#) :

- Chest Pain Screening
- Emergency Intervention
- ST-Elevation Myocardial Infarction (STEMI)
- Acute Myocardial Infarction Complications
- Special Workup
- Non-Cardiac Causes
- Clinic Evaluation

Scope

Disease/Condition(s)

- Chest pain/discomfort, including coronary artery disease (CAD) and non-cardiac causes
- Acute coronary syndrome
- Acute myocardial infarction
- ST-elevation myocardial infarction (STEMI)
- Acute myocardial infarction complications

Note: This guideline focuses mainly on the treatment of acute coronary syndromes, but the algorithms also address the possibility of other cardiovascular causes of chest pain that are life threatening and would require different treatment.

Guideline Category

Diagnosis

Evaluation

Management

Rehabilitation

Risk Assessment

Screening

Treatment

Clinical Specialty

Cardiology

Critical Care

Emergency Medicine

Family Practice

Internal Medicine

Thoracic Surgery

Intended Users

Advanced Practice Nurses

Allied Health Personnel

Emergency Medical Technicians/Paramedics

Health Care Providers

Health Plans

Hospitals

Managed Care Organizations

Nurses

Pharmacists

Physician Assistants

Physicians

Guideline Objective(s)

- To increase the success of emergency intervention for patients with chest pain symptoms suggestive of serious illness
- To minimize the delay in administering fibrinolysis or angioplasty to patients with acute myocardial infarction (AMI)
- To increase the timely initiation of treatment to reduce postinfarction mortality in patients with AMI
- To increase the percentage of patients with AMI using appropriate cardiac rehabilitation

Target Population

Adults presenting with past or present symptoms of chest pain/discomfort and/or indications of acute coronary syndromes

Interventions and Practices Considered

Screening/Evaluation/Diagnosis/Risk Assessment

1. Initial evaluation by triage
2. Medical history, physical examination, and risk assessment
3. Clinic evaluation depending on symptoms and risk factors
4. Vital signs assessment
5. Electrocardiogram
6. Cardiac markers (troponin T or I, creatine kinase MB)
7. Portable chest x-ray
8. Diagnostic coronary angiography
9. Treadmill stress test
10. Computed tomography angiogram, transesophageal echocardiography, magnetic resonance imaging, arterial blood gases, chest x-ray if indicated

Management/Treatment/Rehabilitation

1. Emergency interventions including ambulance transport to emergency department with aspirin and electrocardiogram en route
2. Immediate assessment with cardiac monitoring
3. Early therapy (e.g., intravenous access, oxygen, aspirin, nitroglycerin, morphine, unfractionated heparin or low-molecular-weight heparin [LMWH], nitrates, beta-blockers, P2Y12 inhibitors, glycoprotein IIb/IIIa receptor antagonist)
4. Initial management according to the American Heart Association Advanced Cardiac Life Support guideline for those with compromised vital signs
5. Percutaneous coronary intervention or coronary artery bypass graft if indicated
6. Thrombolytics
7. Treatment of acute myocardial infarction complications
8. Phase 1 cardiac rehabilitation including aspirin, P2Y12 inhibitor, beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, calcium channel blockers, oral nitrates, LMWH, warfarin, oral antiarrhythmics, statins, tobacco cessation, glycemic control, and assessment and treatment of depression
9. Phase 2 cardiac rehabilitation (outpatient management) including education, risk factor modifications, treatment of depression, and exercise prescription
10. Phase 3 and 4 cardiac rehabilitation (maintenance)
11. Follow-up

Major Outcomes Considered

- Diagnostic value of tests
- Prognostic value of risk assessment interventions
- Effectiveness of secondary prevention, treatment, and rehabilitation interventions in reducing mortality and morbidity rates
- Positive predictive value of new ST elevation

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

A consistent and defined process is used for literature search and review for the development and revision of Institute for Clinical Systems Improvement (ICSI) guidelines. The literature search in PubMed was divided into two stages to identify systematic reviews (stage I) and randomized controlled trials, meta-analyses and other literature (stage II). Literature search terms used for this revision are from February 2010 to February 2012 and include acute coronary syndrome (ACS) and bivalirudin, ACS and troponin scale, ticagrelor and acute coronary syndrome, magnetic resonance imaging in emergency department for ACS, emergency medical services role (therapeutic interventions) in ACS and ejection fraction measures for ACS.

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Following a review of several evidence rating and recommendation writing systems, the Institute for Clinical System Improvement (ICSI) has made a decision to transition to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system.

Crosswalk between ICSI Evidence Grading System and GRADE

ICSI GRADE System	Previous ICSI System	
High, if no limitation	Class A:	Randomized, controlled trial
Low	Class B:	[observational]
		Cohort study
Low	Class C:	[observational]
		Non-randomized trial with concurrent or historical controls
Low		Case-control study
Low		Population-based descriptive study
*Low		Study of sensitivity and specificity of a diagnostic test
*Following individual study review, may be elevated to Moderate or High depending upon study design		
Low	Class D:	[observational]
		Cross-sectional study
		Case series
		Case report
Meta-analysis	Class M:	Meta-analysis
Systematic Review		Systematic review
Decision Analysis		Decision analysis
Cost-Effectiveness Analysis		Cost-effectiveness analysis

ICSI GRADE System	Previous ICSI System	
Low	Class R:	Consensus statement
Low		Consensus report
Low		Narrative review
Guideline	Class R:	Guideline
Low	Class X:	Medical opinion

Evidence Definitions

High Quality Evidence = Further research is very unlikely to change confidence in the estimate of effect.

Moderate Quality Evidence = Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.

Low Quality Evidence = Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate or any estimate of effect is very uncertain.

In addition to evidence that is graded and used to formulate recommendations, additional pieces of literature will be used to inform the reader of other topics of interest. This literature is not given an evidence grade and is instead identified as a Reference throughout the document.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review

Description of the Methods Used to Analyze the Evidence

Not stated

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Guideline Development Process

A work group consisting of 6 to 12 members that includes physicians, nurses, pharmacists, and other healthcare professionals relevant to the topic, along with an Institute for Clinical Systems Improvement (ICSI) staff facilitator, develops each document. Ordinarily, one of the physicians will be the leader. Most work group members are recruited from ICSI member organizations, but if there is expertise not represented by ICSI members, one or two members may be recruited from medical groups, hospitals, or other organizations that are not members of ICSI. Patients on occasion are invited to serve on work groups.

The work group will meet for 7 to 8 three-hour meetings to develop the guideline. A literature search and review is performed and the work group members, under the coordination of the ICSI staff facilitator, develop the algorithm and write the annotations and literature citations.

Once the final draft copy of the guideline is developed, the guideline goes to the ICSI members for critical review.

Revision Process of Existing Guidelines

ICSI scientific documents are revised every 12 to 24 months as indicated by changes in clinical practice and literature. For documents that are revised on a 24-month schedule, ICSI checks with the work group on an annual basis to determine if there have been changes in the literature significant enough to cause the document to be revised earlier or later than scheduled.

For yearly reviewed documents, ICSI checks with every work group 6 months before the scheduled revision to determine if there have been changes in the literature significant enough to cause the document to be revised earlier than scheduled.

Literature Search

ICSI staff, working with the work group to identify any new pertinent clinical trials, systematic reviews, or regulatory statements and other professional guidelines, conduct a literature search.

Revision

The work group will meet for 1 to 2 three-hour meetings to review the literature, respond to member organization comments, and revise the document as appropriate.

A second review by members is indicated if there are changes or additions to the document that would be unfamiliar or unacceptable to member organizations. If a review by members is not needed, the document goes to the appropriate steering committee for approval according to the criteria outlined below.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

The guideline developers reviewed published cost analyses.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Critical Review Process

The purpose of critical review is to provide an opportunity for the clinicians in the member groups to review the science behind the recommendations and focus on the content of the guideline. Critical review also provides an opportunity for clinicians in each group to come to consensus on feedback they wish to give the work group and to consider changes necessary across systems in their organization to implement the guideline.

All member organizations are expected to respond to critical review guidelines. Critical review of guidelines is a criterion for continued membership within the Institute for Clinical Systems Improvement (ICSI).

After the critical review period, the guideline work group reconvenes to review the comments and make changes, as appropriate. The work group prepares a written response to all comments.

Document Approval

Each document is approved by the Committee for Evidence-Based Practice (CEBP). The committee will review and approve each guideline/protocol, based on the following criteria:

- The aim(s) of the document is clearly and specifically described.
- The need for and importance of the document is clearly stated.
- The work group included individuals from all relevant professional groups and had the needed expertise.

- Patient views and preferences were sought and included.
- The work group has responded to all feedback and criticisms reasonably.
- Potential conflicts of interest were disclosed and do not detract from the quality of the document.
- Systematic methods were used to search for the evidence to assure completeness and currency.
- Health benefits, side effects, risks and patient preferences have been considered in formulating recommendations.
- The link between the recommendation and supporting evidence is clear.
- Where the evidence has not been well established, recommendations based on community practice or expert opinion are clearly identified.
- Recommendations are specific and unambiguous.
- Different options for clinical management are clearly presented.
- Clinical highlights and recommendations are easily identifiable.
- Implementation recommendations identify key strategies for *health care systems* to support implementation of the document.
- The document is supported with practical and useful tools to ease *clinician* implementation.
- Where local resource availability may vary, alternative recommendations are clear.
- Suggested measures are clear and useful for quality/process improvement efforts.

Once the document has been approved, it is posted on the ICSI Web site and released to members for use.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is classified or graded for selected recommendations (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Successful emergency interventions for patients with chest pain symptoms suggestive of serious illness
- Minimized delay in administering fibrinolysis or angioplasty to patients with acute myocardial infarction (AMI)
- Timely initiation of treatment to reduce post-infarction mortality in patients with AMI
- Appropriate use of cardiac rehabilitation postdischarge

Potential Harms

Adverse Effects of Medications and Precautions

- Switching patients from *unfractionated heparin* to *enoxaparin* or vice versa at the time of referral to tertiary care institutions has been shown to increase adverse events. Hence, start and maintain the patient on a single drug continuously during transfer and treatment at referring and referral institutions.
- *Enoxaparin* should be used with caution in patients with renal insufficiency.
- Due to the risk of catheter thrombosis, do not use *fondaparinux* as the sole anticoagulant to support percutaneous coronary intervention (PCI). Administer an additional anticoagulant with anti-IIa activity (unfractionated heparin, bivalirudin, argatroban).
- *Bivalirudin* alone as compared with heparin plus glycoprotein (GP)IIb/IIIa has similar rates of major adverse cardiac events, lower minor bleeding complications and similar net adverse cardiac events.
- Exercise caution in administering intravenous *beta-blocker* until after revascularization and stabilization of the patient's blood pressure. Avoid intravenous beta-blockers in Killip III/IV patients. Caution should be used in patients with reactive airway disease.
- *Calcium channel blockers* should be avoided in patients with decreased left ventricular dysfunction or heart failure. The short-acting dihydropyridine calcium channel blockers (e.g., *nifedipine*) may be associated with increased risk and should be avoided in acute ischemic syndromes.
- *Flecainide acetate* and *sotalol hydrochloride* should be avoided in patients with significant structural heart disease unless clearly indicated on the basis of electrophysiologic study for the suppression of life-threatening ventricular arrhythmias.

- Low patient weight has been identified as an ongoing risk factor for significant intracranial hemorrhage when *thrombolytics* are administered. It is imperative to accurately estimate the weight of patients with acute myocardial infarction (AMI) to determine the proper dose of thrombolytic to minimize the risk of intracranial hemorrhage.
- Use of *non-steroidal anti-inflammatory drugs* and *cyclooxygenase-2 (COX-2) inhibitors* may reduce the cardioprotective benefits of aspirin.
- *Prasugrel* is not recommended to be used in patients with a prior history of stroke or transient ischemic attack (TIA), or who are >75 years of age due to increased risk of bleeding except in high-risk situations (diabetes mellitus or prior myocardial infarction [MI] history).
- If a P2Y12 inhibitor is given and a coronary artery bypass graft (CABG) is planned, clopidogrel and ticagrelor should be withheld for at least five days and prasugrel for at least seven days prior to surgery due to increased risk of perioperative bleeding. If the risk of bleeding outweighs the benefit, early discontinuation of P2Y12 inhibitor therapy may be considered specifically in patients not treated with an implantation of a drug-eluting coronary stent.
- In March 2010, the Food Drug Administration (FDA) issued a new boxed warning to the product label of *clopidogrel bisulfate* to warn about patients who do not effectively metabolize the drug and therefore may not receive the full benefits of the drug. Specifically, the purpose is to:
 - Warn about reduced effectiveness in patients who are poor metabolizers of clopidogrel – poor metabolizers do not effectively convert clopidogrel to its active form in the body.
 - Inform health care professionals that tests are available to identify genetic differences in CYP2C19 function.
 - Advise health care professionals to consider use of other anti-platelet medications or alternative dosing strategies for clopidogrel bisulfate in patients identified as poor metabolizers.
- *Proton pump inhibitors (PPIs)*, which are often used in conjunction with clopidogrel to reduce the chance of gastrointestinal blood loss, result in reduced plasma concentrations of active metabolite of clopidogrel, thus lowering the antiplatelet effect of clopidogrel in vitro. In November 2009 the FDA issued a statement advising prescribers to avoid using some PPIs and other drugs (e.g., cimetidine, esomeprazole, fluoxetine, fluconazole, ketoconazole) that inhibit CYP2C19 in patients taking clopidogrel.

Contraindications

Contraindications

- P2Y12 inhibitors are contraindicated with anticipated cardiac surgery.
- Prasugrel is contraindicated in patients with a history of transient ischemic attack (TIA) or stroke.
- Contraindications to GP IIb/IIIa inhibitors include active or recent bleeding in the last 30 days, history of intracranial hemorrhage, stroke in previous 30 days, uncontrolled hypertension (greater than 200/100 mmHg), major surgery within the previous six weeks, aortic dissection, acute pericarditis or platelet count less than 100,000 mm³ (eptifibatide is contraindicated in patients who are dialysis dependent).
- Nitroglycerin is contraindicated in patients who are hypotensive, have documented severe aortic stenosis, have hypertrophic cardiomyopathy, or who have received sildenafil or vardenafil within the previous 24 hours or tadalafil in the previous 48 hours.
- Beta-blocker are contraindicated if hypotension, shock, heart block or other contraindication is present. Indications for not starting a beta-blocker are history of intolerance or adverse drug reaction to beta-blockers, symptomatic bradycardia or advanced heart block (excluding treatment by pacemaker), evidence of fluid overload or volume depletion, recent treatment with an intravenous positive inotropic agent (e.g., digoxin, nesiritide and others), suspected cocaine ingestion (completely avoid beta-blockers in cocaine-induced ST-segment elevation myocardial infarction because there is a risk of exacerbating coronary spasm), and cardiogenic shock.
- Fondaparinux is contraindicated in patients with a CrCl < 30 mL/min.
- Magnetic resonance imaging should be avoided if a type A aortic dissection is suspected.

Qualifying Statements

Qualifying Statements

- The information contained in this Institute for Clinical Systems Improvement (ICSI) Health Care Guideline is intended primarily for health professionals and other expert audiences.
- This ICSI Health Care Guideline should not be construed as medical advice or medical opinion related to any specific facts or

circumstances. Patients and families are urged to consult a health care professional regarding their own situation and any specific medical questions they may have. In addition, they should seek assistance from a health care professional in interpreting this ICSI Health Care Guideline and applying it in their individual case.

- This ICSI Health Care Guideline is designed to assist clinicians by providing an analytical framework for the evaluation and treatment of patients, and is not intended either to replace a clinician's judgment or to establish a protocol for all patients with a particular condition.

Implementation of the Guideline

Description of Implementation Strategy

Once a guideline is approved for general implementation, a medical group can choose to concentrate on the implementation of that guideline. When four or more groups choose the same guideline to implement and they wish to collaborate with others, they may form an action group.

In the action group, each medical group sets specific goals they plan to achieve in improving patient care based on the particular guideline(s). Each medical group shares its experiences and supporting measurement results within the action group. This sharing facilitates a collaborative learning environment. Action group learnings are also documented and shared with interested medical groups within the collaborative.

Currently, action groups may focus on one guideline or a set of guidelines such as hypertension, lipid treatment, and tobacco cessation.

Detailed measurement strategies are presented in the original guideline document to help close the gap between clinical practice and the guideline recommendations. Summaries of the measures are provided in the National Quality Measures Clearinghouse (NQMC).

Implementation Recommendations

Prior to implementation, it is important to consider current organizational infrastructure that address the following:

- System and process design
- Training and education
- Culture and the need to shift values, beliefs and behaviors of the organization

The following system changes were identified by the guideline work group as key strategies for health care systems to incorporate in support of the implementation of this guideline.

- Clinics should have a process in place for a patient to be referred for emergency intervention via 911, or be seen in the clinic the same day, within 72 hours, or as an elective clinic evaluation based upon the presence of high-risk symptoms and duration.
- Hospitals should develop and implement emergency department critical pathways and consider standard orders to accomplish rapid evaluation and treatment of acute coronary syndrome. Standard discharge orders/instructions should also be considered.
- A process should be in place for the patient and family that will rapidly orient them to the suspected diagnosis, emergency department and coronary care unit process and other treatment measures to be considered. This could include caregiver face-to-face interactions with the patient and family as well as teaching tools in written form.
- Institutions that cannot meet the recommended treatment times for primary percutaneous coronary intervention (PCI) should consider the preferential use of intravenous thrombolytic therapy, followed by as-soon-as-possible transfer to a PCI capable facility for high risk patients. Lower risk patients may be observed at the initial hospital with later transfer for PCI as indicated. These institutions should have a predetermined plan for treating patients who present with contraindications to thrombolytics. Such plans may employ delayed local primary PCI transfer to another institution.

Implementation Tools

Clinical Algorithm

Quality Measures

Quick Reference Guides/Physician Guides

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Related NQMC Measures

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS): percentage of AMI patients who receive a statin agent within 24 hours of arrival and at discharge from hospital for whom treatment is appropriate.

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS): percentage of patients with AMI who are referred to an appropriate cardiac rehabilitation program post-discharge.

Diagnosis and treatment of chest pain and acute coronary syndrome (ACS): percentage of patients with AMI with referral to an appropriate cardiac rehabilitation program (Phase 2 or Phase 3) post-discharge who enroll in the program.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Patient-centeredness

Timeliness

Identifying Information and Availability

Bibliographic Source(s)

Davis T, Bluhm J, Burke R, Iqbal Q, Kim K, Kokoszka M, Larson T, Puppala V, Setterlund L, Vuong K, Zwank M. Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2012 Nov. 91 p. [159 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2004 Nov (revised 2012 Nov)

Guideline Developer(s)

Institute for Clinical Systems Improvement - Nonprofit Organization

Guideline Developer Comment

Organizations participating in the Institute for Clinical Systems Improvement (ICSI): Affiliated Community Medical Centers; Allina Medical Clinic; Aspen Medical Group; Baldwin Area Medical Center; Brown Clinic; Center for Diagnostic Imaging/Medical Scanning Consultants; CentraCare; Central Lakes Medical Clinic; Chippewa County – Montevideo Hospital & Clinic; Cuyuna Regional Medical Center; Essentia Health; Fairview Health Services; Family HealthServices Minnesota; Family Practice Medical Center; Fergus Falls Medical Clinic; Gillette Children's Specialty Healthcare; Grand Itasca Clinic and Hospital; Hamm Clinic; HealthEast Care System; HealthPartners Central Minnesota Clinics; HealthPartners Medical Group & Regions Hospital; Hennepin County Medical Center; Hennepin Faculty Associates; Howard Young Medical Center; Hudson Physicians; Hutchinson Area Health Care; Hutchinson Medical Center; Integrity Health Network; Lake Region Healthcare Corporation; Lakeview Clinic; Mankato Clinic; MAPS Medical Pain Clinics; Marshfield Clinic; Mayo Clinic; Mercy Hospital and Health Care Center; Midwest Spine Institute; Minnesota Association of Community Health Centers; Minnesota Gastroenterology; Multicare Associates; New Richmond Clinic; North Central Heart Institute; North Clinic; North Memorial Health Care; Northwest Family Physicians; Obstetrics and Gynecology Specialists; Olmsted Medical Center; Park Nicollet Health Services; Planned Parenthood Minnesota, North Dakota, South Dakota; Quello Clinic; Raiter Clinic; Rice Memorial Hospital; Ridgeview Medical Center; River Falls Medical Clinic; Riverwood Healthcare Center; South Lake Pediatrics; Southside Community Health Services; Stillwater Medical Group; University of Minnesota Physicians; Winona Health

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Source(s) of Funding

- The Institute for Clinical Systems Improvement (ICSI) provided the funding for this guideline. The annual dues of the member medical groups and sponsoring health plans fund ICSI's work. Individuals on the work group are not paid by ICSI, but are supported by their medical group for this work.
- ICSI facilitates and coordinates the guideline development and revision process. ICSI, member medical groups, and sponsoring health plans review and provide feedback but do not have editorial control over the work group. All recommendations are based on the work group's independent evaluation of the evidence.

Guideline Committee

Diagnosis and Treatment of Chest Pain and Acute Coronary Syndrome (ACS) Work Group

Composition of Group That Authored the Guideline

Work Group Members: Thomas Davis, MD (*Work Group Leader*) (Park Nicollet Health Services) (Cardiology); Qamar Iqbal, MD (HealthEast Care System) (Internal Medicine); V. Krishna Puppala, MD, MPH (HealthEast Care System) (Internal Medicine); Rynn Burke, MD (HealthPartners Medical Group and Regions Hospital) (Internal Medicine and Hospitalist); Kara Kim, MD (HealthPartners Medical Group and Regions Hospital) (Hospitalist); Khuong Vuong, MD (HealthPartners Medical Group and Regions Hospital) (Hospitalist); Michael Zwank, MD (HealthPartners Medical Group and Regions Hospital) (Emergency Medicine); Tonja Larson, PharmD, BCPS (Marshfield Clinic) (Pharmacy); Marek Kokoszka, MD (Park Nicollet Health Services) (Cardiology); Linda Setterlund, MA, CPHQ (Institute for Clinical Systems Improvement [ICSI]) (Clinical Systems Improvement Facilitator); Jim Bluhm, MPH (ICSI) (Team Director)

Financial Disclosures/Conflicts of Interest

The Institute for Clinical Systems Improvement (ICSI) has long had a policy of transparency in declaring potential conflicting and competing interests of all individuals who participate in the development, revision and approval of ICSI guidelines and protocols.

In 2010, the ICSI Conflict of Interest Review Committee was established by the Board of Directors to review all disclosures and make recommendations to the board when steps should be taken to mitigate potential conflicts of interest, including recommendations regarding removal of work group members. This committee has adopted the Institute of Medicine Conflict of Interest standards as outlined in the report *Clinical Practice Guidelines We Can Trust* (2011).

Where there are work group members with identified potential conflicts, these are disclosed and discussed at the initial work group meeting. These

members are expected to recuse themselves from related discussions or authorship of related recommendations, as directed by the Conflict of Interest committee or requested by the work group.

The complete ICSI policy regarding Conflicts of Interest is available at the [ICSI Web site](#) .

Disclosure of Potential Conflicts of Interest

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National, Regional, Local Committee Affiliations: None

Guideline Related Activities: MN Department of Health Pandemic Planning

Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

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Guideline Related Activities: None

Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

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Guideline Related Activities: None

Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

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Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

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Financial/Non-Financial Conflicts of Interest: None

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Guideline Related Activities: None

Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

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Research Grants: None

Financial/Non-Financial Conflicts of Interest: Consulting for services provided as hospitalist practice.

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Guideline Related Activities: None

Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

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National, Regional, Local Committee Affiliations: None

Guideline Related Activities: None

Research Grants: None

Financial/Non-Financial Conflicts of Interest: None

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Institute for Clinical Systems Improvement (ICSI). Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2011 Nov. 85 p.

Guideline Availability

Electronic copies: Available from the [Institute for Clinical Systems Improvement \(ICSI\) Web site](#) .

Print copies: Available from ICSI, 8009 34th Avenue South, Suite 1200, Bloomington, MN 55425; telephone, (952) 814-7060; fax, (952) 858-9675; Web site: www.icsi.org ; e-mail: icsi.info@icsi.org

Availability of Companion Documents

The following are available:

- Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Executive summary. Bloomington (MN): Institute for Clinical Systems Improvement; 2012 Nov. 1 p. Electronic copies: Available in Portable Document Format (PDF) from the [Institute for Clinical Systems Improvement \(ICSI\) Web site](#) .
- Diagnosis and treatment of chest pain and acute coronary syndrome (ACS). Eighth edition. Order set. Bloomington (MN): Institute for Clinical Systems Improvement; 2012 Nov. 7 p. Electronic copies: Available from the [ICSI Web site](#) .

Print copies: Available from ICSI, 8009 34th Avenue South, Suite 1200, Bloomington, MN 55425; telephone, (952) 814-7060; fax, (952) 858-9675; Web site: www.icsi.org ; e-mail: icsi.info@icsi.org

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI on February 16, 2005. This summary was updated on May 3, 2005 following the withdrawal of Bextra (valdecoxib) from the market and the release of heightened warnings for Celebrex (celecoxib) and other nonselective non-steroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on June 16, 2005, following the U.S. Food and Drug Administration advisory on COX-2 selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs). This NGC summary was updated by ECRI on January 12, 2006 and February 1, 2007. This summary was updated by ECRI on March 6, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin sodium). This summary was updated by ECRI Institute on June 22, 2007 following the U.S. Food and Drug Administration (FDA) advisory on heparin sodium injection. This summary was updated by ECRI Institute on July 12, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Troponin-1 Immunoassay. This summary was updated by ECRI Institute on

September 7, 2007 following the revised U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin). This summary was updated by ECRI Institute on November 9, 2007, following the U.S. Food and Drug Administration advisory on Antidepressant drugs. This summary was updated by ECRI Institute on March 14, 2008 following the updated FDA advisory on heparin sodium injection. This NGC summary was updated by ECRI Institute on April 15, 2009. This summary was updated by ECRI Institute on January 5, 2010 following the U.S. Food and Drug Administration advisory on Plavix (Clopidogrel). This NGC summary was updated by ECRI Institute on June 21, 2010 and on March 2, 2011. This summary was updated by ECRI Institute on June 27, 2011 following the U.S. Food and Drug Administration advisory on Zocor (simvastatin). This NGC summary was updated by ECRI Institute on June 5, 2012 and February 8, 2013. This summary was updated by ECRI Institute on October 28, 2013 following the U.S. Food and Drug Administration advisory on Acetaminophen. This summary was updated by ECRI Institute on December 16, 2013 following the U.S. Food and Drug Administration (FDA) notice on Lexiscan (regadenoson) and Adenoscan (adenosine). This summary was updated by ECRI Institute on March 10, 2014 following the U.S. Food and Drug Administration advisory on Low Molecular Weight Heparins. This summary was updated by ECRI Institute on September 18, 2015 following the U.S. Food and Drug Administration advisory on non-aspirin nonsteroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI Institute on June 2, 2016 following the U.S. Food and Drug Administration advisory on Opioid pain medicines. This summary was updated by ECRI Institute on October 21, 2016 following the U.S. Food and Drug Administration advisory on opioid pain and cough medicines combined with benzodiazepines.

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