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- medical specialty and professional societies;
- researchers;
- federal, state and local government health care policy makers and specialists; and
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Health Care Guideline:
Diagnosis and Treatment of Chest Pain and Acute Coronary Syndrome (ACS)

Chest Pain Screening Algorithm

1. Initial contact with complaint of "chest pain/discomfort" in person or via telephone
   - A = Annotation

2. Initial evaluation by triage indicates elevated risk?
   - yes
   - A

3. Routine Clinic Evaluation
   - Refer to Clinic Evaluation algorithm

4. Brief screening history by medical personnel
   - A

5. A

6. At time of call
   - A

7. Within last 2 days
   - A

8. Between 3 days and last 2 weeks
   - A

9. Between 2 weeks and 2 months
   - A

10. More than 2 months ago
    - A

11. Urgency uncertain
    - A

12. Emergency
    - Transfer to ED (call 911)
    - A

13. Clinic evaluation same day
    - A

14. Elective clinic evaluation (within 2 weeks)
    - A

15. Clinic evaluation same day
    - A

16. Refer to Emergency Intervention algorithm

17. Refer to Clinic Evaluation algorithm

These clinical guidelines are designed to assist clinicians by providing an analytical framework for the evaluation and treatment of patients, and are not intended either to replace a clinician's judgment or to establish a protocol for all patients with a particular condition. A guideline will rarely establish the only approach to a problem.
Emergency Intervention Algorithm

Indications and Relative Contraindications for Thrombolysis:

Indications
1. ST ↑ in greater than or equal to 2 contiguous leads; greater than or equal to 1 mm in limb leads, or
   - greater than or equal to 2 mm in precordial leads
   or
   - new or presumably new LBBB; ST segment depression of greater than or equal to 2 mm in V₁, V₂ (true posterior infarction) and
2. Anginal chest pain greater than 30 minutes but less than 12 hours unrelieved with NTG SL

Absolute Contraindications
1. Previous hemorrhagic stroke at any time; other strokes or cerebrovascular events within one year
2. Known intracranial neoplasm
3. Active internal bleeding (does not include menses)
4. Suspected aortic dissection

Relative Contraindications
1. Severe uncontrolled hypertension on presentation (greater than 180/110 mmHg)
2. History of prior cerebrovascular accident or known intracranial pathology not covered in above absolute contraindications
3. Current use of anticoagulants in therapeutic doses (INR greater than or equal to 2.0·3.0); known bleeding diathesis
4. Recent trauma (including head trauma) within 2-4 weeks
5. Major surgery in past 3-6 months
6. Noncompressible vascular punctures
7. Recent internal bleeding
8. For streptokinase/anistreplase: prior exposure (especially within 5 days -2 years) or prior allergic reaction
9. Pregnancy
10. Active peptic ulcer
11. History of chronic hypertension

See ST Elevation MI algorithm (Annotation # 42)
PCI refers to percutaneous coronary intervention, which includes percutaneous transluminal coronary angioplasty (PTCA), as well as other percutaneous interventions.

ST-segment elevation on ECG

Thrombolytics or PCI* for initial therapy

STEMI Algorithm

Emergency coronary angiography and primary PCI*

Out of guideline

Complications?

Facilities without PCI capabilities should consider establishing processes and criteria for transfer for immediate PCI.

 PCI should be instituted within 30-60 minutes of arrival. Primary PCI* should be performed within 90 minutes of arrival, with a target of less than 60 minutes.

Out of guideline

Risk stratification

Out of guideline

Diagnosis and Treatment of Chest Pain and ACS
Third Edition/October 2006

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3
AMI Complications Algorithm

67
Patient has complications after AMI

68
Arrhythmic complication(s)?

yes

69
Treat arrhythmic complication(s)

no

70
Ischemic complication(s)?

69
Treat arrhythmic complication(s)

yes

71
Treat ischemic complication(s)

no

72
Mechanical complication(s)?

71
Treat ischemic complication(s)

yes

73
Treat mechanical complication(s)

no

74
Complications resolved?

73
Treat mechanical complication(s)

yes

75
Return to STEMI algorithm, box 52 or 54
Special Work-Up Algorithm

76 Chest pain not related to CAD, but indicative of other serious diagnosis

77 Clinical features suggest dissecting or symptomatic aneurysm?

yes

78 Diagnosis of dissection, immediate CT angiogram or echo/TEE: MRI if clinically stable and patient asymptomatic

no

A

79 Test diagnostic of Type A dissection or symptomatic aneurysm?

yes

A

no

A

80 • Arrange for immediate cardiovascular surgery consultation
• Nitroprusside + esmolol drip

81 Treatment of distal dissection
• Control BP and HR with nitroprusside + esmolol drip
• Target SBP 110-120
• Target HR 60-70 bpm (to minimize shearing forces)
• CV surgery consultation
• Admit

82 Sx, ABGs, CXR suggest pulmonary embolus?

yes

83 Refer to ICSI VTE guideline for diagnosis and evaluation of PE

no

A

84 Sx, ABGs, CXR suggest pneumothorax?

yes

85 Consider chest tube and hospitalization

no

A

86 Sx, signs suggest pericardial disease?

yes

87 Tamponade?

yes

88 Pericardiocentesis – prefer echo-directed

no

A

89 Admit CCU / monitored bed

A

Consider non-cardiac causes
See Non-Cardiac Causes algorithm

90 Echo; discharge? /
Consider treatment

A
Non-Cardiac Causes Algorithm

1. Consider non-cardiac causes

2. Symptoms, signs, CXR suggest pleural or parenchymal pulmonary disease?
   - yes → 3. Evaluate for observation or admission
   - no → 4. Symptoms and signs suggest chest wall/costochondritis?
     - yes → 5. NSAIDs/thermal application/follow-up PRN
     - no → 6. Consider gastrointestinal diagnosis?
       - yes → 7. Gastrointestinal evaluation
       - no → 8. Reconsider differential diagnosis

A = Annotation
Clinic Evaluation Algorithm

Institute for Clinical Systems Improvement

A = Annotation

For expanded discussion, refer to ICSI Cardiac Stress Test Supplement.

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Foreword

Scope and Target Population

Adults greater than age 18 years presenting with past or present symptoms of chest pain/discomfort and/or indications of acute coronary syndrome (ACS).

Clinical Highlights and Recommendations

- On initial contact with the health care system, high-risk patients need to be identified quickly and referred to an ER via the 911 system. (Annotations #1-7)

- Patients whose chest pain symptoms are suggestive of serious illness need immediate assessment in a monitored area of the ED and early therapy to include an IV, oxygen, aspirin, nitroglycerin and morphine. (Annotations #20 and 25)

- Triage and management of patients with chest pain and unstable angina must be based on a validated risk assessment system (i.e., ACC/AHA criteria). (Annotation #27)

- Patients with high-risk features need to be identified quickly and treatment instituted in a timely fashion. (Annotations #27-31)

- Patients with low-risk symptoms should be evaluated as outpatients in a timely fashion. (Annotations #27, 36, 37)

- Treadmill test results should be reported using the Duke treadmill score, based on the Bruce protocol. (Annotations #97-103, 107, 111, 115)

- Thrombolysis should be instituted within 30-60 minutes of arrival, or angiogram/primary PCI should be performed within 90 minutes of arrival with a target of less than 60 minutes. (Annotations #43, 45)

- Use of medication: Aspirin and clopidogrel (Plavix®) (or clopidogrel alone if aspirin allergic) at admission. (Avoid clopidogrel if cardiac surgery is anticipated.) Beta-blockers whenever possible and/or ACE inhibitors at 24 hours if stable, nitrates (when indicated), and statins whenever possible. Once the issue of surgery is clarified, consider the early use of clopidogrel for those in whom PCI is planned. (Annotations #25, 48 and 65)

- Recommend appropriate use of cardiac rehabilitation postdischarge. (Annotations #63 and 64)
Priority Aims

1. Increase the success of emergency intervention for patients with high-risk chest pain.
2. Minimize the delay in administering thrombolytics or angioplasty to patients with acute myocardial infarction (AMI).
3. Increase the timely initiation of treatment to reduce postinfarction mortality in patients with AMI.
4. Increase the percentage of patients with AMI who have used tobacco products within the past year, who receive tobacco use assessment and cessation counseling and treatment within 24 hours of admission (JCAHO).
5. Improve the diagnostic value of stress tests through their appropriate use in patients with chest pain symptoms.
6. Increase the percentage of patients with AMI using appropriate cardiac rehabilitation postdischarge.
7. Increase the percentage of patients with AMI whose course of treatment has followed the recommended critical pathway.
8. Increase the use of risk stratifying procedures in patients with AMI.

Related ICSI Scientific Documents

Related Guidelines

- Cardiac Stress Test Supplement
- Heart Failure in Adults
- Hypertension Diagnosis and Management
- Lipid Management in Adults
- Menopause and Hormone Therapy: Collaborative Decision-Making and Management
- Stable Coronary Artery Disease
- Tobacco Use Prevention and Cessation for Adults and Mature Adolescents

Technology Assessment Reports

- B-type Natriuretic Peptide (BNP) for the Diagnosis and Monitoring of Congestive Heart Failure (#91, 2005)
- Cardiac Rehabilitation (#12, 2002)
- Case Management for Chronic Illness, the Frail Elderly, and Acute Myocardial Infarction (#44, 1998)
- Electron-beam and Helical Computed Tomography for Coronary Artery Disease (#34, 2004)
- Intracoronary Brachytherapy to Treat Restenosis after Stent Placement (in-stent restenosis) (#63, 2002)
- Off-Pump Coronary Artery Bypass Grafting (#72, 2003)
• Transmyocardial Laser Therapy for Severe Refractory Angina (#50, 2000)
• Implantable Cardioverter-Defibrillators for the Primary Prevention of Sudden Cardiac Death Due to Ventricular Arrhythmias (#89, 2005)
• Omega-3 Fatty Acids for Coronary Artery Disease (#94, 2006)
• Carotid, Vertebral and Intracranial Artery Angioplasty and Stenting (#93, 2006)

Order Sets
• Admission for Heart Failure Order Set
• Admission to CCU for Acute Coronary Syndrome Order Set
• Discharge for Heart Failure Order Set
• ER Orders for Heart Failure Order Set

Patient and Family Guidelines
• Heart Failure in Adults for Patients and Families
• Hypertension Diagnosis and Management for Patients and Families
• Lipid Management in Adults for Patients and Families
• Menopause and Hormone Therapy: Collaborative Decision-Making and Management for Patients and Families
• Stable Coronary Artery Disease for Patients and Families
• Tobacco Use Prevention and Cessation for Adults and Mature Adolescents for Patients and Families

Evidence Grading
Individual research reports are assigned a letter indicating the class of report based on design type: A, B, C, D, M, R, X.

A full explanation of these designators is found in the Supporting Evidence section of the guideline.

Disclosure of Potential Conflict of Interest
In the interest of full disclosure, ICSI has adopted the policy of revealing relationships work group members have with companies that sell products or services that are relevant to this guideline topic. The reader should not assume that these financial interests will have an adverse impact on the content of the guideline, but they are noted here to fully inform readers. Readers of the guideline may assume that only work group members listed below have potential conflicts of interest to disclose.

R. Scott Wright, MD is a consultant for Pfizer and Merck-Scherling Plough.

No other work group members have potential conflicts of interest to disclose.

ICSI's conflict of interest policy and procedures are available for review on ICSI's Web site at http://www.icsi.org.
Algorithm Annotations

Introduction

Hospitals and clinics are strongly encouraged to consider the following when implementing systems to support best care of patients with acute coronary syndromes:

1. 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.

2. Hospitals should develop and implement ED critical pathways and consider standard orders to accomplish rapid evaluation and treatment of acute coronary syndrome. Standard discharge orders/instructions should also be considered.

3. A process should be in place for the patient and family that will rapidly orient them to the suspected diagnosis, ED and CCU process and other treatment measures to be considered. This could include both caregiver face-to-face interactions with the patient and family, as well as teaching tools in written form.

4. Institutions that cannot meet the recommended treatment times for primary PCI should consider the preferential use of intravenous thrombolytics therapy. These institutions should have a predetermined plan for treating patients who present with contraindications to thrombolytics. Such plans may employ delayed local primary PCI or transfer to another institution.

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"

   (Hutter, 2000)

   Supporting evidence is of class: R

2. Initial Evaluation by Triage Indicates Elevated Risk?

   Key Points:
   
   • The purpose of triage is to avoid delay in the identification of Acute Coronary Syndromes, not to diagnose common, non-emergent causes of chest pain.

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

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

(Buntinx, 1991; Klinkman, 1994)

Supporting evidence is of class: D

4. Brief Screening History by Medical Personnel

Key Points:

- Teach medical triage personnel to appropriately conduct the brief screening history, paying particular attention to presence of high-risk symptoms.

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 nitroglycerine

**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 AMI or acute coronary syndrome. Several serious illnesses are included in the differential diagnosis of chest pain. Assessment of these illnesses requires office or emergency department (ED) evaluation. The initial phone interview is limited to determining the timing and location of the initial office or ED 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; and
• Loss of consciousness.

(Braunwald, 2002)

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.

A suggested shingle outlining the necessary documentation for this encounter is available from ICSI. See the "Support for Implementation" section.

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

Supporting evidence is of class: R

5. **High-Risk Symptom(s) Present at Time of Call**
   Call 911.

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 ED evaluation for patients who call hours or days after transient symptoms resolve.

8. **High-Risk Symptom(s) Present Between Three Days and Last 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 ED.

10. **High-Risk Symptom(s) Present Between Two Weeks and Two Months**
    High-risk symptom(s) within two months of the initial evaluation but not within two weeks identify a group of patients at lower risk for immediate adverse outcome. These patients can be evaluated in the office within three days.

11. **Clinic Evaluation Within 72 Hours**
    Patient education directed toward use of 911 and recognition of signs and symptoms of an advancing coronary event should occur at this point.

12. **High-Risk Symptom(s) Present More Than Two Months Ago**
    Patients who have been stable without high-risk symptoms for the previous two months can be seen as a routine appointment.
13. Elective Clinic Evaluation (Within Two Weeks)
Patient education directed toward use of 911 and recognition of signs and symptoms of an advancing coronary event should occur at this point.

14. Urgency Uncertain
If the severity and/or duration of the chest pain symptoms can not be determined in the phone interview, the patient should be seen on the same day in the office or the ED.

Emergency Intervention Algorithm Annotations

19. Ambulance Transport to Emergency Department
A patient complaining of chest pain suggestive of serious etiology should be transported via ambulance with advanced cardiac life support (ACLS) capabilities whether he/she is being transported from home or outpatient clinic to the ED.

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 ED 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.

(American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures, 1990; de Fillipi, 2000)

Supporting evidence is of classes: B, R

20. Immediate Assessment with Cardiac Monitoring
On arrival in the ED, a patient complaining of chest pain should immediately receive oxygen via nasal cannula, and a 324 mg loading dose of aspirin, preferably chewed (for patient palatability, use four 81 mg baby aspirin tablets). An immediate ECG should be done and the physician called for as the patient is placed on a cardiac monitor. An IV should be started as soon as possible and cardiac markers drawn. Troponin I or T have been proven to be very sensitive and specific for myocardial injury, as well as predictive of short-term risk for myocardial infarction or death. CKMB should no longer be used as the primary marker for myocardial infarction, but can be useful in assessing the timing of the event. It may also be useful in patients with renal failure who also have an elevated troponin. Interpretation of an abnormal serum troponin (or CKMB) is dependent upon the clinical setting in which the myocardial injury occurred. Initial BNP may be of value in assessing cardiac function. A portable chest x-ray may be performed if indicated. The ED physician should also be called to the patient's bedside immediately.

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.

(American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures, 1990; de Fillipi, 2000)

Supporting evidence is of classes: B, R
21. 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 (American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures, 1990; deFillipi, 2000).

22. Initiate ACLS Protocols

The Consolidated Omnibus Budget Reconciliation Act (COBRA) of 1987, 1989 and 1990 places strict requirements and restrictions on initial assessment and transfer of patients with emergency medical conditions and women in labor (American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures, 1990; deFillipi, 2000).

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

23. Symptoms Suggest Possibility of an Acute Coronary Syndrome (ACS)?

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

1. Chest pain description (See Annotation #4, "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); and
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.

Algorithms are available for estimating the pretest probability of CAD based on chest pain description, gender and age (Diamond, 1979).

More elaborate nomograms are available that incorporate history and ECG evidence of prior myocardial infarction, as well as risk factors (Hubbard, 1992).

More recently, several groups have demonstrated the importance of clinical assessment for the estimation of severe (left main or three-vessel) coronary artery disease, as well (Pryor, 1991).

Supporting evidence is of classes: C, M

24. ECG Positive for ST-Segment Elevation?

Key Points:

- An ECG should be obtained immediately upon arrival in the ED.

The recognition of coronary artery disease and evaluation of its severity cannot be adequately carried out without an electrocardiogram. The early performance of an electrocardiogram following arrival at the emergency department is therefore critical. When patients have new or typical chest pain presumably new ST
elevation of greater than 1 mm in two or more contiguous limb leads, or equal to two mm or more in precordial leads, they should be considered to have acute myocardial infarction. Patients with new or presumably new left bundle branch block (LBBB) should be treated similarly to those with ST segment elevation. Although some patients with left bundle branch block will prove not to have acute myocardial infarction, 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 elevation, which has been subsequently been used for entry in a number of very large clinical trials (GUSTO Investigators, The, 1993).

The mortality benefit of acute 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 (ISIS-2 Collaborative Group, 1988).

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 (Rude, 1983; Wang, 2003).

Regardless of ST elevation, consider cardiology consultation early.

Supporting evidence is of classes: A, C, R

25. Early Therapy

Key Points:

- Patients whose chest pain symptoms are suggestive of serious illness need immediate assessment in a monitored area of the ER and early therapy to include an IV, O₂, aspirin, nitroglycerin and morphine (Sabatine, 2005).

- Early therapy may consist of aspirin, heparin or low molecular weight heparin, nitrates, beta-blockers and clopidogrel.

Aspirin reduces mortality, reinfarction and stroke. Although the incremental value of heparin/LMWH in conjunction with aspirin (ASA) and reperfusion therapy is controversial, it does appear to enhance patency and was included in the GUSTO protocol. In eligible patients, beta-blockers reduce mortality, reinfarction and stroke. Although long-acting nitrates (oral and intravenous) appeared to reduce mortality in trials that did not include thrombolysis, more recent studies that did include thrombolysis found no incremental benefit from nitrate therapy. Nitrate therapy is still appropriate for ischemic pain relief.

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.

(Antman, 2004; ISIS-4 Collaborative Group, 1995; Lau, 1992; Saketkhou, 1997)

All patients should receive aspirin (chewable) as soon as possible and continued indefinitely. In those patients who are unable to take aspirin, clopidogrel should be considered in hospitalized patients. If the probability of urgent CABG is low, consider early use of clopidogrel. The benefits of beta-blockers, nitroglycerin and heparin are well established. There is data to support the use of LMWH as an alternative to intravenous heparin.

In high-risk patients, early administration of subcutaneous LMWH (enoxaparin 1mg/kg subcutaneous every 12 hours) or IV UFH (70 units/kg load then 12 to 15 units/kg/hr to achieve aPTT levels of 1.5 to 2.5 times the control) with aspirin and/or clopidogrel is associated with a decrease in the incidence of AMI and ischemia.
LMWH, specifically enoxaparin, has been shown to have a moderate benefit over IV heparin in decreasing the rate of death, MI and recurrent ischemia. A meta-analysis of the two trials showed a statistically significant reduction by 20% in the rate of death and MI.

The use of LMWH should be used with caution in patients with renal insufficiency.

The recently completed SYNERGY study found increased adverse events in patients who were switched from unfractionated heparin to low-molecular weight heparin or vice versa at the time of referral to tertiary care institutions. Therefore, the suggestion is that the patient be started and maintained on one drug or the other during transfer and treatment at referring and referral institutions (SYNERGY Trial Investigators, The, 2004).

Beta-blockers should be initiated early in the absence of any contraindications. In high-risk patients, they should be given initially IV, then followed by the oral route with a goal target resting heart rate of 50-60 bpm. 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 trails in CAD 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 COPD and diabetes mellitus where definite benefit has been demonstrated. Beta-blockers are relatively contraindicated in patients with asthma and hypotension, less so with first degree AV block, heart rate less than 60/min, or decompensated CHF. They should be used cautiously, if at all, in these conditions. They should be completely avoided in STEMI due to cocaine use because of the risk of exacerbating coronary spasm, and in patients with cardiogenic shock (COMMIT, 2005).

Nitroglycerin should be given sublingually (0.4 mg every five minutes) to relieve ischemic symptoms. If symptoms are ongoing or recurrent despite the administration of IV beta-blockers, IV nitroglycerin can be initiated at 10mcg/min and titrated every three to five minutes by 10 mcg/min until symptom response is noted or blood pressure decreases to less than 110 mmHg in patients previously normotensive, or by 25% in patients who were hypertensive on presentation, or to a maximum dose of 200 mcg/min. Patients can be converted to topical or oral nitrates once stabilized (no manifestations of ischemia and pain free for 12 to 24 hours).

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

Nitroglycerin is contraindicated in patients who are hypotensive, have documented severe aortic stenosis, have hypertrophic cardiomyopathy, or who have received sildenafil, vardenafil or ordenafil within the previous 24 hours or tadalafil in the previous 48 hours (Braunwald, 2002).

GPIIb/IIIa inhibitors

Patients with high risk or patients with intermediate risks and diabetes, as defined in Annotation #27, "Risk Assessment (ACC/AHA Criteria)," benefit from receiving GP IIb-IIIa inhibitor (Tirofiban HCl, abciximab, or Eptifibatide) as part of initial treatment.

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

Contraindications to IIb-IIIa inhibitors include bleeding less than six weeks, intracranial hemorrhage (ever), recent stroke less than two years, uncontrolled hypertension greater than 200/100 mmHg, surgery less than six weeks, aortic dissection, acute pericarditis, and platelets less than 100,000 mm$^3$.

(Antman, 2004; Bhatt, 2000; Chew, 2000; GUSTO IV-ACS Investigators, The, 2001)

Supporting evidence is of classes: A, C, M, R
27. Risk Assessment (ACC/AHA Criteria)

Key Points:

- Medical groups and hospitals should implement a validated risk assessment criteria set systemwide.

Low-risk patients may be safely evaluated as outpatients. These will include some patients with slight progression of their symptoms, which may reflect non-compliance with medications, increasing activity, emotional stress or other exacerbating factors. Patients with a low likelihood of CAD on the basis of chest pain description, age, gender and risk factor assessment, and patients at intermediate likelihood who have not had at-rest symptoms that are prolonged or accompanied by shortness of breath or other worrisome features, should also be considered stable.

For patients whose angina does not seem stable, it is important to use objective risk assessment criteria for purposes of triage (CCU, monitored bed or dismissal with follow-up). This guideline endorses the criteria published by the ACC/AHA in 2002 "ACC/AHA 2002 Guideline Update for the Management of Patients with Unstable Angina and Non-ST-segment Elevation Myocardial Infarction." These consist of a simple set of clinical variables to classify patients as high-, intermediate- or low-risk of death of MI. The work group acknowledges that many other risk assessment criteria sets exist (e.g., TIMI), and recommends that medical groups and hospitals choose one that is validated and implement its use systemwide.

Complete certainty of the etiology of a patient's chest pain can commonly not be attained in the ED. It is therefore vitally important to assess risk in order to safely and yet cost effectively triage chest pain patients. Further, it is important to recognize the difference between risk assessment and likelihood assessment in that likelihood assessment merely serves to communicate just that, while risk assessments may be used as a tool for clinical management.

The value of early risk assessment has been discussed in several recent publications and its value has been validated. Two separate sets of criteria using the history, physical exam and ECG are currently in use. Goldman published a risk assessment model that uses a computerized model to separate patients at low, short-term risk from those at high risk for MI or death. The ACC/AHA guideline proposes use of easily obtainable bedside and ECG data to stratify patients into high-, intermediate- or low-risk categories.

(Antman, 2004; Braunwald, 2002; Georgiou, 2001; Morrow, 2000)

The recent ICTUS trial has demonstrated that some patients can be medically stabilized with an aggressive adjunctive regimen including enoxaparin, high dose statin, beta-blocker and clopidogrel while being risk stratified in hospital prior to undergoing early angiography. Over half of patients in ICTUS randomized to the risk stratification arm did undergo angiography during hospitalization, demonstrating the benefit from an invasive approach. The patients who underwent early, intentional angiography and PCI had slightly higher rates of procedural-related myocardial infarctions, while the group randomized to early risk stratification had slightly higher rates of late recurrent AMI. ICTUS demonstrates that early angiography can be deferred in some patients who initially stabilize with adjunctive medical therapy and may help guide clinicians' thinking about which patients to immediately transfer to a facility with a cath lab and which patients to further risk stratify. In most U.S. hospitals, it is not a cost-effective strategy to keep patients in hospital for five to seven days and do stress testing, so an early invasive route will remain the best clinical option.

Supporting evidence is of classes: B, C, R
### Likelihood That Signs and Symptoms Represent an ACS Secondary to CAD

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Likelihood (greater than 85%)&lt;br&gt;Any of the following:</th>
<th>Intermediate Likelihood (15%-85%)&lt;br&gt;Abnormal absence of high-likelihood and presence of any of the following:</th>
<th>Low Likelihood (less than 15%)&lt;br&gt;Abnormal absence of high- or intermediate-likelihood features but may have:</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Chest or left arm pain or discomfort as chief symptom reproducibly documented angina;&lt;br&gt;Known history of CAD, including MI</td>
<td>Chest or left arm pain or discomfort as chief symptom;&lt;br&gt;Over 70 years of age&lt;br&gt;Male gender&lt;br&gt;Diabetes mellitus</td>
<td>Probable ischemic symptoms in absence of any of the intermediate likelihood characteristics;&lt;br&gt;Recent cocaine use</td>
</tr>
<tr>
<td>Exam</td>
<td>Transient MR, hypotension, diaphoresis, pulmonary edema, or rales</td>
<td>Extracardiac vascular disease&lt;br&gt;Chest discomfort reproduced by palpation</td>
<td>T-wave flattening or inversion in leads with dominant R waves;&lt;br&gt;Normal ECG</td>
</tr>
<tr>
<td>ECG</td>
<td>New, or presumably new, transient ST-segment deviation (greater than or equal to 0.05 mV) or&lt;br&gt;T-wave inversion (greater than or equal to 0.2 mV) with symptoms</td>
<td>Fixed Q waves;&lt;br&gt;Abnormal ST segments or&lt;br&gt;T-waves not documented to be new</td>
<td>No high-risk feature but may have:</td>
</tr>
<tr>
<td>Cardiac markers</td>
<td>Elevated cardiac TnI, TnT or CK-MB</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>

### Short-Term Risk of Death or Nonfatal MI in Patients with UA

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Likelihood (20%)&lt;br&gt;At least 1 of the following features must be present:</th>
<th>Intermediate Likelihood (6%)&lt;br&gt;No high-risk feature but must have 1 of the following:</th>
<th>Low Likelihood (less than 1%)&lt;br&gt;No high- or intermediate-risk feature but may have any of the following features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Accelerating tempo of ischemic symptoms in preceding 48 hours</td>
<td>Prior ML, peripheral or cerebrovascular disease, or CABG, prior aspirin use</td>
<td>New-onset or progressive CCS Class III or IV angina the past 2 weeks without prolonged (greater than 20 min.) rest pain but with moderate or high likelihood of CAD</td>
</tr>
<tr>
<td>Character of pain</td>
<td>Prolonged ongoing (greater than 20 min.) rest pain</td>
<td>Prolonged (greater than 20 min.) rest angina, now resolved, with moderate or high likelihood of CAD&lt;br&gt;Rest angina (less than 20 min.) or relieved with rest or sublingual NTG</td>
<td></td>
</tr>
<tr>
<td>Clinical findings</td>
<td>Pulmonary edema, most likely due to ischemia&lt;br&gt;New or worsening MR murmur&lt;br&gt;S3 or new/worsening rales&lt;br&gt;Hypotension, bradycardia, tachycardia&lt;br&gt;Over 75 years of age</td>
<td>Age greater than 70 years</td>
<td></td>
</tr>
<tr>
<td>ECG</td>
<td>Angina at rest with transient ST-segment changes greater than 0.05 mV&lt;br&gt;Bundle branch block, new or presumed new&lt;br&gt;Sustained ventricular tachycardia</td>
<td>T-wave inversions greater than 0.2 mV&lt;br&gt;Pathological Q waves</td>
<td>Normal or unchanged ECG during an episode of chest discomfort</td>
</tr>
<tr>
<td>Cardiac markers</td>
<td>Elevated (e.g., TnT or TnI greater than 0.1 ng/mL)</td>
<td>Slightly elevated (e.g., TnT greater than 0.01 but less than 0.1 ng/mL)</td>
<td>Normal</td>
</tr>
</tbody>
</table>


www.icsi.org
28. High Risk
High-risk unstable angina patients require a high level of care with close monitoring and IV therapy, including heparin, beta-blockade and nitroglycerin. This needs to be started in the ED setting. Hospitalization usually requires an ICU setting or competent nursing in a monitored bed setting.

29. Early Therapy
See Annotation #25, "Early Therapy."

31. Perform Cath Within 24-48 Hours
An early invasive strategy is beneficial in many patients with non-STMI and ACS, especially when coupled with aggressive adjunctive therapy such as unfractionated heparin with a glycoprotein IIb/IIIa antagonist or use of a low molecular weight heparin. 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 cath lab is not available. However, in patients who become unstable or have recurrent symptoms, one should minimize the delay for angiography and percutaneous coronary revascularization.

Contraindications to IIb/IIIa inhibitors include bleeding less than six weeks, intracranial hemorrhage (ever), stroke less than two years, uncontrolled hypertension greater than 200/100 mm Hg, surgery less than six weeks, aortic dissection, acute pericarditis, platelets less than 100,000 mm$^3$ and dialysis dependent renal failure.

(ACC/AHA Pocket Guidelines, 2000; Antman, 2004; Berger, 1999; Bhatt, 2000; Chew, 2000; GUSTO IV-ACS investigators, 2001)

Supporting evidence is of classes: A, C, M, R

32. Intermediate Risk
A patient of intermediate risk unstable angina (as defined by the ACC/AHA Guideline) is by far the most common presentation to the emergency department. Approximately 50% of these patients will turn out to have an endpoint diagnosis other than ACS. It is, however, impossible 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 is between 5% and 20%, it is imperative to treat each patient according to protocol during the evaluation process. These patients should be considered as primary candidates for evaluation in a cardiac observation unit if available, or a critical pathway in a monitored bed setting (Antman, 2004; Braunwald, 2002).

33. Early Therapy
See Annotation #25, "Early Therapy."

34. Admit to CPU or Monitored Bed
If the patient's risk assessment is not clearly in a high- or low-risk category, and the institution has an ED-based chest pain observation unit, admission to this unit would be appropriate. Otherwise, management using a critical pathway for unstable angina with a similar protocol on a monitored bed unit is recommended.

A CPU/critical pathway provides monitoring capabilities, a dedicated nurse, serial cardiac markers (markers should be negative for at least six hours from the onset of symptoms) and a postobservation 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 one-three 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.

It should be emphasized that a patient who requires repeated doses of nitroglycerin and/or IV nitroglycerin or paste, or requires beta-blockade for pain control should be considered high risk (Gibbons, 1997).

Refer to Annotation #27, "Risk Assessment (ACC/AHA Criteria)," for more information on risk stratification.

Supporting evidence is of class: \( R \)


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 and admitted to a monitored bed or an ICU setting. If the serial cardiac markers, troponin T or I and CKMB 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 (i.e., VT or multifocal PVCs 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. 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. Refer to ICSI’s Cardiac Stress Test Supplement guideline. 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.

(Farkouh, 1998; Gibler, 1995; Gibler, 1992)

Supporting evidence is of classes: \( A, C \)

36. **Low Risk**

Patients with a history of brief episodes of chest pain (less than 20 minutes) but suggestive of accelerating and/or class 3 or 4 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.

37. **Discharge to Outpatient Management**

If the diagnosis is low-risk unstable angina, 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 this guideline.

38. **Non-Cardiovascular Chest Pain**

In elevating 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.
39. Chest Pain Not Related to CAD, but Indicative of Other Serious Diagnosis?

Aortic dissection, pulmonary embolus, expanding pneumothorax, pericarditis with impending tamponade or serious gastrointestinal pathology are all potentially life threatening and may closely mimic presentations of an acute coronary syndrome. Further, the presence or absence of reproductible chest wall pain does not preclude the possibility of a more serious underlying cause.

STEMI Algorithm Annotations

42. ST-Segment Elevation on ECG

About 40% of patients with AMI present with ST-segment elevation. They can be treated with thrombolytics or with emergency coronary angiography and percutaneous coronary intervention. 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 elevation (transmural) and those not causing ST elevation (nontransmural or subendocardial). "Infarctions associated with ST-segment elevations will be positively affected by early thrombolytic therapy. There is no question that patients with anterior MIs and those who present very early, less than four-six hours after onset of symptoms, benefit tremendously from any thrombolytic agent, and both in-hospital and late mortality are significantly reduced" (Hochman, 1995).

Facilities without PCI capabilities should consider establishing processes and criteria for transfer for immediate PCI.

43. Thrombolytics or PCI for Initial Therapy

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 V1 V2 (true posterior infarction), and

• Anginal chest pain between 30 minutes and 12 hours in duration that is unrelieved with sublingual nitroglycerin.

When immediately available, PTCA is equal to and may be superior to thrombolysis.

(Gibbons, 1993; Grines, 1993; GUSTO IIb Investigators, 1997; Weaver, 1997; Zijlstra, 1993).
Assessment of Reperfusion Options for Patients with STEMI

**STEP 1: Assess Time and Risk**
- Time since onset of symptoms
- Risk of STEMI
- Risk of fibrinolysis
- Time required for transport to a skilled PCI lab

**STEP 2: Determine if Fibrinolysis or an Invasive Strategy is Preferred**

*If presentation is less than 3 hours and there is no delay to an invasive strategy, there is no preference for either strategy.*

<table>
<thead>
<tr>
<th>Fibrinolysis is generally preferred if (see Section 6.3.1.6.3.1):</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Early Presentation (less than or equal to 3 hours from symptom onset and delay to invasive strategy) (see below)</td>
</tr>
<tr>
<td>* Invasive Strategy is not an option</td>
</tr>
<tr>
<td>Catheterization lab occupied/not available</td>
</tr>
<tr>
<td>Vascular access difficulties</td>
</tr>
<tr>
<td>Lack of access to a skilled PCI lab ††</td>
</tr>
<tr>
<td>* Delay to Invasive Strategy</td>
</tr>
<tr>
<td>Prolonged transport</td>
</tr>
<tr>
<td>(Door-to-Ballon) – (Door-to-Needle) is greater than 1 hour *§</td>
</tr>
<tr>
<td>Medical Contact-to-Ballon or Door-to-Ballon is greater than 90 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>An Invasive Strategy is generally preferred if (see Section 6.3.1.6.4.2):</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Skilled PCI lab available with surgical backup ††</td>
</tr>
<tr>
<td>Medical Contact-to-Ballon or Door-to-Ballon is less than 90 minutes</td>
</tr>
<tr>
<td>(Door-to-Ballon) – (Door-to-Needle) is less than 1 hour *</td>
</tr>
<tr>
<td>* High Risk from STEMI</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
</tr>
<tr>
<td>Killip class is greater than or equal to 3</td>
</tr>
<tr>
<td>* Contraindications to fibrinolysis including increased risk of bleeding and ICH</td>
</tr>
<tr>
<td>* Late Presentation</td>
</tr>
<tr>
<td>The symptom onset was greater than 3 hours ago</td>
</tr>
<tr>
<td>* Diagnosis of STEMI is in doubt</td>
</tr>
</tbody>
</table>

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Options include full dose lytic of choice (tPA, TNK, rPA), half-dose lytic (transfer arrangements with the receiving institution should be worked out in advance; this is a IIb indication per the 2004 ACC/AHA guidelines), or transfer for primary PCI.

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 acute myocardial infarction to determine the proper dose of thrombolytic to minimize the risk of ICH.

Single-bolus agents, such as tenecteplase (TNKase®), simplify administration; however, patient weight remains important in calculating dose.
### Contraindications to Lytics

<table>
<thead>
<tr>
<th>Contraindications to Thrombolytics*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absolute Contraindications</strong></td>
</tr>
<tr>
<td>- Previous hemorrhagic stroke at any time; other strokes or cerebrovascular events within one year</td>
</tr>
<tr>
<td>- Known intracranial neoplasm</td>
</tr>
<tr>
<td>- Active internal bleeding (does not include menses)</td>
</tr>
<tr>
<td>- Suspected aortic dissection</td>
</tr>
<tr>
<td><strong>Cautions/Relative Contraindications</strong></td>
</tr>
<tr>
<td>- Severe uncontrolled hypertension on presentation (greater than 180/110 mm Hg)†</td>
</tr>
<tr>
<td>- History of prior cerebrovascular accident or known intracerebral pathology not covered in above absolute contraindications</td>
</tr>
<tr>
<td>- Current use of anticoagulants in therapeutic doses (INR greater than or equal to 2.0-3.0); known bleeding diathesis</td>
</tr>
<tr>
<td>- Recent trauma (including head trauma) within two-four weeks</td>
</tr>
<tr>
<td>- Major surgery in past three-six months</td>
</tr>
<tr>
<td>- Noncompressible vascular punctures</td>
</tr>
<tr>
<td>- Recent internal bleeding</td>
</tr>
<tr>
<td>- For streptokinase/anistreplase: prior exposure (especially within five days-two years) or prior allergic reaction</td>
</tr>
<tr>
<td>- Pregnancy</td>
</tr>
<tr>
<td>- Active peptic ulcer</td>
</tr>
<tr>
<td>- History of chronic hypertension</td>
</tr>
</tbody>
</table>

*Advisory only. May not be all inclusive or definitive. Patients with relative contraindications should be evaluated on a case-by-case basis. Percutaneous coronary intervention (PCI) may provide equal or increased benefit at decreased risk.

† Severe uncontrolled hypertension on presentation is a relative contraindication. Even if hypertension is brought under control, patients subsequently treated with thrombolytics experience increased rates of ICH compared to patients who are normotensive on presentation. Arrange for primary PCI in high-risk hypertensive patients if feasible.

INR = International Normalized Ratio

NOTE: Cardiopulmonary resuscitation performed for less than 10 minutes is NOT a contraindication.


The use of a particular thrombolytic agent is very controversial and continuously being reassessed (Antman, 2004).

A. The earlier thrombolytic therapy is initiated in the course of AMI, the greater the reduction in mortality. Thrombolytics started within one hour of symptoms has been demonstrated to lead to a 47% reduction in mortality (Simoons, 1993).
B. Common causes of delay in initiation of thrombolytics include (Sharkey, 1989):
   1. Patient is not accessing the emergency medical system promptly,
   2. Failure to obtain an ECG promptly on patient's arrival in the emergency department,
   3. Delay in diagnosis after ECG has been obtained, and
   4. Delay in delivery of drug once decision is made to initiate therapy.

C. Patients who may have a mortality benefit with tPA:
   1. Patients with larger MIs such as an anterior MI or complicated inferior MI have slightly lower mortality with tPA (GUSTO Investigators, The, 1993).
   2. Patients with prior CABG usually have a thrombus in the bypass graft, a larger thrombus burden and a significantly decreased mortality when treated with tPA versus streptokinase (GUSTO Angiographic Investigators, The, 1993).

Supporting evidence is of classes: A, C, D, R

45. Emergency Coronary Angiography and Primary PCI

Key Points:

- Primary PCI has been demonstrated to be more effective than thrombolysis in opening acutely occluded arteries in settings where it can be rapidly employed by experienced interventional cardiologists.

Time to open artery is critical to effective primary PCI. Current American College of Cardiology/American Heart Association 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.

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, heparin, nitrates and beta-blockers should be administered early to these patients, unless contraindicated.

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

For centers that have demonstrated high success rates and low complications 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 salvageable patients to an institution capable of treating this condition is indicated for the presentation or development of cardiogenic shock (Berger, 1999).

Experienced, high-volume interventionalists are defined in one study as those performing more than 12 primary PCI procedures per year in institutions performing at least 56 primary PCI procedures yearly (ACC/AHA Pocket Guidelines, 2000).
Rescue angioplasty involves the use of PCI to restore coronary flow after thrombolysis has failed. 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. 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.

Facilitated PCI is the use of additional agents to pretreat the patient awaiting primary PCI. No strategy employing full- or reduced-dose thrombolytic (with or without a glycoprotein IIb/IIIa receptor inhibitor) has been approved for facilitated PCI. GPIIb/IIIa inhibitors should be considered in patients with symptoms refractory (persistent chest pain or ECG changes consistent with ischemia) to standard therapy. Otherwise these agents may be given at the time of angiography. Based on REPLACE-2 study, a reasonable alternative to heparin is to use bivalirudin for patients who will be undergoing percutaneous coronary interventions.

Current ACC 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.

(GUSTO IIb Investigators, 1997)

Supporting evidence is of classes: C, R

48. CCU Admission

Patients who present with acute ST-segment elevation, hemodynamic instability, or both should be admitted to the CCU. Early use of adjunctive medications can be reconsidered. Once the issue of surgery is clarified, consider the early use of clopidogrel (Plavix®) for those in whom PCI is planned. (See Emergency Interventions Algorithm Annotations #20-#31.) A CCU admission order set template has been developed by the ICSI Acute Coronary Syndrome work group and is available from ICSI – see the "Support for Implementation" section.

49. CCU Care: Chronic Adjunctive Medications/Phase I Cardiac Rehabilitation

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

Use of the following medications should be considered:

- ASA/aspirin must be continued as the clinical situation warrants. ASA/aspirin has been shown to reduce reinfarction and mortality long-term and should be continued whenever possible. Use of NSAIDs and COX-2 inhibitors may reduce the cardioprotective benefits of aspirin (U.S. Food and Drug Administration, 2006).

- Clopidogrel. ASA/aspirin (dose should be 81 mg when given with clopidogrel) with clopidogrel in intermediate- and high-risk ACS patients is beneficial. Anyone with an allergy to aspirin or NSAIDs should receive a bolus dose of clopidogrel (300 mg) with maintenance dosing indefinitely. For patients who present with unstable angina or non-ST elevation MI who are not at high risk for bleeding, clopidogrel should be continued for 9-12 months. For patients undergoing a non coated stent, clopidogrel should be continued for at least one month. For patients who receive a sirolimus eluting stent, clopidogrel should be continued for at least three months, and at least six months for a paclitaxel eluting stent. For patients who have undergone brachytherapy, clopidogrel should be continued for 12 months. ASA/aspirin plus clopidogrel or clopidogrel alone can also be used with patients who have stents. If clopidogrel is given and coronary artery bypass surgery planned, clopidogrel should be held for five days prior to surgery due to increased risk of perioperative bleeding.
• **Beta-Blockers***. Beta-blockers reduce mortality, readmission and reinfarction for both CAD and congestive heart failure. They should be instituted and/or continued whenever possible. Intravenous esmolol should be considered if a clinician is concerned about potential adverse effects of beta-blockers. Patients who prove intolerant of a beta-blocker after a large infarction should be reconsidered for beta-blocker therapy after discharge (Hjalmarson, 2000).

• **ACE inhibitors***. ACE inhibitors are indicated (ARBs if ACEI 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 LV dysfunction, to reduce adverse ventricular remodeling that may result in further reduction in EF, and for potential reduction of future MI and stroke. Consider hydralazine/isosorbide dinitrate if intolerant to ACEIs or ARBs or either drug is contraindicated.

- The SOLVD trial and ISIS-4 have confirmed a mortality reduction for patients with LV dysfunction treated as early as three days postinfarction (ISIS-4, 1995; SOLVD Investigators, The, 1991).

- Randomized studies have shown short-term and long-term outcomes were significantly improved in anterior MI patients who were treated with ACE inhibitors (ISIS-4, 1995; SOLVD Investigators, The, 1991).

- Low dose ACE inhibitor use in hemodynamically stable patients has been shown to reduce mortality (Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico, 1994).

* Shown in large clinical trials to reduce infarction mortality in all MIs.

** Shown in large clinical trials to reduce infarction mortality in non-STEMIs.

**Supporting evidence is of class: A**

• **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 LV 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 congestive heart failure.

• **Low-molecular-weight heparin** has been shown to be superior to unfractionated heparin in patients without ST-segment elevation and can preferentially be used in subcutaneous dosing (e.g., enoxaparin sodium (Lovenox®), 1 mg/kg every 12 hours). Heparin may be continued for two-four days or maintained until conversion to warfarin is completed. If unfractionated heparin is used, the dose should be regulated to maintain an activated partial thromboplastin time of 50-75 seconds.

• **Warfarin** therapy may be initiated in certain clinical situations (e.g., postinfarction congestive heart failure or anterior MI with high risk of LV thrombus) as soon as clinical stability is achieved and invasive diagnostic studies are completed. The usual target international normalized ratio is 2.0-3.0.

• **Oral antiarrhythmics** are not recommended, especially when LV function is reduced. Flecainide acetate (Tambocor®) and sotalol hydrochloride (Betapace®) 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 (Cordarone®) in post-MI patients with nonsustained ventricular ectopy has not been shown to reduce mortality.
- CAST demonstrated significantly reduced survival when encainide and flecainide were used to treat PVCs and nonsustained ventricular tachycardia post-MI with reduced LV function (Akiyama, 1991; Amiodarone Trials Meta-Analysis Investigators, 1997).

Supporting evidence is of classes: A, M

- **Statins.** The large majority of patients who have an AMI have high serum lipid levels. Lipid treatment, including administration of statins, should be addressed as soon as possible. A patient's lipid status should be determined within the first 24 hours. If the LDL level is greater than 70 mg/dL, the patient should be started on a statin within the first 24 hours of the onset of MI (Schwartz, 2001).

- **Tobacco cessation** should be addressed as soon as possible for patients who smoke or use tobacco products. Appropriate treatment may include administration of bupropion and/or a nicotine patch in the hospital.

- **Glycemic control.** Tight control of blood glucose in patients with diabetes is recommended.

Medication tables and dosing protocols are attached in Appendix B, "AMI Acute Medications and Adjunctive Therapy."

**Phase 1 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 1 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, and
- Dietary instruction, including a heart healthy diet.
- Manageable exercise regimen should be explained.

**50. Complications?**

Arrhythmic complications include sinus bradycardia, Möbitz I block (Wennekebach), Möbitz II block, complete heart block or asystole, premature ventricular contractions (PVCs), 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, LV dysfunction, and aneurysm formation (Latini, 2000; Menon, 2000).

Supporting evidence is of classes: C, M

**52. Transfer to Post-CCU Care**

Patients should be transferred from the CCU 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 12-24 hours after MI). Discontinuation of cardiac monitoring should be considered for patients who attain electrical stability (usually within three days of infarction).
54. Risk Stratification

Assessment of ejection fraction is important in predicting prognosis. Most patients should undergo echocardiography or other assessment of LV ejection fraction. A treadmill test is useful for assessing functional reserve but is not useful for predicting recurrence of AMI. If ST-segment depression or angina is present early in treatment, angiography should be considered. If the patient is unable to exercise, pharmacologic stress testing should be considered, and if the ECG is uninterpretable, stress imaging (nuclear or echocardiographic) should be considered.

Patients with no high-risk indications following thrombolytics therapy may be stratified noninvasively into low, medium and high risk.

Some clinicians may elect to measure multiple cardiac biomarkers in patients with myocardial infarction. This may especially be helpful in those in whom risk stratification is not available by other clinical evidence. The work by Sabatine, Morrow, et al. demonstrated the utility of cardiac troponins, c-reactive protein and B type natriuretic peptide measurements (BNP). 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 stepwise increase in risk going from one abnormality to two abnormalities to elevations of all three biomarkers. For patients with obvious clinical heart failure there is little utility in measuring BNP during hospitalization for AMI. At present, there is no clear consensus about what to do with an elevated BNP value during hospitalization for AMI. Some have suggested there is limited utility in measuring BNP in patients if one is planning an intentional invasive strategy, as well. Some have suggested that a lack of BNP elevation may identify patients hospitalized for AMI who are eligible for early discharge strategies. Further studies are warranted to fully understand how to apply BNP values in these populations. The most prudent strategy may be not to measure BNP in the great majority of patients until further data are available (Sabatine, 2002).

(American College of Cardiology/American Heart Association Task Force on Practice Guidelines, 1996; Deedwania, 1997; Peterson, 1997; Reeder, 1995)

Supporting evidence is of class: R

55. Patient at Increased Risk and Needs Intervention?

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 CAD, limited exercise tolerance, or rales/crackles in more than one-third of lung fields.

The following factors increase long-term risk:

- 70 years of age or older
- 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 METs had less than a 2% subsequent incidence of death or myocardial infarction within one year, compared with 18% for those in the high-risk group (Madsen, 1985).

Supporting evidence is of class: B

56. Cardiac Catheterization

Angiography should be performed for patients at increased risk as defined in Emergency Intervention Algorithm Annotation #27, "Risk Assessment (ACC/AHA Criteria)."

Recent trials (collectively FRISC II and TACTICS-TIMI 18) suggest an early aggressive/invasive approach (early diagnostic coronary angiography and appropriate PCI or CABG) within 48 hours of presentation, in non-ST ACS (with ST-segment deviation, elevated cardiac markers or TIMI Risk Score greater than 3), significantly reduces the risk of major cardiac events. A TIMI Risk Score Calculator can be downloaded at www.timi.tv/riskscore/risk_home.htm. However, the majority of non-STEMI patients should undergo coronary angiography (Lincoff, 2004).


57. Revascularization Candidate?

CABG should be considered for patients with left main, three-vessel or two-vessel disease with left anterior descending coronary artery involvement and demonstration of ischemia or in 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.

PCI should be considered 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.

60. Continue Adjunctive Medications

See STEMI Algorithm Annotation #49, "CCU Care: Chronic Adjunctive Medications/Phase I Cardiac Rehabilitation."

61. Secondary Prevention and Risk Factor Modification

Modification of risk factors (e.g., high lipid levels, hypertension, smoking) significantly reduces subsequent cardiovascular mortality. Risk factor counseling must be documented in the medical record in a consistent manner. A "care plan" or "critical pathway" approach with flow sheets may be used. Ongoing patient monitoring and feedback are important. Adjunctive therapy (ASA or clopidogrel if ASA allergic, beta-blockers, warfarin for large anterior infarctions, ACE inhibitors and statins) should be continued.

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 (Sacks, 1996; Scandinavian Simvastatin Survival Study Group, 1994).
The Cooperative Cardiovascular Project (CCP) 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 CCP steering committee (Ellerbeck, 1995).

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.

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 (Leon, 1990; Oldridge, 1988).

Supporting evidence is of classes: A, D, M, R

62. 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, and
- Targeting a return-to-work date. Patients with sedentary jobs often return to work in two-three weeks. More physically demanding jobs often can be resumed in four-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 MIs 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 (Grines, 1998).

Information on discharge medication is attached in Appendix C, "Medications to Consider on Discharge."

Supporting evidence is of class: A

63. ECG-Monitored Exercise Needed?
Most patients do not require an ECG-monitored, hospital-based (phase 2; outpatient) exercise program, but those with any of the following characteristics may be at increased risk for infarction or sudden death with unmonitored exercise and should be considered for a phase 2 program, usually lasting one-four weeks: very
low functional capacity (less than 4 METs), severely depressed ventricular function (ejection fraction less than or equal to 35%), complex resting ventricular arrhythmias, exercise-induced hypotension, exertional angina or significant silent ischemia, or inability to initiate a self-directed exercise program.

For certain patients, referral to a phase 2 program may facilitate earlier hospital discharge by providing emotional support in the outpatient hospital setting. The decision to refer a patient to a phase 2 program should be made on a case-by-case basis. The patient's current exercise capacity and the demands of expected occupational and recreational activities should be considered.

Most patients with uncomplicated MIs achieve a return to their prehospital levels of activity without a formal monitored exercise program. Home exercise training programs have been shown to be beneficial in certain low-risk patient groups (DeBusk, 1994; Institute for Clinical Systems Improvement, 1994).

Certain patients felt to be at higher risk of complications postdischarge are more likely to require monitoring during exercise in the immediate postdischarge period (Institute for Clinical Systems Improvement, 1994; Oldridge, 1988).

Supporting evidence is of classes: A, M, R

64. Phase 2 Cardiac Rehabilitation – Outpatient

Patients at increased risk for adverse events during exercise should be considered for phase 2 cardiac rehabilitation. The length of time spent in phase 2 should be dependent on improvement in functional capacity (Gulanick, 1991; Institute for Clinical Systems Improvement, 1994). Phase 2 (outpatient monitored) programs, if indicated, consist of medically supervised exercise with continuous ECG monitoring attended by trained personnel who have emergency equipment. Most phase 2 programs are hospital-based. Health education and risk factor modifications need to be included in these programs.

More patients should be enrolled in a phase 2, monitored exercise program. In the past, the main emphasis was exercise-based, but today the focus also 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 (Ades, 2001).

Cardiac rehabilitation programs have been shown to decrease mortality but have no effect on nonfatal recurrent myocardial infarctions (O'Connor, 1989, Oldridge, 1988). Unless there is a long-term effort of encouragement, most patients will revert back to previous sedentary activities (Holmback, 1994).

This initial outpatient phase includes comprehensive evaluation, education and treatment for outpatients who have experienced a cardiac-related event. Phase 2 patients are monitored with continuous EKG, blood pressure, heart rate and subjective RPE ratings.

Goals of Phase 2 Rehab:

- Assist with appropriate risk factor modification
  - Smoking cessation
  - Lipid management and low fat diet
  - Stress management and relaxation techniques
  - Weight loss and BMI measurement
  - Safe exercise guidelines
- Blood pressure control
- Diabetes education and glucose monitoring

- Increase exercise tolerance and endurance to enable patient to perform activities of daily living, and return to, or above 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 consists of:

- **Intensity of exercise:** In general, moderate intensity (to 40%-60% of functional capacity) is advisable during the first weeks of conditioning with a goal to reach 40%-85%, or that of the functional capacity of the population at large (Institute for Clinical Systems Improvement, 1994).

- **Monitoring rate of perceived exertion** (RPE) 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 (Squires, 1990).

- **Monitoring METs:** Monitoring is determined by the patient's post-MI exercise tolerance test and/or in rehab and is highly individual. The table in Appendix D can be used to compare the demands of certain activities to the patient's known capacity. However, its usefulness lies primarily in vocational counseling (Institute for Clinical Systems Improvement, 1994).

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
The number of sessions in the program and the exercise prescription is evaluated based on risk stratification and each patient's individual needs. The goals of the patient, his/her physical condition, as well as physician input determine the duration of the program.

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

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

**Mode** - The emphasis is aerobic exercise – continuous activity for 30-40 minutes, using large muscle groups. Options include treadmill, stationary bike, recumbent bike, airdyne bike, Nustep, elliptical machine, upper body ergometer, hallwalking and chair aerobics. Pure isometric exercise should be minimized because it may result in LC decompensation in patients with poor LV function.

**Frequency** - Two-three times per week supervised in rehab and additional home exercise program of three-four times per week.

**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 2-3 METs, i.e., two-three mph, 0% grade on treadmill, or 25-50 watts on bicycle. In patients with an angina threshold of two-three METs, exercise training may not be appropriate.

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

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

A METs table is attached in Appendix D, "METs Table."

*Supporting evidence is of classes:  A, R*

## 65. Phase 3 Cardiac Rehabilitation

Phase 3 is a maintenance program based on the continuation of a heart healthy lifestyle. The program is designed for patients who have completed a Phase 2 cardiac rehabilitation program or for individuals with a cardiac history or significant cardiac risk factors. Patients are not continually monitored by EKG, but spot check EKGS and daily blood pressures and heart rates are recorded. Trained staff 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 3.

*Supporting evidence is of classes:  A, M, R*
66. Short-Term Follow-Up: Chronic Adjunctive Medications/Outpatient Management

Chronic Adjunctive Medications

Use of enteric-coated ASA/aspirin or ASA/aspirin plus clopidogrel should be continued. Use of beta-blockers 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 (INR 2-3), usually for three months to reduce risk of systemic emboli. ACE inhibitors provide long-term cardiac protection for patients (with or without symptoms) with left ventricular EF of less than 40%.

Most patients should be receiving a statin or alternative lipid-lowering medication at discharge from the hospital. Lipid-lowering therapy should be considered for patients who have undergone PCI or CABG and patients whose low-density lipoprotein cholesterol level is 100 mg/dL or greater. Calcium channel blockers should be considered only for patients with NSTEMI who cannot take beta-blockers, and patients without CHF or decreased LV ejection fraction. Oral nitrates should be considered for patients with ongoing ischemia (Nichols-English, 2000).

Clinicians should be measuring LDL cholesterol and C-reactive protein levels in patients following myocardial infarction. Recent evidence has revealed that use of statin therapy following hospitalization for AMI reduces long-term risks. A substudy from the PROVE-IT trial has demonstrated that the achievement of an LDL less than 70 and CRP less than 2 mg/l around 30 days following hospitalization was associated with the lowest risk of recurrent clinical events by two years of follow-up. The achievement of these goals was more important than the selection of an individual statin agent. This evidence supports the measurement of LDL cholesterol and C-reactive protein levels about one month following hospital discharge and the aggressive use of statin therapy to achieve an LDL less than 70 mg/dl and a CRP of less than 2 mg/l by that time frame. Some patients may achieve these values through moderate statin doses, most will require higher doses of potent statins, and some patients will require combination therapy with a statin plus ezetemibe. Of interest, achievement of either goal alone (LDL less than 70 or CRP less than two) but not both was associated with significantly higher recurrence risks (Ridker, 2005).

Follow-Up Visits

Usually, patients should return for a follow-up visit with their cardiologist or primary care physician within two-three weeks so the physician can monitor progress, answer questions and consider further risk stratification (i.e., stress testing). Risk factor modification should be continued.

Phase 4 Cardiac Rehabilitation

Phase 4 cardiac rehabilitation begins after the desired functional capacity has been attained (usually greater than or equal to 8 METs) and/or VO₂ max has reached a plateau. Maintenance is the principal goal. The exercise prescription should continue as at the end of phase 3 unless angina or exercise intolerance develops, either of which requires cessation of exercise and urgent medical attention. Refer to "METs Table" in Appendix D and "Nomogram of the Prognostic Relations Embodied in the Treadmill Score" in Appendix E for guidance in setting exercise goals.

AMI Complications Algorithm Annotations

68. Arrhythmic Complication(s)?

Arrhythmic complications including sinus bradycardia, Möbitz I (Wenckebach), PVCs, accelerated idioventricular rhythm, and supraventricular arrhythmias (transient atrial flutter, atrial fibrillation, supraventricular).
tachycardia and hemodynamic stability) are generally benign and may require symptomatic therapy. Transient Mobitz II block with MI may be treated symptomatically. Permanent pacing is indicated for persistent and symptomatic second- and third-degree AV block (Col, 1972).

6 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 (VT), either spontaneous or induced by an EP 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 VT, such as long QT syndrome or hypertrophic cardiomyopathy.
4. Coronary artery disease with documented prior MI, EF less than 35%, an inducible sustained VT or VF at EP study.
5. Documented prior MI, EF less than or equal to 30%, QRS duration of greater than 120 msec (patient must not have 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, heart failure and left ventricular EF less than or equal to 35% for longer than nine months.

69. Treat Arrhythmic Complication(s)

Key Points:

- ACLS guidelines provide in-depth descriptions of short-term treatment.

A. Atrioventricular/Bundle Branch Blocks:

AV blocks are more common in acute inferior infarction and occur usually within 72 hours after the onset of infarction. Bundle branch blocks are more common in anterior infarctions and occur below the AV node. Blocks occurring with anterior infarctions have a poor prognosis and high mortality rate because of the extensive amount of myocardial necrosis present and the higher incidence of mechanical complications (Hindman, 1978; Nicod, 1988).

B. Ventricular Arrhythmias:

Premature ventricular contractions are detected in more than 75% of patients.

Ventricular tachycardia occurs in about 20% of patients with AMI and is more often seen in patients with transmural infarction and in those with a large infarction that causes severe left ventricular dysfunction (Campbell, 1981).

C. Accelerated Idioventricular Rhythm:

This rhythm is seen in 12%-25% of patients with AMI, usually by the second or third day after onset. It is seen with equal frequency in inferior and anterior MIs. It should not be treated and usually has no adverse prognosis (Eldar, 1992).

D. Supraventricular Arrhythmias:

Atrial fibrillation occurs rarely. These arrhythmias occur most commonly within 24 hours after infarction and are associated with increased morbidity and mortality, particularly in patients with anterior infarctions (Behar, 1992).

Supporting evidence is of classes: B, C
70. Ischemic Complication(s)?

Ischemic complications include postinfarction angina.

71. 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 LV 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.

72. Mechanical Complication(s)?

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, LV dysfunction and aneurysm formation.

73. 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, insertion of an intraaortic balloon pump (IABP). Because of the high mortality rate with this complication, urgent surgical repair is indicated.

- Some papillary muscle dysfunction occurs in more than half of AMIs. Papillary muscle rupture is a rare but catastrophic complication. It is seen three to five times more often in inferior infarctions than anterior and results in severe mitral regurgitation (Kishon, 1992).

- The mortality rate without surgical intervention is less than 50% within 24 hours and 94% within 8 weeks. The mortality rate in mitral valve surgery done early after infarction is 38% (Subramaniam, 1994).

Ventricular septal rupture (VSR) occurs within one week of infarction and results in left-to-right shunting and subsequent hemodynamic deterioration. VSR 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 (RV) PO₂ 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 IABP, or all of these. Because of the high mortality rate, urgent surgical repair is indicated.

- Ventricular septal rupture occurs within one week of infarction in 1%-3% of patients with almost equal frequency in anterior and inferior infarctions (Radford, 1981).

- The mortality rate without surgical intervention is 24% within 24 hours, 50% within a week and 90% within 2 months. Although surgical mortality rates are also high, it should be considered in all patients as the mortality with medical therapy alone is even higher (Menon, 2000).

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
Institute for Clinical Systems Improvement

five-seven days of MI. LV free-wall rupture leads to hemopericardium and subsequent death from tamponade. Contained rupture may result in formation of a pseudoaneurysm. Surgical resection is recommended.

- Free-wall rupture accounts for about 10% of fatal infarctions.
- Free-wall rupture occurs more frequently in transmural rather than subendocardial infarctions and is 8-10 times more common than papillary muscle or septal rupture.
- Women are four times more often at risk than men for myocardial rupture.
- Pseudoaneurysm occurs in one-third of all cases and surgical resection of myocardial rupture is recommended.

(Oliva, 1993; Pohjola-Sintonen, 1989; Subramaniam, 1994)

Right ventricular (RV) 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 V₄R through V₆R 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 AV synchrony should be considered. Agents that reduce RV 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 RV dysfunction post-MI (Cintron, 1981; Lavie, 1990).

- About one-third of patients with inferior infarctions have some impairment of the right ventricle.
- The prognosis of patients with RV infarction depends primarily on the presence of shock and hypotension, as well as systolic function of the LV. The prognosis for patients with corrected hemodynamic compromise is excellent.

Post-MI pericarditis can be early (occurring within 72-96 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 (Widimsky, 1995).

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%-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 (Widimsky, 1995).

Risk of developing LV dysfunction and subsequent HF is greatly increased in patients with more extensive MI. Restricted diastolic filling patterns on echocardiography may predict subsequent clinical HF:

- Pulmonary congestion in the early phases of AMI is a serious finding that requires prompt evaluation.
- Treatment of HF in the setting of AMI may include vasodilators, diuretics and in certain situations, beta-blockers and/or positive inotropic agents. Long-term management of patients with varying
degrees of LV dysfunction should include ACE inhibitors. ACE inhibitors have been shown to alter the process of ventricular enlargement and, subsequently, decrease the incidence and severity of heart failure in patients with LV dysfunction and improve survival.

(Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico, 1994; SOLVD Investigators, The, 1991)

Supporting evidence is of classes: A, B, C, D, R

Special Work-Up Algorithm Annotations

77. Clinical Features Suggest Dissecting or Symptomatic Aneurysm?

- 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
- CXR – abnormalities around aortic knob, increased diameter of ascending aorta
- Blood pressure discrepancy between right and left arm

78. Diagnosis of Dissection, Immediate CT Angiogram or Echo/TEE; MRI if Clinically Stable and Patient Asymptomatic

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

A careful comparison of magnetic resonance imaging and transesophageal echocardiography has been published elsewhere (Cigarroa, 1993; Nienaber, 1993).

Supporting evidence is of classes: C, R

79. Test Diagnostic of Type A Dissection or Symptomatic Aneurysm?

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

80. Arrange for Immediate Cardiovascular Surgery Consultation/ Nitroprusside + Esmolol Drip

- Surgical intervention for symptomatic thoracic aneurysms and proximal (type A; ascending aorta) dissections (DeSanctis, 1987)
- Control BP with nitroprusside or esmolol drip

Supporting evidence is of class: R
81. Treatment of Distal Dissection

- Distal (type B; distal to left subclavian artery) aortic dissections generally appropriate for pharmalogical therapy
  - Nitroprusside or esmolol drip to control BP and heart rate (eliminate pain and stabilize dissection)
  - Consider surgery if therapy not effective

82. Symptoms, ABGs (Arterial Blood Gases), CXR (Chest X-Ray)
Suggest Pulmonary Embolus?

- Symptoms may include dyspnea, tachnypnea, pleuritic chest pain
- Physical findings extremely variable, may include fever, wheezing
- ECG – nonspecific ST-T changes
- CXR – normal, pleural effusion, wedge-shaped infiltrate
- ABG – abnormal A-a gradient

84. Symptoms, ABGs, CXR Suggest Pneumothorax?

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

85. Consider Chest Tube and Hospitalization

- Pneumothorax greater than 10%-20% usually require chest tube
  - Primary pneumothorax – occurs in otherwise healthy people (idiopathic most frequently in tall young males, catamenial associated with endometriosis and menses) (May, 1992; Schwartz, 1992)
  - Secondary pneumothorax – COPD, asthma, pneumonia, cystic fibrosis (May, 1992; Schwartz, 1992)
- 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

86. 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)
87. Tamponade?

- Chest pressure and shortness of breath
- Exam – elevated jugular venous pressure, hypotension, tachypnea, narrow pulse pressure, pulsus paradoxus greater than 20 mmHg
- ECG may reveal electrical alternans
- CXR – normal or enlarged cardiac silhouette
- Echocardiogram diagnostic test of choice
- Pericardial space typically contains 50cc of fluid, with chronic accumulation may contain up to 2,000cc
- With acute, rapid accumulation, overt tamponade may develop with as little as 150cc (Schwartz, 1992)

88. Pericardiocentesis – Prefer Echo-Directed

- Echo-directed apical pericardiocentesis procedure of choice
- Subxyphoid approach if echo not available and patient unstable

(Callahan, 1983; Callahan, 1985; Kopecky, 1986)

89. Admit CCU/Monitored Bed

The patient should be observed in a CCU/monitored bed setting (Schwartz, 1992).

90. Echo; Discharge?/Consider Treatment

- Pericarditis without tamponade – obtain echocardiogram
- NSAIDs or ASA and close follow-up for viral or idiopathic

Non-Cardiac Causes Algorithm Annotations

92. Symptoms, Signs, CXR 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 chronic obstructive pulmonary disease (COPD), asthma, infectious processes, and malignancies. Specific management of these diagnoses is beyond the scope of this guideline.
93. 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 immuno-competency and reliability. If a patient is labile or unstable, or at risk of becoming unstable, admit the patient (Schwartz, 1992).

94. Symptoms and Signs Suggest Chest Wall/Costochondritis?

Costochondritis and intercostal strain frequently presents with chest pain. Typically, the patient is able to localize the discomfort to a fairly limited area. Physical examination should reveal reproducible pain at the site of the discomfort.

95. NSAIDs/Thermal Application/Follow-Up PRN

Once the clinician has determined that the chest discomfort is indeed limited to the chest wall, treatment with nonsteroidal anti-inflammatory medication should be started and the patient should be advised on local application. Follow-up may be arranged as needed. For expanded discussion, refer to the ICSI Assessment and Management of Acute Pain guideline (Isselbacher, 1995; Schwartz, 1992).

Supporting evidence is of classes: C, R

96. Consider Gastrointestinal Diagnosis?

GI 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 GI diagnosis should be considered.

97. Gastrointestinal Evaluation

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

98. 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. For anxiety diagnoses, refer to the ICSI Major Depression in Adults in Primary Care guideline.

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

Atypical chest pain associated with mitral valve prolapse is a poorly understood symptom (Schwartz, 1992).
Clinic Evaluation Algorithm Annotations

100. Initial Focused Assessment for High-Risk History, Physical Exam and Other Findings

History should include characterization of pain, exacerbating or relieving factors, associated symptoms and risk factors for coronary disease. Physical exam should include careful cardiovascular and pulmonary exam, peripheral vascular exam, and evaluation for hypertension and hypercholesterolemia. Lab studies may include resting ECG, chest x-ray, hemoglobin, and others if clinically indicated (Pryor, 1983).

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 exam 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

Supporting evidence is of class: C

102. Initiate Emergency Interventions and Transfer to ED 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, IV started, oxygen administered and immediate ECG taken. Institution of stabilizing therapy (including NTG and chewable aspirin for suspect anginal pain) prior to the completion of the history or physical is appropriate and often necessary at this level.

(American Heart Association, 1992; Braunwald, 2002)

103. CAD 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 under the ICSI Stable Coronary Artery Disease guideline.

104. Refer to ICSI Stable CAD Guideline
Typical angina pectoris, if stable for 60 days and without evidence of recent myocardial infarction, may be treated under the ICSI Stable Coronary Artery Disease guideline.

105. 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.

106. Choose Stress Test/Cardiology Referral Optional
Choose the best type of cardiac stress test based on:
- The resting cardiogram,
- The patient's ability to walk, and
- Local expertise.

107. 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 (Braunwald, 1992).

109. Resting ECG Interpretable?
Marked resting ECG abnormalities such as LBBB, LVH with repolarization abnormality, ventricular pre-excitation, or ventricular paced rhythm render the exercise ECG uninterpretable for ischemic changes. Patients on digoxin and those 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. A stable abnormality with exercise is reassuring (American College of Cardiology/American Heart Association Task Force on Assessment of Cardiovascular Procedures, 1986; Goldman, 1982; Weiner, 1979).

Supporting evidence is of classes: C, R
110. Do Exercise Imaging Study
When the resting ECG is markedly abnormal, use an exercise imaging test (stress echo, stress radionuclear perfusion, stress radionuclear ventriculogram) (Braunwald, 1992).

111. Do Regular 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 (Fletcher, 1990; Gibbons, 1997).

112. 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 CAD. Of these two types of information, the first, establishing the patient's prognosis, is the more reliable.

Treadmill findings that signify a poor prognosis are:

- Poor exercise tolerance,
- Hypotension, and
- 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 that stratifies high-, intermediate-, and low-risk patients. Refer to the ICSI Cardiac Stress Test Supplement for scoring methods and application.

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.

Refer to Appendix E, "Nomogram of the Prognostic Relations Embodied in the Treadmill Score."

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 the best well-validated measurement for the prognostic interpretation of treadmill tests. A nomogram is included in Appendix E, "Nomogram of the Prognostic Relations Embodied in the Treadmill Score."

(Braunwald, 1992; Chaitman, 1986; Dubach, 1988; Farkouh, 1998; Mark, 1987; Mark, 1991)

Supporting evidence is of classes: A, B, C, R

113. Is Patient a Candidate for Revascularization?
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 (European Coronary Surgery Study Group, 1982; Weiner, 1986).

Supporting evidence is of classes: A, C
116. 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 1.0 mm ST depression at 10 minutes has a good prognosis even though he has coronary disease.

117. Is Diagnostic Certainty Adequate?
A positive test may confirm the clinical diagnosis of coronary disease and allow treatment as outlined under the ICSI Stable Coronary Artery Disease guideline (Cohn, 1979; Kotler, 1990).
Refer to cardiology if diagnostic certainty is critical.

Supporting evidence is of classes: C, M

120. 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 (Cohn, 1979; Kotler, 1990).

Supporting evidence is of classes: C, M

121. Is Diagnostic Certainty Adequate?
Knowing that the patient is not at high risk may suggest empiric treatment or non-cardiac evaluation. Refer to cardiology if diagnostic certainty is important (Diamond, 1979; Cohn, 1979; Giroud, 1992; Kotler, 1990; Patterson, 1989).

Supporting evidence is of classes: C, M

124. 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 (Diamond, 1979).

| Percent Prevalance of Angiographic Coronary Disease |
|-----------------|-----------------|-----------------|
| Age             | Nonanginal Chest Pain | Atypical Angina | Typical Angina |
|                 | Men | Women | Men | Women | Men | Women | Men | Women |
| 30-39           | 5.2 ± 0.8 | 0.8 ± 0.3 | 21.8 ± 2.4 | 4.2 ± 1.3 | 67.9 ± 3.2 | 25.8 ± 6.6 |
| 40-49           | 14.1 ± 1.3 | 2.8 ± 0.7 | 46.1 ± 1.8 | 13.3 ± 2.9 | 87.3 ± 1.0 | 55.2 ± 6.5 |
| 50-59           | 21.5 ± 1.7 | 8.4 ± 1.2 | 58.9 ± 1.5 | 32.4 ± 3.0 | 92.0 ± 0.6 | 79.4 ± 2.4 |
| 60-69           | 28.1 ± 1.9 | 18.6 ± 1.9 | 67.1 ± 1.3 | 54.4 ± 2.4 | 94.3 ± 0.4 | 90.6 ± 1.0 |

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 EKG 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." Refer to the table published in Diamond and Forrester, which describes the relationship between symptoms, demographics, ST findings and angiographic coronary disease.

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 nonobstructive plaque may become active, provoke 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.

*(Cohn, 1979; Giroud, 1992; Kotler, 1990; Patterson, 1989)*
## Appendix A – Unstable Angina Treatment

<table>
<thead>
<tr>
<th>Drug</th>
<th>UA Type</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>All UA</td>
<td>160-325 mg/day – change dose to 81 mg if also on clopidogrel.</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>High risk</td>
<td>300-600 mg by mouth load immediate; 75 mg by mouth once daily.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Start after CABG ruled out.</td>
</tr>
<tr>
<td>Heparin</td>
<td>High/int risk UA</td>
<td>Low Molecular Weight Heparin (do not use if CrCL less than 30 mL/min): Enoxaparin 1 mg/kg subcutaneous every 12 hrs or Dalteparin 120 IU/kg subcutaneous every 12 h (max 10,000 IU twice daily) or Unfractionated Heparin: Bolus 60-70 U/kg (max 5000 U) IV followed by infusion of 12-15 U kg⁻¹ h⁻¹ (max 1000 U/h) titrated to aPTT 1.5-2.5 times control</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>Ongoing pain</td>
<td>Sublingual Tablets: 0.4 mg every 5 minutes times 3 doses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recommend additional caution in inferior MI.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intravenous: 5-200 mcg/min. (tolerance in 7-8 h). Use with extreme caution in patients with severe aortic stenosis or hypertrophic cardiomyopathy. Increased risk of hypotension with doses greater than 200 mcg/min.</td>
</tr>
<tr>
<td>β-Blocker</td>
<td>All UA</td>
<td>Low/Int Risk Patient: Oral Drug</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Risk: IV Metoprolol (1-5 mg IV Slow push every 5 min to 15 mg total) or IV Atenolol 5 mg every 5 min to 10 mg total or Esmolol load 500 mcg/kg &amp; drip @ 50 mcg/kg/min</td>
</tr>
<tr>
<td>Narcotics</td>
<td>Ongoing pain after above</td>
<td>Morphine 2-5 mg IV. Repeat as needed for adequate pain control. Vasodilation (which can occur with opioids) is most likely to occur in volume-depleted patients.</td>
</tr>
</tbody>
</table>

**Use calcium channel blockers** – only after nitrates and beta-blockers and when:
- Systolic BP greater than 150 mm Hg; Refractory Ischemia; Vasospastic Angina.

Adapted from Mayo Alliance for Clinical Trials (Mayo ACT)
1-800-541-5815  http://www.mayo.edu/mact/ Revised July 2002
## Appendix B – AMI Acute Medications and Adjunctive Therapy

### Myocardial Infarction: Acute Rx* Guidelines

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Clinical Condition</th>
<th>Dose</th>
<th>Route</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA</td>
<td>All</td>
<td>81 mg, 160-325 mg</td>
<td>Chewed</td>
<td>Platelet inhibition</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>Poststen or ASA allergic</td>
<td>300 mg</td>
<td>By mouth</td>
<td>Platelet inhibition</td>
</tr>
<tr>
<td>Heparin</td>
<td>All* (optional w/SK) start when aPTT less than 70 seconds</td>
<td>60 Units/Kg IV Bolus (max 5000 U bolus) then 12 units/Kg/Hr (max 1000 U/hr) or</td>
<td>IV w/PA or r-PA (IV or SQ w/SK)</td>
<td>aPTT 50-75 seconds x 48'HR</td>
</tr>
<tr>
<td></td>
<td>Suspected no ST elevation MI</td>
<td>Low molecular weight heparin: (do not use if Cr Cl less than 30 mL/min**) Enoxaparin 1 mg/kg every 12 hrs for greater than or equal to 48 hrs</td>
<td>SQ</td>
<td>No parameter to follow</td>
</tr>
<tr>
<td>ß-Blocker</td>
<td>All except patients greater than 2nd degree HB, cardiogenic shock or severe pulmonary edema</td>
<td>Esmolol bolus 500 mcg/kg and drip @ 50 mcg/kg/min-rebolus with each drip or Metoprolol 5 mg IV x 3 (every 5 min) or Atenolol 5 mg IV x 2 (every 10 min)</td>
<td>IV to by mouth Over 24 hours</td>
<td>Pulse 55-60</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>Continued ischemia or large MI</td>
<td>IV x 24 hours 5-200 mcg/min</td>
<td>IV</td>
<td>Systolic BP greater than 100 mmHg and to achieve pain relief</td>
</tr>
<tr>
<td>Morphine</td>
<td>1 gm = 8 mEq Torsades or long-term diuretics**</td>
<td>Torsades – infuse over 10 minutes Low Mg # levels – infuse 2-4 gm IV over 30 minutes and repeat as necessary to maintain high-normal mg** levels at 2-2.4 mEq/L.</td>
<td>IV</td>
<td>(CHF &amp; Rhythm)</td>
</tr>
<tr>
<td>ACE Inhibitor</td>
<td>Hemo. Stable anterior Mls Low initial dose (Start Within 24 hrs)</td>
<td>PO</td>
<td>(Improved remodeling)</td>
<td></td>
</tr>
<tr>
<td>LLb/IIIa</td>
<td>NSTEMI with PCI</td>
<td>IV</td>
<td>Platelet inhibition</td>
<td></td>
</tr>
</tbody>
</table>

* If ST elevation – also Rx with thrombolysis or PTCA  
** Routine use in acute MI is not recommended

### Acute MI: Adjunctive Therapy to Be Considered

<table>
<thead>
<tr>
<th></th>
<th>Hypotension less than 80 SYS</th>
<th>Heart Block greater than 1° AV</th>
<th>Bleeding</th>
<th>Severe COPD</th>
<th>Severe Asthma</th>
<th>Renal Failure</th>
<th>History Of CHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-Blocker</td>
<td>No#</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No#</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nitroglycerin IV</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Heparin</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ASA Chew</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mg++ IV</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ace Inhibitor by mouth</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>With caution</td>
<td>Yes</td>
</tr>
</tbody>
</table>

# Esmolol IV?
Appendix C – Medications to Consider on Discharge

**Acute MI: What Medicines Should Be Considered On Discharge Post-MI?**

<table>
<thead>
<tr>
<th>Medicines</th>
<th>Beneficial Subsets</th>
<th>Dosing</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clopidogrel</td>
<td>Patients with ACS and overt infarction who may or may not receive stents. If clopidogrel is given and coronary artery bypass surgery planned clopidogrel should be held for five days prior to surgery.</td>
<td>75 mg daily</td>
<td>UA or NSTEMI = 9-12 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Noncoated stent = at least 1 month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sirolimus eluting stent = at least 3 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Paclitaxel eluting stent = at least 6 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Brachytherapy = 12 months</td>
</tr>
<tr>
<td>ASA*</td>
<td>All</td>
<td>81 mg or 160-325 mg/day</td>
<td>Indefinite</td>
</tr>
<tr>
<td>Warfarin*</td>
<td>EJ FRAC less than 40% Post-Thrombolysis or LV Aneurysm</td>
<td>Target INR 2.0-3.0</td>
<td>Indefinite</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Three months</td>
</tr>
<tr>
<td>Beta-Blocker*</td>
<td>All but low risk †</td>
<td>Target heart rate 60</td>
<td>Indefinite</td>
</tr>
<tr>
<td>Ace Inhibitor*</td>
<td>EJ FRAC less than or equal to 40%</td>
<td>Titrate to tolerated BP (90-120)</td>
<td>Indefinite</td>
</tr>
<tr>
<td>Statin*</td>
<td>All patients with CAD or heart disease equivalent</td>
<td>Titrate to LDL less than 70 mg/dL</td>
<td>Indefinite</td>
</tr>
<tr>
<td>Long-Acting Calcium Blocker</td>
<td>Non Q MI – No CHF</td>
<td>Titrate to BP control (90-120)</td>
<td>6-12 months</td>
</tr>
<tr>
<td>Nitrates</td>
<td>Ischemia</td>
<td>Titrate to symptom control</td>
<td>Indefinite</td>
</tr>
<tr>
<td>Sustained Release Bupropion</td>
<td>Tobacco Users</td>
<td>Recommended</td>
<td>Up to 12 months</td>
</tr>
<tr>
<td>Nicotine Replacement Therapy</td>
<td>Tobacco Users</td>
<td>Recommended</td>
<td>Up to 12 months</td>
</tr>
</tbody>
</table>

* Shown in large clinical trials to reduce infarction mortality.

† Low risk is equal to no angina, no arrhythmia, first MI, normal exercise tolerance test, and LVEF greater than or equal to 50%.


Health Care Guideline: “Tobacco prevention and cessation for adults and mature adolescents.” Institute for Clinical Systems Improvement. 2002. (Class R)
# Appendix D – METs Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Self-Care or Home Care</th>
<th>Occupational</th>
<th>Physical Conditioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Light:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 3 METs*</td>
<td>Washing, shaving, dressing, desk work, writing, washing</td>
<td>Sitting (clerical), standing (clerk), driving</td>
<td>Walking (2 mph), stationary bike (very low resistance),</td>
</tr>
<tr>
<td>Less than 10 ml/kg x min.</td>
<td>dishes, driving automobile</td>
<td>truck, operating crane</td>
<td>very light calisthenics</td>
</tr>
<tr>
<td>Less than 4 kcal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-5 METs</td>
<td>Cleaning windows, raking leaves, painting</td>
<td>Stocking shelves (light objects), golf (walking)</td>
<td>Walking (3-4 mph), level bicycling (6-8 mph), light</td>
</tr>
<tr>
<td>11-18 ml/kg x min.</td>
<td></td>
<td></td>
<td>calisthenics</td>
</tr>
<tr>
<td>4-6 kcal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-7 METs</td>
<td>Easy digging in garden, level hand lawn mowing, climbing</td>
<td>Carpentry, shoveling dirt, using pneumatic tools</td>
<td>Walking (4.5-5 mph), bicycling (9-10 mph), swimming (breast stroke)</td>
</tr>
<tr>
<td>19-24 ml/kg x min.</td>
<td>stairs (slowly), carrying objects (30-60 lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-7 kcal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-9 METs</td>
<td>Sawing wood, heavy shoveling, climbing stairs (moderately),</td>
<td>Tending furnace, mountain climbing, pick and shovel</td>
<td>Jogging (5 mph), swimming (crawl stroke), rowing machine, heavy calisthenics</td>
</tr>
<tr>
<td>25-32 ml/kg x min.</td>
<td>carrying objects (60-90 lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-10 kcal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Heavy:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than 9 METs</td>
<td>Carrying loads up stairs, carrying objects (greater than 90 lbs.), shoveling heavy snow</td>
<td>Lumberjack, heavy laborer</td>
<td>Running (greater than 6 mph), bicycling (greater than 13 mph), rope jumping</td>
</tr>
<tr>
<td>Greater than 32 ml/kg x min.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than 10 kcal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*A MET is a multiple of the resting energy expenditure; 1 MET = approximately 3.5 cc oxygen consumed/kg/min.

Appendix E – Nomogram of the Prognostic Relations Embodied in the Treadmill Score

<table>
<thead>
<tr>
<th>ST-segment deviation during exercise</th>
<th>Ischemia-reading line</th>
<th>Angina during exercise</th>
<th>Prognosis</th>
<th>Duration of exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>0mm</td>
<td></td>
<td>None</td>
<td>Percent</td>
<td>MET</td>
</tr>
<tr>
<td>1mm</td>
<td></td>
<td>Nonlimiting</td>
<td>Survival</td>
<td>Min</td>
</tr>
<tr>
<td>2mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3mm</td>
<td></td>
<td>Exercise limiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4mm</td>
<td></td>
<td></td>
<td>5-year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>average</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>annual</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>mortality</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.99</td>
<td>0.2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.98</td>
<td>0.4</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.95</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.93</td>
<td>1.5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.90</td>
<td>2</td>
<td>10</td>
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<td></td>
<td></td>
<td>0.85</td>
<td>3</td>
<td>7</td>
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<td></td>
<td></td>
<td>0.80</td>
<td>4</td>
<td>6</td>
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<td></td>
<td>0.75</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.70</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55</td>
<td>9</td>
<td>0</td>
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</tbody>
</table>

Determination of prognosis proceeds in five steps. First, the observed amount of exercise-induced ST-segment deviation (the largest elevation or depression after resting changes have been subtracted) is marked on the line for ST-segment deviation during exercise. Second, the observed degree of angina during exercise is marked on the line for angina. Third, the marks for the ST-segment deviation and degree of angina are connected with a straight edge. The point where this line intersects the ischemia-reading line is noted. Fourth, the total number of minutes of exercise in treadmill testing according to the Bruce protocol (or equivalent in multiples of resting oxygen consumption [METs] from an alternative protocol) is marked on the exercise-duration line. Fifth, the mark for ischemia is connected with that for exercise duration. The point at which this line intersects the line for prognosis indicates the five-year survival rate and the average annual mortality with these characteristics.

Duke Score

**Treadmill score** = duration of exercise in minutes on the Bruce protocol
- (minus) 5x maximal mm ST deviation
- (minus) 4x treadmill angina index

**Treadmill Angina Index:**

0  if no angina  
1  if nonlimiting angina  
2  if limiting angina

**High Risk** = treadmill score less than -10
- 79% 4-year survival

**Moderate Risk** = treadmill score -10 to +4
- 95% 4-year survival

**Low Risk** = treadmill score greater than or equal to +5
- 99% 4-year survival

A Duke score of greater than 4 is generally accepted as a passing score, and such patients may be discharged to home with follow-up within 72 hours.
Supporting Evidence:
Diagnosis and Treatment of Chest Pain and ACS

Released in October 2006 for Third Edition.
*The next scheduled revision will occur within 12 months.*

Availability of references

References cited are available to ICSI participating member groups on request from the ICSI office. Please fill out the reference request sheet included with your guideline and send it to ICSI.

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**Original Work Group Members**

<table>
<thead>
<tr>
<th>John Butler, MD</th>
<th>Dale Meyer, MD</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Internal Medicine, Work Group Leader</em></td>
<td><em>Internal Medicine</em></td>
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<tr>
<td>HealthPartners Medical Group</td>
<td>HealthPartners Medical Group</td>
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<tr>
<td>Nancy Greer, PhD</td>
<td>Jenelle Meyer, RN</td>
</tr>
<tr>
<td>Evidence Analyst</td>
<td>Facilitator</td>
</tr>
<tr>
<td>ICSI</td>
<td>ICSI</td>
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<table>
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<tr>
<th>Teresa Hunteman</th>
<th>James Morrison, MD</th>
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<td>Measurement/Implementation Advisor</td>
<td>Cardiology</td>
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<td>HealthPartners Medical Group</td>
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<th>Stephen Kopecky, MD</th>
<th>Steve Mulder, MD</th>
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<td><em>Family Practice</em></td>
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<th>Hutchinson Area Health Care</th>
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<table>
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<tr>
<th>Kathy Melsha, PharmD</th>
<th>Merlene Petrik, RN</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pharmacy</em></td>
<td><em>Cardiology Nurse</em></td>
</tr>
</tbody>
</table>

| Park Nicollet Health Services | Park Nicollet Health Services |

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Online at http://www.ICSI.org

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Evidence Grading System

I. CLASSES OF RESEARCH REPORTS

A. Primary Reports of New Data Collection:

Class A: Randomized, controlled trial
Class B: Cohort study
Class C: Non-randomized trial with concurrent or historical controls
Case-control study
Study of sensitivity and specificity of a diagnostic test
Population-based descriptive study
Class D: Cross-sectional study
Case series
Case report

B. Reports that Synthesize or Reflect upon Collections of Primary Reports:

Class M: Meta-analysis
Systematic review
Decision analysis
Cost-effectiveness analysis
Class R: Consensus statement
Consensus report
Narrative review
Class X: Medical opinion
References


American College of Cardiology/American Heart Association Task Force on Assessment of Cardiovascular Procedures. Guidelines for exercise testing. *JACC* 1986;8:725-38. (Class R)

American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures. Guidelines for the early management of patients with acute myocardial infarction. *Circulation* 1990;82:664-707. (Class R)


Braunwald E. Clinical results of exercise testing and myocardial perfusion imaging. *In Heart Disease*, 4th ed. Philadelphia: Saunders, 1992;287-89. (Class R)
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Chaitman BR. The changing role of the exercise electrocardiogram as a diagnostic and prognostic test for chronic ischemic heart disease. JACC 1986;8:1195-1210. (Class R)


COMMIT (Clopidogrel and Metoprolol in Myocardial Infarction Trial) collaborative group. Addition of clopidogrel to aspirin in 45,852 patients with acute myocardial infarction: randomised placebo-controlled trial. Lancet 2005;366:1607-21. (Class A)


Institute for Clinical Systems Improvement

REFERENCES


Hochman, J. Modern treatment of acute myocardial infarction. *CVR&R* 1995;23-35. (Review article; Class R)


Institute for Clinical Systems Improvement. Cardiac rehabilitation. #12, 1994. (Class R)


References

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Lincott AM, Kleiman NS, Kereiakes DJ, et al. Long-term efficacy of bivalirudin and provisional glycoprotein IIb/IIIa blockades vs heparin and planned glycoprotein IIb/IIIa blockades during percutaneous coronary revascularization: REPLACE-2 randomized trial. JAMA 2004;292:696-703. (Class A)


Peterson ED, Shaw LJ, Califf RM. Guidelines for risk stratification after myocardial infarction. Ann Intern Med 1997;126:556-60. (Class R)


Schwartz GC, Olsson AG, Ezekowitz MD, et al. Effects of atorvastatin on early recurrent ischemic events in acute coronary syndromes/the MIRA study: a randomized controlled trial. *JAMA* 2001;285:1711-18. (Class A)


SYNERGY Trial Investigators, The. Enoxaparin vs unfractionated heparin in high-risk patients with non-ST-segment elevation acute coronary syndromes managed with an intended early invasive strategy: primary results of the SYNERGY randomized trial. *JAMA* 2004;292:45-54. (Class A)


This section provides resources, strategies and measurement specifications for use in closing the gap between current clinical practice and the recommendations set forth in the guideline.

The subdivisions of this section are:

- Priority Aims and Suggested Measures
  - Measurement Specifications
- Key Implementation Recommendations
- Knowledge Products and Resources
- Other Resources Available
Priority Aims and Suggested Measures

1. Increase the success of emergency intervention for patients with high-risk chest pain.

   Possible measures of accomplishing this aim:

   a. Percentage of patients with chest pain symptoms in ED receiving early therapy including IV, oxygen, nitroglycerin, morphine and a chewable aspirin on arrival. (Prescribing aspirin on arrival is a CMS/JCAHO quality measure.)

   b. Percentage of patients with chest pain symptoms whose ED record shows documented classification, according to ACC/AHA criteria, of risk for adverse outcome.

2. Minimize the delay in administering thrombolytics or angioplasty to patients with acute myocardial infarction (AMI).

   Possible measures of accomplishing this aim:

   a. Percentage of patients with AMI receiving thrombolytics with a "door-to-drug time" (time from presentation to administration of drug) of less than 30 minutes. (CMS/JCAHO quality measure)

   b. Percentage of patients with AMI receiving angiogram/primary PCI with a presentation to cath lab time of less than 90 minutes (target = less than 60 minutes). (CMS/JCAHO quality measure)

3. Increase the timely initiation of treatment to reduce postinfarction mortality in patients with AMI.

   Possible measures of accomplishing this aim:

   a. Percentage of patients with AMI placed on prophylactic aspirin initiated prior to discharge, for whom this treatment is appropriate. (CMS/JCAHO quality measure)

   b. Percentage of patients with AMI receiving beta-blockers initiated prior to discharge, for whom this treatment is appropriate. (CMS/JCAHO quality measure)

   c. Percentage of patients with AMI placed on ACE inhibitors or ARBs if ACEI intolerant) prior to discharge, for whom this treatment is appropriate. (CMS/JCAHO quality measure)

   d. Percentage of patients with AMI receiving statin agent initiated within 24 hours of arrival and prior to discharge, for whom this treatment is appropriate.

4. Increase the percentage of patients with AMI who have used tobacco products within the past year, who receive tobacco use assessment and cessation counseling and treatment within 24 hours of admission (JCAHO).

   Possible measure for accomplishing this aim:

   a. Percentage of patients with AMI who have used tobacco products within the past year, who receive tobacco use assessment and cessation counseling and treatment within 24 hours of admission that is documented in the medical record. (CMS/JCAHO quality measure)

5. Improve the diagnostic value of stress tests through their appropriate use in patients with chest pain symptoms.

   Possible measure of accomplishing this aim:

   a. Percentage of patients with chest pain symptoms who have had treadmill tests with a Duke score present and aren't high risk.
6. Increase the percentage of patients with AMI using appropriate cardiac rehabilitation postdischarge.

   Possible measures for accomplishing this aim:
   
   a. Percentage of patients with AMI who received postdischarge cardiac rehabilitation education including dietary instruction, tobacco cessation, and a manageable exercise regimen, and medications: statin, ACEI, beta-blockers, nitrate, aspirin and/or clopidogrel (Plavix®).
   
   b. Percentage of patients with AMI who are using appropriate cardiac rehabilitation.
      
      Phase 2 Programs: ECG-monitored, outpatient
      
      Phase 3 Programs: nonmonitored, outpatient

7. Increase the percentage of patients with AMI whose course of treatment has followed the recommended critical pathway.

   Possible measure for accomplishing this aim:
   
   a. Percentage of patients whose course of treatment followed the critical pathway.

8. Increase the use of risk stratifying procedures in patients with AMI.

   Possible measure of accomplishing this aim:
   
   a. Percentage of patients with AMI receiving or scheduled for a risk stratifying procedure prior to discharge.
      
      - Echocardiogram
      - Angiogram
      - Stress test (treadmill test)
Measurement Specifications

Possible Success Measure #1a
Percentage of patients with chest pain symptoms in ED receiving early therapy including IV, oxygen, nitroglycerin, morphine and a chewable aspirin on arrival.

Population Definition
Patients greater than age 18 presenting to the ED with chest pain symptoms.

Data of Interest
# of patients with chest pain symptoms receiving early therapy including IV, oxygen, nitroglycerin, morphine and a chewable aspirin on arrival in ED
Total # of patients seen in ED with chest pain symptoms

Numerator/Denominator Definitions
Numerator: # of patients with chest pain symptoms in ED receiving early therapy including IV, nitroglycerin, morphine oxygen and a chewable aspirin on arrival.
Denominator: # of patients with chest pain seen in ED.

Method/Source of Data Collection
Identify patients seen in the ED with a diagnosis of chest pain. Medical records can then be reviewed to determine if the patient received chewable aspirin on arrival in the ED. A minimum sample of 15-20 randomly selected records should be reviewed for evidence of the patient receiving chewable aspirin.

Time Frame Pertaining to Data Collection
It is suggested that data is collected monthly.

Notes
For patients arriving in the emergency department complaining of chest pain, institution of stabilizing therapy (including chewable aspirin for suspect anginal pain) prior to completing history or physical is appropriate and often necessary.
Possible Success Measure #2a

Percentage of patients with AMI receiving thrombolytics with a "door-to-drug time" (time from presentation to administration of drug) of less than 30 minutes.

Population Definition

Adults 18 and older diagnosed as having an acute myocardial infarction.

Data of Interest

Formula for calculating door-to-drug time

\[
\text{Time of initiation of thrombolytic therapy to patient with AMI} - \text{Time of arrival of patient with AMI in the ED} = \text{Door-to-drug time in minutes}
\]

Numerator/Denominator Definitions

Numerator: # of patients with AMI receiving thrombolytics within 30 minutes of presentation in the ED. (All reportable door-to-drug times are rounded to the nearest minute.)

Denominator: # of patients with AMI receiving thrombolytics the ED in the measurement period.

Method/Source of Data Collection

Plan A: It is suggested that data collection be completed on a real-time basis. This measure references all patients to improve process sensitivity at sites where few AMI patients are routinely discharged in a given measurement period.

Plan B: Should real-time data collection present insurmountable institutional obstacles, consider using the following principal diagnosis codes (ICD-9-CM) for identification of patient records for abstracting:

Rubric 410 - Acute Myocardial Infarction, with or without first decimal extensions in the set (0, 1, 2, 3, 4, 5, 6, 7, 8, 9); as well as second decimal extensions in the set (0 or 1 only).

Sites may use the attached AMI patient record as a stand-alone data collection tool. It is recommended that any emergency department collection document be routed to a central clinical/hospital liaison at the time of patient discharge, and that all routing be independent of the patient medical record. Data collection forms can be forwarded to the medical group for analysis.

In addition to tracking the percentage of patients treated in less than 30 minutes, sites may choose to also track either the mean (average) or the median (middle point) of the data. Using the median is preferred. The median is the value of the middle item in the data set. The median value is preferred over the mean (average) value because it minimizes the impact of outlying data points.

For example, if one case of receiving thrombolytics took 120 minutes when the other 10 cases in the data set received them within 20-30 minutes, the mean would be about 34 minutes. However, the median for that same data set might be around 26 minutes and would more accurately reflect the usual performance of the system.
Time Frame Pertaining to Data Collection

Data can be collected weekly or monthly.

Notes

The rationale for development of this measure included several elements. First, multiple authors have identified time-to-thrombolytics administration as one key to reducing mortality in patients with AMI. The 1995 JCAHO hospital accreditation organization and the HCFA-Cooperative Cardiovascular Project will both be auditing hospital efforts for improving the care of patients with AMI. Time to thrombolysis is an important measure in that the resulting statistics would have great sensitivity to process changes, even in facilities with small numbers of patients with AMI. The percentage of patients receiving thrombolytics within 30 minutes should increase over time if the guideline is successfully implemented. This is an important success measure.
Possible Success Measure #3b
Percentage of patients with AMI receiving beta-blockers within 24 hours of arrival and on discharge.

Population Definition
Adults 18 and older diagnosed as having an acute myocardial infarction.

Data of Interest
# of patients with AMI receiving one or more beta-blockers within 24 hours of arrival and on discharge
# of patients with AMI discharged in the measurement period

Numerator/Denominator Definitions
Numerator: # of patients with AMI receiving beta-blockers within 24 hours of arrival and on discharge.
Denominator: # of patients with AMI discharged in the measurement period.

Method/Source of Data Collection
Plan A: It is highly recommended that data collection be completed on a real-time basis. This measure references all patients to improve process sensitivity at sites where few patients with AMI are routinely discharged in a given time period.

Plan B: Should real-time data collection present insurmountable institutional obstacles, consider retrospective chart review of all, or a simple random sample, records of patients with AMI. A random sample is best employed in the presence of more than 30 discharges in a measurement period. If fewer than 30 discharges occur in a measurement period, consider examining all the records.

Use the "Listing of Acute AMI Medications" included at the end of this section to suggest relevant medication trade names and NDC codes.

Sites may use the attached AMI patient record as a stand-alone data collection tool. It is recommended that any inpatient collection document be routed to a central clinical/hospital liaison at the time of patient discharge, and that all routing be independent of the patient medical record. Data collection forms can be forwarded to the medical group for analysis.

Time Frame Pertaining to Data Collection
Data can be collected weekly or monthly.

Notes
The rationale for development and reporting of this measure included two elements. Multiple post-MI studies (Gusto, CCP) have shown that approximately half of the patients in which beta-blockers are indicated are actually given the drug. Multiple authors have identified underutilization of beta-blockers as potentially increasing the likelihood of reinfarction and (as a result) increasing mortality rates. The HCFA-Cooperative Cardiovascular Project will be auditing use of beta-blockers in assessing hospital efforts for improving the care of patients with AMI. This rate should increase over time.
**Possible Success Measure #5a**
Percentage of patients with chest pain symptoms who have had treadmill tests with the Duke score present and aren't high risk.

**Population Definition**
Patients with a diagnosis of chest pain who receive a treadmill test and are not high risk. This measure would be pertinent to medical groups with direct control over the process that produces its treadmill stress tests.

**Data of Interest**
\[
\frac{\text{# of treadmill reports with the Duke treadmill score present}}{\text{Total # of stress tests reviewed of patients with chest pain symptoms}}
\]

**Numerator/Denominator Definitions**
Numerator: # of treadmill reports with the Duke score on the report as it is received.
Denominator: Total # of stress tests reviewed for patients with a diagnosis of chest pain.

**Method/Source of Data Collection**
Identify patients who have a diagnosis of chest pain. Medical records can then be reviewed and the treadmill stress test report examined. A minimum sample of 15 randomly selected test reports should be reviewed to determine if the Duke treadmill rating score is contained in the report.

**Time Frame Pertaining to Data Collection**
It is suggested that data is collected monthly.

**Notes**
The Duke treadmill risk rating score is the only validated method available to stratify patient risk based on treadmill test results. This measure is intended to be used ONLY by medical groups who have direct control over the treadmill reporting system.
Possible Success Measure #8a
Percentage of patients with AMI receiving or scheduled for a risk stratifying procedure prior to discharge.

Population Definition
Adults 18 and older diagnosed as having an acute myocardial infarction.

Data of Interest

\[
\frac{\text{# of patients with AMI receiving or scheduled for a risk stratifying procedure}}{\text{total # of patients with AMI discharged in the measurement period}}
\]

Numerator/Denominator Definitions
Numerator: \# of patients receiving or scheduled for an echocardiogram, angiogram or stress test (treadmill test) prior to discharge.
Denominator: \# of patients with AMI discharged in the measurement period.

Method/Source of Data Collection

Plan A: It is suggested that data collection be completed on a real-time basis. This measure references all patients to improve process sensitivity at sites where few patients with AMI are routinely discharged in a given time period.

Plan B: Should real-time data collection present insurmountable institutional obstacles, consider using the following principal diagnosis codes (ICD-9-CM) for identification of patient records for abstracting:

Rubric 410 - Acute Myocardial Infarction, with or without first decimal extensions in the set (0, 1, 2, 3, 4, 5, 6, 7, 8, 9); as well as second decimal extensions in the set (0 or 1 only).

Sites may use the attached AMI patient record as a stand-alone data collection tool. It is recommended that any inpatient collection document be routed to a central clinical/hospital liaison at the time of patient discharge, and that all routing be independent of the patient medical record. Data collection forms can be forwarded to the medical group for analysis.

Time Frame Pertaining to Data Collection
Data can be collected weekly or monthly.
### Acute Myocardial Infarction Medical Record Form

*For use with ALL AMI (AMI) arrivals in ER/ETU*

Attach to Medical Record at time of admission

Please retain this form at your facility if patient is transferred.

**Route to**  
Quality Assurance Auditor (Guideline Coordinator)  
upon discharge/transfer of patient.

#### Optional Data Collection Tool

**Patient Identifying Information**

**PROCESS STEPS**

<table>
<thead>
<tr>
<th>Increased Risk Criteria:</th>
<th>AMI time of arrival</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>— Ejection fraction less than 40%</td>
<td>12 lead ECG start time</td>
<td></td>
</tr>
<tr>
<td>— Residual ischemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Electrical instability greater than 10 PVC/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— L. Main or 3 vessel CAD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Age greater than or equal to 70 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Prior infarction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Anterior wall MI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Hypotension and sinus tachycardia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Diabetes Mellitus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Female gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Continuation of smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Rales/crackles greater than 1/3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Atrial fibrillation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Thrombolytics administered**

- [ ] Streptokinase  
- [ ] tPA  
- [ ] Other  

**Date/Time**

**Check when addressed/completed. Mark NA if not applicable.**

- [ ] Aspirin or Plavix® Given  
- [ ] prior to emergency department  
- [ ] in emergency department

- [ ] Beta-blockers initiated within 24 hours of arrival and prior to discharge

- [ ] ACE inhibitors initiated prior to discharge

- [ ] Statin agent initiated prior to discharge

- [ ] Angiogram
  - [ ] done
  - [ ] scheduled

- [ ] Assessment of LV ejection fraction
  - [ ] cardiac catheterization
  - [ ] echocardiogram
  - [ ] nuclear study

- [ ] Stress Test
  - [ ] done
  - [ ] scheduled

- [ ] Risk factors addressed
  - [ ] smoking
  - [ ] diet/lipids
  - [ ] exercise
  - [ ] hypertension

- [ ] PCI
- [ ] CABG

- [ ] Discharged/transfered
  - [ ] home
  - [ ] long-term care facility
  - [ ] deceased
  - [ ] AMA
  - [ ] transferred

**Discharge Date: __________  Discharge/transfer diagnosis: __________________**
Key Implementation Recommendations

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.

1. 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.

2. Hospitals should develop and implement ED critical pathways and consider standard orders to accomplish rapid evaluation and treatment of acute coronary syndrome. Standard discharge orders/instructions should also be considered.

3. A process should be in place for the patient and family that will rapidly orient them to the suspected diagnosis, ED and CCU process and other treatment measures to be considered. This could include both caregiver face-to-face interactions with the patient and family, as well as teaching tools in written form.

4. Institutions that cannot meet the recommended treatment times for primary PCI should consider preferential use of intravenous thrombolytic therapy. These institutions should have a predetermined plan for treating patients who present with contraindications to thrombolytics. Such plans may employ delayed local primary PCI or transfer to another institution.
Knowledge Products

Criteria for Selecting Resources

The following resources were selected by the Diagnosis and Treatment of Chest Pain and ACS guideline work group as additional resources for providers and/or patients. The following criteria were considered in selecting these resources.

• The site contains information specific to the topic of the guideline.
• The content is supported by evidence-based research.
• The content includes the source/author and contact information.
• The content clearly states revision dates or the date the information was published.
• The content is clear about potential biases, noting conflict of interest and/or disclaimers as appropriate.

Resources Available to ICSI Members Only

The following materials are available to ICSI members only. Also available is a wide variety of other knowledge products, including tool kits on CQI processes and Rapid Cycling that can be helpful. To obtain copies of these or other Knowledge Products, go to http://www.icsi.org/knowledge.

To access these materials on the Web site, you must be logged in as an ICSI member.

Educational Resources

Process Improvement Reports (PIRs)

• #27 – Park Nicollet Health Services: Improved Efficiencies in Initial Reperfusion Treatment in Patients with AMI
• #21 – Acute Chest Pain Initiative at PNHS
• #12 – Case Report on Anticoagulation Therapy.

Tools

• Acute Coronary Syndrome documentation forms
• Diagnosis of Chest Pain Pilot Implementation Report
## Other Resources Available

<table>
<thead>
<tr>
<th>Title/Description</th>
<th>Audience</th>
<th>Author/Organization</th>
<th>Web sites/Order Information</th>
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</thead>
<tbody>
<tr>
<td>Information for ACC members and non-members. Includes clinical statements, advocacy and practice management information.</td>
<td>Professionals</td>
<td>American College of Cardiology</td>
<td><a href="http://www.acc.org">http://www.acc.org</a></td>
</tr>
<tr>
<td>Information and education on various aspects of heart disease. Includes information on lifestyle change. Provides links to local information.</td>
<td>Patients and Professionals</td>
<td>American Heart Association</td>
<td><a href="http://www.americanheart.org">http://www.americanheart.org</a></td>
</tr>
<tr>
<td>Health information on various cardiovascular diseases and conditions.</td>
<td>Patients</td>
<td>Mayo Clinic</td>
<td><a href="http://www.mayohealth.org">http://www.mayohealth.org</a></td>
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