Evaluation of Acute Coronary Syndromes

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Cardiology Fellow, PGY 6
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Epidemiology

- 1,680,000 unique discharges for ACS in 2001
- Applying the conservative estimate of 30% of the ACS patients who have STEMI from the National Registry of Myocardial Infarction [NRMI-4], we estimate 500,000 STEMI events per year in the U.S.
- However, there has been a steady decline in the mortality rate from STEMI over the last several decades.
- This appears to be due to a combination of a fall in the incidence of MI (replaced in part by an increase in the incidence of unstable angina) and a reduction in the case fatality rate once an MI has occurred.
- There has been a progressive increase in the proportion of patients who present with NSTEMI compared with STEMI.
Patient experiences chest pain/discomfort

Has the patient been previously prescribed nitroglycerin?

No

Is Chest Discomfort/Pain Unimproved or Worsening 5 Minutes After It Starts?

No

Notify Physician

Yes

CALL 9-1-1 IMMEDIATELY

Follow 9-1-1 instructions
[Patients may receive instructions to chew aspirin (162-325 mg)* if not contraindicated or may receive aspirin* en route to the hospital]

Yes

Take ONE Nitroglycerin Dose Sublingually

Is Chest Discomfort/Pain Unimproved or Worsening 5 Minutes After Taking ONE Nitroglycerin Dose Sublingually?

Yes

No

See ACC/AHA 2002 Guideline Update for the Management of Patients with Chronic Stable Angina
ACS – Unstable Angina, NSTEMI, and STEMI

• Acute coronary syndrome
  – UA
  – NSTEMI
  – STEMI

• UA differentiated from NSTEMI by absence of biomarkers
  – Troponin, CPK/MB
| TABLE 46–2 | Revised Definition of Myocardial Infarction (MI) |

**Criteria for acute, evolving, or recent MI**

Either one of the following criteria satisfies the diagnosis for an acute, evolving, or recent MI:

1. Typical rise and gradual fall (troponin) or more rapid rise and fall (CK-MB) of biochemical markers of myocardial necrosis with at least one of the following:
   a. Ischemic symptoms
   b. Development of pathologic Q waves on the ECG reading
   c. ECG changes indicative of ischemia (ST-segment elevation or depression)
   d. Coronary artery intervention (e.g., coronary angioplasty)

2. Pathological findings of an acute MI

**Criteria for established MI**

Either of the following criteria satisfies the diagnosis for established MI:

1. Development of new pathological Q waves on serial ECG readings. The patient may or may not remember previous symptoms. Biochemical markers of myocardial necrosis may have normalized, depending on the length of time that has passed since the infarct developed.

2. Pathological findings of a healed or healing MI

CK = creatine kinase; ECG = electrocardiographic.

Etiology of UA

Table 2. Causes of UA*

Nonocclusive thrombus on pre-existing plaque
Dynamic obstruction (coronary spasm or vasoconstriction)
Progressive mechanical obstruction
Inflammation and/or infection
Secondary UA

*These causes are not mutually exclusive; some patients have greater than or equal to 2 causes.

Pathophysiology of UA/NSTEMI

Multiple “vulnerable” plaques detected in non-culprit segments 1–7

Culprit lesion (8) detected with thrombus (red)

Multiple “vulnerable” plaques detected in non-culprit segments 10–12

Braunwald, 7th ed
## Symptoms related to ACS

### Table 5. Likelihood That Signs and Symptoms Represent an ACS Secondary to CAD

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Likelihood Any of the following:</th>
<th>Intermediate Likelihood Absence of high-likelihood features and presence of any of the following:</th>
<th>Low Likelihood 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 reproducing prior documented angina</td>
<td>Chest or left arm pain or discomfort as chief symptom Age &gt;70 years Male sex Diabetes mellitus</td>
<td>Probable ischemic symptoms in absence of any of the intermediate likelihood characteristics Recent cocaine use</td>
</tr>
<tr>
<td>Examination</td>
<td>Known history of CAD, including MI</td>
<td>Extracardiac vascular disease</td>
<td>Chest discomfort reproduced by palpation</td>
</tr>
<tr>
<td>ECG</td>
<td>Transient MR, hypotension, diaphoresis, pulmonary edema, or rales</td>
<td>Fixed Q waves Abnormal ST segments or T waves not documented to be new</td>
<td>T-wave flattening or inversion in leads with dominant R waves Normal ECG</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>

Physical Exam

Table 5. Brief Physical Examination in the Emergency Department
1. Airway, Breathing, Circulation (ABC)
2. Vital signs, general observation
3. Presence or absence of jugular venous distension
4. Pulmonary auscultation for rales
5. Cardiac auscultation for murmurs and gallops
6. Presence or absence of stroke
7. Presence or absence of pulses
8. Presence or absence of systemic hypoperfusion (cool, clammy, pale, ashen)
Implications of Physical Exam

- General: Restless agitated, anguished facies, clenched fist (Levine’s sign)
- Skin: Cool, clammy, pale, ashen
- Low-grade fever: Nonspecific response to myocardial necrosis
- Hypertension, tachycardia: High sympathetic tone (anterior MI)
- Hypotension, bradycardia: High vagal tone (inferior-posterior MI)
- Small-volume pulses: Low cardiac output
- Fast, slow, or irregular pulse: Atrial or ventricular arrhythmias, heart block
- Paradoxical “ectopic” systolic impulse: LV dyskinesis, ventricular aneurysm (anterior MI)
- Soft S1: Decreased LV contractility; first-degree AV block (inferior MI)
- S4 gallop: Decreased LV compliance
- Paradoxically split S2: Severe LV dysfunction, LBBB, S3
Implications of Physical Exam

- Hypotension: Skin – cool, clammy, cyanotic; CNS – altered mental status; kidneys – oliguria (signs of cardiogenic shock)
- Jugular venous distension: with Kussmaul’s sign, hypotension,
- RV S4 and S3 gallops, clear lungs (RV infarction)
- Systolic murmur of VSR: VSR (LSB, palpable thrill common). Differentiate from systolic murmur of MR: papillary muscle rupture
- Pericardial friction rub: Pericarditis (accompanies transmural MI) – late post-MI (Dressler’s) syndrome
- Signs of cardiac tamponade, EM dissociation: Cardiac rupture
- Absent pulses and murmur of aortic regurgitation: Aortic dissection
- Screening Neurological Examination
  - Cognitive disorientation: memory loss, dysarthria, aphasia, hemispatial neglect
  - Motor: facial asymmetry, pronator drift, reflex symmetry, limb dysmetria
Differential Diagnosis of STEMI

**Life-threatening**
- Aortic dissection
- Pulmonary embolus
- Perforating ulcer
- Tension pneumothorax
- Boerhaave syndrome (esophageal rupture with mediastinitis)

**Other noncardiac**
- Gastroesophageal reflux (GERD) and spasm
- Chest-wall pain
- Pleurisy
- Peptic ulcer disease
- Panic attack
- Biliary or pancreatic pain
- Cervical disc or neuropathic pain
- Somatization and psychogenic pain disorder

**Other cardiovascular and nonischemic**
- Pericarditis
- Atypical angina
- Early repolarization
- Wolff-Parkinson-White syndrome
- Deeply inverted T waves suggestive of a central nervous system lesion or apical hypertrophic cardiomyopathy
- LV hypertrophy with strain
- Brugada syndrome
- Myocarditis
- Hyperkalemia
- Bundle-branch blocks
- Vasospastic angina
- Hypertrophic cardiomyopathy

ACC 2004 STEMI
Table 9. Laboratory Evaluations for Management of ST-Elevation Myocardial Infarction

Serum biomarkers for cardiac damage (do not wait for results before implementing reperfusion strategy)

- CBC with platelet count
- INR
- aPTT
- Electrolytes and magnesium
- BUN
- Creatinine
- Glucose
- Serum lipids

CBC = complete blood count; INR = international normalized ratio; aPTT = activated partial thromboplastin time; BUN = blood urea nitrogen.
### Biomarkers

**Table 10. Molecular Biomarkers for the Evaluation of Patients With ST-Elevation Myocardial Infarction**

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Molecular Weight, Da</th>
<th>Range of Times to Initial Elevation, h</th>
<th>Mean Time to Peak Elevations (Nonreperfused)</th>
<th>Time to Return to Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently used in clinical practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK-MB</td>
<td>86 000</td>
<td>3-12 h</td>
<td>24 h</td>
<td>48-72 h</td>
</tr>
<tr>
<td>cTnI</td>
<td>23 500</td>
<td>3-12 h</td>
<td>24 h</td>
<td>5-10 d</td>
</tr>
<tr>
<td>cTnT</td>
<td>33 000</td>
<td>3-12 h</td>
<td>12 h–2 d</td>
<td>5-14 d</td>
</tr>
<tr>
<td>Infrequently used in clinical practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myoglobin</td>
<td>17 800</td>
<td>1-4 h</td>
<td>6-7 h</td>
<td>24 h</td>
</tr>
<tr>
<td>CK-MB tissue isoform</td>
<td>86 000</td>
<td>2-6 h</td>
<td>18 h</td>
<td>Unknown</td>
</tr>
<tr>
<td>CK-MM tissue isoform</td>
<td>86 000</td>
<td>1-6 h</td>
<td>12 h</td>
<td>38 h</td>
</tr>
</tbody>
</table>

Da = Daltons; h = hours; CK-MB = MB isoenzyme of creatine kinase; cTnI = cardiac troponin I; cTnT = cardiac troponin T; CK-MM = MM isoenzyme of creatine
TIMI Risk Score for UA/NSTEMI
## Risk Stratification with UA

### Table 6. Short-Term Risk of Death or Nonfatal MI in Patients With UA*

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Risk</th>
<th>Intermediate Risk</th>
<th>Low Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least 1 of the following features must be present</td>
<td>No high-risk feature but must have 1 of the following:</td>
<td>No high- or intermediate-risk feature but may have any of the following features:</td>
</tr>
<tr>
<td>History</td>
<td>Accelerating tempo of ischemic symptoms in preceding 48 h</td>
<td>Prior MI, 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 (&gt;20 min) rest pain but with moderate or high likelihood of CAD (see Table 5)</td>
</tr>
<tr>
<td>Character of pain</td>
<td>Prolonged ongoing (&gt;20 min) rest pain</td>
<td>Prolonged (&gt;20 min) rest angina, now resolved, with moderate or high likelihood of CAD</td>
<td></td>
</tr>
<tr>
<td>Clinical findings</td>
<td>Pulmonary edema, most likely due to ischemia, New or worsening MR murmur, ( S_3 ) or new/worsening rales, Hypotension, bradycardia, tachycardia, Age &gt;75 years</td>
<td>Age &gt;70 years</td>
<td></td>
</tr>
<tr>
<td>ECG</td>
<td>Angina at rest with transient ST-segment changes &gt;0.05 mV, Bundle-branch block, new or presumed new, Sustained ventricular tachycardia</td>
<td>T-wave inversions &gt;0.2 mV, 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 &gt;0.1 ng/mL)</td>
<td>Slightly elevated (e.g., TnT &gt;0.01 but &lt;0.1 ng/mL)</td>
<td>Normal</td>
</tr>
</tbody>
</table>

*Estimation of the short-term risks of death and nonfatal cardiac ischemic events in UA is a complex multivariable problem that cannot be fully specified in a table such as this; therefore, this table is meant to offer general guidance and illustration rather than rigid algorithms.

Evaluation of UA/NSTEMI

High/intermediate risk

Coronary arteriography

LMCD, 3VD + LV dysfunction or diabetes mellitus

CABG

1 or 2 V\textsubscript{D}, suitable for PCI

IIb/IIIa inhibitors

PCI

Consider alternative diagnosis

Discharge on ASA, clopidogrel, statin, ACE-I

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Braunwald, 7\textsuperscript{th} ed
Risk Stratification with UA

Class I

• 1. Noninvasive stress testing in low-risk patients (Table 6) who have been free of ischemia at rest or with low level activity and of CHF for a minimum of 12 to 24 h. (Level of Evidence: C)

• 2. Noninvasive stress testing in patients at intermediate risk (Table 6) who have been free of ischemia at rest or with low-level activity and of CHF for a minimum of 2 or 3 days. (Level of Evidence: C)
High Risk Noninvasive Results

High risk (>3% annual mortality rate)
1. Severe resting LV dysfunction (LVEF <0.35)
2. High-risk treadmill score (score ≤ –11)
3. Severe exercise LV dysfunction (exercise LVEF <0.35)
4. Stress-induced large perfusion defect (particularly if anterior)
5. Stress-induced multiple perfusion defects of moderate size
6. Large, fixed perfusion defect with LV dilation or increased lung uptake (thallium-201)
7. Stress-induced moderate perfusion defect with LV dilation or increased lung uptake (thallium-201)
8. Echocardiographic wall motion abnormality (involving >2 segments) developing at a low dose of dobutamine (≤ 10 mg · kg⁻¹ · min⁻¹) or at a low heart rate (<120 bpm)
9. Stress echocardiographic evidence of extensive ischemia
Intermediate and Low risk results

Intermediate risk (1–3% annual mortality rate)
1. Mild/moderate resting LV dysfunction (LVEF 0.35–0.49)
2. Intermediate-risk treadmill score (−11 < score <5)
3. Stress-induced moderate perfusion defect without LV dilation or increased lung intake (thallium-201)
4. Limited stress echocardiographic ischemia with a wall motion abnormality only at higher doses of dobutamine involving ≤2 segments

Low risk (<1% annual mortality rate)
1. Low-risk treadmill score (score ≥5)
2. Normal or small myocardial perfusion defect at rest or with stress
3. Normal stress echocardiographic wall motion or no change of limited resting wall motion abnormalities during stress

ACC 2002 UA/NSTEMI
Table 18. Noninvasive Test Results That Predict High Risk for Adverse Outcome (LV Imaging)

<table>
<thead>
<tr>
<th>Stress radionuclide ventriculography</th>
<th>Stress echocardiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise EF ≤0.50</td>
<td>Rest EF ≤0.35</td>
</tr>
<tr>
<td>Rest EF ≤0.35</td>
<td>Wall motion score index &gt;1</td>
</tr>
<tr>
<td>Fall in EF ≥0.10</td>
<td></td>
</tr>
</tbody>
</table>


Table 19. Noninvasive Test Results That Predict High Risk for Adverse Outcome on Stress Radionuclide Myocardial Perfusion Imaging

- Abnormal myocardial tracer distribution in >1 coronary artery region at rest or with stress or a large anterior defect that reperfuses
- Abnormal myocardial distribution with increased lung uptake
- Cardiac enlargement

Early invasive therapy for UA/NSTEMI

Class I
1. An early invasive strategy in patients with UA/NSTEMI and any of the following high-risk indicators. (Level of Evidence: A).
   a) Recurrent angina/ischemia at rest or with low level activities despite intensive anti-ischemic therapy
   b) Elevated TnT or TnI
   c) New or presumably new ST-segment depression
   d) Recurrent angina/ischemia with CHF symptoms, an S3 gallop, pulmonary edema, worsening rales, or new or worsening MR
   e) High-risk findings on noninvasive stress testing
   f) Depressed LV systolic function (e.g., EF less than 0.40 on noninvasive study)
   g) Hemodynamic instability
   h) Sustained ventricular tachycardia
   i) PCI within 6 months
   j) Prior CABG
2. In the absence of these findings, either an early conservative or an early invasive strategy in hospitalized patients without contraindications for revascularization. (Level of Evidence: B)

Class IIA
An early invasive strategy in patients with repeated presentations for ACS despite therapy and without evidence for ongoing ischemia or high risk. (Level of Evidence: ACC 2002 UA/NSTEMI
Troponin correlates with mortality

Figure 5. Plot of the appearance of cardiac markers in blood vs. time after onset of symptoms. Peak A, early release of myoglobin or CK-MB isoforms after AMI. Peak B, cardiac troponin after AMI. Peak C, CK-MB after AMI. Peak D, cardiac troponin after UA. Data are plotted on a relative scale, where 1.0 is set at the AMI cutoff concentration. Reprinted with permission from National Academy of Clinical Biochemistry, Washington, DC. Standards of laboratory practice: recommendations for use of cardiac markers in coronary artery disease. November 5, 1999.
Symptoms Suggestive of ACS

A

B1
Noncardiac diagnosis

B2
Chronic stable angina

B3
Possible ACS

B4
Definite

C1
Treatment as indicated by alternative diagnosis

C2
No ST elevation

C2
ST and/or ischemic changes

D1
Nondiagnostic ECG Normal Initial serum cardiac markers

D2
ST and/or ischemic changes

E1
Observe
Follow-up at 4-8 hours: ECG, cardiac markers

F1
No recurrent pain; Negative follow-up studies

F2
Recurrent ischemic pain or Positive follow-up studies Diagnosis of ACS confirmed

G1
Stress study to provoke ischemia Consider evaluation of LV function if ischemia is present Tests may be performed either prior to discharge or as outpatient

ACC 2002 UA/NSTEMI
Acute Ischemia Pathway

Recurrent ischemia and/or
ST segment shift, or
Deep T-wave inversion, or
Positive cardiac markers

Aspirin
Beta blockers
Nitrates
Antithrombin regimen
GP IIb/IIIa inhibitor
Monitoring (rhythm and ischemia)

Early invasive strategy
Immediate angiography
12-24 hour angiography

Early conservative strategy
Recurrent symptoms/ischemia
Heart failure
Serious arrhythmia

Patient stabilizes
Treatment of UA/NSTEMI

Table 10. Class I Recommendations for Anti-Ischemic Therapy in the Presence or Absence of Continuing Ischemia or High-Risk Features*

<table>
<thead>
<tr>
<th>Continuing Ischemia/Other Clinical High-Risk Features*</th>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed rest with continuous ECG monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplemental $O_2$ to maintain $Sao_2 &gt; 90%$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTG IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta-blockers, oral or IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morphine IV for pain, anxiety, pulmonary congestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IABP if ischemia or hemodynamic instability persists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEI for control of hypertension or LV dysfunction, after MI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEI for control of hypertension or LV dysfunction, after MI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Recurrent angina and/or ischemia-related ECG changes (greater than or equal to 0.05-mV ST-segment depression or bundle-branch block) at rest or low-level activities; or ischemia associated with CHF symptoms, $S_3$ gallop, or new or worsening mitral regurgitation; or hemodynamic instability or depressed LV function (EF $<0.40$ on noninvasive study); or malignant ventricular arrhythmia.
### Antiplatelet therapy for UA/NSTEMI

#### Table 14. Class I Recommendations for Antithrombotic Therapy*

<table>
<thead>
<tr>
<th>Possible ACS</th>
<th>Likely/Definite ACS</th>
<th>Definite ACS With Continuing Ischemia or Other High-Risk Features† or Planned Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>Aspirin + Subcutaneous LMWH or IV heparin + IV platelet GP IIb/IIIa antagonist</td>
<td>Aspirin + IV heparin + IV platelet GP IIb/IIIa antagonist</td>
</tr>
</tbody>
</table>

*Clinical data on the combination of LMWH and platelet GP IIb/IIIa antagonists are lacking. Their combined use is not currently recommended.
†High-risk features are listed in Table 6; others include diabetes, recent MI, and elevated TnT or Tnl.

- Plavix is also a class 1 recommendation for UA/NSTEMI, for both early invasive and conservative therapy
**LMWH in UA**

*Figure 9.* The use of LMWH in UA showing effects on the triple endpoints of death, MI, and recurrent ischemia with or without revascularization. Early (6-day) and intermediate outcomes of the 4 trials that compared LMWH and UFH: ESSENCE (169), TIMI 11B (170), FRIC (218), and FRAXIS (219). Nadroparine in FRAXIS was given for 14 days.
Figure 8. Summary of trials of antithrombotic therapy in UA. Meta-analysis of randomized trials in UA/NSTEMI that have compared ASA with placebo, the combination of UFH and ASA with ASA alone, the combination of an LMWH and ASA with ASA alone, and the combination of a platelet GP IIb/IIIa antagonist (anta.), UFH (hep.), and ASA with UFH plus ASA. The RR values, 95% CIs, and probability value for each trial are shown. The timing of the end point (death or MI) varied. Results with the platelet GP IIb/IIIa antagonists are reported at the 30-day time point. Incremental gain is observed from single therapy with ASA to double therapy with ASA and UFH and to triple antithrombotic therapy with ASA, UFH, and a platelet GP IIb/IIIa antagonist. In the CAPTURE trial, nearly all patients underwent PCI after 20 to 24 h per study design. From PURSUIT (10), PRISM-PLUS (21), Lewis et al. (175), Cairns et al. (176), Théroux et al. (177), RISC group (178), ATACS group (179), Gurfinke et al. (180), FRISC group (181), CAPTURE (182), PARAGON (183), and PRISM (184).
Figure 11. Adverse outcome by initial ECG in ACS. Adapted from Nyman I, Areskog M, Areskog NH, Swahn E, Wallentin L. Very early risk stratification by electrocardiogram at rest in men with suspected unstable coronary heart disease. The RISC Study Group. J Intern Med 1993;234:293–301.
**Figure 12.** Revascularization strategy in UA/NSTEMI. *There is conflicting information about these patients. Most consider CABG to be preferable to PCI.*

ACC 2002 UA/NSTEMI
# Choice of Revascularization

## Table 20. Mode of Coronary Revascularization for UA/NSTEMI

<table>
<thead>
<tr>
<th>Extent of Disease</th>
<th>Treatment</th>
<th>Class/Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left main disease,* candidate for CABG</td>
<td>CABG</td>
<td>I/A</td>
</tr>
<tr>
<td>Left main disease, not candidate for CABG</td>
<td>PCI</td>
<td>III/C</td>
</tr>
<tr>
<td>Three-vessel disease with EF &lt; 0.50</td>
<td>PCI</td>
<td>IIb/C</td>
</tr>
<tr>
<td>Multivessel disease including proximal LAD with EF &lt; 0.50 or treated diabetes</td>
<td>CABG or PCI</td>
<td>I/A</td>
</tr>
<tr>
<td>Multivessel disease with EF &gt; 0.50 and without diabetes</td>
<td>PCI</td>
<td>I/A</td>
</tr>
<tr>
<td>One- or 2-vessel disease without proximal LAD but with large areas of myocardial ischemia or high-risk criteria on noninvasive testing (see Table 17)</td>
<td>CABG or PCI</td>
<td>I/B</td>
</tr>
<tr>
<td>One-vessel disease with proximal LAD</td>
<td>CABG or PCI</td>
<td>IIa/B†</td>
</tr>
<tr>
<td>One- or 2-vessel disease without proximal LAD with small area of ischemia or no ischemia on noninvasive testing</td>
<td>CABG or PCI</td>
<td>III/C†</td>
</tr>
<tr>
<td>Insignificant coronary stenosis</td>
<td>CABG or PCI</td>
<td>III/C</td>
</tr>
</tbody>
</table>

*≥50% diameter stenosis.
†Class/level of evidence I/A if severe angina persists despite medical therapy.

ACC 2002 UA/NSTEMI
## Medications following UA/NSTEMI

### Table 21. Medications Used for Stabilized UA/NSTEMI

<table>
<thead>
<tr>
<th>Anti-Ischemic and Antithrombotic/Antiplatelet Agent</th>
<th>Drug Action</th>
<th>Class/Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>Antiplatelet</td>
<td>I/A</td>
</tr>
<tr>
<td>Clopidogrel* or ticlopidine</td>
<td>Antiplatelet when aspirin is contraindicated</td>
<td>I/A</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>Anti-ischemic</td>
<td>I/A</td>
</tr>
<tr>
<td>ACEI</td>
<td>EF less than 0.40 or CHF EF greater than 0.40</td>
<td>I/A IIa/A</td>
</tr>
<tr>
<td>Nitrates</td>
<td>Antianginal</td>
<td>I/C For ischemic symptoms</td>
</tr>
<tr>
<td>Calcium antagonists (short-acting dihydropyridine antagonists should be avoided)</td>
<td>Antianginal</td>
<td>I For ischemic symptoms</td>
</tr>
<tr>
<td>Warfarin low intensity with or without aspirin</td>
<td>Antithrombotic</td>
<td>IIb/B</td>
</tr>
<tr>
<td>Dipyridamole</td>
<td>Antiplatelet</td>
<td>III/A</td>
</tr>
</tbody>
</table>
Medications following UA/NSTEMI

<table>
<thead>
<tr>
<th>Agent</th>
<th>Risk Factor</th>
<th>Class/Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMG-CoA reductase inhibitors</td>
<td>LDL cholesterol greater than 130 mg/dL</td>
<td>I/A</td>
</tr>
<tr>
<td>HMG-CoA reductase inhibitors</td>
<td>LDL cholesterol 100–130 mg/dL</td>
<td>IIa/B</td>
</tr>
<tr>
<td>Gemfibrozil</td>
<td>HDL cholesterol less than 40 mg/dL</td>
<td>IIa/B</td>
</tr>
<tr>
<td>Niacin</td>
<td>HDL cholesterol less than 40 mg/dL</td>
<td>IIa/B</td>
</tr>
<tr>
<td>Niacin or gemfibrozil</td>
<td>Triglycerides greater than 200 mg/dL</td>
<td>IIa/B</td>
</tr>
<tr>
<td>Folate</td>
<td>Elevated homocysteine</td>
<td>IIb/C</td>
</tr>
<tr>
<td>Antidepressant</td>
<td>Treatment of depression</td>
<td>IIb/C</td>
</tr>
<tr>
<td>Treatment of hypertension</td>
<td>Blood pressure greater than 135/85 mm Hg</td>
<td>I/A</td>
</tr>
<tr>
<td>HRT (initiation)†</td>
<td>Postmenopausal state</td>
<td>III/B</td>
</tr>
<tr>
<td>HRT (continuation)†</td>
<td>Postmenopausal state</td>
<td>IIa/C</td>
</tr>
</tbody>
</table>

ACEI indicates angiotensin-converting enzyme inhibitor; CHF, congestive heart failure; EF, ejection fraction; HDL, high-density lipoprotein; HRT, hormone replacement therapy; LDL, low-density lipoprotein; NSTEMI, non-ST-segment elevation myocardial infarction; UA, unstable angina.

*Preferred to ticlopidine.
†For risk reduction of coronary artery disease.
## Antiplatelet agents following stenting

<table>
<thead>
<tr>
<th></th>
<th>Bare Metal Stent</th>
<th>Cypher (Sirolimus)</th>
<th>Taxus (Tacrolimus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin 325</td>
<td>1 month</td>
<td>3 months</td>
<td>6 months</td>
</tr>
<tr>
<td>Plavix 75</td>
<td>1 month</td>
<td>3 months</td>
<td>6 months</td>
</tr>
</tbody>
</table>

Aspirin 81mg daily is recommended indefinitely following stenting. Plavix use is variable, with some practitioners continuing plavix for 1 year following drug eluting stent.

ACC 2004 STEMI
Thrombus occludes vessel
Thrombus Formation

- Angiographic evidence of coronary thrombus formation may be seen in more than 90% of patients with STEMI but in only 1% of patients with stable angina and about 35% to 75% of patients with unstable angina or NSTEMI
Panel A

Onset of symptoms of STEMI → Call 9-1-1 → Call fast → 9-1-1 EMS Dispatch → EMS on-scene

- Encourage 12-lead ECGs
- Consider prehospital fibrinolytic if capable and EMS-to-needle within 30 min

Goals†

- Patient: 5 min after symptom onset
- Dispatch: 1 min
- EMS on scene: Within 8 min

EMS transport

EMS transport: EMS-to-Balloon within 90 min

Prehospital fibrinolysis:
EMS-to-Needle within 30 min

Total ischemic time: Within 120 min*

*Golden Hour = First 60 minutes
ACC 2004 STEMI
EKG Criteria for STEMI

• New (or presumed new) LBBB
• 0.1 mm ST elevation
  – 0.2mm V1-V4 may reduce false positive anteroseptal infarction
• 0.1 mm ST depression with tall R waves and upright T waves in V1-V4 (Posterior Infarct, V7-V8 may show ST elevation)
STEMI on EKG
Anterior Injury, 100% LAD occlusion
Anteroseptal Injury, 100% mid LAD occlusion
Posterior injury
Inferior Injury
Inferior Injury......
Right Ventricle Injury – 1mm ST elevation in V4R
Posterior Injury – 99% Circumflex, 90% RCA
Pericarditis – note PR depression in II
EKG Criteria for STEMI with pre-existing LBBB

- ST elevation greater than or equal to 0.1 mV in leads with a positive QRS
- ST depression greater than or equal to 0.1 mV in V1 to V3
- ST elevation greater than or equal to 0.5 mV in leads with a negative QRS
## Killip Class and Mortality

### Table 7. Percent Mortality by Killip Class*

<table>
<thead>
<tr>
<th>Killip Class</th>
<th>Killip and Kimball (Inhospital)</th>
<th>Fibrinolytic Trials (30 Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>6</td>
<td>7 (Placebo)</td>
</tr>
<tr>
<td>II</td>
<td>17</td>
<td>20 (Placebo)</td>
</tr>
<tr>
<td>III</td>
<td>38</td>
<td>39 (Placebo)</td>
</tr>
<tr>
<td>IV</td>
<td>81</td>
<td>70 (Placebo)</td>
</tr>
</tbody>
</table>

Class I = no rales, no S3; Class II = rales less than 50%; Class III = pulmonary edema; Class IV = cardiogenic shock.

*Values cited are subject to survivor bias.
†Highly selected group of patients.

Guideline Use of Biomarkers for STEMI

Class I
1. Cardiac-specific troponins should be used as the optimum biomarkers for the evaluation of patients with STEMI who have coexistent skeletal muscle injury. *(Level of Evidence: C)*

2. For patients with ST elevation on the 12-lead ECG and symptoms of STEMI, reperfusion therapy should be initiated as soon as possible and is not contingent on a biomarker assay. *(Level of Evidence: C)*

Class IIa
Serial biomarker measurements can be useful to provide supportive noninvasive evidence of reperfusion of the infarct artery after fibrinolytic therapy in patients not undergoing angiography within the first 24 hours after fibrinolytic therapy. *(Level of Evidence: B)*

Class III
Serial biomarker measurements should not be relied upon to diagnose reinfarction within the first 18 hours after the onset of STEMI. *(Level of Evidence: C)*
Management of STEMI

Class 1 Recommendations (in absence of Contraindication)

• Oxygen

• Nitroglycerin (in absence of hypotension or recent PDE-5 inhibitor use [24 hours viagra, levitra; 48 hours for cialis]

• Morphine (2-8mg IV q 5-15min)

• ASA (162-325mg, chewed)

• Beta Blocker (oral preferred vs IV)

• Reperfusion
PCI vs Lysis - Early

Figure 15. PCI versus lysis with fibrin-specific agents: is timing (almost) everything? RCT = randomized controlled trial; N = Number of patients; PCI = percutaneous coronary intervention. Modified from Nallamothu and Bates. Am J Cardiol 2003;92:824-6 (305). Copyright 2003, with permission from Excerpta Medica, Inc.
Choosing Lysis vs PCI

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

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

STEMI = ST-elevation myocardial infarction; PCI = percutaneous coronary intervention; ICH = intracranial hemorrhage.
*Applies to fibrin-specific agents (See Figure 15).
†Operator experience greater than a total of 75 Primary PCI cases/year.
‡Team experience greater than a total of 36 Primary PCI cases/year.
§This calculation implies that the estimated delay to the implementation of the invasive strategy is greater than one hour versus initiation of fibrinolytic therapy immediately with a fibrin-specific agent.
Absolute lytic contraindications

**Table 12. Contraindications and Cautions for Fibrinolysis in ST-Elevation Myocardial Infarction***

Absolute contraindications

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

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Relative contraindications

Relative contraindications

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

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Time to Balloon impacts mortality

Figure 22. Relationship between 30-day mortality and time from study enrollment to first balloon inflation. Patients assigned to angioplasty in whom angioplasty was not performed are also shown. PTCA = percutaneous transluminal coronary angioplasty. Reprinted with permission from Berger et al. Circulation 1999;100:14-20 (294).
Cardiogenic Shock

Early Shock, Diagnosed on Hospital Presentation
- Fibrinolytic therapy if all of the following are present:
  1. Greater than 90 minutes to PCI
  2. Less than 3 hours post STEMI onset
  3. No contraindications
- Arrange prompt transfer to invasive procedure-capable center

Delayed Onset Shock
- Echocardiogram to rule out mechanical defects
- Arrange rapid transfer to invasive capable center

IABP

Cardiac Catheterization and Coronary Angiography

1-2 vessel CAD
- PCI IRA
  - Staged Multivessel PCI

Moderate 3-vessel CAD
- PCI IRA
  - Staged CABG

Severe 3-vessel CAD
- Immediate CABG
  - Cannot be performed

Left main CAD

ACC 2004 STEMI
Basic Thrombolytic Therapy

• Given up to 12 hours after symptom onset
• Aspirin
• Fibrin Specific Lytics
  – rPA (10 units x 2, separated by 30 minutes)
  – tnK (weight based single bolus 30-50mg)
• Heparin (used with fibrin specific lytics)
  – 60 unit/kg bolus (NTE 4000 units)
  – 12 unit/kg/hour infusion (NTE 1000 units/hour)
  • Use for 24-48? Hours
• Plavix? (New data from Commit/Clarity trials)

ACC 2004 STEMI
Basic Primary PCI

• ASA

• Heparin
  – 50-70 unit/kg bolus with 2b-3a
    • Goal ACT 200-250 at time of PCI
  – 70-100 unit/kg bolus without 2b-3a
    • Goal ACT 250-300 at time of PCI

• Glycoprotein 2b-3a
  – Reopro preferred
    • (0.25mg/kg bolus, 0.125 mcg/kg/min infusion)

• Plavix
Ancillary medications

• ACE inhibitors
  – Oral ACE inhibitor, if BP allows, useful for anterior infarctions or LVEF <=40%; start within 24 hours of STEMI

• Aldosterone antagonists (eplerenone, aldactone)
  – Class 1 indication for Post MI LV dysfunction (LVEF <=40) AND either Diabetes or CHF

• Statins – not mentioned as initial treatment in guidelines
Faded Fads

- IV ACE inhibitor is discouraged
- IV insulin recommended only for hyperglycemia (GIK is out of favor)
- Magnesium useful to correct hypomagnesemia or empiric treatment of torsades (no routine supplementation)
- Sublingual nifedipine is contraindicated for all purposes
References