ACUTE CORONARY SYNDROMES

Part of "48 - Definitions of Acute Coronary Syndromes"

ACS is actually a unifying term representing a common end result, acute myocardial ischemia. Acute ischemia is usually, but not always, caused by atherosclerotic CAD and is associated with an increased risk of cardiac death and myonecrosis.4 It encompasses acute MI (both resulting in ST elevation or non-ST elevation) and unstable angina. The importance of recognizing a cardiac patient with ACS concerns both triage and management. Those deemed to have an ACS in the emergency department should be triaged immediately to an area with continuous electrocardiogram (ECG) monitoring and defibrillation capability. An ECG should be able to be obtained and accurately interpreted within 10 min. Moreover, those with suspected ACS should be managed immediately with antiplatelet and anticoagulant therapies and considered for immediate revascularization mechanically or pharmacologically if new ST elevation is noted.5

Because of the life-threatening nature of an ACS, it is prudent to have a low threshold in suspecting a patient with acute chest pain as potentially having an ACS. Because the efficient diagnosis and optimal management of these patients are derived from information mostly only readily available from initial clinical presentation, there is overlap of those with true ACS and those that ultimately do not have CAD as a cause of their cardiac symptoms. In addition, it may not be possible to differentiate patients with MI (either ST elevation or non-ST elevation) from those with unstable angina in the initial hours.

Nonetheless, proper initial triage of patients suspected to have acute coronary ischemia should eventually identify patients as having (1) ACS; (2) a non-ACS cardiovascular condition such as pericarditis, aortic dissection, or pulmonary embolism; (3) a noncardiac cause of chest pain such as gastroesophageal reflux; and (4) a noncardiac condition that is yet undefined.6 ACS patients with new evidence of ST-segment elevation on the presenting ECG are labeled as having an ST-segment elevation myocardial infarction (STEMI) and should be considered for immediate reperfusion therapy by thrombolytics or percutaneous coronary intervention (PCI). Those without ST-segment elevation but with evidence of myonecrosis are determined to have a non-ST-segment elevation myocardial infarction (NSTEMI); and those without any evidence of myonecrosis are diagnosed with unstable angina (Fig. 48-1).

FIGURE 48-1 Schematic representation of the causes of unstable angina. Each of the five bars represents one of the etiologic mechanisms, and the dark portion of the bar represents the extent to which the mechanism is operative. *A*. Most common form of unstable angina in which atherosclerotic plaque causes moderate (60 percent diameter) obstruction, and acute thrombus overlying plaque causes very severe (90 percent diameter) narrowing. *B*. Mild coronary obstruction, adjacent to which there is intense (90 percent vasoconstriction). (From Braunwald E: Unstable angina: An etiologic approach to management. *Circulation* 1998;98:2219–2222).

Definition of Unstable Angina

Unstable angina is usually secondary to reduced myocardial perfusion resulting from coronary artery atherothrombosis. In this event, however, the nonocclusive thrombus that developed on a disrupted atherosclerotic plaque does not result in any biochemical evidence of myocardial necrosis. Unstable angina and NSTEMI can be viewed as very closely related clinical conditions with similar presentations and pathogenesis but of differing severity.

Because of the lack of objective data associated with the condition, unstable angina (also known as preinfarction angina, intermediate coronary syndrome, or acute coronary insufficiency) must be diagnosed from careful history taking and is thus the most subjective of the ACS diagnoses. The Agency for Health Care Policy and Research (AHCPR) has published guidelines listing features that signify the likelihood of signs and symptoms suggestive of an ACS likely due to CAD (Table 48-1).7 There are 3 principal presentations of unstable angina: (1) rest angina or angina with minimal exertion usually lasting at least 20 min, (2) new-onset severe angina usually defined as within the last month, and (3) crescendo angina defined as previously diagnosed angina that has become distinctly more frequent, longer in duration, or more severe in nature.8

TABLE 48-1 Likelihood that Signs and Symptoms Represent an ACS Secondary to CAD

Feature	High Likelihood *Any of the following:*	Intermediate Likelihood *Absence of high-likelihood features and presence of any of the following:*	Low Likelihood *Absence of high- or intermediate-likelihood features but may have:*
History	Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina Known history of CAD, including MI	Chest or left arm pain or discomfort as chief symptom Age > 70 years Male sex Diabetes vascular	Probable ischemic symptoms in absence of any of the intermediate-likelihood characteristics Recent cocaine use
Examination	Transient MR, hypotension,	Extracardiac vascular disease	Chest discomfort reproduced by

	diaphoresis, pulmonary edema, or rales		palpation
ECG	New, or presumably new, transient, ST-segment deviation (≥ 0.05 mV) or T-wave inversion (≥ 0.2 mV) with symptoms	Fixed Q waves Abnormal ST segments or T waves not documented to be new	T-wave flattening or inversion in leads with dominant R waves Normal ECG
Cardiac markers	Elevated cardiac TnI, TnT or CK-MB	Normal	Normal

ABBREVIATIONS: ACS = acute coronary syndrome; CAD, coronary artery disease; CK-MB = creatine kinase-MB; ECG = electrocardiogram; MI = myocardial infarction; MR = mitral regurgitation; TnI = troponin I; TnT = troponin T.

SOURCE: Braunwald E, Mark DB, Jones RH, et al. Unstable angina: Diagnosis and management. Rockville, MD: Agency for Health Care Policy and Research and the National Heart, Lung, and Blood Institute, US Public Health Service, US Dept. of Health and Human Services; 1994:1. AHCPR Publication 94-0602.

Because of the heterogenous group of patients who fall under these loose definitions, many classification schemes have been

P.1216

proposed for unstable angina. While not devised precisely to help define unstable angina, the Canadian Cardiovascular Society (CCS) has developed an easy classification system to grade anginal symptoms (Table 48-2, see also Chap. 12).9 Class I angina is the least symptomatic and denotes that ordinary physical activity does not illicit anginal symptoms. Class II angina implies anginal symptoms that slightly impair ordinary activity such as walking and climbing stairs. For example, Class II angina would occur after walking more than 2 blocks on a level surface or climbing more than 1 flight of stairs. Class III angina is defined as symptoms that limit markedly ordinary physical activity. For example, symptoms that occur less than 1 block of walking on a level ground or less than 1 flight of stairs. Finally, Class IV angina is symptoms at rest or that cause an inability to carry on any physical activity without discomfort. The relevance of this classification system is exemplified in the definition of crescendo angina. Worsening angina can be defined as symptoms that result in at least 1 CCS Class increase or to at least CCS Class III severity.10

TABLE 48-2 Grading of Angina Pectoris According to CCS Classification (See also Chap. 12)

Class	Description of Stage
I	"Ordinary physical activity does not cause … angina," such as walking or climbing stairs. Angina occurs with strenuous, rapid, or prolonged exertion at work or recreation.
II	"Slight limitation of ordinary activity." Angina occurs on walking or climbing stairs rapidly; walking uphill; walking or stair climbing after meals; in cold, in wind, or under emotional stress; or only during the few hours after awakening. Angina occurs on walking >2 level blocks and climbing >1 flight of ordinary stairs at normal pace and under normal conditions.
III	"Marked limitation of ordinary physical activity." Angina occurs on walking 1 to 2 level blocks and climbing 1 flight of stairs under normal conditions and at a normal pace.
IV	"Inability to carry on any physical activity" without discomfort—anginal symptoms may be present at rest.

ABBREVIATION: CCS = Canadian Cardiovascular Society

Braunwald has developed a useful classification of unstable angina assessing risk.10 By differentiating the severity and clinical circumstances surrounding the presentation of unstable angina and considering also the presence or absence of ECG changes and the intensity of medical therapy, Braunwald has estimated the risk of death or MI at 1 year (Table 48-3). In terms of severity, Class I unstable angina is new onset or accelerated angina but with no rest pain. Class II presents with rest angina within the last month but not within the previous 48 h. Class III angina presents at rest and within the last 48 h or initial evaluation. In terms of clinical circumstances, Class A represents unstable angina in the setting of a secondary noncoronary cause of demand ischemia such as anemia, hypotension, or prolonged tachycardia. Class B is worsening primary CAD in the absence of extracardiac conditions. Class C is postinfarction unstable angina within 2 weeks of a documented MI. Furthermore, patients fared worse over the following 12 months if they presented with transient ST-T wave changes during pain and if they had angina despite

maximal anti-ischemic therapy. In summary, patients with a 48-h pain-free interval and the absence of ECG changes were at decreased risk while those with postinfarction angina and the need for maximal medical therapy have the highest risk of death or MI over the next 1 year after presentation with UA. The AHCPR has also published guidelines assessing the short-term risk of death or nonfatal MI in patients with unstable angina using similar clinical features (Table 48-4). It should be noted that an elevated level of a cardiac marker such as a troponin places the patient at high risk. These patients would now be considered to have an NSTEMI instead of high risk unstable angina.4

TABLE 48-3 Braunwald Classification of Unstable Angina

	CLINICAL CIRCUMSTANCES		
Severity	**A. Develops in Presence of Extracardiac Condition that Intensifies Myocardial Ischemia (Secondary UA)**	**B. Develops in Absence of Extracardiac Condition (Primary Unstable UA)**	**C. Develops within 2 Weeks After Acute MI (Post-infarct UA)**
I. New onset of severe angina or accelerated angina; no rest pain	IA	IB	IC
II. Angina at rest within last month, but not within preceding 48 h (angina at rest, subacute)	IIA	IIB	IIC
III. Angina at rest within 48 h (angina at rest, acute)	IIIA	IIIB	IIIC

ABBREVIATIONS: MI = myocardial infarction; UA = unstable angina.

TABLE 48-4 Short-Term Risk of Death or Nonfatal MI in Patients with UA

Feature	High Risk *At least 1 of the following features must be present:*	Intermediate Risk *No high-risk feature but must have 1 of the following:*	Low Risk *No high- or intermediate-risk feature but may have any of the following following:*
History	Accelerating tempo of ischemic symptoms in preceding 48 h	Prior MI, peripheral or cerebrovascular disease, or CABG, prior aspirin use	
Character of pain	Prolonged ongoing (> 20 min) rest pain	Prolonged (> 20 min) rest angina, now resolved, with moderate or high likelihood of CAD Rest angina (< 20 min) or relieved with rest or sublingual NTG	New onset or progressive CCS Class III or IV angina the past 2 weeks without prolonged (> 20 min) rest pain but with moderate or high likelihood of CAD (see Table 48-1)
Clinical findings	Pulmonary edema, most likely due to ischemia New or worsening MR murmur S_3 or new/worsening rales Hypotension, bradycardia, tachycardia	Age > 70 years	

	Age > 75 years		
ECG	Angina at rest with transient ST-segment changes > 0.05mV Bundle branch block, new or presumed new Sustained ventricular tachycardia	T-wave inversions > 0.2 mV Pathologic Q waves	Normal or unchanged ECG during an episode of chest discomfort
Cardiac markers	Elevated (e.g., TnT or TnI >0.1 ng/mL)	Slightly elevated (e.g., TnT > 0.01 but < 0.1 ng/mL)	Normal

ABBREVIATIONS: CABG = coronary artery bypass graft; CAD = coronary artery disease; ECG = electrocardiogram; MI = myocardial infarction; MR = mitral regurgitation; NTG = nitroglycerin; TnI = troponin I; TnT = troponin T; UA = unstable angina.

SOURCE: Braunwald E, Mark DB, Jones RH, et al. Unstable angina: Diagnosis and management, Rockville, MD: Agency for Health Care Policy and Research and the National Heart, Lung and Blood Institute. US Public Health Service, US Dept. of Health and Human Services; 1994:1. AHCPR Publication 94-0602.

As mentioned earlier while nonocclusive thrombus on a preexisting atherosclerotic plaque is the most common cause of unstable angina/NSTEMI, other causes may lead to acute coronary ischemia6 (Table 48-5 and Fig. 48-2). A less common cause is dynamic obstruction of an epicardial artery leading to intense focal spasm (Prinzmetal's angina). It is thought that this spasm is caused by hypercontractility of vascular smooth muscle and/or endothelial dysfunction. Abnormal constriction of small intramural resistance vessels can also lead to dynamic obstruction and acute ischemia. A third cause of unstable angina is severe mechanical obstruction without spasm or thrombus. An example would be restenosis after percutaneous coronary intervention (PCI) or some patients with progressive atherosclerosis. A fourth cause is arterial inflammation and/or infection. It is thought that chronic inflammation perhaps related to infection leads to activation of macrophages and T-lymphocytes at the shoulder of a vulnerable plaque and increased expression of metalloproteins resulting in distruption and rupture of the plaque. Finally, a fifth cause of unstable angina is alluded to in Braunwald's classification as unstable angina from a secondary cause. These patients generally have chronic stable CAD, which worsens due to

a noncoronary condition that increases myocardial oxygen demand such as fever or tachycardia, reduces coronary blood flow such as in hypotension, or reduces myocardial oxygen delivery such as hypoxemia or anemia. These causes are not mutually exclusive.

TABLE 48-5 Secondary Precipitants of Myocardial Ischemia

Increased Myocardial Oxygen Demand

1. Fever
2. Thyrotoxicosis
3. Tachycardia
4. Malignant hypertension
5. Pheochromocytoma
6. Aortic stenosis
7. High output state
8. Pregnancy
9. Drugs: cocaine, amphetamine

Decreased Oxygen Supply

1. Anemia
2. Hypoxemia
3. Carbon monoxide poisoning
4. Polycythemia vera
5. Hyperviscosity syndromes

FIGURE 48-2 Approach to suspected acute coronary syndrome. Tn = troponin.

Non-ST-Segment Elevation Myocardial Infarction

NSTEMI represents a clinical condition presenting very similarly to unstable angina but with evidence of myonecrosis by some form of

P.1217

cardiac markers without ST-segment elevation on ECG. Patients presenting with NSTEMI have an intermediate risk of acute complications when compared to unstable angina (lower risk) and STEMI-higher risk.11 Because evidence of myonecrosis is required, the diagnosis of NSTEMI is less subject to error than is unstable angina and requires more careful monitoring and aggressive therapy. In fact, the most important reason to differentiate true unstable angina from NSTEMI is in determining the ideal management strategy in the early hospitalization period. It is becoming more and more evident from large, randomized

multicenter clinical trials that early aggressive management with enhanced antiplatelet (clopidogrel and glycoprotein IIb/IIIa inhibitors) and earlier angiography/mechnical revascularization is superior to conservative traditional medical therapy and ischemia-guided revascularization12,13 and 14 (see Figure 48-2).

Because the diagnosis of NSTEMI implies ischemia severe enough to cause sufficient myocardial damage to release detectable quantities of a maker of myocardial injury, it is important to discuss the different cardiac markers of injury. Biochemical markers such as troponins, creatinine kinase, and myoglobin are useful for both the diagnosis of myonecrosis and prognostically.15 An ideal cardiac marker would be very specific to cardiac muscle and absent from nonmyocardial tissue. It would be released quickly into the peripheral blood after onset of injury and would measure quantitatively the magnitude of necrosis. Finally, the marker should be convenient and inexpensive to use.

Until recently creatine kinase (CK) activity has been the most widely used serum cardiac marker in the evaluation of ACS. Although this marker is very sensitive for detecting myocardial damage (average time to peak is 24 h and becomes initially elevated in 4 to 8 h after insult) and can accurately predict the magnitude of necrosis, several limitations do exist with this marker. CK levels are elevated in patients with muscle disease, alcohol intoxication, skeletal muscle trauma, seizures, vigorous exercise, thoracic outlet syndrome, and pulmonary embolism. Even the more cardiac muscle specific MB isoform may be present in the tongue, small intestine, uterus, and prostate.

Recent methods to improve specificity include measurement of CK-MB levels by specific enzyme immunoassays that use monoclonal

P.1218

antibodies directed against CK-MB (mass method) and by measuring CK-MB isoforms. The mass method of CK-MB levels has proved to be more accurate than traditional radioimmunoassay or agarose gel electrophoresis methods, especially in patients presenting within 4 h of injury.16 CK-MB isoforms exist in only 1 form in cardiac muscle ($CK\text{-}MB_2$) while they exist in different isoforms in the plasma ($CK\text{-}MB_1$). An absolute value of $CK\text{-}MB_2$ of greater than 1 U/L and a ratio of $CK\text{-}MB_2/CK\text{-}MB_1$ of greater than 2.5 has significantly improved the sensitivity of diagnosing myonecrosis at 6 h.17 However, these isoform assays are not readily available and are still limited by

P.1219

specificity issues concerning CK-MB levels in the heart versus other tissues.

Cardiac troponins represent a major clinical shift in the diagnosis of NSTEMI.18 The troponin complex consists of 3 subunits that regulate contraction of cardiac muscle: Troponin I (TnI), TnT, and TnC. Troponin C binds to calcium; TnI binds to actin and inhibits the actin-myosin interaction; TnT binds to tropomyosin, which attaches the troponin complex to the thin filament. Monoclonal antibody-based immunoassays have been developed to detect these cardiac-specific TnT and TnI. Because cardiac and smooth muscle share isoforms for TnC, no immunoassays of TnC have been developed to date. Because of the increased sensitivity and specificity of cardiac troponins relative to CK, it is estimated that up to 30 percent of patients who present with rest pain and normal CK-MB levels previously diagnosed with unstable angina actually can be reclassified as having NSTEMI when assessed with troponins.19 There has been some controversy as to whether

this subgroup of patients with negative CK-MB levels and minor elevations in troponins should be labeled as having high-risk unstable angina or NSTEMI. Some investigators have used the term *microinfarction*, or *minor myocardial damage*, to describe this situation.20 Similarly, there is controversy in labeling a patient with no significant ECG changes and a minor troponin elevation as having unstable angina or NSTEMI.

There is no disagreement concerning the utility of elevated cardiac troponin levels in establishing prognosis.21,22 Elevated levels indicate a high risk subgroup independent of ECG presentation and predischarge exercise testing.23 There is an incremental risk of death or MI in patients with elevated troponins that can be seen in a quantitative fashion, even in patients with chronic renal insufficiency.24 Even patients in whom CK-MB levels are within normal limits, troponin elevation signifies a higher risk of death than it does in those without elevation.25 It should be emphasized that cardiac troponins should be used only as one tool in the initial evaluation along with the history, physical exam (heart failure, hypotension, tachycardia, mitral regurgitation all portend a poor prognosis), and baseline ECG in making a diagnosis of ACS. Most patients with high-risk clinical and ECG features will have elevated troponin levels. Still, it has been documented that decompensated heart failure can elevate troponin levels, indicating that myocardial damage from any etiology may lead to elevated levels.26

It is of interest that the intravenous infusion of a glycoprotein IIb/IIIa inhibitor in the acute medical management of coronary ischemia is mostly beneficial in patients with elevated troponin levels.27,28 Furthermore, there are convincing data that early angiography and mechanical revascularization are superior to medical therapy in patients with NSTEMI and troponin elevation.12,13 and 14

Myoglobin is a low-molecular-weight heme protein found in both cardiac and skeletal muscle. While not specific for cardiac muscle, it is released rapidly (usually within 2 h) from necrotic myocardium after onset of injury. Levels are only elevated from 24 h limiting the period of use. Confirmation of myonecrosis should be made with a more specific marker such as cardiac troponins or CK-MB levels. Because of its high sensitivity, however, myoglobin measurements made within 4 to 8 h of symptom onset can be used to rule out an MI if normal levels are documented.29

The Diagnostic Marker Cooperative Study evaluated the role of these biochemical markers in the evaluation of ACS patients.30 This large, multicenter, randomized, double-blind study of patients suspected of an MI in the emergency department compared the

P.1220

P.1221

sensitivity and specificity of both cardiac troponin assays, CK-MB mass levels, CK-MB isoforms, and myoglobin for the diagnosis of myonecrosis. Within the first 6 h of symptom onset, CK-MB isoforms and myoglobin were the most efficient for diagnosis, whereas both cardiac troponins proved to be the most cardiac specific and were very useful for the late diagnosis of MI as their levels usually remain elevated for 7 to 14 days.

In summary, cardiac troponins have become the biochemical marker of choice in the evaluation of myonecrosis and the diagnosis of NSTEMI. Its superb sensitivity and specificity to cardiac muscle damage, in addition to its proven prognostic value, has

established its current clinical position. CK-MB levels by mass method remains a reliable technique to diagnose more than minor myocardial damage. CK-MB isoforms are particularly useful in detecting early myocardial damage. Because of its high sensitivity to detect myonecrosis, myoglobin levels can be used in the early hours after symptom onset to rule out MI. Table 48-6 summarizes the strengths and weaknesses of each cardiac marker (see also Chap. 51 and Chap. 52).

TABLE 48-6 Biochemical Cardiac Markers for the Evaluation and Management of Patients with Suspected ACS but W Segment Elevation of 12-Lead

Marker	Advantages	Disadvantages	Point of Care Test Available?	Comment	Clinic Reco
CK-MB	1. Rapid, cost-efficient, accurate assay 2. Ability to detect early reinfarction	1. Loss of specificity in setting of skeletal muscle disease or injury, including surgery 2. Low sensitivity during very early MI (<6 h after symptom onset) or later after symptom onset (>36 h) and for minor myocardial damage (detectable with troponins)	Yes	Familiar to majority of clinicians	Prior still a diagn most circur
CK-MB isoforms	1. Early detection of MI	1. Specificity profile similar to that of CK-MB 2. Current assays require special	No	Experience to date Predominantly in dedicated research centers	Used early symp detec cente demo famili assay

		expertise			
Myoglobin	1. High sensitivity 2. Useful in early detection of MI 3. Detection of reperfusion 4. Most useful in ruling out MI	1. Very low specificity in setting of skeletal muscle injury or disease 2. Rapid return to normal range limits sensitivity for later presentations	Yes	More convenient early marker than CK-MB isoforms because of greater availability of assays for myoglobin; Rapid-release kinetics make myoglobin useful for noninvasive monitoring of reperfusion in patients with established MI	
Cardiac troponins	1. Powerful tool for risk stratification 2. Greater sensitivity and specificity than CK-MB 3. Detection of recent MI up to 2 weeks after onset 4. Useful for selection of therapy 5. Detection of reperfusion	1. Low sensitivity in very early phase of MI (<6 h after symptom onset) and requires repeat measurement at 8-12 h, if negative 2. Limited ability to detect late minor reinfarction	Yes	Data on diagnostic performance and potential therapeutic implications increasingly available from clinical trails	Usefu test tc diagn (inclu myoc dama serial meas Clinic famili thems diagn used hospi

ABBREVIATIONS: ACS = acute coronary syndrome; CK-MB = creative kinase-MB; MI = myocardial infarction; N non-ST-segment elevation myocardial infarction.

Research continues on new biochemical cardiac markers for injury. For example, there has been much interest in documenting levels of inflammatory markers such as C-reactive protein (CRP), serum amyloid A, and interleukin-6 in patients with unstable angina.31,32 and 33 While there is hard evidence now that these inflammatory markers can help risk-

stratify patients with unstable angina/NSTEMI on presentation, they are not valid for diagnosing myonecrosis at this time. Levels of circulating soluble adhesion molecules such as E-selectin and intercellular adhesion molecule-1 are under investigation.34 Finally, markers of the coagulation cascade such as fibrinopeptide and fibrinogen levels appear to signify an increased risk of death in ACS patients.35,36 To reiterate, however, none of these markers is currently accepted as a biochemical means of demonstrating MI.

ST-Segment Elevation Myocardial Infarction

STEMI represents the most lethal form of ACS, one in which a completely occlusive thrombus results in total cessation of coronary blood flow in the territory of the occluded artery and the resultant ST-segment elevation on the ECG. Typically new Q waves evolve due to full or nearly full thickness necrosis of the ventricular wall supplied by the occluded artery. As this may only occur in up to 70 percent of patients and because a minority of patients without ST-segment elevation can eventually develop new Q waves, the nomenclature has changed from Q-wave MI to STEMI.37

The actual diagnosis of an STEMI does not completely rely on the ECG itself as the name might imply. The classic World Health Organization criteria for an acute MI requires that two of the following three elements be present: (1) a history suggestive of coronary ischemia for a prolonged period (>30 min), (2) evolutionary changes on serial ECGs suggestive of MI, and (3) a rise and fall in serum cardiac markers consistent with myonecrosis.38 Only 2 out of 3 criteria are needed because of the wide variability in the pattern of patient presentation with acute MI. It has been estimated that up to one-third of patients with STEMI do not describe classic chest pain.39 In contrast, due to the multitude of etiologies producing chest pain, objective evidence of myocardial necrosis is needed in order to confirm an MI. ST-segment elevation from noncoronary causes such as pericarditis, left ventricular hypertrophy, or J-point elevation must be differentiated from true myocardial ischemia

The accurate diagnosis of STEMI is of paramount importance for two reasons. First, the diagnosis mandates immediate consideration for reperfusion therapy, either by thrombolytic agents or by mechanical revascularization, most probably PCI. Mortality has been significantly decreased by reperfusion with 12 h of onset of symptoms in patients with STEMI.40 However, both pharmacologic and mechanical means of reperfusion have potentially fatal side-effects or complications and should not be employed unless diagnosis is relatively certain. In order to prevent unnecessary dangers, thrombolytic agents are only recommended for at least 2-mm ST-segment elevation in at least two contiguous leads in the precordium or at least 1-mm ST-segment elevation in two contiguous limb leads in addition to biochemical marker data and clinical history.41 It should be noted that a new left bundle branch block in the clinical setting of an acute MI also meets criteria for aggressive revascularization therapy with thrombolytic agents or by mechanical means.

Copyright (c) 2000-2004 *Ovid Technologies, Inc.*
Version: rel9.2.0, SourceID 1.9998.1.313