both short- and long-term mortality. Cognitive impairment may be significant in survivors, particularly those who are elderly.

PREVENTION

Prevention offers the best opportunity to reduce morbidity and mortality from severe sepsis. In developed countries, most episodes of severe sepsis and septic shock are complications of nosocomial infections. These cases might be prevented by reducing the number of invasive procedures undertaken, by limiting the use (and duration of use) of indwelling vascular and bladder catheters, by reducing the incidence and duration of profound neutropenia (<500 neutrophils/μL), and by more aggressively treating localized nosocomial infections. Indiscriminate use of antimicrobial agents and glucocorticoids should be avoided, and optimal infection-control measures (Chap. 168) should be used. Studies indicate that 50–70% of patients who develop nosocomial severe sepsis or septic shock have experienced a less severe stage of the septic response on at least one previous day in the hospital. Research is needed to identify patients at increased risk and to develop adjunctive agents that can modulate the septic response before organ dysfunction or hypotension occurs.

326 Cardiogenic Shock and Pulmonary Edema

Judith S. Hochman, David H. Ingbar

Cardiogenic shock and pulmonary edema are life-threatening conditions that should be treated as medical emergencies. The most common joint etiology is severe left ventricular (LV) dysfunction that leads to pulmonary congestion and/or systemic hypoperfusion (Fig. 326-1). **The pathophysiology of pulmonary edema and shock is discussed in Chaps. 47e and 324, respectively.**

CARDIOGENIC SHOCK

Cardiogenic shock (CS) is characterized by systemic hypoperfusion due to severe depression of the cardiac index (<2.2 [L/min]/m^2) and sustained systolic arterial hypotension (<90 mmHg) despite an elevated filling pressure (pulmonary capillary wedge pressure [PCWP] >18 mmHg). It is associated with in-hospital mortality rates >50%. The major causes of CS are listed in Table 326-1. Circulatory failure based on cardiac dysfunction may be caused by primary myocardial failure, most commonly secondary to acute myocardial infarction (MI) (Chap. 295), and less frequently by cardiomyopathy or myocarditis (Chap. 287), cardiac tamponade (Chap. 288), or critical valvular heart disease (Chap. 283).

Incidence The rate of CS complicating acute MI was 20% in the 1960s, stayed at ~8% for >20 years, but decreased to 5–7% in the first decade of this millennium largely due to increasing use of early reperfusion therapy for acute MI. Shock is more common with ST elevation MI (STEMI) than with non-ST elevation MI (Chap. 295).

LV failure accounts for ~80% of cases of CS complicating acute MI. Acute severe mitral regurgitation (MR), ventricular septal rupture (VSR), predominant right ventricular (RV) failure, and free wall rupture or tamponade account for the remainder.

Pathophysiology CS is characterized by a vicious circle in which depression of myocardial contractility, usually due to ischemia, results in reduced cardiac output and arterial blood pressure (BP), which result in hypoperfusion of the myocardium and further ischemia and depression of cardiac output (Fig. 326-1). Systolic myocardial dysfunction reduces stroke volume and, together with diastolic dysfunction, leads to elevated LV end-diastolic pressure and PCWP as well as to pulmonary congestion. Reduced coronary perfusion leads to worsening ischemia and progressive myocardial dysfunction and a rapid downward spiral, which, if uninterrupted, is often fatal. A systemic inflammatory response syndrome may accompany large infarctions and shock. Inflammatory cytokines, inducible nitric oxide synthase, and excess nitric oxide and peroxynitrite may contribute to the genesis of CS as they do to that of other forms of shock (Chap. 324). Lactic acidosis and hypoxemia from CS contribute to the vicious circle by worsening myocardial ischemia and hypotension. Severe acidosis reduces the efficacy of endogenous and exogenously administered catecholamines. Refractory sustained ventricular or atrial tachyarrhythmias can cause or exacerbate CS.

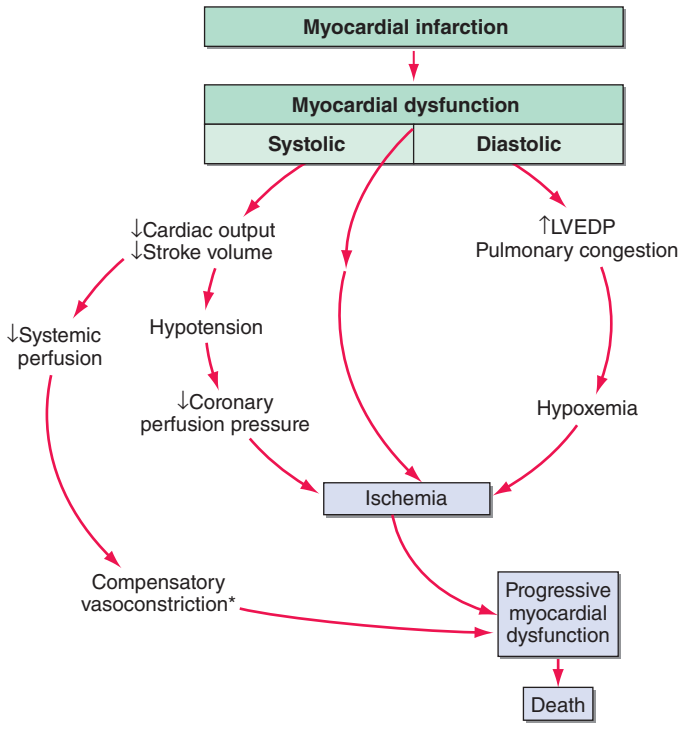

FIGURE 326-1 Pathophysiology of cardiogenic shock. Systolic and diastolic myocardial dysfunction results in a reduction in cardiac output and often pulmonary congestion. Systemic and coronary hypoperfusion occur, resulting in progressive ischemia. Although a number of compensatory mechanisms are activated in an attempt to support the circulation, these compensatory mechanisms may become maladaptive and produce a worsening of hemodynamics. *Release of inflammatory cytokines after myocardial infarction may lead to inducible nitric oxide expression, excess nitric oxide, and inappropriate vasodilation. This causes further reduction in systemic and coronary perfusion. A vicious spiral of progressive myocardial dysfunction occurs that ultimately results in death if it is not interrupted. LVEDP, left ventricular end-diastolic pressure. *(From SM Hollenberg et al: Ann Intern Med 131:47, 1999.)*

Patient Profile Older age, female sex, prior MI, diabetes, anterior MI location, and extensive coronary artery stenoses are associated with an increased risk of CS complicating MI. Shock associated with a first inferior MI should prompt a search for a mechanical cause. CS may rarely occur in the absence of significant stenosis, as seen in LV apical ballooning/Takotsubo's cardiomyopathy.

Timing Shock is present on admission in only one-quarter of patients who develop CS complicating MI; one-quarter develop it rapidly thereafter, within 6 h of MI onset. Another quarter develop shock later on the first day. Subsequent onset of CS may be due to reinfarction, marked infarct expansion, or a mechanical complication.

Diagnosis Due to the unstable condition of these patients, supportive therapy must be initiated simultaneously with diagnostic evaluation (Fig. 326-2). A focused history and physical examination should be performed, blood specimens sent to the laboratory, and an electrocardiogram (ECG) and chest x-ray obtained.