



**FIGURE 326-2** The emergency management of patients with cardiogenic shock, acute pulmonary edema, or both is outlined.

\*Furosemide: <0.5 mg/kg for new-onset acute pulmonary edema without hypervolemia; 1 mg/kg for acute on chronic volume overload, renal insufficiency. †For management of bradycardia and tachycardia, see [Chaps. 274 and 276](#). Additional information can also be found in Section 9.5 of the 2013 American College of Cardiology Foundation/American Heart Association Guidelines for Management of ST-Elevation Myocardial Infarction and Figures 3 and 4 of the 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 8: Adult Advanced Cardiovascular Life Support. \*Indicates modification from published guidelines. ACE, angiotensin-converting enzyme; BP, blood pressure; MI, myocardial infarction. (Modified from *Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 7: The era of reperfusion: Section 1: Acute coronary syndromes [acute myocardial infarction]. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation 102:172, 2000.*)

with several etiologies of circulatory shock. Although it did not significantly improve survival compared to dopamine, its relative safety suggests that norepinephrine is reasonable as initial vasopressor therapy. Norepinephrine should be started at a dose of 2 to 4  $\mu\text{g}/\text{min}$  and titrated upward as necessary. If systemic perfusion or systolic pressure cannot be maintained at >90 mmHg with a dose of 15  $\mu\text{g}/\text{min}$ , it is unlikely that a further increase will be beneficial.

*Dopamine* has varying hemodynamic effects based on the dose; at low doses ( $\leq 2 \mu\text{g}/\text{kg}$  per min), it dilates the renal vascular bed, although its outcome benefits at this low dose have not been demonstrated conclusively; at moderate doses (2–10  $\mu\text{g}/\text{kg}$  per min), it has positive chronotropic and inotropic effects as a consequence of  $\beta$ -adrenergic receptor stimulation. At higher doses, a vasoconstrictor effect results from  $\alpha$ -receptor stimulation. It is started at an infusion rate of 2–5  $\mu\text{g}/\text{kg}$  per min, and the dose is increased every 2–5 min to a maximum of 20–50  $\mu\text{g}/\text{kg}$  per min. *Dobutamine* is a synthetic sympathomimetic amine with positive inotropic action and minimal positive chronotropic activity at low doses (2.5  $\mu\text{g}/\text{kg}$  per min) but moderate chronotropic activity at higher doses. Although the usual dose is up to 10  $\mu\text{g}/\text{kg}$  per min, its vasodilating activity precludes its use when a vasoconstrictor effect is required.

### MECHANICAL CIRCULATORY SUPPORT

Circulatory assist devices can be placed percutaneously or surgically and can be used to support the left, right, or both ventricles. Venoarterial extracorporeal membrane oxygenation (VA ECMO, a pump in combination with an oxygenator) may be used when respiratory failure accompanies biventricular failure. Temporary percutaneous devices can be used as a bridge to surgically implanted devices in community hospital settings or when neurologic status is uncertain. The most commonly used device is an intraaortic balloon pump (IABP), which is inserted into the aorta via the femoral artery and provides temporary hemodynamic support. However, routine IABP use in conjunction with early revascularization (predominantly with percutaneous coronary intervention [PCI]) did not reduce 30-day mortality in the IABP-SHOCK II trial. Although other percutaneous devices, including VA ECMO, result in better hemodynamic support compared to IABP, the effects on clinical outcomes are unknown. Surgically implanted devices can support the circulation as bridging therapy for cardiac transplant candidates or as destination therapy ([Chap. 281](#)). Assist devices should be used selectively in suitable patients in consultation with advanced heart failure specialists.