Integrating Interventional Cardiology and Heart Failure Management for Cardiogenic Shock

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KEYWORDS

• Interventional heart failure • Mechanical circulatory support • Heart team • Cardiogenic shock

KEY POINTS

- Cardiogenic shock remains a major clinical problem with high rates of in-hospital mortality that have not changed significantly over the past 3 decades.
- The primary objectives when managing cardiogenic shock include providing (1) circulatory support, (2) ventricular unloading, and (3) coronary perfusion.
- The use of percutaneous acute mechanical circulatory support (AMCS) has steadily grown in the last decade.
- Four primary AMCS device platforms are clinically available for hemodynamic support and include (1) the intra-aortic balloon pump (IABP), (2) TandemHeart (TandemLife, Pittsburgh, PA), (3) centrifugally driven venoarterial extracorporeal membrane oxygenation (VA-ECMO), and (4) microaxial flow catheters (Impella, Abiomed, Danvers, MA).
- Interventional heart failure (IHF) is an emerging specialty within cardiology.

THE SPECTRUM OF ADVANCED HEART FAILURE AND CARDIOGENIC SHOCK

Cardiogenic shock remains a major clinical problem with high rates of in-hospital mortality that have not changed significantly over the past 3 decades.[1–3] One potential explanation for the lack of progress in the management of cardiogenic shock is that the profile of patients presenting with cardiogenic shock has changed. In the late 1980s, the SHOCK trial (Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock) highlighted the beneficial impact of early revascularization on long-term outcomes among patients with acute myocardial infarction (AMI) complicated by cardiogenic shock.[4] For this reason, more patients are surviving AMI and shock, which has contributed to the growing population of patients with advanced heart failure.[5] Recent projections estimated that more than 8 million individuals in the United States alone will be diagnosed with heart failure.[6] As a result, more patients currently presenting with cardiogenic shock tend to be older, have more comorbidities, and have preexisting cardiovascular disease, including prior myocardial infarction or heart failure.[7] This new complex profile of

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cardiogenic shock requires a more comprehensive management approach that involves both interventional cardiologists and advanced heart failure cardiologists.

CHANGING OBJECTIVES FOR THE MANAGEMENT OF CARDIOGENIC SHOCK

Three primary objectives when managing cardiogenic shock include providing (1) circulatory support, (2) ventricular unloading, and (3) coronary perfusion (Fig. 1). The sequence of achieving these 3 objectives must be tailored to each patient. Although early revascularization for cardiogenic shock secondary to AMI remains an important therapeutic objective, a recent analysis of patients with ST segment elevation myocardial infarction (STEMI) failed to identify any incremental reduction in in-hospital mortality with door-to-balloon reperfusion times less than 90 minutes.[8] These data suggest that timely coronary reperfusion alone may be insufficient to reduce mortality associated with cardiogenic shock and that other therapeutic objectives may take priority depending on the clinical scenario. For example, a patient with profound hypoperfusion due to low cardiac output in the setting STEMI may not benefit from immediate coronary reperfusion but instead may require stabilization of their mean arterial pressure (circulatory support) and a reduction in cardiac filling pressures before reperfusion. Typically, physicians start vasopressors and inotropes, which may partially achieve these objectives but at the cost of reducing end-organ microvascular perfusion and forcing the heart to work harder. The net result is more myocardial oxygen consumption and potentially worse myocardial ischemia. In contemporary clinical practice, the 3 objectives of shock management can be achieved using AMCS pumps.

MECHANICAL CIRCULATORY SUPPORT: INTERVENTIONAL TOOLS FOR COMPLEX HEART FAILURE AND SHOCK

In contrast to the IABP, the rotary flow pumps that can achieve these objectives include both intracorporeal axial-flow (Impella, Abiomed) and extracorporeal centrifugal flow (TandemHeart, TandemLife) pumps that can directly reduce ventricular filling pressures while increasing mean arterial pressure within minutes of activation.[9] The TandemHeart left ventricular (LV) support pump requires a trans-septal puncture and diverts blood from the left atrium to the femoral artery using 2 large-bore cannulas. The Impella pump is a transvalvular pump that diverts blood from the left ventricle to the aorta. In contrast to the TandemHeart LV pump, the Impella series of pumps can be implanted via the femoral, brachial, or axillary approach. Access via the brachial or axillary approach allows for increased patient mobility, which becomes critically important when managing patients in shock awaiting myocardial recovery, a decision to advanced therapies, or palliation. Under emergent conditions, both the Impella and TandemHeart devices may be deployed quickly; however, emergent trans-septal puncture is not commonly performed in most centers. VA-ECMO is another support option that pumps

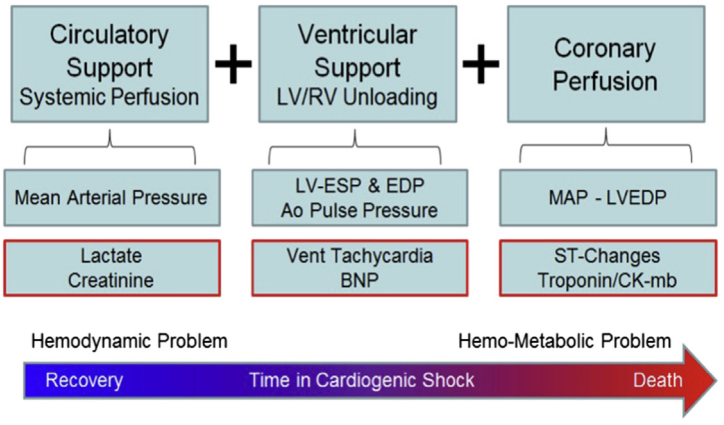

Fig. 1. Illustration of the acute hemodynamic support equation. Circulatory support is defined by an increase in mean arterial pressure. Ventricular support is defined by a reduction in LV pressure and volume, thereby reducing myocardial wall stress and oxygen demand. Coronary perfusion is defined by an increase in the transmyocardial gradient, which is determined by the difference between coronary arterial and LV end-diastolic pressure. The net effect of optimal hemodynamic support is increased urine output, reduced serum lactate, reduced pulmonary capillary wedge pressure, resolution of ischemic electrocardiographic changes, and reduced levels of myocardial injury biomarkers, such as creatine kinase–MB. An ideal mechanical circulatory support device would target all elements of the hemodynamic equation and prove safe and easy to use in the acute setting. Ao, aortic; BNP, brain natriuretic peptide; CK-MB, Creatine Kinase-MB; EDP, end-diastolic pressure; ESP, end-systolic pressure; MAP, mean arterial pressure.