Mechanical Circulatory Support

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KEYWORDS

- Mechanical circulatory support • Intra-aortic balloon pump
- Ventricular assist device • Extracorporeal membrane oxygenation (ECMO)
- Cardiogenic shock

KEY POINTS

- The routine use of an intra-aortic balloon pump is no longer recommended for patients with refractory cardiogenic shock.
- Common ventricular assist device (VAD) complications include thrombosis, bleeding, right-sided heart failure, infection, cerebral vascular accidents, arrhythmias, and device failure.
- Driveline infection is the most common infectious complication for the patient with a VAD.
- Ventricular arrhythmias are most common within the first 3 months after VAD placement and should be cardioverted in a timely fashion.
- Venoarterial ECMO is a treatment modality that can be considered in the patient with refractory cardiogenic shock or cardiac arrest from a reversible cause.

INTRODUCTION

Mechanical circulatory support, a term that most emergency physicians did not concern themselves with 10 years ago, is now an area of patient care that emergency physicians must understand. The role of mechanical support for both acute and chronic heart failure is rapidly growing. For example, as of April 2012 more than 10,000 HeartMate (Pleasanton, CA, USA) left ventricular assist devices (LVADs) had been implanted, yet only a handful of the patients who received these devices will go on to receive a heart transplant.[1] Most of these patients will never receive a transplant and will spend most of their time receiving outpatient care. The use of extracorporeal membrane oxygenation (ECMO) for refractory cardiogenic shock and cardiac

Funding Sources: Nothing to disclose.
Conflict of Interest: Nothing to disclose.
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Emerg Med Clin N Am 32 (2014) 851–869
http://dx.doi.org/10.1016/j.emc.2014.07.009 **emed.theclinics.com**
0733-8627/14/$ – see front matter

arrest is also rapidly growing. As of January 2013, more than 200 centers provide some type of extracorporeal support and more than 4200 cardiac patients have been treated by extracorporeal cardiopulmonary resuscitation (CPR).[2]

This review has several purposes: (1) to discuss the use of the intra-aortic balloon pump (IABP) in patients with cardiogenic shock, (2) to describe the complications and management strategies for the critically ill patient with an LVAD, and (3) to explore the emerging role of ECMO in the emergency department for patients presenting in cardiac arrest.

IABP

The IABP has classically been regarded as the mainstay of mechanical support for patients in cardiogenic shock (CS). This device provides hemodynamic support by augmenting diastolic arterial blood pressure during the normal cardiac cycle. By increasing diastolic blood pressure, IABP counterpulsation is believed to improve coronary perfusion, reduce myocardial oxygen demand, and reduce left ventricular afterload during systole.[3] IABP therapy is the most widely used form of mechanical hemodynamic support in patients with CS secondary to acute myocardial infarction.[4] Historically, American and European guidelines have recommended the use of IABP therapy, giving it a class IB and class IC recommendation, respectively.[5,6] However, an emerging body of literature questions the outcome and mortality benefits of IABP therapy for CS associated with acute myocardial infarction (AMI).[7–9] As a result, American and European guidelines have downgraded the use of IABP therapy to class IIa and IIb recommendations, respectively.[10–13]

Despite the recent controversy surrounding the routine use of IABP therapy, it is important for the emergency physician to be aware of the traditional indications for an IABP, the mechanisms of support, and the contraindications. The traditional indications for IABP insertion include refractory CS caused by AMI, refractory unstable angina, and mechanical causes, such as acute mitral regurgitation, papillary muscle rupture, and ventricular septal defect. Generally accepted contraindications to counterpulsation therapy are aortic insufficiency, aortic dissection, and chronic end-stage heart failure with no anticipation of recovery.

The device consists of a double-lumen 8.0-French to 9.5-French catheter with a 25-mL to 50-mL balloon at the distal end. The IABP catheter is inserted percutaneously using a Seldinger technique through the femoral artery. Traditionally, the IABP balloon is placed after measuring the distance from the insertion point to the manubrium, followed by confirmation with a chest radiograph, or alternatively it can be placed under direct fluoroscopic guidance. Ultrasound is also being used to guide tube placement at some centers.[14] The balloon itself is positioned 2 to 3 cm distal to the left subclavian artery and is inflated during the diastolic portion of the cardiac cycle.

Evidence behind the use of IABP therapy for refractory CS has historically been mixed, especially for CS secondary to myocardial infarction. There is some evidence that IABP therapy reduces preoperative mortality in a subset of patients, including those with CS secondary to acute mitral regurgitation or a ventricular septal defect after myocardial infarction.[15] The routine use of IABP therapy in refractory CS has fallen out of favor. A meta-analysis performed on the use of IABP in ST-elevation myocardial infarction (STEMI) found insufficient evidence to routinely recommend this therapy.[16] These findings were followed by the IABP Shock-II Trial, a multicenter, randomized, prospective study,[8,9] which found no significant reduction in short-term (30-day) or long-term (12-month) all-cause mortality for patients in CS related to AMI undergoing early revascularization. Despite these observations, a small subset of patients,