Mechanical Circulatory Support in Acute Decompensated Heart Failure and Shock

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KEYWORDS

• Interventional management • Cardiogenic shock • Decompensated heart failure
• Intraaortic balloon pump • TandemHeart • Extracorporeal membrane support

KEY POINTS

- In the current era, failure of maximal medical therapy is no longer a justifiable endpoint given the array of available advanced mechanical options.
- Deciding which mechanical device is most suitable depends largely on the degree of support needed.
- These temporary support devices, if implemented in a timely fashion, can often bridge patients to decision, recovery, long-term support devices (ventricular assist devices [VADs] and total artificial heart), and/or heart transplant.

INTRODUCTION

Approximately 6 million adults in the United States have congestive heart failure. Many of these patients, at some point in their care and evaluation, pass through a cardiac catheterization laboratory.[1] The emerging subspecialty of "interventional heart failure" has arisen due to this expanding patient population who require expertise in not only the pathophysiology but also the practical application and implementation of mechanical therapeutics to improve such hemodynamics, particularly once refractory to optimal medical management (Fig. 1).[2,3] An array of interventional therapeutics is available in the modern era, with uses depending on acute or chronic situations (Fig. 2). This article focuses on support in acute decompensated heart failure and cardiogenic shock, including intra-aortic balloon pumps (IABPs), continuous aortic flow augmentation, and extracorporeal membrane oxygenation (ECMO).

INTRA-AORTIC BALLOON PUMP

Introduction and Components

The IABP has grown to be the most widely used hemodynamic support device since its introduction in the 1960s.[4] This device uses the counterpulsation of a balloon in the descending aorta to improve cardiac output and increase coronary perfusion. The system comprises a dual-lumen 7.5F to 8.0F catheter with a polyethylene balloon and the control console. The inner catheter lumen accepts the guide wire during placement and transduces aortic pressure for monitoring. The gas lumen serves as the conduit for the rapid exchange of helium in and out of the balloon. Helium has low viscosity and is absorbed rapidly in blood if the balloon inadvertently ruptures.

Hemodynamic Effects

The hemodynamic consequences of counterpulsation can be organized into those that occur during inflation and those during deflation

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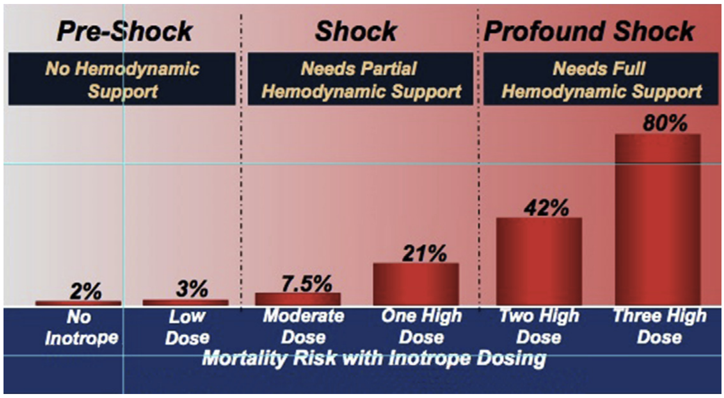

Fig. 1. The emerging subspecialty of "interventional heart failure" has arisen due to the expanding patient population who requires expertise in not only the pathophysiology but the practical application and implementation of mechanical therapeutics to improve such hemodynamics, particularly once refractory to optimal medical management, which forebodes incredible mortality. (*Adopted from* Samuels LE, Kaufman MS, Thomas MP, et al. Pharmacological criteria for ventricular assist device insertion following postcardiotomy shock: experience with the Abiomed BVS system. J Card Surg 1999;14(4):288–93.)

(Fig. 3). Inflation occurs at the onset of diastole and causes a displacement of blood that increases the diastolic pressure in the aorta. There is a resulting increase in systemic mean arterial pressure and cardiac output as well as an improvement in coronary perfusion. Balloon deflation is timed to occur immediately prior to systole, leading to an abrupt drop in aortic pressure just prior to ventricular ejection. This reduces the ventricular afterload and leads to

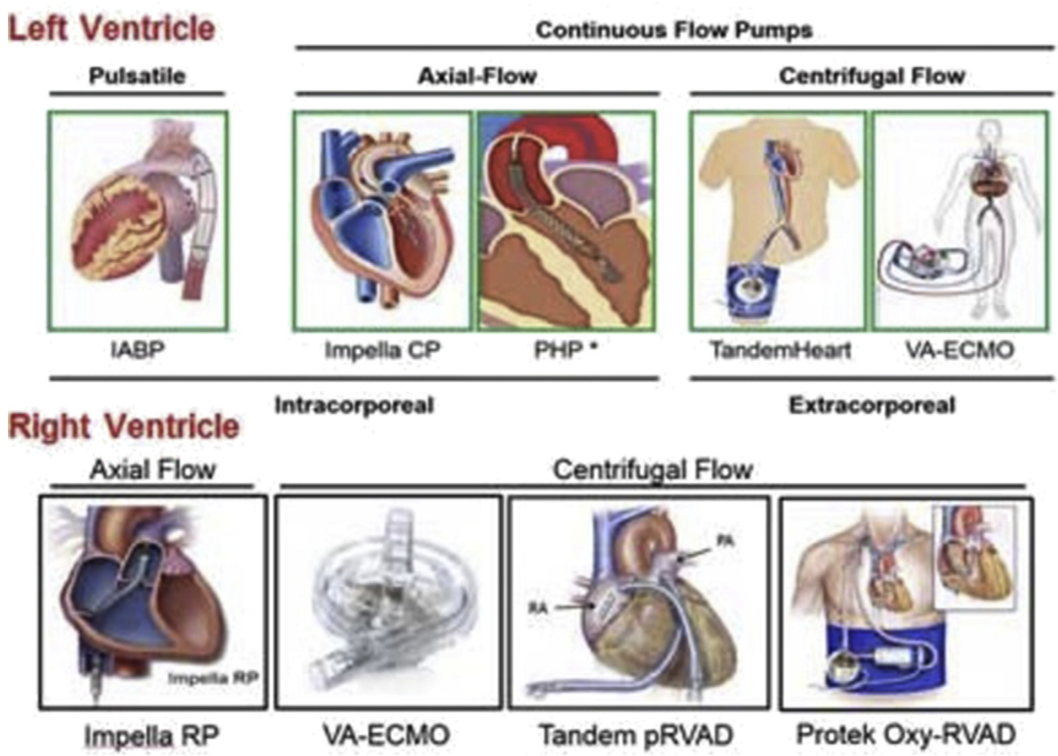

Fig. 2. The array of mechanical support options for LV failure and RV failure, respectively. (*Data from* Kapur NK, Esposito ML. Door to unload: a new paradigm for the management of cardiogenic shock. Curr Cardiovasc Risk Rep 2016;10:41.)