Left Ventricular Assist Device Management and Complications

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KEYWORDS

• Heart failure • Left ventricular assist device • Complications • Post-LVAD

KEY POINTS

- Mechanical assist devices have emerged as one of the main therapies of advanced heart failure.
- Patients on long-term LVAD support present unique challenges in the intensive care unit.
- Managing patients on mechanical circulatory support require basic understanding of the physiology and characteristics of the devices and awareness of its complications.

Heart failure (HF) is one of the most frequent medical diagnoses, with more than 650,000 new patients with HF diagnosed annually and more than 5 million persons in the United States currently suffering from HF.[1] HF is a very common cause for hospital admissions in the United States, with more than 37.5 million hospitalizations during the years 2001 to 2009.[2]

Patients with advanced HF suffer from severe circulatory compromise and require special care, including heart transplantation, mechanical assist device, inotropes, and hospice. These patients are very ill, suffering from significant HF symptoms during rest or mild exercise, and their prognosis without therapy is unfavorable, with life expectancy of less than 2 years.[3]

Heart transplantation remains the definitive therapy for advanced HF. However, because of the lack of organ supply and the substantial increase in the prevalence of HF, durable mechanical assist devices have emerged as one of the main therapies of advanced HF. Inotrope therapy can be given as an inpatient or outpatient therapy. Despite an improvement in symptoms, these drugs can foreshorten life.[4,5] Thus, inotropes should be given only as a bridge to definite advanced HF therapy (long-term mechanical support or transplantation), and only rarely as definite therapy for palliation.[3]

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VENTRICULAR ASSIST DEVICES

A ventricular assist device (VAD) is a mechanical circulatory device that is used to partially or completely replace the function of a failing heart. The first-generation devices, the HeartMate I and Novacor, had pulsatile flow, trying to mimic the normal blood flow that the heart produces. These devices were shown to increase survival and quality of life of patients with end-stage HF compared with optimal medical therapy but had clear limitations. The primary limitation was the lack of durability noted across all the first-generation devices.[6] The pulsatile LVAD was approved in 1994 by the US Food and Drug Administration (FDA) as a bridge to heart transplantation and subsequently, in 2003 for those not eligible for transplantation as destination therapy (DT). The second-generation and third-generation devices, which are currently being used (mainly, HeartMate II and HeartWare), have continuous flow patterns, generating up to 10 L a minute. The HeartMate II trial[7] compared the treatment with continuous flow devices with the first-generation pulsatile flow devices. The results showed that continuous flow LVAD improved the primary end point of survival free from stroke and device failure at 2 years compared with a pulsatile device. In addition, patients with continuous flow devices had better survival rates after 2 years. The success of these devices is reflected in the number of implantations. Since FDA approval in 2006 of the first continuous flow device, more than 6000 implants have been reported in our national registry. Worldwide, more than an estimated 18,000 continuous flow devices have been implanted, and the number keeps increasing exponentially. Thus, the likelihood that the critical care physician will encounter one of these patients is becoming higher.

The physiologic basis and sequelae of circulatory support with a continuous flow device are not fully understood. As blood moves through the systemic circulation, the pulsatile flow in the aorta is progressively decreased, transforming into continuous flow at the level of the capillary (**Fig. 1**). This process suggests that a pattern of pulsatile flow may not be necessary for an end-organ to remain fully viable with adequate perfusion.[8] It is important for clinicians to recognize that left-sided continuous flow devices produce some pulsatility. This situation is because the flow of the device is influenced by the remnants of native left ventricular (LV) contractility, and all determinants that affect LV preload, such as right ventricular (RV) function and volume depletion, affect the pulsatility.

VADs may serve the RV (RVAD), LV (LVAD), or both (BiVAD). The LVAD configuration is the most common in the current era. Most devices are being developed and

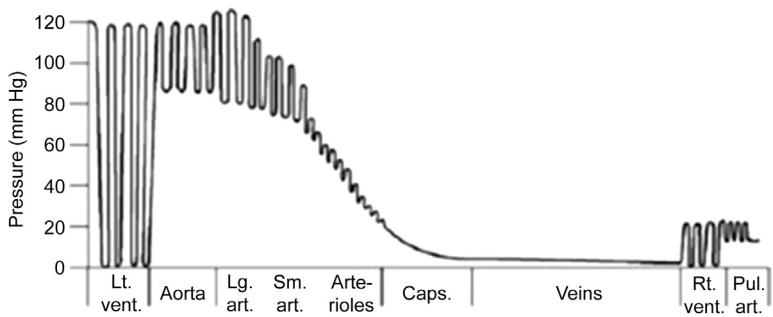

Fig. 1. The flow pattern in the blood vessels. Caps, capillaries; Lg art, large artery; Lt vent, left ventricle; Pul Art, pulmonary artery; Rt vent, right ventricle; Sm art, small artery. (*From* Sayer G, Naka Y, Jorde UP. Ventricular assist device therapy. Cardiovasc Ther 2009;27(2):142; with permission.)