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Sedation and anesthetic considerations in ambulatory endoscopy for patients with ventricular assist devices

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ABSTRACT

The number of patients with left ventricular assist devices (LVADs) implanted for heart failure continues to grow each year. Despite the survival and quality-of-life benefit LVADs can afford, adverse events do occur. Gastrointestinal bleeding is a known complication associated with continuous-flow LVADs, and many LVAD patients undergo endoscopic procedures to evaluate for sources of gastrointestinal bleeding. As the number of these patients increases, the approach to caring for them evolves. They present a number of challenges to the endoscopy team, including preprocedural planning, resource and personnel allocation, and postprocedural disposition.

1. Introduction

Heart failure affects an estimated 5.7 million American adults, with an incidence of 870,000 new cases yearly [1]. Mortality is high in this population, (50% mortality within 5 years of diagnosis). Left ventricular assist devices (LVADs) have been shown to provide both survival and quality-of-life benefit in patients with advanced heart failure, and the implantation of these devices has continued to grow over the past decade [1]. Survival, quality of life, and adverse event rates are improved with the current generation of devices compared to the previous generation, and increasing numbers of LVAD patients present for noncardiac procedures. Survival with continuous-flow LVADs is 80% at 1 year and 70% at 2 years [2]. Despite reduced adverse event rates in modern LVADs, the risk of bleeding complications, including gastrointestinal bleeding (GIB), continues. Endoscopy plays a major role in the evaluation and management of LVAD patients with GIBs. LVAD patients may also increasingly present for endoscopy procedures unrelated to GIBs; however, literature on this patient population is sparse, and management may need to be extrapolated from the experience in LVAD patients presenting for endoscopy to manage GIBs.

LVAD patients undergoing endoscopy present several challenges regarding preprocedural planning, intraprocedural management, postprocedural disposition, and resource allocation (Table 1). As the experience with these patients grows, the approach to their management has continued to evolve. The purpose of this article is to summarize these management topics regarding the current generation of continuous-flow durable LVADs in an ambulatory endoscopy setting.

2. Current left ventricular assist devices

The Interagency Registry for Mechanically Assisted Circulatory Support reports over 13,000 LVADs implanted from 2006-2014 [2]. Most of the devices implanted since 2008 has been continuous-flow devices. Durable continuous-flow LVADs approved in the United States for implantation in adults are the HeartMate II Left Ventricular Assist System (Thoratec Corporation, Pleasanton, CA) and the HeartWare HVAD Left Ventricular Assist System (HeartWare International, Framingham, MA).

The HeartMate II is an axial-flow device that received Food and Drug Administration (FDA) approval for bridge-to-transplant in 2008 and for destination therapy in 2010 [3]. It uses a magnetic rotor to draw blood from the left ventricle through an inflow conduit into the device pump and to pump blood out to the ascending aorta via the outflow conduit [4]. The pump is implanted beneath the diaphragm outside the abdomen in a preperitoneal pocket or in the abdomen (intraperitoneal placement). A percutaneous lead connects the implanted device to external components (eg, system controller, monitor, and power sources).

The HeartWare HVAD received Food and Drug Administration approval for bridge-to-transplant in 2012, with clinical trials ongoing to evaluate the device for destination therapy [3]. Like

This article focuses on the current state of LVAD technology and implications for endoscopic procedures, anesthetic considerations, and periprocedural planning.

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Table 1
Periprocedural considerations.

Preprocedural
Preprocedural evaluation by multidisciplinary LVAD team
Anticoagulation management
Cardiovascular implantable electronic device management (sources of electromagnetic interference)
LVAD personnel availability for procedure
Intraprocedural
Anesthesia choice (general anesthesia vs sedation)
Intraprocedural monitoring (noninvasive and invasive)
Management of hemodynamic changes (preload, afterload, contractility, rhythm disturbances, and LVAD suction events)
Device management
Postprocedural
LVAD personnel availability for recovery area
Postprocedural monitoring

the HeartMate II, the HeartWare HVAD uses a magnetic rotor to move blood from the left ventricle into the ascending aorta. Distinguishing features include centrifugal-flow pump design and a smaller pump housing that is implanted within the pericardium [5]. A percutaneous driveline analogous to the HeartMate II percutaneous lead connects the implanted device to external components.

In addition to the HeartMate II and the HeartWare HVAD, each company has new continuous-flow durable LVADs in ongoing clinical trials, with features to decrease pump size and shear stress to formed blood elements. A number of devices are also available for short-term or intermediate-term support of the left and right ventricle (RV)—usually placed for bridge-to-transplant or bridge-to-recovery in acutely ill patients. Such short- and intermediate-term devices and other durable devices not commercially available in the United States are beyond the scope of this article.

Currently, durable right ventricular assist devices are very unlikely to be encountered in the ambulatory setting and are excluded from this article. Only the SynCardia Total Artificial Heart (SynCardia Systems, Inc, Tucson, AZ) and the Thoratec Paracorporeal Ventricular Assist Device (Thoratec Corporation, Pleasanton, CA) are approved for outpatient right ventricular support, with approximately 20-70 units of each device implanted annually. Owing to the relative rarity of these devices, management of patients with these devices is best served by multidisciplinary discussion on an individual basis, in an inpatient setting. Short-term or intermediate-term devices for right ventricular support are more likely to be encountered than durable right ventricular support devices. Such patients are acutely ill and should be managed in an intensive care or operating room setting, with invasive monitoring.

3. LVADs and gastrointestinal pathology

Despite improved survival, quality of life, and adverse event rates for continuous-flow LVADs compared to earlier generation devices, GIB continues to be a significant source of morbidity. The prevalence of GIB in continuous-flow LVAD patients is estimated to be 15%-20%, with the majority attributed to gastrointestinal angiodysplastic disease, acquired von Willebrand deficiency, and anticoagulation [6-10]. Recurrence rate is estimated to be 9% [6]. In angiodysplastic disease, there is a proposed association between the narrowed pulse pressure in patients with continuous-flow LVADs and arteriovenular dilatation [11,12].

The management of continuous-flow LVAD patients presenting with GIB focuses on endoscopic techniques [8]. Upper endoscopy is recommended for the initial evaluation for GIB in an LVAD patient, as it has been shown to successfully identify the source of bleeding in 70% of the patients [9]. If upper endoscopy fails to identify the source of bleeding, then enteroscopy, colonoscopy, and video capsule endoscopy [13] may be considered [8]. Hemostatic therapies including thermal coagulation, argon beam coagulation, hemostatic clipping, and injection of epinephrine have been performed safely in LVAD patients.

4. Anesthesia choice and intraprocedural management

Experience in anesthesia for LVAD patients undergoing noncardiac surgical procedures has grown with the increasing number of durable LVADs implanted. Owing to the reduced pulsatility with continuous-flow LVADs, monitoring modalities that rely on pulsatility such as pulse oximetry, oscillometric automated noninvasive blood pressure cuffs, and manual noninvasive blood pressure measurement using auscultation with a sphygmomanometer may not operate consistently and yield misleading data. Within the anesthesiology literature, invasive monitoring (eg, arterial blood pressure, central venous access, pulmonary artery catheter, and transesophageal echocardiography) or involvement of cardiothoracic anesthesiologists or both have been reported or recommended by some authors [3,14-17]. Other authors report safe anesthetics with noninvasive blood pressure monitoring (automated cuff or manual cuff with Doppler) [16,18,19] or without anesthesiologist involvement [9,17,18]. Cerebral oximetry, which uses near-infrared spectroscopy to measure regional cerebral oxygenation, does not rely on pulsatility and can be useful as a monitor of oxygenation in place of, or in addition to pulse oximetry [3,20].

Endoscopy in LVAD patients has been performed safely under general anesthesia [14,16,18,19], monitored anesthesia care [9,14,16,18,19], and endoscopist-directed sedation [9,18]. The use of propofol, ketamine, etomidate, fentanyl, and midazolam in various combinations for sedation have been reported [16,18]. Based on the available literature, various sedation or anesthetic techniques can be reasonably considered, as they have been safely reported in LVAD patients. Clear outcomes data regarding sedation or anesthetic technique in this setting are not available. Whether an anesthesiologist is routinely involved in the care of LVAD patients presenting for endoscopic procedures is likely to be dependent on institutional practice [16,18]. The appropriate choices for anesthetic and monitoring modalities can be made on individual patient factors and on institutional protocols. A list of suggested factors to consider is shown in Table 2.

For endoscopic procedures, the LVAD controller should be connected to the monitor console and a grounded power outlet.

Table 2
Factors influencing monitoring and anesthetic choices.

Favors invasive* or alternative monitoring†
Hemodynamic instability
Low pulsatility
Significant right ventricular dysfunction
Favors anesthesiologist-directed care
Requirement for deep sedation or general anesthesia
Hemodynamic instability
Significant right ventricular dysfunction
Complex airway management
Significant aspiration risk
Complex comorbidities
Institutional practice or protocols

* Examples include arterial line, central venous catheter, and pulmonary artery catheter.

† Examples include cerebral oximetry, Doppler blood pressure monitoring, and transesophageal echocardiography.