# Perioperative Management of Patients With Left Ventricular Assist Devices Undergoing Noncardiac Procedures: A Survey of Current Practices

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***Objectives:*** **To describe perioperative management of patients with left ventricular assist devices (LVAD) in noncardiac procedures.**

***Design:*** **Survey of (1) respondent demographic characteristics, (2) anesthetic practices for LVAD patients having endoscopies, and (3) low-risk surgeries requiring general anesthesia.**

***Setting:*** **Internet-based.**

***Participants:*** **Society of Cardiovascular Anesthesiologists membership.**

***Interventions:*** **None.**

***Measurements and Main Results:*** **Inpatient endoscopic procedures were done mainly in the endoscopy suite (71.7%) by a solo practitioner or 1:1 staffing ratio 59% of the time. LVAD-specific support personnel were present in more than 80% of all procedures. Both endoscopy and surgical patients used post-anesthesia recovery units and intensive care units for recovery; however, compared with endoscopy patients, surgical patients recovered in the ICU more frequently (45.5% *v* 29.1%, $p < 0.001$). In addition, 18% of endoscopy patients recovered on site. Regarding patient monitoring, more than 90% of responders used electrocardiogram, pulse oximetry, end-tidal $CO_2$, and blood pressure monitors on LVAD patients. Responders reported using arterial catheters to monitor blood pressure in 49% of endoscopy cases and 71% of surgical patients. The reported use of invasive monitors by individual clinicians was related inversely to institutional LVAD volume ($p = 0.04$ and $p = 0.01$ in endoscopy and surgical procedures, respectively).**

***Conclusions:*** **This survey found heterogeneity in hospital resource utilization for noncardiac LVAD procedures. There was a decrease in the use of invasive monitors with increased institutional LVAD volume in both endoscopy and surgical procedures.**



***KEY WORDS: survey, LVAD, left ventricular assist device, anesthesia, monitors, noncardiac surgery, endoscopy***

THE NUMBER OF PATIENTS suffering from heart failure has increased drastically in recent years. An estimated 5.1 million Americans live with heart failure, of whom 10% progress to advanced stages.[1] When their condition fails to respond to medical therapy, surgically implanted devices such as left ventricular assist devices (LVADs) may be indicated. Unlike first-generation pulsatile LVADs, newer generation LVADs use continuous-flow (CF) mechanics for circulatory support. Studies have shown favorable device durability and survival outcomes with CF devices compared with pulsatile devices, resulting in the trend of increasing CF device implantation since 2010.[2,3] Currently, more than 95% of implants are CF devices.[3] LVADs may be placed temporarily as a resolution of a reversible cardiac condition, "bridge" to cardiac transplantation, or as a long-term destination therapy.[4]

LVAD-supported patients who present for noncardiac procedures are also on the rise. Nearly 50% of patients supported by LVADs experience a hospital readmission within 6 months of implantation, frequently for noncardiac elective procedures.[5] Stehlik et al reported 24% of mechanical circulatory support patients required noncardiac surgeries at their program.[6] These patients potentially are challenging for anesthesiologists because of their extensive coexisting medical problems. Furthermore, the nonpulsatile LVADs in these patients make the monitoring of perioperative pulse oximetry and blood pressure difficult. As a patient's reliance on the LVAD increases, arterial pulsatility decreases. Both oscillometric blood pressure measurement and pulse oximetry become less reliable.

Several case series have described noncardiac surgery in patients supported with LVADs in the past decade.[6–15] These cases were mostly major abdominal-, thoraco-, or intracranial-related surgeries requiring multiple blood transfusions and high vasopressor or inotropic support. Invasive monitors commonly were used in those cases, but many of them were in situ before the surgeries. Current literature on the management and monitoring of LVAD patients undergoing minor noncardiac procedures is either unavailable or incomplete.

The primary objective of this survey was to assess the common management and resource utilization for LVAD-supported patients undergoing minor outpatient diagnostic endoscopies and elective noncardiac surgeries with minimal anticipated blood loss. The secondary objective was to define the association between institutional clinical LVAD volume and the routine use of invasive monitors (eg, arterial catheter, central catheter, pulmonary artery catheter, and transesophageal echocardiography) by anesthesiologists. It was hypothesized that institutional LVAD volume would be related inversely to the routine use of these invasive monitors by clinicians.

## METHODS

After institutional review board approval, an internet-based survey (Appendix) was created and sent to the members of the Society of Cardiovascular Anesthesiologists (SCA). The survey, designed to be completed within 10 minutes, was critiqued by anesthesiologists from both private and academic centers and reviewed by statisticians before

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sending to the SCA members. The survey included 3 sections: (1) respondent demographic characteristics, (2) common management and resource utilization for LVAD patients having endoscopic procedures for gastrointestinal (GI) bleeding evaluation, and (3) common management and resource utilization for LVAD patients having noncardiac surgeries with minimal anticipated blood loss and requiring >1 hour of general anesthesia. Questions regarding common management mainly focused on monitors applied during the procedures. Questions pertaining to resource utilization focused specifically on perioperative personnel availability and locations for procedure and recovery. Possible responses were listed for each question in a multiple choice format. Some questions were designed to have multiple responses selected and free text entered.

An invitation to participate was sent by the SCA to their membership e-mail list (total of 4,008 e-mail addresses). Two rounds of responses were collected from September 4, 2013 to September 30, 2013, with the survey opened for approximately 2 weeks each round. Participants' responses were anonymous with further de-identification of specific user codes and IP addresses before data analyses. All data were downloaded to Microsoft Excel 2010 (Microsoft, Redmond, GA) for storage and analysis. Only responses with complete demographic characteristics and either completed endoscopy or surgical sections were included for analysis.

Descriptive statistics were reported for all survey responses. Proportions were estimated and reported with exact or asymptotic two-sided 95% confidence intervals (CI), as appropriate. For the secondary objective, two-way association between the institutional LVAD volume (categorized as low and high volume using the bottom and top quartile, respectively) and routine placement of any invasive monitors (yes and no) by respondents were examined using a chi-square test in both endoscopy and surgical settings. Other two-way association analyses were examined between institutional LVAD volume and decision of anesthetic technique in endoscopic procedures and frequency of LVAD educational meetings. With an estimated sample size of 100 respondents, there was 80% power to detect a difference in invasive monitor use between the low and high institutional volume groups when the true proportions were 50% and 23%, respectively. This calculation was based on a test of 2 proportions with two-sided alpha equal to 0.05. Power calculations were performed using NCSS/PASS software (version 11.0.9, Kaysville, UT).

## RESULTS

### Response Rate

Of the 4,008 SCA invitations, 35 e-mails were returned to sender, and 1,403 members opened the e-mail invitation (35.3%). Three hundred twenty-two members accessed the survey, and 307 of these members filled out the demographic characteristics section. Of this group, 244 completed the endoscopy section of the survey and 233 completed the surgical section of the survey, giving the response rate of those who opened the survey e-mail invitation (1,403) to be 17.4% and 16.6%, respectively (Fig 1).

### Demographic Characteristics

The 233 respondents who completed the surgical section also completed the endoscopy section; therefore, the demographic characteristics of both groups were very similar. More than 90% of the respondents from both sections were cardiothoracic anesthesiologists, with the remaining being general or other fellowship-trained anesthesiologists. Approximately 50% of the respondents had more than 15 years of experience, 30% had 5 to 15 years of experience, and 20% had fewer than 5 years of experience. Roughly 87% of the respondents worked in a tertiary care (university, academic, VA) hospital and the remaining in community hospitals for both sections (Table 1). The distributions of the estimated number of patients with

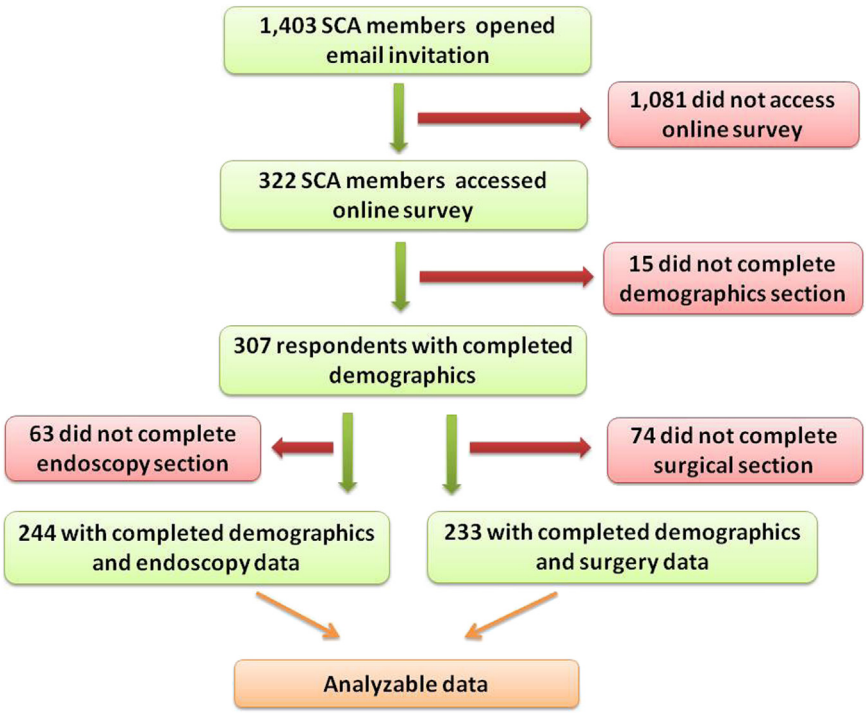


**Fig 1. Data collection process with exclusion criteria indicated. Total of 244 and 233 respondents' data, for endoscopy and surgery sections, respectively, were analyzed. Abbreviations: SCA, Society of Cardiovascular Anesthesiologists.**