

Perioperative Anesthetic Management of Patients With Left Ventricular Assist Devices Undergoing Noncardiac Surgery

Assay

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم العظيم

صدق الله العظيم

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List of Abbreviations

Abb.	Full term
<i>ACLS</i>	<i>Advanced Cardiac Life Support</i>
<i>AICDS</i>	<i>Automated Internal Cardioverter- Defibrillators</i>
<i>AVM</i>	<i>Arteriovenous Malformation</i>
<i>BIVAD</i>	<i>Bi-Ventricular Assist Device</i>
<i>BSA</i>	<i>Body Surface Area</i>
<i>BTC</i>	<i>Bridge To Candidacy</i>
<i>BTR</i>	<i>Bridge-To-Recovery</i>
<i>BTT</i>	<i>Bridge To Transplant</i>
<i>CE MARK</i>	<i>Conformité Européenne: Ce Marking Is A Mandatory Conformity Marking For Certain Products Sold Within The European Economic Area (Eea)</i>
<i>CPB</i>	<i>Cardiopulmonary Bypass</i>
<i>CUBS</i>	<i>Clinical Utility Baseline Study</i>
<i>CVP</i>	<i>Central Venous Pressure</i>
<i>DT</i>	<i>Destination Therapy</i>
<i>FDA</i>	<i>Food And Drug Administration</i>
<i>GI</i>	<i>Gastrointestinal</i>
<i>HF</i>	<i>Heart Failure</i>
<i>ICU</i>	<i>Intensive Care Unit</i>
<i>INR</i>	<i>International Normalized Ratio</i>
<i>INTERMACS</i>	<i>Interagency Registry For Mechanically Assisted Circulatory Support</i>
<i>ISHLT</i>	<i>International Society Of Heart And Lung Transplantation</i>
<i>IVAD</i>	<i>Implantable Vad</i>
<i>LDH</i>	<i>Lactate Dehydrogenase</i>
<i>LVAD</i>	<i>Left Ventricular Assist Devices</i>
<i>LVEDP</i>	<i>Left Ventricular End-Diastolic Pressure</i>
<i>MCS</i>	<i>Mechanical Circulatory Support</i>
<i>MCSDS</i>	<i>Mechanical Circulatory Support Devices</i>
<i>NIH</i>	<i>The National Institute Of Health</i>

List of Abbreviations **cont...**

Abb.	Full term
<i>PFHG</i>	<i>Plasma Free Haemoglobin</i>
<i>PI</i>	<i>Pulsatile Index</i>
<i>PTFE</i>	<i>Polytetrafluoroethylene</i>
<i>PVAD</i>	<i>Pneumatic Vad</i>
<i>PVR</i>	<i>Pulmonary Vascular Resistance</i>
<i>REMATCH</i>	<i>Randomized Evaluation Of Mechanical Assistance Of Chronic Heart Failure</i>
<i>RV</i>	<i>Right Ventricle</i>
<i>RVAD</i>	<i>Right Ventricular Assist Device</i>
<i>RVF</i>	<i>Right Ventricular Failure</i>
<i>SVR</i>	<i>Systemic Vascular Resistance</i>
<i>TEE</i>	<i>Transesophageal Echocardiography</i>
<i>TNF-α</i>	<i>Tumor Necrosis Factor α</i>
<i>VAD</i>	<i>Ventricular Assist Device</i>

Abstract

Full information about the device obtained from the LVAD team, including the current settings, the duration of the implantation, and any complications. The preoperative evaluation should also focus on identifying any other underlying end-organ dysfunction as renal and hepatic dysfunction, which can be common in DT patients. Preoperative full laboratory studies should be available. Patients should have blood available before the procedure. Patients should be admitted to the hospital in advance of their procedure for bridging of their anticoagulation from warfarin to heparin. However, in emergent cases, fresh frozen plasma may be necessary to partially reverse the effects of a patient's anticoagulation. Because of the risk of LVAD thrombosis, full reversal of a patient's anticoagulation should be avoided. the degree of anticoagulation reversal should be agreed by the surgical, anesthesia, and LVAD teams.

LVAD Preparation, LVADs can be powered via batteries or a base/module that plugs into a standard power outlet, it is advisable for even the shortest procedures to power the LVAD from its base/module. However, batteries should be available immediately in case of an equipment or power failure. An LVAD's base/module also allows monitoring of the LVAD's pump speed and flow rate. The electrosurgical unit grounding pad should be placed in such a manner that the path of the electrical current from the electrosurgical unit does not go through the LVAD. many of these patients also have automated internal cardioverter-defibrillators (AICDs), which should be turned off just before coming to the operating room, and external defibrillator pads should be applied.

All LVAD patients should have an arterial catheter placed for blood pressure monitoring, the relative lack of pulsatile blood flow may make the pulse oximeter does not work or to be inaccurate, serial arterial blood gas measurements or cerebral oximetry have been used as alternatives. According to the patient's right ventricular function, either a central venous catheter or a pulmonary artery catheter should be used to monitor preload and right ventricular function. Intraoperative transesophageal echocardiography (TEE) also recommended.

Keywords: *Pneumatic Vad - Systemic Vascular Resistance- Ventricular Assist Device- Lactate Dehydrogenase- Destination Therapy Cardiopulmonary Bypass*

INTRODUCTION

End-stage heart failure is the final common pathway for many chronic heart diseases and represents a substantial worldwide problem for the healthcare system. The prevalence of heart failure has been rising with the aging of the population and According to the American Heart Association 2010 update, more than 5.7 million people in the United States suffer from heart failure (*Lloyd et al. 2010*).

In spite of advancements in the pharmacologic management of heart failure, mortality rates have remained relatively unchanged. After a diagnosis of heart failure, the 1-year mortality rate is 20%, and once a patient has American College of Cardiology/American Heart Association stage D heart failure (i.e., end-stage heart failure), the 2-year mortality rate approaches 75% (*Thunberg et al. 2010*).

At this stage, advanced therapies are considered, including heart transplantation, continuous inotropic therapy, mechanical circulatory support (*Metra et al. 2007*).

Heart transplantation remains the preferable therapy for advanced heart failure, but the number of transplants done worldwide is trivial compared to demand. Limited severely by the number of available donor organs along with strict criteria defining acceptable recipients. Thus, durable mechanical circulatory support (MCS) devices have emerged as an important therapy for advanced heart failure (*Kirklin et al. 2014*).

A ventricular assist device (VAD) is a MCS device that is used to partially or completely support the function of a failing heart. Left ventricular assist devices (LVAD) pump blood from the left ventricle and transfer it to the ascending aorta (*Pratt et al. 2014*).

LVADs may be used as a bridge to transplant (BTT) for candidates awaiting heart transplantation or as destination therapy (DT) for patients who are not candidates for transplantation or as a bridge to decision for patients too sick to survive the transplant evaluation (so that their suitability for transplantation has not been determined at the time of VAD implantation) and as a bridge to recovery for selected patients who might recover their cardiac function (*Peura et al. 2012*).

According to the Sixth annual report of the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) the proportion of patients treated with LVAD as DT in the United States has increased from 14.7 % in 2006–7 to 41.6 % in 2011–13 (*Kirklin et al. 2014*).

As the prevalence of patients with LVADs continues to increase, so will the number of these patients presenting for noncardiac surgery, and, as a result, both cardiac- and non-cardiac-trained anesthesiologists will need to be familiar with the perioperative management of these patients (*Slininger et al. 2013*).

With proper knowledge, and adequate preoperative preparation and intraoperative care, anesthesiologists should be able to achieve safe and successful patient outcomes through anesthesia care. Thus, it is important for all anesthesiologists to be aware of the special anesthesia needs of patients with VADs requiring noncardiac surgery (*Khoo, 2010*).

AIM OF THE WORK

To describe the perioperative anesthetic management of patients with left ventricular assist devices (LVADs) undergoing non-cardiac surgery.

WHAT ANESTHIOLOGISTS SHOULD KNOW ABOUT VADS?

According to the American Heart Association 2010 update, more than 5.7 million people in the United States suffer from heart failure. The prevalence of heart failure in the United States has been rising with the aging population. The annual number of heart failure–related hospitalizations has increased to more than 1 million and has resulted in combined direct and indirect costs (*Lloyd Jones et al., 2010*).

Despite advancements in the pharmacologic management of heart failure, mortality rates have remained unchanged. After a diagnosis of heart failure, the 1-year mortality rate is 20%, and once a patient has American College of Cardiology/American Heart Association stage D heart failure (i.e., end-stage heart failure) the 2-year mortality rate approaches 75% (*Thunberg et al., 2010*).

Although cardiac transplantation has excellent results for the treatment of end-stage heart failure, this option is limited severely by the number of available donor organs, with the annual number of heart transplants having plateaued at approximately 2,300 over the last 15 years (*Rose et al., 2001*).

In 1991, since the landmark Randomized Evaluation of Mechanical Assistance of Chronic Heart Failure (REMATCH) trial showed improved 1- and 2-year survival rates in the

mechanical circulatory support group versus the medical management group, left ventricular assist devices (LVADs) have taken a more prominent role in the management of heart failure. Since 2006 when the Interagency Registry for Mechanically Assisted Circulatory Support started collecting data on mechanical circulatory support devices, more than 3,000 primary adult LVADs have been implanted. It was estimated that about 20,000 and 60,000 patients could benefit from LVAD therapy annually (*Slininger et al., 2013*)

Definition

Ventricular Assist Devices (VADs) are mechanical pumps that take over the function of the damaged ventricle in order to re-establish normal hemodynamics and end-organ blood flow, Its intent is to remove some or all work of cardiac output from either or both left and right ventricles unloading the native heart allowing it to rest and in some cases, the heart can recover function (*Goldstein et al., 1998*).

Ventricular assist devices (VADs) can be used to provide:

- **Temporary Ventricular Assistance**, typically for patients recovering from myocardial infarction (heart attack) and for patients recovering from cardiac surgery, with the assumption that ventricular function will recover rather quickly (days).

- **Prolonged Ventricular Assistance (Durable mechanical devices) months to years**, typically for patients suffering from advanced congestive heart failure, with the intent of bridge-to-transplant support, bridge to recovery (with the expectation of sufficient ventricular recovery to allow device explantation), or permanent (destination) therapy (*Nicholas et al., 2013*).

VADs are distinct from artificial hearts, which are designed to assume cardiac function, and generally require the removal of the patient's heart. Moreover, VADs are designed to assist either the right ventricle (RVAD) or the left ventricle (LVAD), or to assist both ventricles (BiVAD) (*Birks et al., 2006*).

The type of ventricular assistance device applied depends upon the type of underlying heart disease, and upon the pulmonary arterial-resistance, which determines the workload of the right ventricle. The left-ventricle assistance device (LVAD) usually is the most common device applied to a defective heart, but when the pulmonary arterial-resistance is high, then a right-ventricle assistance device (RVAD) might be necessary to resolve the problem of cardiac circulation (*Birks et al., 2006*).

Mechanical pumping mechanisms can be placed internally (**implantable**) or external to the body (**paracorporeal**). Their power source can be electric or pneumatic, located outside the body or completely within it, with electric power conducted transcutaneously. Their pump flow characteristic can be pulsatile or continuous flow (*Nicholas et al., 2013*).