Ventricular Assist Device Infections

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KEYWORDS

• VAD infection • Driveline infection • Ventricular assist device

KEY POINTS

- Ventricular assist device (VAD) infections are common and associated with increased morbidity and mortality.
- The International Society for Heart and Lung Transplantation's criteria should be used to diagnose a VAD-specific and VAD-related infection.
- VAD infections are biofilm based and difficult to eradicate.
- Treatment strategies for VAD infection include intravenous antibiotics followed by oral suppression in tandem with surgical debridement.
- Prevention strategies center on patient selection, surgical strategies, and driveline management.

INTRODUCTION

Ventricular assist devices (VADs) are well established as a therapy for heart failure and are increasingly used on a global scale both for destination therapy and as a bridge to transplant. The International Society for Heart and Lung Transplantation Registry for Mechanically Assisted Circulatory Support's (IMACS) first report published outcomes of almost 6000 VAD recipients who received an implant between 2013 and 2014 in 31 countries.[1] A recent report from the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) (which publishes data on VADs placed in the United States) published outcomes of more than 15,000 VAD recipients over a 9-year period.[2]

As VADs have evolved over the past 2 decades, so has the epidemiology of infection. Previous first-generation pulsatile-flow devices were associated with high rates of bacterial and fungal infection, the latter being associated with up to a 90% mortality rate.[3] However, changes in device type and size as well as improvement in surgical techniques have led to a decreased incidence of infection. Fig. 1 demonstrates the significant difference in freedom from bacteremia between the current continuous-flow devices when compared with the older pulsatile VADs.[4] Within the category of continuous-flow devices, there has been a significant decline in the rate of sepsis in the recent era as well: from 8.22 per 100 patient months in the era 2008 to 2011 to 7.28 per 100 patient months in the era 2012 to 2014.[2] Despite the decline in event rate, infection remains an important cause of morbidity and mortality in these patients. The incidence of infection-related death is highest in the early postoperative period and then subsides; but with a longer support period, the incidence increases again, as noted in Fig. 2.[2] In fact, infection is the third most common cause of death 1 year following device placement after neurologic complications and multisystem organ failure; the rate of infection steadily increases up to 4 years of follow-up.[2]

In addition to the morbidity associated with the infection itself, VAD infections are also implicated in complications, such as device thrombosis, stroke, intracerebral hemorrhage, and gastrointestinal bleeding. It is difficult to state this conclusively

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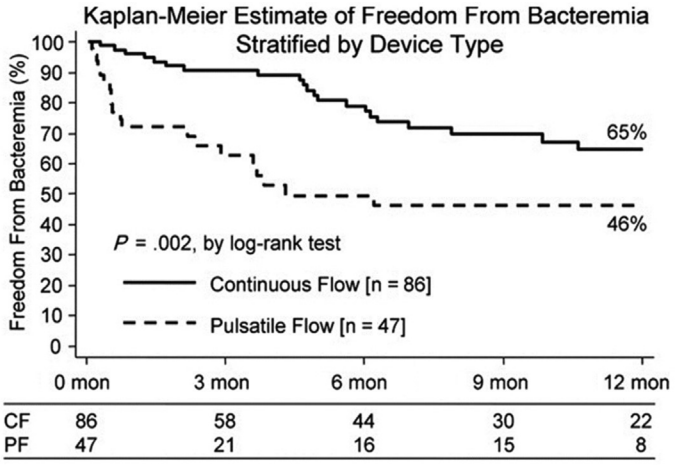

Fig. 1. Significant difference in freedom from bacteremia between pulsatile and continuous-flow VADs. CF, continuous flow; PF, pulsatile flow. (*Adapted from* Schaffer, Allen JG, Weiss ES, et al. Infectious complications after pulsatile-flow and continuous-flow left ventricular assist device implantation. J Heart Lung Transplant 2011;30(2):168; with permission.)

based on current evidence, as some of these complications may also predispose to infection.[5,6]

VENTRICULAR ASSIST DEVICE INFECTIONS AND DIAGNOSTIC CRITERIA

The International Society of Heart and Lung Transplantation (ISHLT) published a consensus paper in 2011 that clearly defined infections in VAD recipients and put forth diagnostic criteria in order to standardize such definitions with the goal of making comparison of infection rates simpler across different studies and clinically relevant.[7]

Infection is divided in 3 main categories: VAD-specific, VAD-related, and non-VAD infections.

- VAD-specific infections are those that are related directly to the device hardware and are specific to VAD recipients. This category includes infections of the driveline, surgical pocket, pump, and cannula and may present as a continuum.
- VAD-related infections are those that can occur in patients without VADs but warrant special considerations in a VAD recipient because of the presence of hardware. This category includes infections such as bacteremia, mediastinitis, and endocarditis.
- Non-VAD infections are those that are unrelated to the indwelling device and consist of infections such as pneumonia, urinary tract infection, and *Clostridium difficile* infection.

Detailed diagnostic criteria and definitions for VAD-specific and VAD-related infections were published by the ISHLT in 2011.[7] In brief, driveline infection (DLI) can be considered to be superficial if the infection is superficial to the fascial/muscle layers or deep if it is present within these tissue planes. Pump and/or cannula infections are diagnosed based on direct microbiological cultures from the device and/or blood cultures along with appropriate clinical presentation and imaging

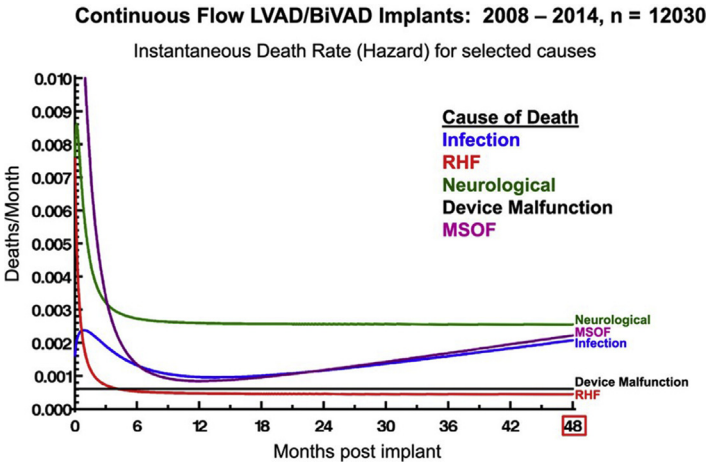

Fig. 2. Hazard function curves indicating the instantaneous risk of death overtime showing the bimodal pattern related to infection following VAD placement. BiVAD, biventricular assist device; LVAD, left VAD; MSOF, multisystem organ failure; RHF, right heart failure. (*From* Kirklin JK, Naftel DC, Pagani FD, et al. Seventh INTERMACS annual report: 15,000 patients and counting. J Heart Lung Transplant 2015;34(12):1498; with permission.)