Analysis of a Fatal Left Ventricular Assist Device Infection: A Case Report and Discussion

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Introduction

Left ventricular assist device (VAD) therapy is an increasingly utilized treatment as a bridge to heart transplantation or as long-term destination therapy. Recent reports show there is a 22% - 32% incidence of VAD-associated infections with staphylococci and nosocomial gram-negative bacilli being the most common causative organisms (1,2). These organisms are often found in intensive care units, where they have the highest proportion of resistance, thus exposing already critically ill patients to the possibility of resistant organism VAD-associated infections (3). Mortality rates exceed 60% when sepsis develops in a patient with a continuous flow left VAD and infection is the number one cause of death in those awaiting cardiac transplantation (4,5). With continued left VAD use clinicians will likely see multidrug-resistant (MDR) or even pandrug-resistant organism VAD-associated infections. Clinicians need to be prepared to manage such an intimidating entity.

Case Report

We report a case of a 25 year-old male with a pandrug-resistant Pseudomonas aeruginosa VAD-associated infection. The patient’s medical history is significant for a diagnosis of idiopathic dilated cardiomyopathy refractory to maximal medical therapy requiring implantation of a HeartMate II (Thoratec Co., Pleasanton, CA, USA) continuous flow left VAD (Figure 1). His course was complicated with multiple hospital admissions for recurrent VAD-associated infections and numerous episodes of P. aeruginosa bacteremia that had been treated with a multitude of antipseudomonal antibiotics. He presented to our hospital for management of severe volume overload in the setting of VAD-associated infections. Transesophageal echocardiography demonstrated a left ventricular ejection fraction of 24% with severe left and right ventricular dilatation. Chest x-ray revealed cardiomegaly and multiple devices including the left VAD (Figure 2).
Figure 1. HeartMate II® left VAD schematic (reprinted with the permission of Thoratec Co., Pleasanton, CA, USA).

Figure 2. Chest X-ray demonstrating an enlarged cardiac silhouette, the HeartMate II axial pump (*) with inflow (down arrow, ↓) and outflow (up arrow, ↑) cannulas, biventricular pacer with leads in right atrium (A), coronary sinus (B), and right ventricle (C) (dashed arrows).
Blood cultures revealed MDR *P. aeruginosa*; except for showing intermediate sensitivity to tobramycin there was resistance to all antimicrobials tested. *In vitro* synergy testing revealed modest bacterial inhibition when only colistin, fosfomycin, imipenem, and tobramycin were combined. After maximizing medical therapy, multiple left VAD pocket washings and implantation of tobramycin beads followed. Intraoperative findings included an encapsulated infection around the driveline and obvious infection of the left VAD pocket. Repeat blood cultures showed *P. aeruginosa* had developed resistance to all antimicrobials including tobramycin. Subsequently the left VAD was explanted and the patient was transitioned to an extracorporeal membrane oxygenator (ECMO) in attempt to clear the infection. He was then transitioned to a TandemHeart (CardiacAssist Inc., Pittsburgh, PA, USA), a percutaneous LVAD, as he was not dependent on ECMO for oxygenation. He was able to clear the bacteremia after removal of the infected HeartMate II while on colistin, fosfomycin, tobramycin, azithromycin and rifampin, but was not able to clear the remaining left VAD pocket infection, which again spread systemically. Despite maximal medical and surgical interventions, he died from profound septic shock and multisystem organ failure. To date this is the first known case of a pandrug-resistant *P. aeruginosa* VAD-associated infection reported in the literature.

**Discussion**

*P. aeruginosa* organisms have intrinsic resistance to numerous broad spectrum antibiotics, and can easily develop acquired resistance to most if not all available antimicrobial agents (3). Risk factors for the development of pandrug-resistant *P. aeruginosa* include previous treatment with antipseudomonal antibiotics and prolonged treatment times. Given our patient had multiple *P. aeruginosa* infections, treated with multiple rounds of antipseudomonal antibiotics, it is not surprising that pandrug-resistance developed. Few therapeutic options are available for treatment and no new agents are available to evade the known resistance mechanisms. Treatment can be optimized using synergistic combination therapy, which may be the only medical management option in patients with pandrug-resistant *P. aeruginosa* infections. Some have suggested that rifampin in combination with colistin may be a promising approach (3). Some experts recommend *in vitro* synergy testing when an organism is resistant to currently recommended antibiotic regimens (6,7). However, a recent review of antibiotic therapy for gram-negative infections describes the utility of *in vitro* synergy testing equivocal in the context of Pseudomonas infection (8). We managed our patient with combination therapy; however, not until pandrug-resistant *P. aeruginosa* was isolated did we introduce rifampin in combination with colistin.

A recent review of VAD-associated infections showed the majority were managed without surgical intervention; only 13% required surgical debridement and only in cases of severe infection and/or failed conservative treatment was left VAD explantation required. Since this case there has been a proposed algorithm for management of VAD-associated infections (2); our management, though prior to published guidelines, was in step with the algorithm. Of note, there was no discussion of explanting an left VAD to ECMO to aid in clearing a resistant infection. We felt this was a rational option given our
inability to clear the infection. It is unclear as to exactly why our patient was never able to fully clear his infection. Given the patient’s other pre-existing extensive cardiac hardware (i.e. implanted pacer), it is possible that he remained colonized even after maximal surgical and medical therapy. Though speculative, it is possible that removing all foreign material may have allowed for complete infection clearance.

Aside from aggressive medical and surgical management, systolic heart failure with VAD-associated infections may be effectively managed with heart transplantation (9). Our consensus was that this option was neither in the best interest of the patient nor the best use of available resources given the severity of his condition.

**Conclusion**

Clinicians will continue to see VAD-associated infections with resistant organisms. To minimize adverse outcomes, including VAD-associated infection, prudent patient selection and timing of VAD placement is paramount, as VAD’s placed in critically ill patients have been consistently associated with adverse outcomes (10).

**References**