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Disseminated *Streptococcus pneumoniae* infection involving a ventricular assist device

J.S. Reeves¹, N. Rajagopalan², and M.A. Huaman¹

¹Division of Infectious Diseases, University of Kentucky College of Medicine, Lexington, Kentucky, USA

²Division of Cardiology, University of Kentucky College of Medicine, Lexington, Kentucky, USA

Abstract

We describe the first reported case, to our knowledge, of disseminated pneumococcal infection involving a left ventricular assist device (LVAD). The management of this infection was extremely challenging, requiring multiple surgical debridements, LVAD removal, and prolonged courses of antibiotics. The *Streptococcus pneumoniae* isolate was found to be serotype 19F, which is included in both the pneumococcal polysaccharide and conjugate vaccines. This report highlights the importance of routine screening for up-to-date vaccination in patients who undergo LVAD implantation.

Keywords

Streptococcus pneumoniae; left ventricular assist device; device-related infection; transplant; vaccine

Introduction

The use of left ventricular assist devices (LVADs) as definitive therapy for patients with advanced heart failure continues to grow in the United States (1). LVAD infections are common and remain a significant cause of morbidity and mortality in this population. LVAD infections are primarily caused by *Staphylococcus aureus*, coagulase-negative staphylococci, *Enterococcus* species, enteric gram-negative bacteria, *Pseudomonas* species, and less frequently by *Candida* species (2–10). LVAD infections due to *Streptococcus pneumoniae* have not been reported. We describe the first case, to our knowledge, of disseminated pneumococcal infection involving an LVAD.

Correspondence to: Jeffrey S. Reeves, MD, 740 South Limestone, K512, Lexington, KY 40536-0284 USA, Tel: (859) 323-8178, Fax: (859) 323-8926, js.reeves@uky.edu.

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Case report

A 55-year-old Caucasian man presented to his local emergency department with intermittent sinus congestion, fatigue, and epistaxis approximately 3 weeks before his eventual admission. Past medical history was significant for chronic systolic congestive heart failure due to non-ischemic cardiomyopathy requiring HeartMate II LVAD (Thoratec Corporation, Pleasanton, California, USA) implantation as destination therapy 2 years before presentation. He also had an implantable cardiac defibrillator placed 4 years before presentation, and type 2 diabetes mellitus. He underwent nasal packing and was discharged on a course of treatment with oral ampicillin due to concern for bacterial sinusitis. After 3 days, he discontinued his ampicillin, as his symptoms had improved.

Because of the development of subjective fever and altered mental status 2 weeks later, he was taken to his local emergency department where he was found to have a subarachnoid hemorrhage, presumably related to coagulopathy as his international normalized ratio was 6.3. He was noted to have a fever of 39.6°C (103.2°F) and leukocytosis of 14,500 cells/μL. Blood cultures were drawn, and he was given a dose of ceftriaxone. He was then transferred to our hospital for further care.

Upon arrival at our hospital, blood cultures were obtained, and he was initiated on vancomycin and piperacillin-tazobactam intravenously. He denied any recent travel or exposure to sick contacts. He denied tobacco, alcohol, or illicit drug use. Physical examination was significant for mild, diffuse abdominal tenderness and negative for any erythema, fluctuance, or warmth at the LVAD driveline exit site.

A computed tomography (CT) scan of chest, abdomen, and pelvis revealed a large fluid collection surrounding his LVAD (Fig. 1), as well as multiple splenic and renal infarctions. Blood cultures returned positive for *S. pneumoniae*. His isolate was noted to have intermediate resistance to penicillin (minimum inhibitory concentration [MIC] 6 μg/mL) and ceftriaxone (MIC 2 μg/mL) by Etest, but it was susceptible to vancomycin (MIC 0.5 μg/mL), ceftaroline (MIC 0.19 μg/mL), and levofloxacin (MIC 0.75 μg/mL). A transesophageal echocardiogram was negative for valvular or lead vegetations. Interestingly, echocardiogram demonstrated that his native ventricular function had returned to normal, with estimated left ventricular ejection fraction of 55%.

Following an Infectious Diseases consultation, he was transitioned to vancomycin and high-dose ceftriaxone, based on culture results for *S. pneumoniae* and concern for septic emboli to the brain contributing to his subarachnoid hemorrhage. On hospital day 2, he underwent drainage of the LVAD pump pocket abscess. Intraoperatively, he was noted to have purulent material in the LVAD pump pocket. Culture of this material also grew *S. pneumoniae*.

Repeat imaging on hospital day 8 showed resolving LVAD pump pocket abscess; however, a new focus of gas was noted within the proximal LVAD outflow cannula that was concerning for ongoing infection. He subsequently underwent sternotomy, mediastinal irrigation and debridement, and partial LVAD explantation. The outflow cannula could not be fully removed. The wound was not closed, and a wound vacuum-assisted closure dressing

was used postoperatively. Native cardiac function remained normal and inotropes were discontinued 4 days after LVAD explantation.

A repeat chest CT was concerning for ongoing mediastinitis and mediastinal abscess. He underwent multiple repeat mediastinal irrigation and debridement procedures, with no apparent infection on his last washout, which allowed for surgical wound closure.

His course was also complicated by an acute ischemic cerebrovascular accident, which led to further concern for septic embolic events to the brain with a presumed source of the retained outflow cannula. CT angiography did not show evidence of mycotic aneurysm. This complication prompted a change in his antibiotics to high-dose ceftaroline intravenously. Because of his neutropenia (absolute neutrophil count of 300 cells/ μ L) while on ceftaroline, he was transitioned to vancomycin with a goal trough of 15–20 μ g/mL. However, he subsequently developed acute kidney injury on vancomycin, and he ultimately completed a 6-week course of treatment from time of last debridement with intravenous daptomycin 10 mg/kg daily. Acute kidney injury and cytopenias resolved on daptomycin.

On his most recent outpatient follow-up visit, the patient had no major neurologic deficits from cerebrovascular events. His heart function remains stable, and no inotropic support has been required. He currently remains on oral levofloxacin as suppressive therapy owing to partial retention of LVAD hardware.

The patient's *S. pneumoniae* isolate was sent to the Centers for Disease Control and Prevention for serotyping test and returned as 19F. This serotype is a component of available conjugated (Pneumovax 13[®]) and polysaccharide (Pneumovax[®]23) vaccines. Of note, the patient reported receiving an anti-pneumococcal vaccine within the previous 3 years; however, evidence of prior vaccination was not found in records from the 3 medical systems that the patient had accessed during the prior 5 years, nor in the Kentucky Immunization Registry. In fact, he had refused vaccination with Pneumovax[®] 3 years before his hospitalization.

Discussion

LVAD-related infections can involve the driveline exit site, the pump pocket, or any part of the device itself, including the driveline, inflow/outflow cannula, and the pump. LVAD-associated endocarditis has also been reported. LVAD-related infections are a significant source of morbidity and have a reported incidence of 0.37 to 1.06 events per patient-year (5). LVAD infection rates have been reported to range from 25% to 80% (4). LVAD infections have also been shown to contribute significantly to increased cost (3, 6, 7, 11).

Cardiac device-related infections caused by *Staphylococcus* species, *Enterococcus* species, *Candida* species, enteric gram-negative rods, and *Pseudomonas* species have been reported, but infections caused by *S. pneumoniae* are exceedingly rare (2–10, 12–15). Infections caused by *S. pneumoniae* have been reported, related to prosthetic heart valves (14, 15) and cardiovascular implantable electronic devices (CIED), such as pacemakers and implantable cardiac defibrillators (12, 13). Many of the reported prosthetic heart valve infections caused by *S. pneumoniae* have been successfully managed without prosthetic valve removal;

however, the reported CIED infections caused by *S. pneumoniae* have been treated with antibiotics along with surgical explantation of the devices (12–15).

A MEDLINE search did not reveal any reported case of pneumococcal LVAD infection. To our knowledge, this is the first case of pneumococcal LVAD infection reported in the literature. As described in the case presentation, the management of this infection was extremely challenging, requiring multiple surgical debridements, LVAD removal, and prolonged courses of antibiotic regimens tailored by culture data and tolerability. Fortunately, the patient's intrinsic cardiac function had normalized, which facilitated treatment and allowed for LVAD explantation.

Treatment for LVAD infection depends on numerous factors including the overall clinical status of the patient, the degree of device involvement, and the presence of bacteremia, abscess, vegetations, or other complications (6). The Mayo Clinic has proposed a useful algorithm for management of LVAD-associated infections (4). In our case, we were able to successfully manage the patient with surgical debridement, an 11-week course of intravenous antibiotic therapy (including all agents given), and chronic suppressive antibiotic therapy owing to our inability to remove the entire hardware.

We hypothesize that our patient developed *S. pneumoniae* LVAD infection following transient bacteremia during his recent upper respiratory illness. Our case was complicated by probable central nervous system involvement as well as adverse effects related to antibiotic therapy. Ultimately, high-dose daptomycin was utilized because of his bacteremia, the severity of his infection, and our inability to remove the entirety of his hardware. Multiple studies have shown improved *in vitro* efficacy of high-dose daptomycin without a significant effect on safety and tolerability and suggest its use in high inoculum and difficult-to-treat infections caused by resistant gram-positive bacteria (16). These studies have focused on infections caused by *S. aureus* or *Enterococcus* species; therefore, the role of high-dose daptomycin in complicated streptococcal infections is uncertain at this time and requires further investigation. Our case is further evidence that pneumococcal device-related infection can occur, and should be suspected in any patient with an implanted device and concurrent pneumococcal bacteremia or recently suspected pneumococcal illness.

As the number of persons with advanced heart failure receiving a LVAD increases and the average duration of LVAD support grows, infection prevention has an increasingly prominent role in the care of these patients. A retrospective review of the medical records of our patient revealed that he had never received a pneumococcal vaccination, which raises the question of whether his pneumococcal infection could have been prevented, had he received a vaccine.

Pneumococcal vaccination is associated with minimal risk and provides protection against invasive pneumococcal infections, not only those related to cardiac devices (17). Information gathered from LVAD programs in our United Network for Organ Sharing region revealed that the primary care provider of LVAD patients generally handles pneumococcal vaccination, and LVAD programs do not routinely require proof of vaccination. The most recent guidelines from the International Society for Heart and Lung

Transplantation recommend routine vaccinations as part of follow-up care and health maintenance (18). The American Society of Transplantation guidelines recommend pre-transplant evaluation of vaccination status and vaccination before transplantation, if possible (19). The current recommendation by the Advisory Committee on Immunization Practices is that all solid organ transplant patients and congestive heart failure patients aged 19–64 years should undergo pneumococcal vaccination (20). Our case highlights the importance of routine screening for up-to-date vaccination in patients who undergo LVAD implantation.

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Fig. 1. Computed tomography image showing a large abscess with thin wall enhancement and a small amount of air surrounding the body of the ventricular assist device located in the extraperitoneal upper abdomen. Several low-density areas, consistent with infarcts, are also visualized within the spleen.