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Original article

Left ventricular assist device-related infections: a multicentric study

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ABSTRACT

Objectives: The implantable left ventricular assist device (LVAD) is a major therapeutic development for end-stage heart failure in selected patients. As their use is expanding, infectious complications are emerging, with limited data available to guide their management. We aimed to better characterize LVAD-related infections.

Methods: We enrolled all consecutive patients diagnosed with LVAD-related infections in three referral centres in France, using a standardized definition of infections in patients with LVAD. Data were collected from medical charts using a standardized questionnaire.

Results: Between 2007 and 2012, 159 patients received LVAD for end-stage heart failure. Among them, 36 (22.6%; 5 women, 31 men) presented at least one infectious complication, after a median time of 2.9 months from LVAD implantation (interquartile range, 1.8–7.5), with a median follow up of 12 months (interquartile range 8–17). Main co-morbidities were alcoholism (33%), diabetes (11%) and immunosuppression (11%). Mean age at implantation was 51 (±11) years. LVAD were implanted as bridge-to-transplantation ($n = 22$), bridge-to-recovery ($n = 8$), destination therapy ($n = 4$), or unspecified ($n = 2$). LVAD-related infections were restricted to the driveline exit site ($n = 17$), had loco-regional extension ($n = 13$), or reached the internal pump ($n = 3$). The main bacteria isolated were *Staphylococcus aureus* ($n = 20$), coagulase-negative staphylococci ($n = 7$), *Enterobacteriaceae* ($n = 14$), *Pseudomonas aeruginosa* ($n = 10$) and *Corynebacterium* sp. ($n = 7$), with polymicrobial infections in 19 cases. LVAD could be retained in all patients, with the use of prolonged antibacterial treatment in 34 (94%), and debridement in 17 (47%). One patient died due to LVAD-associated infection.

Conclusions: LVAD-related infections are common after LVAD implantation, and may be controlled by prolonged antibiotic treatment. **S. Siméon, Clin Microbiol Infect 2017;23:748**

Introduction

Heart failure is a major cause of morbidity and mortality worldwide [1,2]. The prevalence and incidence of heart failure are increasing [3,4], and the constant shortage of donor organs increases the need for alternatives to heart transplant in patients with end-stage heart failure refractory to medical treatment [5]. Currently, around 2% of the adult population in developed countries suffers from heart failure [6].

Abbreviations: LVAD, left ventricular assist device; INTERMACS, Interagency Registry for Mechanically Assisted Circulatory Support.

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In this context, the advent of the implantable left ventricular assist device (LVAD) represents a major medical development for end-stage heart failure in selected patients [7,8], and is currently used as a bridge-to-transplantation, a bridge-to-recovery, or as destination therapy (i.e. as the last resort in patients with neither perspectives of recovery, nor heart transplant). Implantable LVAD intended for long-term use rely on a percutaneous driveline, to carry electric signals and energy from the controller and batteries to the implanted pump. As with any other implantable foreign device, LVAD is subject to LVAD-related infections, a consequence of medical progress that is gradually emerging, proportionally to the number of patients implanted with LVAD [9,10]. Indeed, the presence of a driveline piercing the skin places the patient at continual risk of infections that can affect the exit site, the subcutaneous tunnel, the abdominal pocket (if present) and the implanted pump, and that can disseminate through bloodstream infections. The transition from pulsatile to continuous-flow LVAD significantly improved clinical outcome [11], and decreased the risk of infectious complications, but LVAD-related infections are still common [12,13]. Due to the scarcity of data currently available in the medical literature, the management of these emerging infections is poorly standardized, and mostly derives from the state-of-the-art for the management of other cardiovascular device-related infections (e.g. pacemaker, intracardiac defibrillator, prosthetic valves or vascular prosthesis), although their characteristics are significantly different. We aimed to better characterize LVAD-related infections, their treatment, and their outcome, through a multicentre study in three referral centres in France.

Materials and methods

La Pitié-Salpêtrière is a 1663-bed university hospital located in Paris (France); Laennec is a 489-bed university hospital located in Nantes (Pays-de-Loire, France); and Pontchaillou is a 992-bed university hospital located in Rennes (Brittany, France). They all serve as referral centres for end-stage heart failure in their area. Although no national guidelines are currently available for LVAD implantation in France, all three centres use antibacterial prophylaxis with cefamandole for <24 h from the time of LVAD implantation, under rigorous aseptic conditions, with no continuous antibacterial prophylaxis following implantation. Throughout the study period, skin preparation procedures included preoperative shower with chlorhexidine gluconate solution the night before surgery, and two separate skin preparations before incision with either povidone-iodine or chlorhexidine with ethanol in the three participating sites.

Patients with LVAD receive repeated counselling and education by specialized nurses before and after LVAD implantation, to reduce the risk of infection and trauma at the exit site. When LVAD-related complication is suspected, patients are reviewed by the endocarditis team in each site, including at least one cardiac surgeon, one infectious diseases specialist and one microbiologist. In the absence of any consensus on the management of LVAD-related infections during the study period, patients were managed on a case-by-case basis, taking into account clinical and microbiological data, including drug susceptibility profiles. Follow up was tailored to the characteristics of LVAD-related complications, and was mostly performed by the cardiac surgery department, in association with an infectious diseases specialist for any suspicion of infectious complication. All patients enrolled in these databases provided informed consent for observational studies.

Cases of LVAD-related infections were identified through a retrospective review of medical charts for all patients with LVAD implanted from January 2007 to December 2012 in the participating centres. LVAD-related infections were defined according to criteria established by the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) [14], the North American registry for mechanical circulatory support devices that serves as a quality improvement system to assess the characteristics, treatments and outcomes of patients receiving mechanical circulatory support devices. Briefly, percutaneous site infections were defined as pain, erythema or purulent drainage restricted to the LVAD entry site, with a positive culture from the skin, and the decision to initiate systemic antimicrobial therapy. LVAD-related infections were defined as loco-regional when the erythema or induration extended >1 cm along the subcutaneous part of the driveline, and/or in the case of fever or leucocytosis not explained by other conditions, with the decision to initiate systemic antimicrobial therapy. Lastly, LVAD-related infections where classified as pump infections when an indistinguishable organism (genus, species and antimicrobial susceptibility pattern) was recovered from two or more peripheral blood cultures taken at least 12 h apart with no other focus of infection, leading to the initiation of an antimicrobial treatment.

A standardized questionnaire was used to collect demographical, clinical and laboratory data from medical records, with a focus on the clinical features and microbiology of LVAD-related infections, any surgical and antibacterial treatment, and outcome. Statistical analyses were descriptive. Categorical variables were presented as number and percentages. Continuous variables were presented as either means with standard deviations (SD), or medians with first and third quartiles (interquartile range; IQR), if the distribution of the data were skewed. Statistical analyses were

Table 1
Characteristics of patients with left ventricular assist device-related infections ($n = 36$) by time of implantation

Demographic characteristics	
Age at implantation (years)	51 ± 11
Male	31 (86)
Co-morbidity	
Immunocompromised	4 (11)
Diabetes mellitus	4 (11)
Chronic alcoholism	12 (33)
Left ventricular ejection fraction (%)	22 ± 7
Body mass index (kg/m^2)	25.4 ± 4.9
Aetiology of heart failure	
Ischaemic cardiomyopathy	22 (61)
Dilated cardiomyopathy	14 (39)
Duration of heart failure	
<12 months	17 (48)
1–5 years	9 (26)
>5 years	9 (26)
Indication of LVAD implantation[a]	
Bridge-to-transplantation	22 (65)
Bridge-to-recovery	8 (23)
Destination therapy	4 (12)
INTERMACS profile[b]	
I	21 (58)
II	0 (0)
III	5 (14)
IV	3 (8)
V–VII	7 (20)
LVAD device	
Heartmate II (Thoratec)	33 (92)
Others[c]	3 (8)

Categorical data are summarized as n (%) of patients and continuous data are summarized as mean ± standard deviation.

[a] Data available for 34 patients.

[b] INTERMACS profile I = critical cardiogenic shock, II = progressive decline on inotropic support, III = stable, but inotrope dependent, IV = resting symptoms, V = exertion intolerant, VI = exertion limited, VII = advanced New York heart association class 3.

[c] Heartware, Thoratec ($n = 2$); VentrAssist, Ventracor ($n = 1$).