MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN

ADULT VENTRICULAR ASSIST DEVICE-SPECIFIC INFECTIONS

I. Purpose

A. This guideline provides recommendations for clinicians caring for adult patients with a left ventricular assist device (LVAD) who have suspected device-specific infection, irrespective of device type. These recommendations will be implemented as per individual patient and physician needs.

II. Background

A. Epidemiology: infection is a common complication following LVAD implantation. The reported incidence of has ranged from 28-66%. The most common pathogens are *Staphylococcus* spp, *Pseudomonas aeruginosa*, and *Enterococcus* spp.

B. Definitions:

i. VAD-specific infection – may involve any aspect of the device (pump, cannula, pocket or driveline) and may cause sepsis
ii. Culture-positive - clinical signs of infection with supporting culture data (e.g., positive wound or blood cultures)
iii. Culture-negative - clinical signs of infection with negative or no culture data (e.g., erythema at driveline site without drainage)
iv. Serous drainage – non-purulent drainage with no clinical signs of infection, antibiotic therapy not warranted as likely non-infectious etiology
v. SIRS (systemic inflammatory response syndrome) criteria – presence of two or more of the following: temperature greater than 38°C or less than 36°C; heart rate greater than 90 beats/min; respiratory rate greater than 20 breaths/min; WBC greater than 12 K/uL, less than 4 K/uL, or greater than 10% bands

C. Pathogenesis: Infection may be introduced intra-operatively in the pump, cannula or pocket, may enter via the driveline exit site, or may occur as a result of a bloodstream infection (BSI) from another focus of infection.

D. Risk factors may include the following: older age; diabetes; renal failure; severity of heart failure; malnourishment; indwelling lines, drainage tubes, urinary catheters, endotracheal tubes, and pulmonary artery catheters; obesity; delayed sternal closure; prolonged hospitalization/ICU stay; longer duration of MCS support; trauma to driveline; exposed velour

III. Prevention

A. Utilize driveline immobilization

i. Anchor(s) for all patients
ii. Binders as determined necessary by VAD team

B. Dressing procedures

i. See the following source for exit site care guideline and video:
   a. https://cardiac-surgery.i.medicine.umich.edu/vad-program/staff-education
ii. Frequency
   a. New implant driveline exit site dressing changes will occur every 3 days. Dressing changes may occur more frequently if deemed clinically appropriate by the VAD team (for example, in the setting of significant drainage).
   b. Dressing changes will be transitioned to weekly dressing changes at the discretion of VAD team at follow-up clinic visits.

C. Hygiene/Bathing

i. Patients may shower once driveline is fully incorporated and well healed, when deemed appropriate by the VAD team. This assessment will be made at follow-up VAD clinic appointments.
   a. For weekly dressing changes, patients may shower up to twice weekly (patients are allowed two dressing kits per week)
ii. Peripherals must be covered with appropriate protection provided by the VAD team
iii. Use appropriate waterproof dressing (e.g. water tight plastic wrap or a shower shield) as recommended by the VAD team to cover driveline exit site during bathing
iv. After bathing, driveline should be cleaned and fully dry. Apply new dressing per exit side care guideline above.

D. Driveline Assessment and Follow-up

i. Each clinic visit and as needed
ii. Assessment: signs of infection, trauma, line damage, or torsion

iii. Masks and gloves should be worn when assessing the driveline exit site

IV. Empiric Treatment

Clinical Setting	Recommended Therapy	Duration	Comments
Driveline infection New or increased drainage from exit site with local signs of infection (increased pain, erythema, warmth around exit site) ± SIRS criteria			
Mild to Moderate, and Non-Purulent drainage No SIRS criteria and hemodynamically stable	• In clinically stable patients, "Watch and culture" method is preferred. Send drainage for culture and use results to guide antibiotic therapy. <u>Culture-positive:</u> **Targeted antibiotics** <u>Culture-negative:</u> *First line:* **Cephalexin*** 1000 mg PO TID *High-risk allergy to cephalosporins**:* **Doxycycline** 100 mg PO BID • NOTE: if the "watch and culture" method is deemed inappropriate by the providing clinicians; empiric antibiotics should match recommendations provided above in the culture-negative section	**10-14 days** Follow up in clinic at the end of treatment course NOTE: If drainage or clinical symptoms of infections are worsening, contact the clinic	• In patients with persistent drainage but no local signs of infection as described here, continuation of antibiotics is not recommended. • Although trauma to the driveline exit site and exposed velour are risk factors for infection, antibiotics in the absence of increase drainage and local or systemic signs of infection are *not* routinely recommended. • Previous cultures should be used to tailor empiric antibiotics.
Purulent OR **Severe** (Severe defined as SIRS criteria present – sepsis, severe sepsis, septic shock)	• **Recommend inpatient admission** • **Obtain blood and wound cultures** • **Recommend imaging – ultrasound or CT (TTE/TEE recommended if blood cultures are positive)** • **Recommend consulting infectious diseases** <u>Mild to moderate, purulent:</u> **Vancomycin** IV (pharmacist to dose) <u>Sepsis, severe sepsis OR septic shock:</u> **Vancomycin** IV (pharmacist to dose) + **Cefepime*** 2 g IV q8h <u>Alternative for vancomycin, if documented severe allergy (not vancomycin infusion reactions):</u> **Daptomycin*** 6 mg/kg IV q24h <u>Alternative for cefepime, if high-risk allergy**:</u> **Aztreonam*** 2 g IV q8h	Per infectious diseases consult NOTE: Generally, 2-4 weeks in the absence of bacteremia NOTE: For patients with purulent infections and no SIRS criteria, 2 weeks may be appropriate NOTE: Follow up in clinic at the end of treatment course NOTE: If drainage or clinical symptoms of infections are worsening, contact the clinic	• In patients with persistent drainage but no local signs of infection as described here, continuation of antibiotics is not recommended. • Step down to oral antibiotics may be appropriate once clinically stable and should be based on culture results. • Although rare, Candida spp may cause severe driveline infections. Empiric antifungal therapy in all patients is not warranted. However, Candida may be considered in patients who are critically ill and failing to respond to antibiotic therapy. • Previous cultures should be used to tailor empiric antibiotics.
Other VAD-specific Infections			
Pocket Infection (New pain, erythemia, tenderness, swelling over	• **Recommend inpatient admission** • **Please obtain blood cultures** • **Recommend imaging – ultrasound or CT or PET**	Per infectious diseases consult	• Although rare, Candida spp may cause severe driveline infections. Empiric antifungal therapy in all patients is not warranted. However, Candida may be considered

Clinical Setting	Recommended Therapy	Duration	Comments
pocket site ± SIRS criteria) OR **Pump Infection** OR **Cannula Infection**	• **Recommend consulting infectious diseases and cardiothoracic surgery** Empiric: **Vancomycin** IV (pharmacist to dose) **+ cefepime*** 2 g IV q8h Alternative for vancomycin, if documented severe allergy (not vancomycin infusion reaction): **Daptomycin*** 6 mg/kg IV q24h Alternative for cefepime, if high-risk allergy**: **Aztreonam*** 2 g IV q8h		in patients who are critically ill and failing to respond to antibiotic therapy. • The final antibiotic treatment plan will be individualized for patients with bacteremia and recurrent infections by the infectious diseases consult team.

* Dose adjustments necessary in patients with renal insufficiency. See Antimicrobial Dosing Recommendations.

** See Beta-lactam Allergy Evaluation and Empiric Therapy Guidance.
High-risk allergies are defined as: respiratory symptoms (chest tightness, bronchospasm, wheezing, cough), angioedema (swelling, throat tightness), cardiovascular symptoms (hypotension, dizzy/lightheadedness, syncope/passing out, arrhythmia), anaphylaxis. If a patient has a high-risk allergy to penicillins, cephalosporins, or carbapenems, the only beta-lactam antibiotic that can be safely used without Allergy consult is aztreonam (if the allergy is to ceftazidime or aztreonam, aztreonam should be avoided as well).

V. References

A. Hannan MM, Husain S, Mattner F, et al. Working formulation for the standardization of definitions of infections in patients using ventricular assist devices. J Heart Lung Transplant. 2011 Apr;30(4):375-84.

B. Kusne S, Mooney M, Dansiger-Isakov L, et al. An ISHLT consensus document for prevention and management strategies for mechanical circulatory support infection. J Heart Lung Transplant. 2017 Oct;36(10):1137-1153.

C. Feldman D, Pamboukian SV, Teuteberg JJ, et al. The 2013 International Society for Heart and Lung Transplantation Guidelines for mechanical circulatory support: executive summary. J Heart Lung Transplant. 2013 Feb;32(2):157-87.

D. Nienaber JJ, Kusne S, Riaz T, et al. Clinical manifestations and management of left ventricular assist device-associated infections. Clin Infect Dis. 2013 Nov;57(10):1438-48.

E. http://cardiac-surgery.i.medicine.umich.edu/staff-education/driveline-management-system

F. http://cardiac-surgery.i.medicine.umich.edu/staff-education

VI. Authors & Consultants

A. Authors: R. Hasan, MD; E. Stoneman, MD; K. Knott, PA-C; A. Rose, PA-C;; C. Walter, PharmD

VII. Approval

A. Medical VAD committee meeting 10/17/19

B. Antimicrobial Subcommittee 11/18/19

C. Pharmacy and Therapeutics Committee 2/18/2020

Antimicrobial Subcommittee Approval: 11/2019	Originated: 02/2020
P&T Approval: 02/2020	Last Revised: 03/2022

Revision History:
09/21: Updated vancomycin infusion reaction terminology
03/22: Revised Prevention section