



## 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:
- VAD-specific infection – may involve any aspect of the device (pump, cannula, pocket or driveline) and may cause sepsis
  - Culture-positive - clinical signs of infection with supporting culture data (e.g., positive wound or blood cultures)
  - Culture-negative - clinical signs of infection with negative or no culture data (e.g., erythema at driveline site without drainage)
  - Serous drainage – non-purulent drainage with no clinical signs of infection, antibiotic therapy not warranted as likely non-infectious etiology
  - 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
- Anchor(s) for all patients
  - Binders as determined necessary by VAD team
- B. Dressing procedures
- See the following sources for exit site care:
    - Daily and Weekly exit site care guidelines linked below:
      - <http://cardiac-surgery.i.medicine.umich.edu/staff-education/driveline-management-system>
    - Exit site care videos linked below:
      - <http://cardiac-surgery.i.medicine.umich.edu/staff-education>
  - Frequency
    - New driveline exit site requires minimum of daily dressing changes
    - Once the driveline is fully incorporated and well healed with no signs of irritation or infection, switching from daily to weekly dressing changes will be at the discretion of the VAD team.
    - Increase dressing changes to daily if any concern for infection.
- C. Hygiene/Bathing
- Patients may shower once driveline is fully incorporated and well healed, and when deemed appropriate by the VAD team
    - For weekly dressing changes, patients may shower up to twice weekly (patients are allowed two dressing kits per week)
      - When transitioning from daily to weekly dressing changes, an assessment will be made at the next clinic visit following the transition. If deemed appropriate by the VAD team at the following visit, the patient will be allowed to shower.
    - For daily dressing changes, patients may shower up to once daily
  - Peripherals must be covered with appropriate protection provided by the VAD team

- iii. Use appropriate waterproof dressing (e.g. water tight plastic wrap) 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
<b>Driveline infection</b> New or increased drainage from exit site with local signs of infection (increased pain, erythema, warmth around exit site) ± SIRS criteria			
<p><b>Mild to Moderate, and Non-Purulent drainage</b></p> <p>No SIRS criteria and hemodynamically stable</p>	<ul style="list-style-type: none"> <li>• In clinically stable patients, “Watch and culture” method is preferred. Send drainage for culture and use results to guide antibiotic therapy.</li> </ul> <p><u>Culture-positive:</u> <b>Targeted antibiotics</b></p> <p><u>Culture-negative:</u> <i>First line:</i> <b>Cephalexin*</b> 1000 mg PO TID <i>High-risk allergy to cephalosporins**:</i> <b>Doxycycline</b> 100 mg PO BID</p> <ul style="list-style-type: none"> <li>• 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</li> </ul>	<p><b>10-14 days</b> Follow up in clinic at the end of treatment course</p> <p>NOTE: If drainage or clinical symptoms of infections are worsening, contact the clinic</p>	<ul style="list-style-type: none"> <li>• In patients with persistent drainage but no local signs of infection as described here, continuation of antibiotics is not recommended.</li> <li>• 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 <i>not</i> routinely recommended.</li> <li>• Previous cultures should be used to tailor empiric antibiotics.</li> </ul>
<p><b>Purulent OR Severe</b></p> <p>(Severe defined as SIRS criteria present – sepsis, severe sepsis, septic shock)</p>	<ul style="list-style-type: none"> <li>• <b>Recommend inpatient admission</b></li> <li>• <b>Obtain blood and wound cultures</b></li> <li>• <b>Recommend imaging – ultrasound or CT (TTE/TEE recommended if blood cultures are positive)</b></li> <li>• <b>Recommend consulting infectious diseases</b></li> </ul> <p><u>Mild to moderate, purulent:</u> <b>Vancomycin</b> IV (pharmacist to dose)</p> <p><u>Sepsis, severe sepsis OR septic shock:</u> <b>Vancomycin</b> IV (pharmacist to dose) + <b>Cefepime*</b> 2 g IV q8h</p> <p><u>Alternative for vancomycin, if documented severe allergy (not vancomycin infusion reactions):</u> <b>Daptomycin*</b> 6 mg/kg IV q24h</p> <p><u>Alternative for cefepime, if high-risk allergy**:</u> <b>Aztreonam*</b> 2 g IV q8h</p>	<p>Per infectious diseases consult</p> <p>NOTE: Generally, 2-4 weeks in the absence of bacteremia</p> <p>NOTE: For patients with purulent infections and no SIRS criteria, 2 weeks may be appropriate</p> <p>NOTE: Follow up in clinic at the end of treatment course</p> <p>NOTE: If drainage or clinical symptoms of infections are worsening, contact the clinic</p>	<ul style="list-style-type: none"> <li>• In patients with persistent drainage but no local signs of infection as described here, continuation of antibiotics is not recommended.</li> <li>• Step down to oral antibiotics may be appropriate once clinically stable and should be based on culture results.</li> <li>• Although rare, <i>Candida</i> spp may cause severe driveline infections. Empiric antifungal therapy in all patients is not warranted. However, <i>Candida</i> may be considered in patients who are critically ill and failing to respond to antibiotic therapy.</li> <li>• Previous cultures should be used to tailor empiric antibiotics.</li> </ul>

Clinical Setting	Recommended Therapy	Duration	Comments
<b>Other VAD-specific Infections</b>			
<b>Pocket Infection</b> (New pain, erythema, tenderness, swelling over pocket site ± SIRS criteria) OR <b>Pump Infection</b> OR <b>Cannula Infection</b>	<ul style="list-style-type: none"> <li>• <b>Recommend inpatient admission</b></li> <li>• <b>Please obtain blood cultures</b></li> <li>• <b>Recommend imaging – ultrasound or CT or PET</b></li> <li>• <b>Recommend consulting infectious diseases and cardiothoracic surgery</b></li> </ul> <p>Empiric:  <b>Vancomycin</b> IV (pharmacist to dose)  <b>+ cefepime* 2 g IV q8h</b></p> <p><u>Alternative for vancomycin, if documented severe allergy (not vancomycin infusion reaction):</u>  <b>Daptomycin* 6 mg/kg IV q24h</b></p> <p><u>Alternative for cefepime, if high-risk allergy**:</u>  <b>Aztreonam* 2 g IV q8h</b></p>	Per infectious diseases consult	<ul style="list-style-type: none"> <li>• 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.</li> <li>• The final antibiotic treatment plan will be individualized for patients with bacteremia and recurrent infections by the infectious diseases consult team.</li> </ul>

\* 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

- 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.](#)
- 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.](#)
- 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.](#)
- 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.](#)
- <http://cardiac-surgery.i.medicine.umich.edu/staff-education/driveline-management-system>
- <http://cardiac-surgery.i.medicine.umich.edu/staff-education>

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#### VII. Approval

- Medical VAD committee meeting 10/17/19
- Antimicrobial Subcommittee 11/18/19
- Pharmacy and Therapeutics Committee 2/18/2020

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The recommendations in this guide are meant to serve as treatment guidelines for use at Michigan Medicine facilities. If you are an individual experiencing a medical emergency, call 911 immediately. These guidelines should not replace a provider's professional medical advice based on clinical judgment, or be used in lieu of an Infectious Diseases consultation when necessary. As a result of ongoing research, practice guidelines may from time to time change. The authors of these guidelines have made all attempts to ensure the accuracy based on current information, however, due to ongoing research, users of these guidelines are strongly encouraged to confirm the information contained within them through an independent source.

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