LVADventures

CID conference
Hunter Ratliff
08/08/2024

Ages, dates, and other identifying information may have been changed

Shortcuts

Case 1: Start
Case 2: Start

Discussion

- **Background** | types | timing | pathogens
- **Diagnosis** | workup | definitions (2011, 2024)
- **Treatment**

Case #1

Case 1: HPI

A **75 y/o M** with PMH HFrEF **s/p ICD & LVAD** (HM3; implanted **2 years ago**), well controlled DM, afib on warfarin presented as a direct admission for **positive blood cultures** that were obtained outpatient

Case 1: HPI

A **75 y/o M** with PMH HFrEF **s/p ICD & LVAD** (HM3; implanted **2 years ago**), well controlled DM, afib on warfarin presented as a direct admission for **positive blood cultures** that were obtained outpatient

He was **discharged from the hospital 10 days ago** (more on this later), and following discharge he reports generalized malaise and **night sweats**.

- Symptoms have been ***progressively worsening*** since discharge
- Reports **diarrhea** (watery, nonbloody) but no other GI symptoms
- He cannot recall any discharge or pain from his driveline site

Routine labs (discharge follow up) obtained at the VA were abnormal, so they asked him to get blood cultures. Patient was called to come in after BCx were abnormal

Positive ROS:

- Night sweats
- Diarrhea
- Dizziness
- Anorexia

Negative ROS:

- Fevers
- N/V
- Abdominal pain
- Urinary symptoms (besides oliguria)
- New respiratory symptoms

Case 1: Recent admission

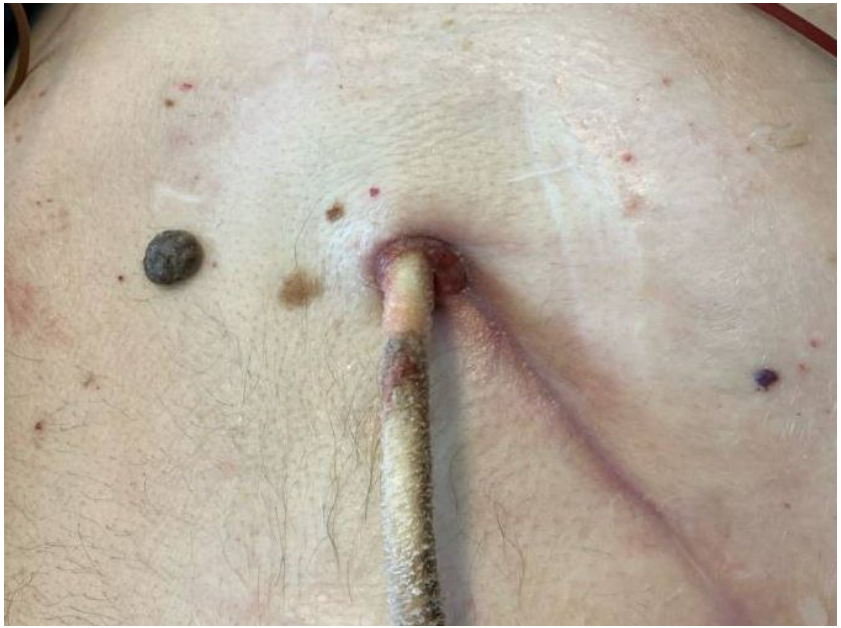
Had a short (24 hour) admission 10 days ago for altered mental status

- Presented for 3 days of slurred speech (NIHSS = 1)
  - Admitted for vague chest pain
- During TTE, had witnessed episode of loss of consciousness
  - Had LVAD alarms for low flow at time of LOC
- Neurology saw him for possible seizure
  - CT stroke was unremarkable
  - EEG unremarkable
  - Attributed to cardiogenic syncope
- Discharged on increased dose of Lasix

Case 1: Physical Exam

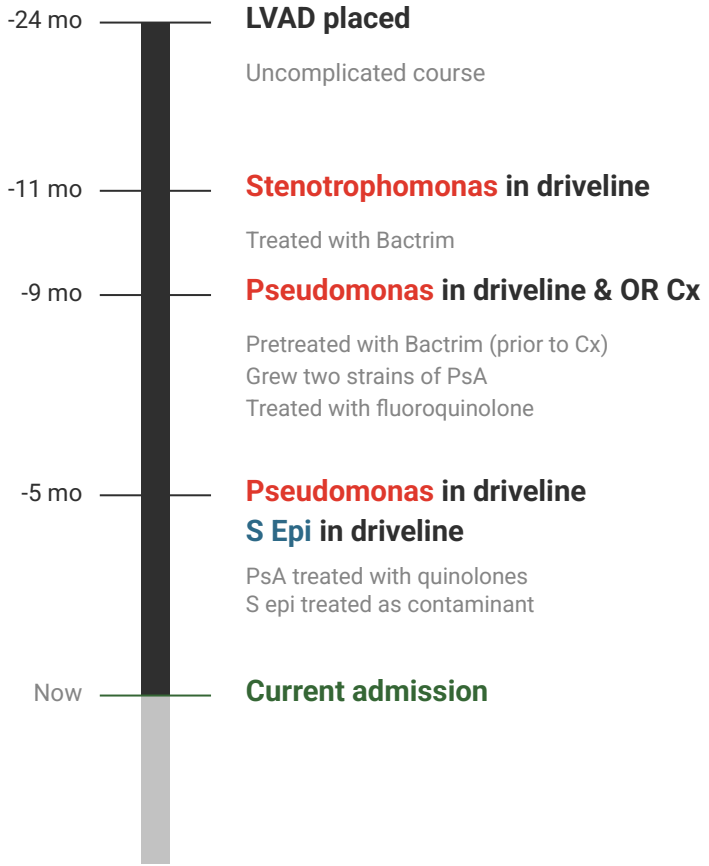
VS: 36.4 C | 77 bpm | MAP 80 | 99% | BMI 20.2

Gen: alert and oriented, NAD, **historical alternans**?
Head/Neck: NCAT; trachea appears midline
ENT: EOMI grossly, anicteric sclerae; MMM
Resp: normal respiratory effort, symmetric chest rise
CV: VAD hum; extremities perfused
GI: non-distended; no rebound or guarding
Ext: no clubbing or cyanosis
Neuro/MSK: moves extremities
Psych: normal mood; appropriate affect



Case 1: Infectious Hx

Social history pretty boring



Case 1: Labs

WBC: 22.0 **Hgb**: 10.8 **PLT**: 310

Chem7: normal **LFT**: normal

UA: LE (+), nitrate (+), bacteria (-)

A1c: 7.0

INR: 4.3

Case 1: Labs

WBC: 22.0 **Hgb**: 10.8 **PLT**: 310

Chem7: normal **LFT**: normal

UA: LE (+), nitrate (+), bacteria (-)

A1c: 7.0

INR: 4.3

CT C/A/P: Pretty normal. No fluid collections, prostatomegaly but kidney/ureters/bladder normal

Case 1: Summary

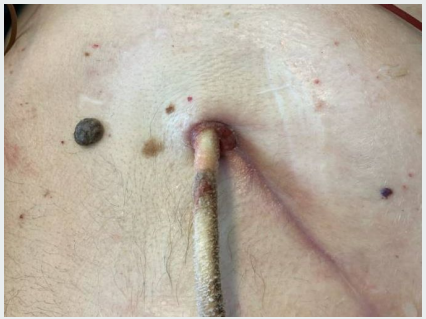
A **75 y/o M** with PMH HFrEF **s/p ICD & LVAD** (**2 years ago**), 10 days of symptoms since last hospitalization

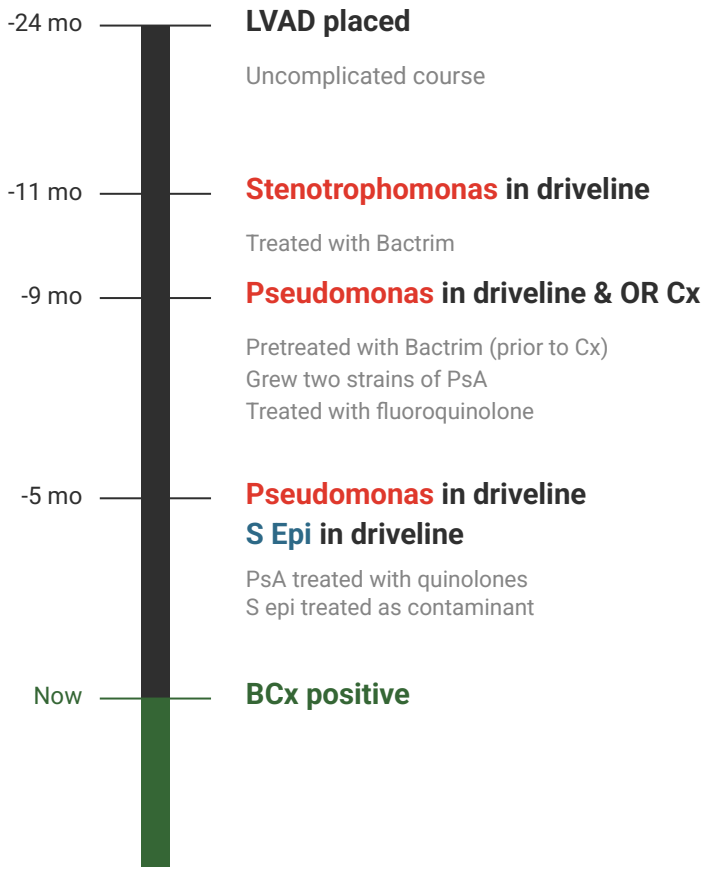
WBC: 22.0

UA: LE (+), nitrate (+), bacteria (-), symptoms (-)

CT C/A/P: Normal

BCx: ???





Case 1: Micro data on admission

Date	Source	Result
(PTA)	Blood	GNR, non-LF
Admission	Blood	GNR

Case 1: Hospital course

- Started on cefepime
  - Favored to be urinary source of bacteremia at time of consult
- After BCx remained positive, requested TEE
  - Cardiology deferred TEE, didn't get TTE either (had one from recent admission)
- ID signed off on HD#7 recommending 6 weeks +/- suppression

Date	Source	Result
Outpatient	Blood	**P. aeruginosa**
Admission	Blood	**PsA** (2/2 sets)
Admission	**Urine**	**P. aeruginosa**
HD #2	Blood	**PsA** (2/2 sets)
HD#4	Blood	No growth

Case 1: Hospital course

- Started on cefepime
  - Favored to be urinary source of bacteremia
- After BCx remained positive, requested TEE
  - Cardiology deferred TEE, didn't get TTE either (had one from recent admission
- ID signed off on HD#7 recommending 6 weeks +/- suppression

- The same day we signed off (HD#7), optho & neuro consulted for **left homonymous hemianopia** & **left sided ataxia**
- CTH/CTA H/N showed **right occipital intraparenchymal hematoma** & small SAH
  - INR at time of symptom onset 3.85
  - **No MRI due to LVAD**
  - Attributed etiology to warfarin
- Discharged off of warfarin
- Doing well at recent ID follow up

Case #2

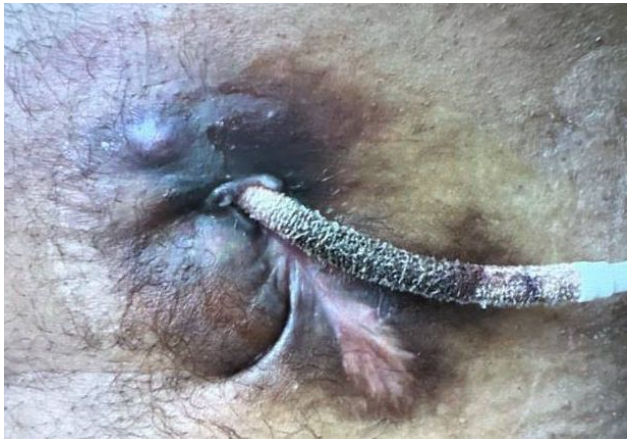
Case 2: HPI

A **53 y/o M** with PMH HFrEF **LVAD** (HM3; implanted **2.5 years ago**), DM (A1c 10.3) presents with...

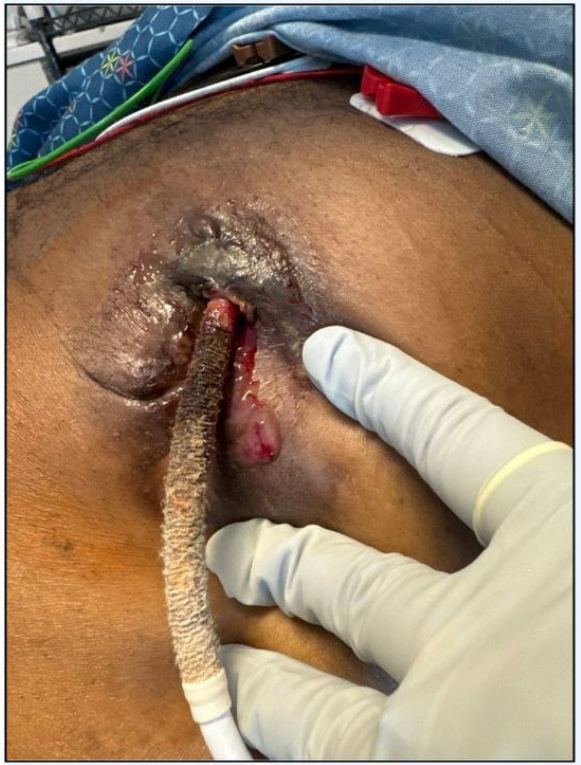
Case 2: HPI

A **53 y/o M** with PMH HFrEF **LVAD** (HM3; implanted 2.5 years ago), DM (A1c 10.3) presents with…

For four months!



45 days before admission



On admission

Case 2: HPI

A **53 y/o M** with PMH HFrEF **LVAD** (HM3; implanted **2.5 years ago**), DM (A1c 10.3) presents with a **four month history of a wound** at his LVAD driveline site

About five months ago, he started getting a **new type of dressing** for his driveline

- States he had a reaction to new dressing kit, so started **buying dressing kits online**

About a month later he noticed:

- **Foul smelling**, **creamy yellow** discharge
- An **abscess** superior to his driveline site

For past month, noticed the driveline **seemed to be "loose"**

- **Copious discharge** from the site in past two days

Case 2: Social History, Exposures, Risk Factors

Geographic & Occupational: No recent foreign or domestic travel. They are not working, but previously worked as a barber.

Substance: They deny alcohol use and he is a former smoker (quit 3 years ago after STEMI & LVAD). They report no recreational drug use **aside from weed**

Sexual History: active with only their female partner (of many years). He has no known history of sexually transmitted infections.

Environmental exposures: They deny known tick/mosquito exposures, freshwater exposure, or well water exposures. Does a fair amount of gardening so he thinks it's **possible he had some soil exposure** (given the chronicity of the wound), but cannot recall a time where it was overtly dirty.

Animal Exposures: Has two outdoor pitbulls, three indoor dogs, and a few outdoor cats. **No other animals**

Tattoos & Piercing: No unprofessional piercings or tattoos .

Infectious PMH: They deny previous intolerances/allergies to antimicrobials; he **reports recent antimicrobial use (Amoxicillin**, see HPI). They deny history of C. diff or known prior exposure to tuberculosis.

Case 2: Exam

VS: 36.6 C | 67 bpm | MAP ok | 97% | BMI 21.9

Gen: alert and oriented, NAD
Head/Neck: NCAT; trachea appears midline
ENT: EOMI grossly, anicteric sclerae; MMM
Resp: normal respiratory effort, symmetric chest rise
CV: VAD hum; extremities perfused
GI: non-distended; no rebound or guarding
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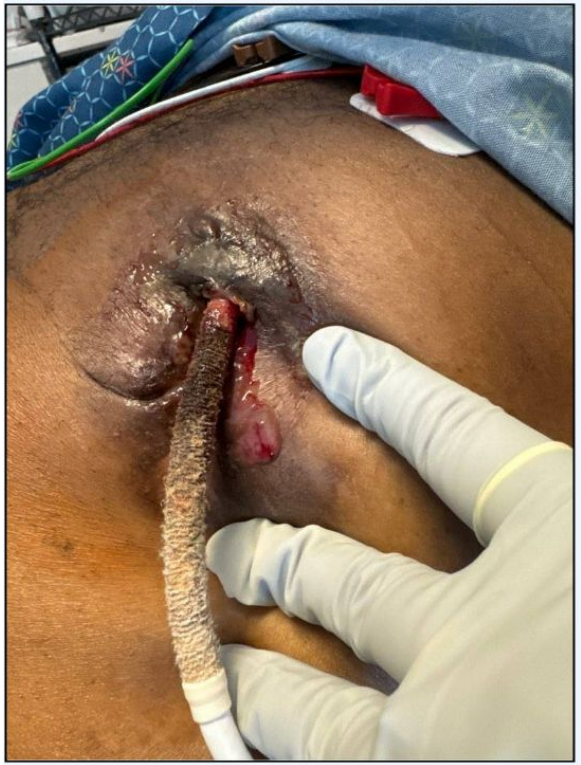
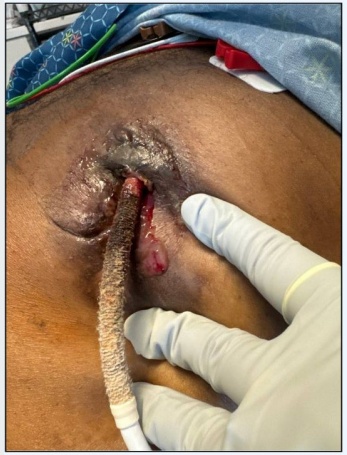
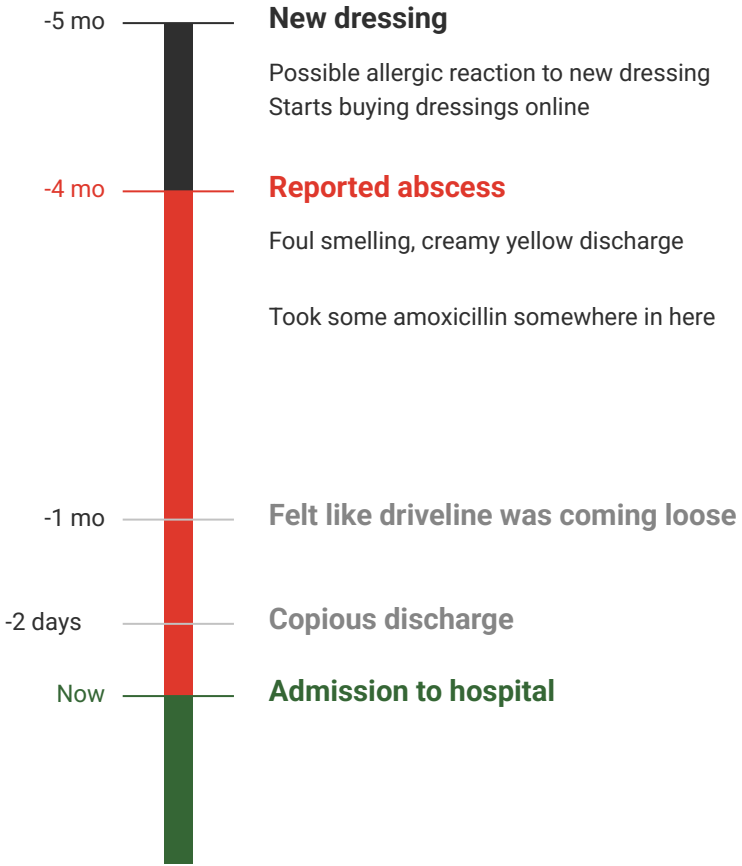


Case 2: Take a guess!

A **53 y/o M** with PMH HFrEF **LVAD** (HM3; implanted 2.5 years ago), DM (A1c 10.3)



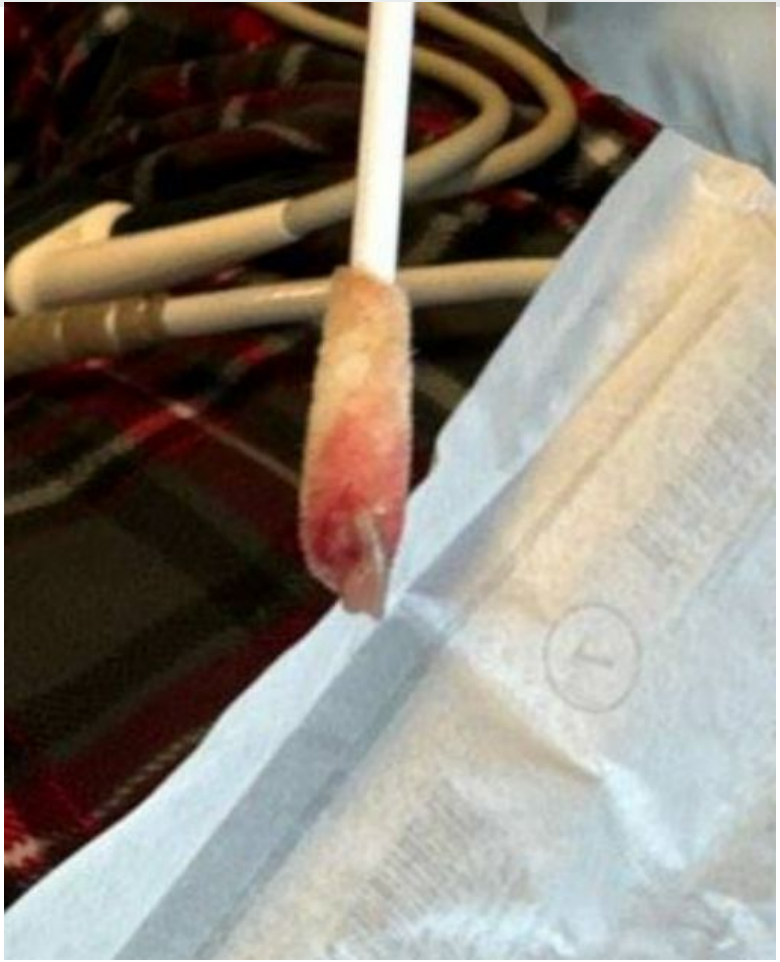
Hint: the order is *Diptera*



Case 2: The *unexpected* bug

He had been having issues at the driveline site after his driveline was changed on [redacted] (about five months ago). He states a month following the driveline change, he began having foul smelling discharge that was mostly bloody, but sometimes a creamy yellow; he attributes this to a new type of dressing he was using, as he notices an abscess (superior to the driveline site) after he changed from his prior dressing to a new dressing. For the past month or so, he had notice increasing discharge and during this time he also noticed a portion of the driveline had come out. Two days prior to admission, he noted worsening (now copious, would soak a gauze pad very quickly) drainage from the ongoing wound. After seeing maggots come out of his wound when he was showering, he reached out to VAD coordinator and was told to present to the ED. One day prior to admission, he had chills so he presented to the ED. The only other infectious symptom he reports during the time course of this illness had been chills (around the time the maggots came out of the abscess).

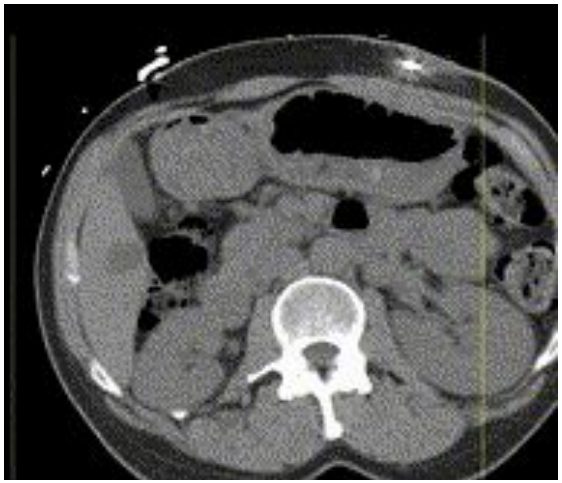
He reports he took some amoxicillin (which he bought from a friend) and finished it two weeks ago. He states he took the amoxicillin due to tooth pain, and the pain improved. Did not have fevers or headaches during this time.

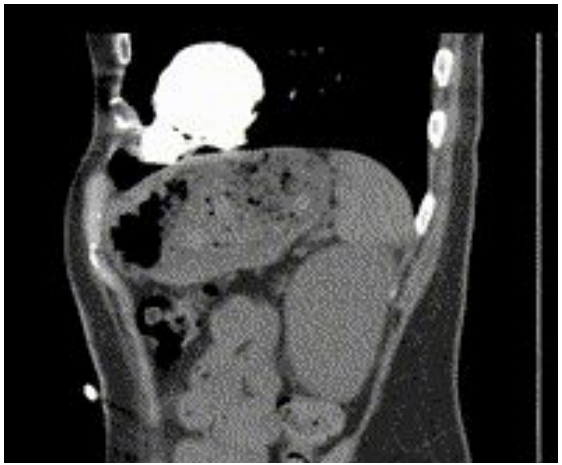


Case 2: Workup

WBC: 6.2 **Hgb**: 11.9 **Plt**: 190

Chem7: normal **LFTs**: normal





Case 2: Hospital course

Clinically stable during admission

Uncomplicated I&D

Discharged on Augmentin & dapto

Wound Cx

3+ mixed anaerobes

Blood Cx

NGTD

OR Cx

Mixed anaerobes

Actinomyces

Discussion

Links to articles discussed here

LVAD infections

- **The VAD population**
  - National estimates
  - Here at WVU
- Epidemiology
- Presentation & diagnosis
- Treatment

National estimates

From data ~2016

- Over 40% are placed as destination therapy
  - 57% are placed under transplant (either listed patients or those under evaluation)
- Over 40% of those who receive OHT had an LVAD before transplant

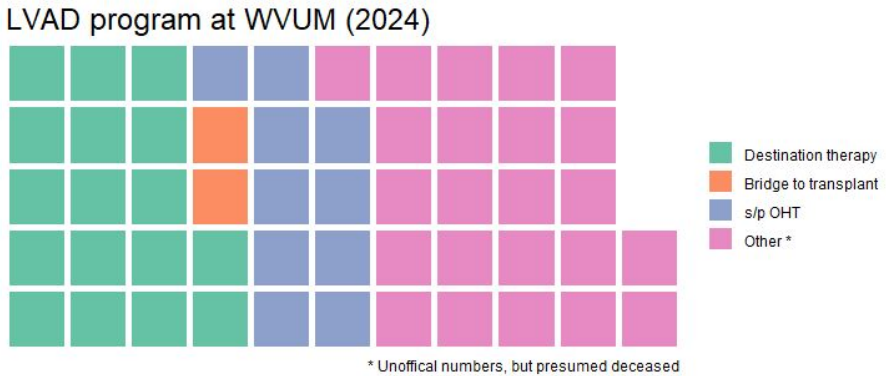
LVADs at WVU

Our WVU program totals:

- 45 total implants (one was HM2 → HM3)
- 7 patients have transferred care to our program
- 10 total LVAD patients in our program have been transplanted

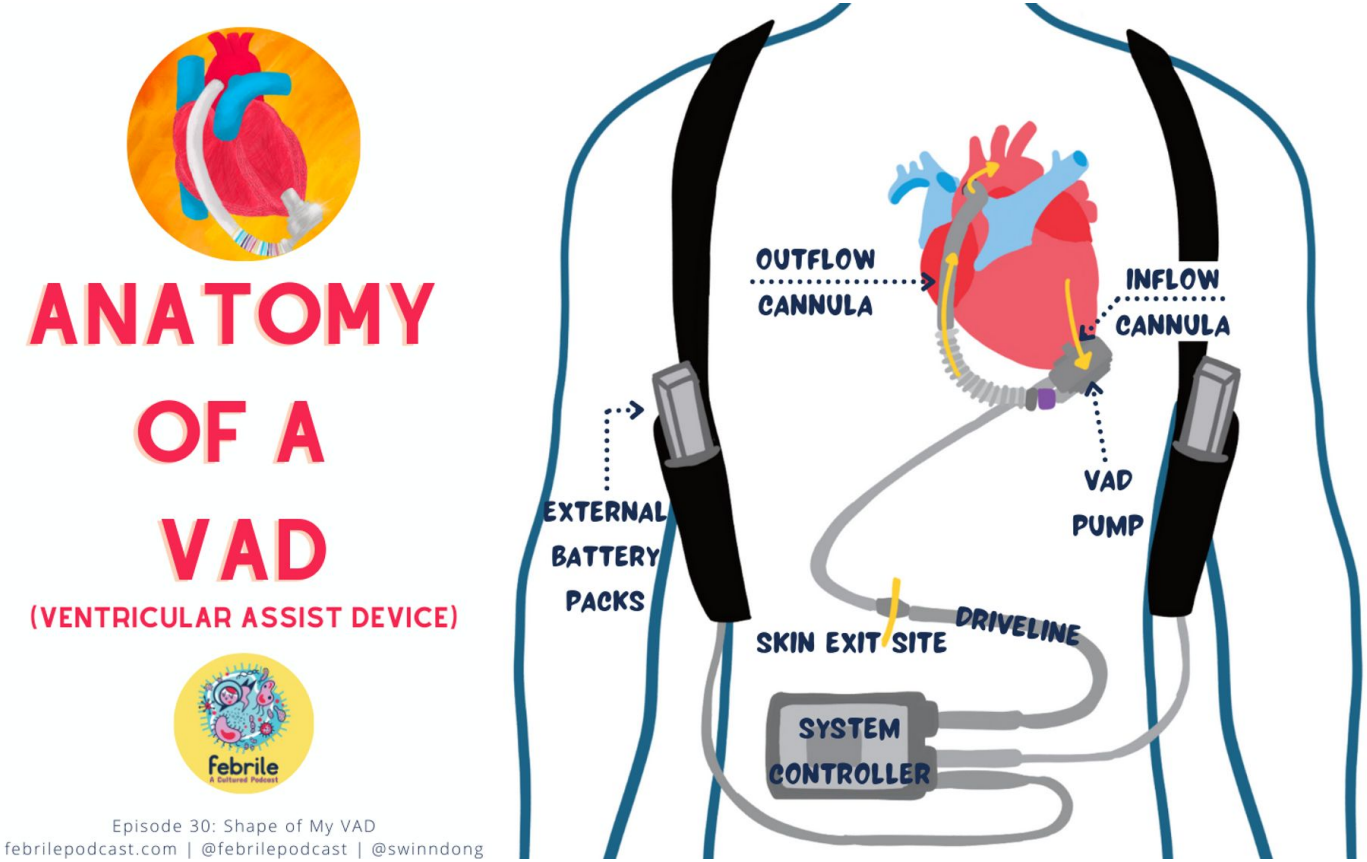
Currently, we have a total of 19 patients

- Bridge to transplant: 2
- Destination therapy: 17
- Two of the DT patients are working on weight loss to become BTT)



LVAD infections

- The VAD population
- **Epidemiology**
  - Types of infection
  - Timing
  - Pathogens
- Presentation & diagnosis
- Treatment



FebrilePodcast.com (episode 30)

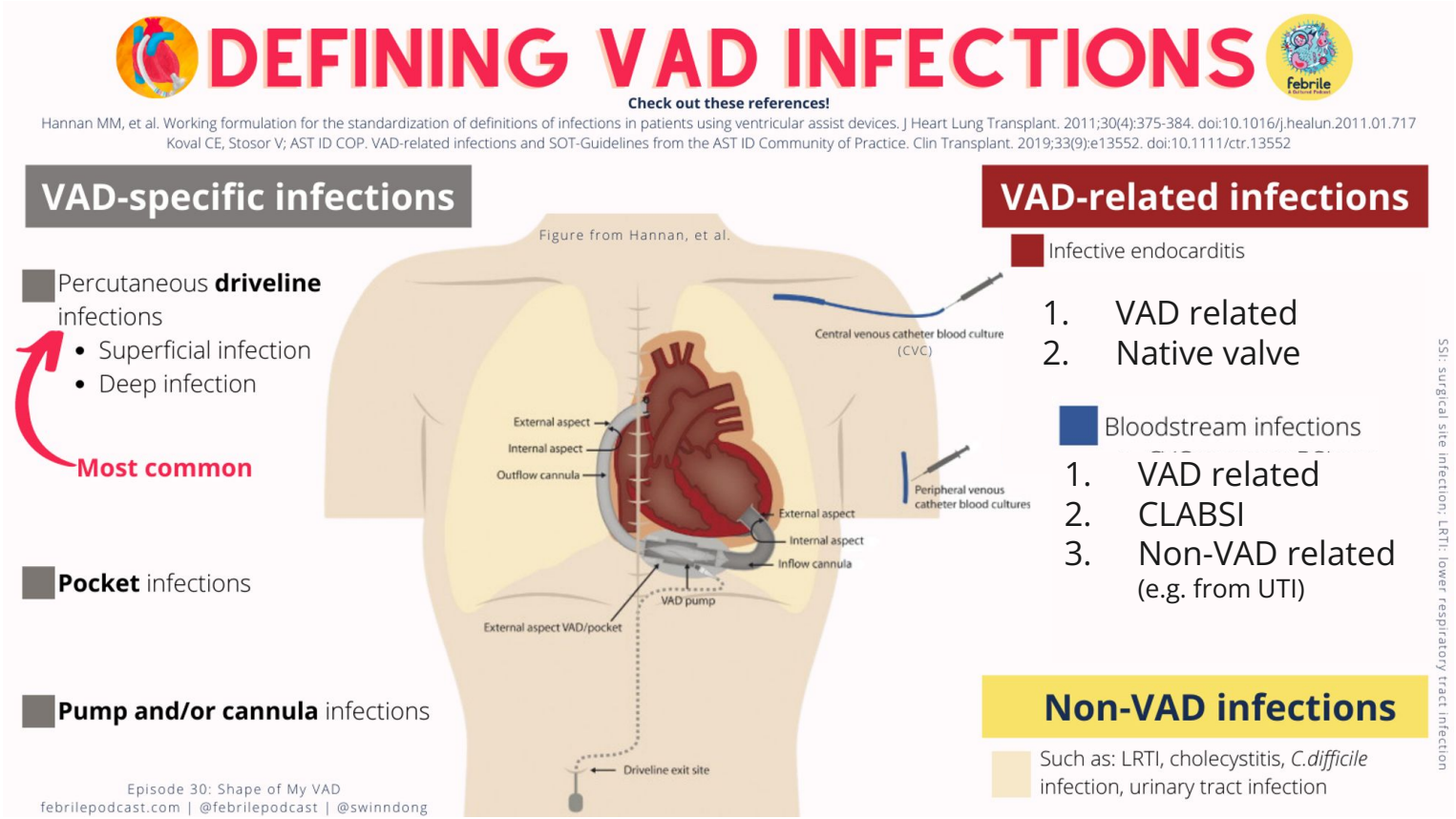


Figure adapted from FebrilePodcast.com [A] & 2019 AST ID guidelines [1]

Epidemiology

- Infections are quite common
- Depends on the time from VAD

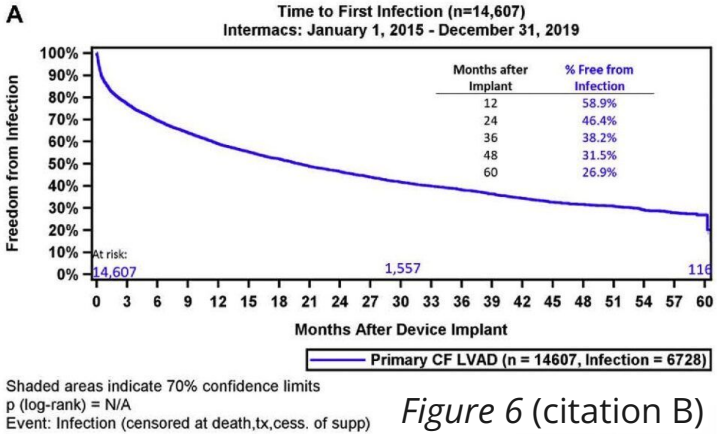


Figure 6 (citation B)

Epidemiology

- Infections are quite common
- Depends on the time from VAD
  - Early (first month) highest overall risk, mostly from non-VAD infections

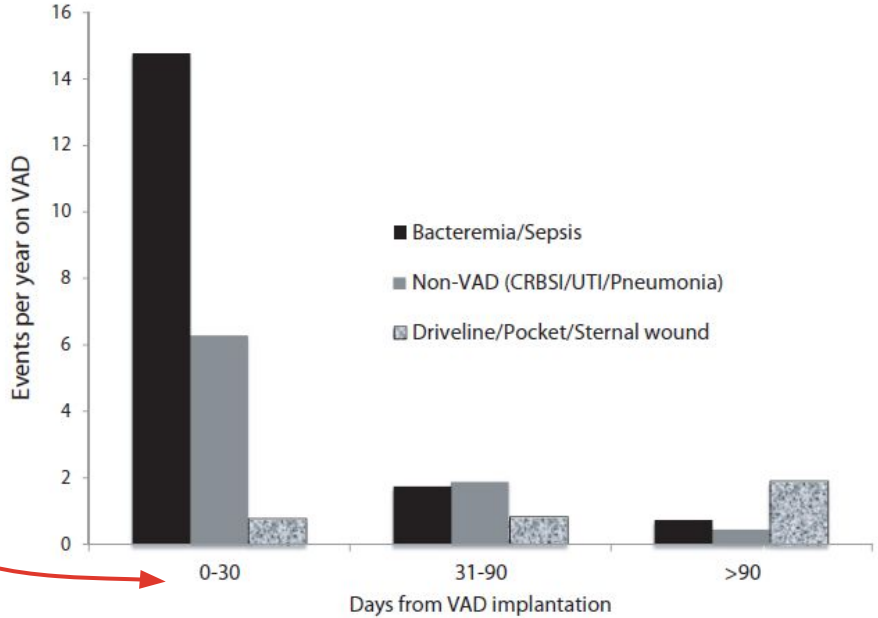


Figure 2 (citation #1)

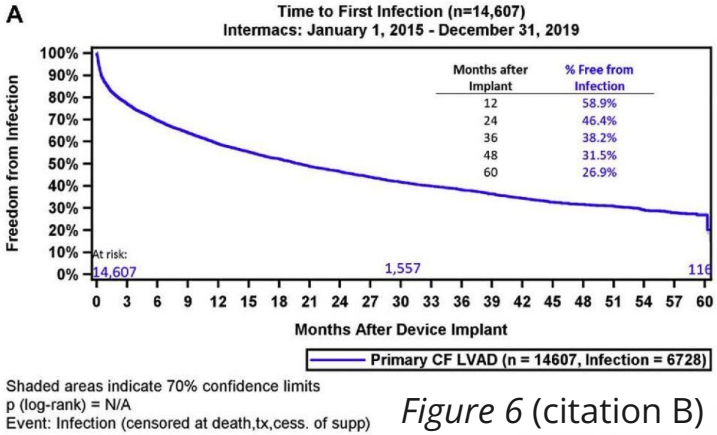
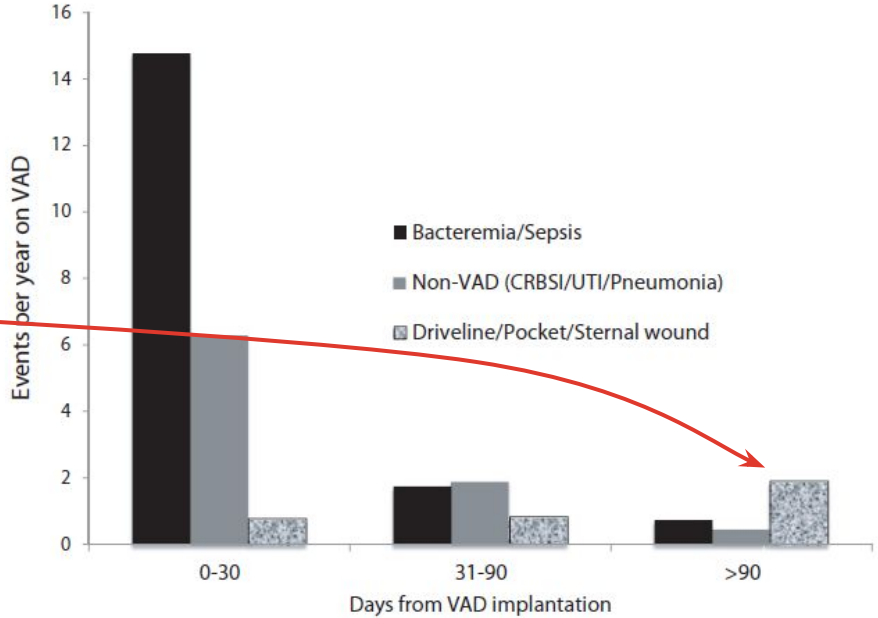


Figure 6 (citation B)

Epidemiology

- Infections are quite common
- Depends on the time from VAD
  - After 90 days, driveline infections are the main drivers of infection (*pun fully intended*)



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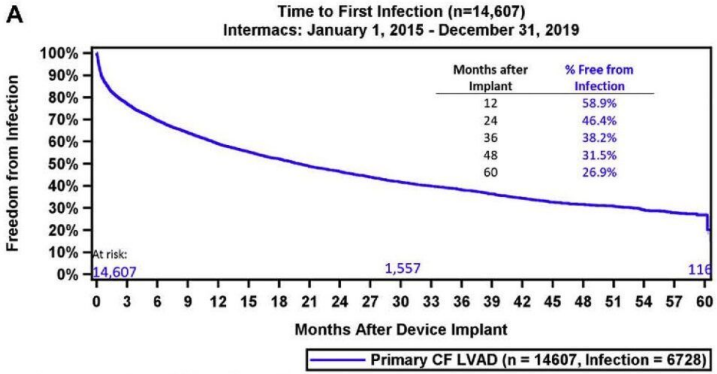

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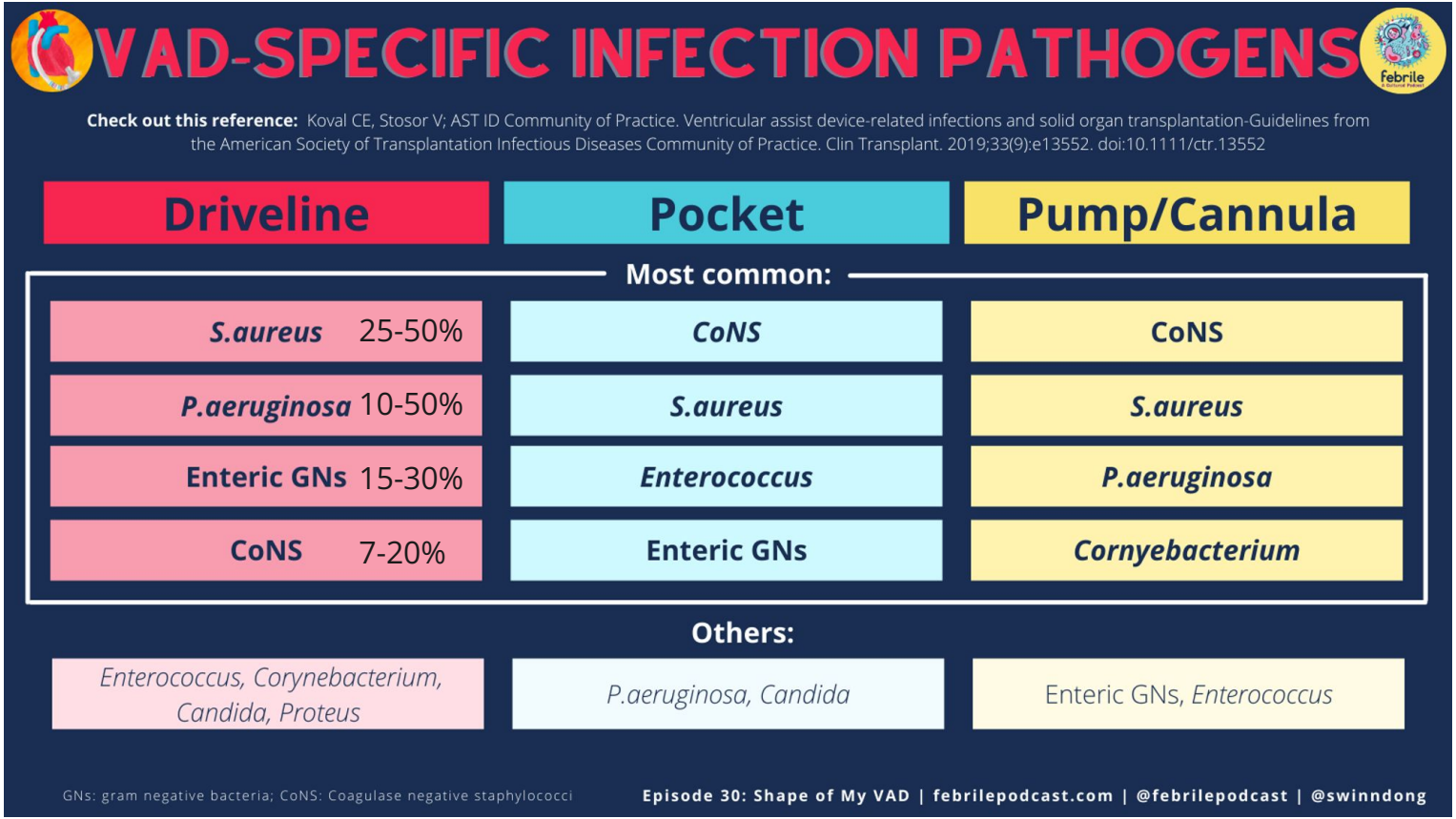


Figure adapted from FebrilePodcast.com [A] & 2019 AST ID guidelines [1]

LVAD infections

- The VAD population
- Epidemiology
- **Presentation & diagnosis**
  - Workup
  - New definitions
- Treatment

RISK & TIMING OF VAD INFECTIONS

Reference: Koval CE, Stosor V; AST ID COP. VAD-related infections and SOT-Guidelines from the AST ID COP. Clin Transplant. 2019;33(9):e13552. doi:10.1111/ctr.13552

Reported risk factors in patients with VAD in place by infection type

Overall infection risk	Sepsis / Bloodstream infection (BSI)	DLES and other VAD-specific infections
Prior cardiac surgery	Older age	Longer duration of VAD support
Infection prior to VAD implantation	Frailty	Older age; Younger age (<50)
Alcohol use	IABP prior to VAD implantation	Lower cardiac index; Higher heart failure score
No hemodialysis	Previous cardiac surgery	Longer duration of mechanical ventilation
Higher BMI	Chronic renal disease and hemodialysis	DLES on right side of abdomen
Diabetes mellitus	Higher heart failure score	Velour interface material
Malnutrition	Higher BMI	Use of driveline anchoring sutures
		Trauma (traction injury) at DLES

IABP, intra-aortic balloon pump; DLES, driveline exit site infection

Type and site of infection varies with timing after device implantation

Timing post-VAD implantation	0 - 30 days	31 - 90 days	>90 days
Predominant type of infection	Sepsis/BSI Non-VAD infections	Non-VAD infections	Driveline infections Pump pocket infections

APPROACHING VAD INFECTIONS

You suspect an LVAD infection, now what?

DETAILED H&P

- Full history and review of symptoms -- need a heightened suspicion as classic signs and symptoms of infection may be absent!
  - Any accidental trauma or tugs to the driveline? Any changes at driveline site?
  - Review of VAD function, any recent alarms?
- Comprehensive exam
  - Inspect and palpate driveline as able - is there a loss of tissue seal? Purulent discharge? Cellulitis?
  - Any other surgical wounds?

BASIC LABS

- CBC with differential
- Chemistry
- C-reactive protein or ESR
- Rule out other causes of infection as appropriate: UA, urine culture, sputum culture

MICRO

- Blood cultures!!
  - At least 2-3 sets (both aerobic/anaerobic bottle)
  - If CVC or PICC present, culture from line (ideally with a paired peripheral culture)
- If purulent drainage from driveline exit site, send sterile aspirate for Gram stain, bacterial and fungal cultures
- If abscess identified on imaging, would collect for GS and culture via aspiration if possible

IMAGING

- Chest x-ray
- Abdominal ultrasound or CT abdomen/thorax if suspect deep infection or abscess
  - CT will be impacted by artifact from VAD
- Echo to look for vegetations, turbulent flow, abscess, cannula dehiscence
- Can consider nuclear imaging studies in certain circumstances (FDG PET/CT, SPECT/CT)

Episode 30: Shape of My VAD
febrilepodcast.com | @febrilepodcast | @swinndong

References: **Hannan MM, et al**. Working formulation for the standardization of definitions of infections in patients using ventricular assist devices. J Heart Lung Transplant. 2011;30(4):375-384. doi:10.1016/j.healun.2011.01.717; **Koval CE, Stosor V; AST ID COP**. VAD-related infections and SOT-Guidelines from the AST ID COP. Clin Transplant. 2019;33(9):e13552. doi:10.1111/ctr.13552

Old (2011) definitions of types of infections

ISHLT definitions (2011)

- VAD-Specific infections
  - Pump pocket &/or cannula
  - Pocket
  - Driveline exit site
    - Superficial
    - Deep
- VAD-related infections
  - Bloodstream
    - VAD-related
    - Non-VAD related
  - Endocarditis
    - VAD-related
    - Valvular (native valve)
- Non-VAD infections
  - Respiratory infections, UTI, CDI, IAI

The old definitions had proven, probable, possible

- Categorized based on multiple criteria (histopath/microbio, clinical criteria)
- See tables in citation [5] for details
- Classification of infection **impacts duration of therapy**

Case 2: Proven superficial driveline infection

Table 7 Definitions of Ventricular Assist Device-Specific Percutaneous Driveline Infection

	Surgical/histology	Microbiology	Clinical	General wound appearance
A. Superficial VAD-specific Percutaneous Driveline Infection				
Proven = Surgical/histology criteria ± other criteria	• Involvement of tissues superficial to the fascia and muscle layers of the incision documented	• Aseptic skin culture positive or not cultured	• Local increase in temperature around the exit site	• Purulent discharge from the incision but not involving fascia or muscle layers or • Erythema spreading around the exit site[a]
Probable = No surgical/ histology criteria with purulent discharge ± other criteria	• Surgical debridement not performed • No histology	• Aseptic skin culture positive or negative but patient already on antibiotic or had antiseptic used to clean wound	• Local increase in temperature around the exit site and • Treated as superficial infection with clinical response	• Purulent discharge from the incision but not involving fascia or muscle layers or • Erythema spreading around the exit site[a]
Possible = No surgical/ histology or purulent discharge ± other criteria	• Surgical debridement not performed • No histology	• Aseptic skin culture positive or negative and patient not on antibiotics or had antiseptic used to clean the wound	• Local increase in temperature around the exit site and • Treated as superficial infection with clinical response	• No discharge • Erythema spreading around the exit site[a]

Case 2: Not? a deep driveline infection

	Surgical/histology	Microbiology	Clinical	General wound appearance
B. Deep VAD-specific Percutaneous Driveline Infection				
Proven = Surgical/histology criteria ± other criteria	• Involves deep soft tissue (eg, fascial and muscle layers) on direct examination or on direct examination during re-operation • An abscess is found on direct examination during re-operation	• Culture positive or histology puncture positive for infection	• Temperature >38°C • Localized pain or tenderness	• A deep incision spontaneous dehiscence • Abscess deep to the incision around the driveline
Probable = No surgical/ histology criteria with spontaneous dehiscence ± other criteria	• No surgical debridement • No histology	• Culture negative but patients already on antibiotics or had antiseptic used on exit site	• Temperature >38°C or • Localized pain or tenderness and • Treated as a deep infection	• An incision spontaneous dehiscence
Possible = No surgical/ histology criteria with positive ultrasound ± other clinical criteria	• No surgical debridement • No histology	• Cultures not reserved	• Localized pain or tenderness and • Treated as a deep infection with clinical response	• Positive ultrasound

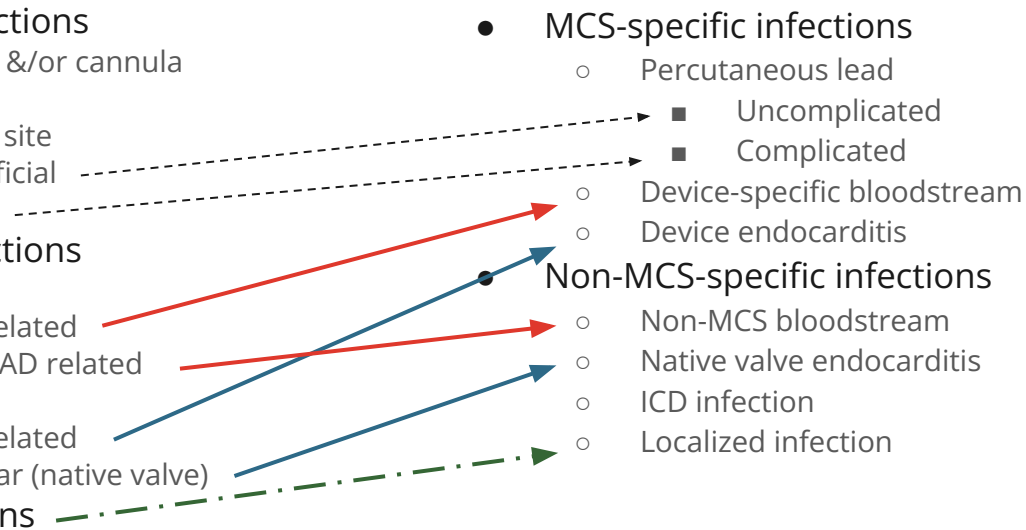
New (2024) definitions of types of infections

ISHLT definitions (2011) [5]

- VAD-Specific infections
  - Pump pocket &/or cannula
  - Pocket
  - Driveline exit site
    - Superficial
    - Deep
- VAD-related infections
  - Bloodstream
    - VAD-related
    - Non-VAD related
  - Endocarditis
    - VAD-related
    - Valvular (native valve)
- Non-VAD infections
  - Respiratory infections, UTI, CDI, IAI

ISHLT definitions (2024) [2]

- MCS-specific infections
  - Percutaneous lead
    - Uncomplicated
    - Complicated
  - Device-specific bloodstream
  - Device endocarditis
- Non-MCS-specific infections
  - Non-MCS bloodstream
  - Native valve endocarditis
  - ICD infection
  - Localized infection



New (2024) definitions: Percutaneous lead infection

Uncomplicated percutaneous lead infection

- ❏ Pain, tenderness, erythema, drainage, and/or induration at driveline site
  - ➢ +/- Positive drainage culture
- ❏ Blood cultures are negative
- ❏ Systemic signs of infection are absent
- ❏ Imaging is negative for fluid collection/abscess
- ❏ Clinical improvement or resolution with antibiotics

Complicated percutaneous lead infection

- Pain, tenderness, erythema, drainage, induration, and/or fistulous tract at the percutaneous lead (driveline) site; and/or
- Fluid collection/abscess at exit site noted on imaging with positive culture; and/or
- Radiographic evidence of findings consistent with infection along the path of the lead; and/or
- Presence of systemic signs/symptoms including fever, chills, leukocytosis, SIRS, and sepsis; and/or
- Positive drainage or blood cultures (bloodstream infection); and/or
- Cultures demonstrating multidrug-resistant organisms or fungi; and/or
- Presence of infection of the external surfaces of an implantable component

LVAD infections

- The VAD population
- Epidemiology
- Presentation & diagnosis
- **Treatment**

VAD-SPECIFIC INFECTION MANAGEMENT

Check out this reference: Koval CE, Stosor V; AST ID Community of Practice. Ventricular assist device-related infections and solid organ transplantation-Guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13552. doi:10.1111/ctr.13552

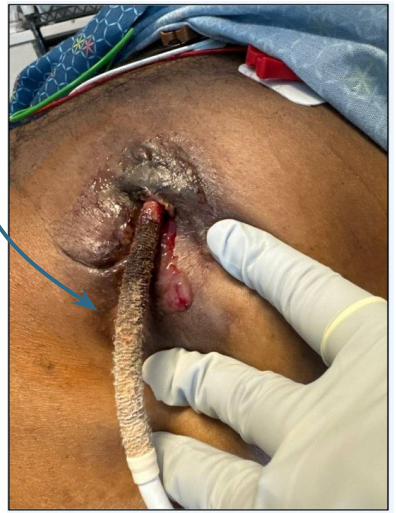
Infection	Antibiotic Strategy**			Adjunctive Strategies
	Route	Duration	Suppressive antibiotics?	
Superficial driveline infection	PO or IV	≥2 wks	Can consider stopping if resolved	• Ensure driveline immobilization • Optimize driveline hygiene • Monitor for relapse, secondary infection
Deep driveline infection	IV	2-8 wks#	Oral suppressive antibiotics expected	• Surgical debridement of abscess(es) • Externalization of driveline • Wound care, including possible wound VAC • Reinsertion of driveline in new tract may be of benefit • In limited situations, complete device exchange can be considered
Pump pocket infection	IV	4-8 wks#	Oral suppressive antibiotics expected	• Drainage of abscess, at least for culture • Surgical debridement if size and position favorable or if recurrent. Possible wound VAC • Transplant with device explant is ideal surgical strategy • In limited situations, complete device exchange can be considered
Pump/cannula infection	IV	≥6 wks	Suppressive antibiotics (may be IV) expected	• Transplant with device explant is ideal surgical strategy • In limited situations, complete device exchange can be considered

** If sepsis, empiric coverage for *Pseudomonas* spp and MRSA
Depending on time to source control and if coincident bloodstream infection

Treatment

Drivelines: Once infected, it's nearly impossible to eradicate without removing device

- The polyester velour surface is designed to promote tissue growth (at the DLES)
- But this promotes biofilm formation



Surgical VAD exchange?

- Not well studied [3][4]
- Often high operative risk
- One case series [3] still had 40% recurrence of infection

Maggots?

- Also not well studied

Case 1: Hospital course

- Started on cefepime
  - Favored to be urinary source of bacteremia
- After **BCx remained positive**, we requested TEE
  - Cardiology deferred TEE, didn't get TTE either (had one from recent admission)

➢ The same day we signed off (HD#7), optho & neuro consulted for **left homonymous hemianopia** & **left sided ataxia**

➢ CTH/CTA H/N showed **right occipital intraparenchymal hematoma** & small SAH
  - INR at time of symptom onset 3.85
  - **No MRI due to LVAD**
  - Attributed etiology to warfarin

In addition to the inherent morbidity and mortality related to infectious complications of VAD implantation, emerging data indicate VAD-related bloodstream infections are associated with both ischemic and hemorrhagic stroke.[29,40,41] Infection-associated cerebrovascular accidents tend to occur in the later postimplantation period, with *Staphylococcus aureus* and *Pseudomonas aeruginosa* being frequently encountered[13,29] pathogens in this setting.[41,42] The postulated pathophysiology, confirmed in a small number of patients at the time of neurosurgical intervention, is cerebral mycotic angiopathy with subsequent vascular rupture.[41,42]

2019 AST ID guidelines [1]

Thoughts? Questions?

Sources:

- https://www.hunterratliff1.com/talk/
- Click on the “citations” button!