

Heart to Heart: Prehospital Care of the VAD Patient

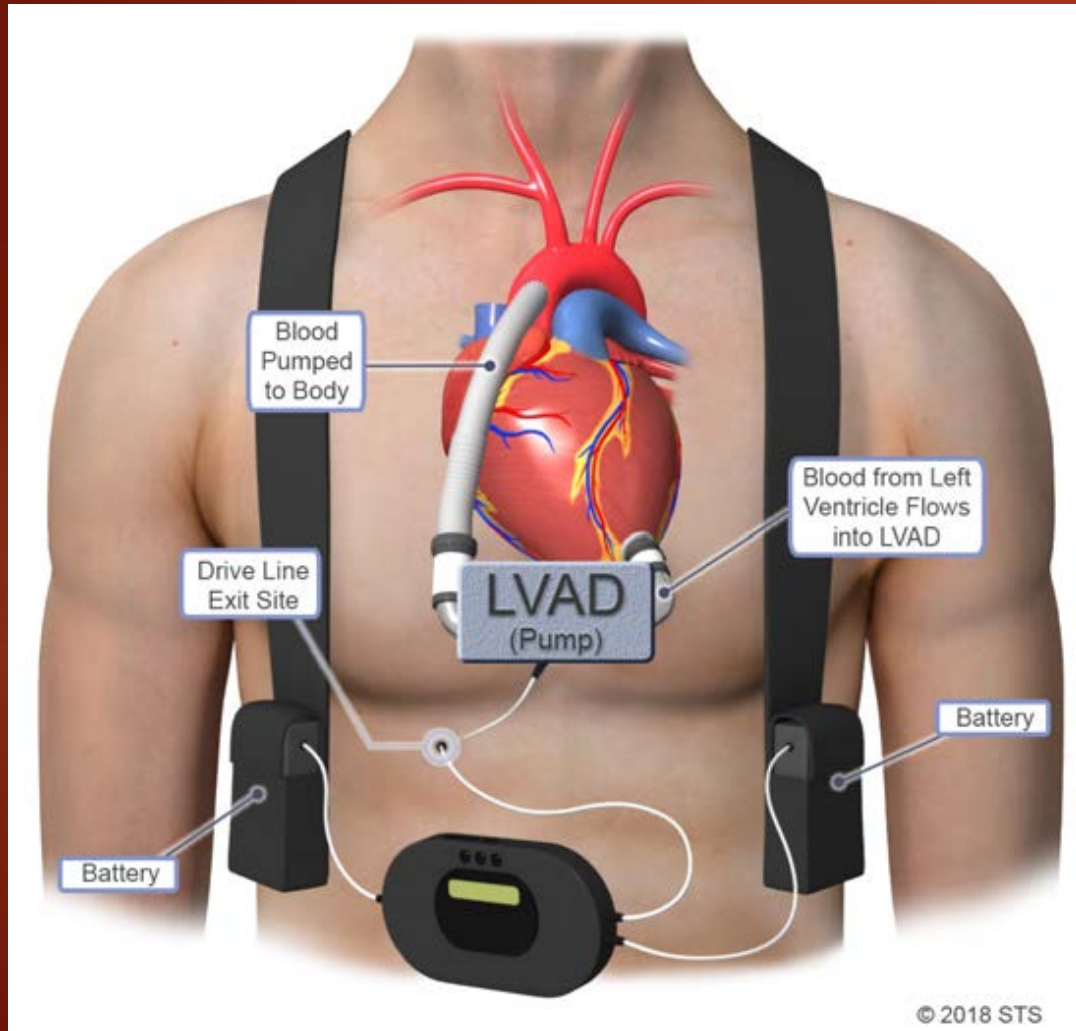
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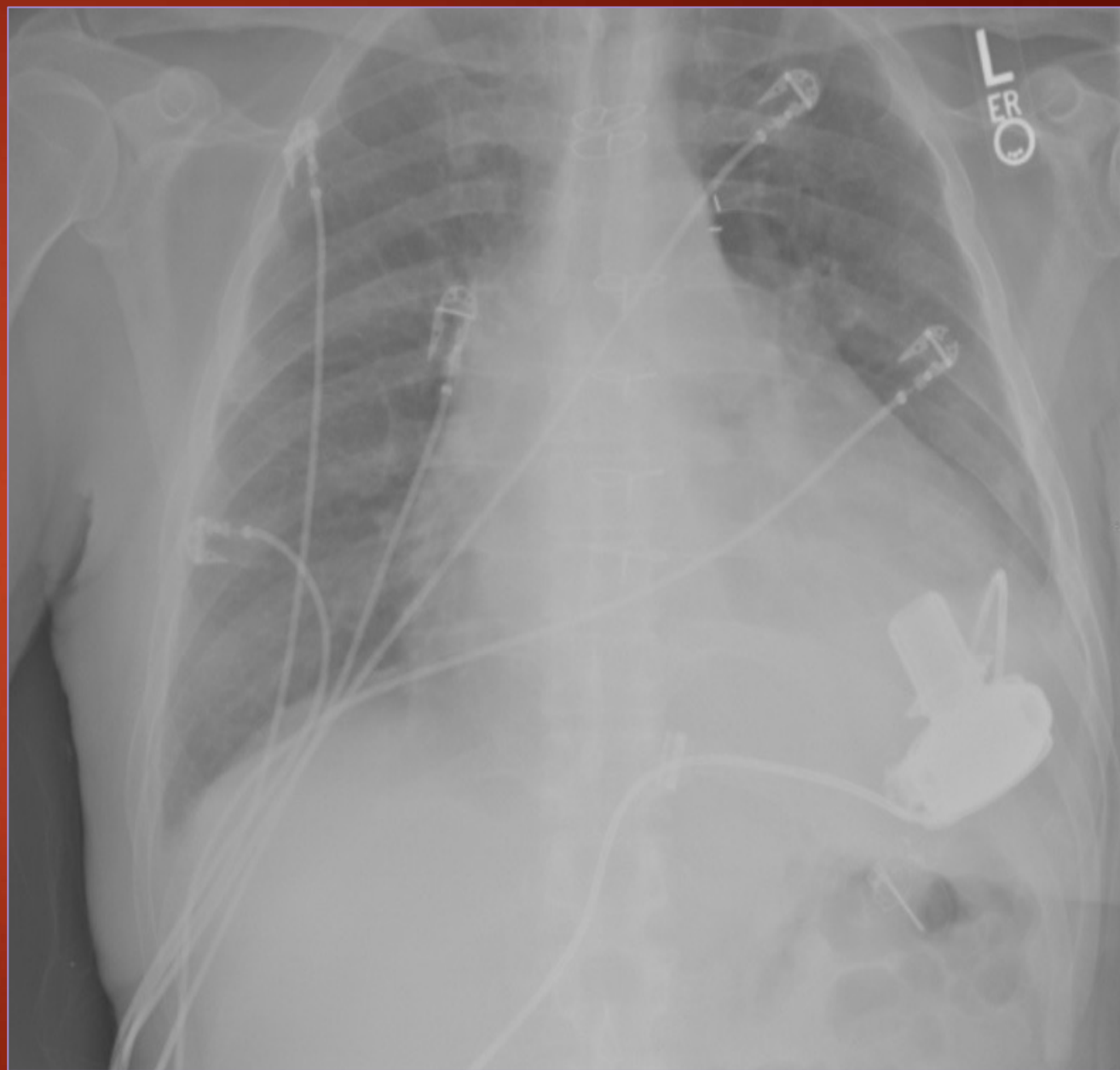
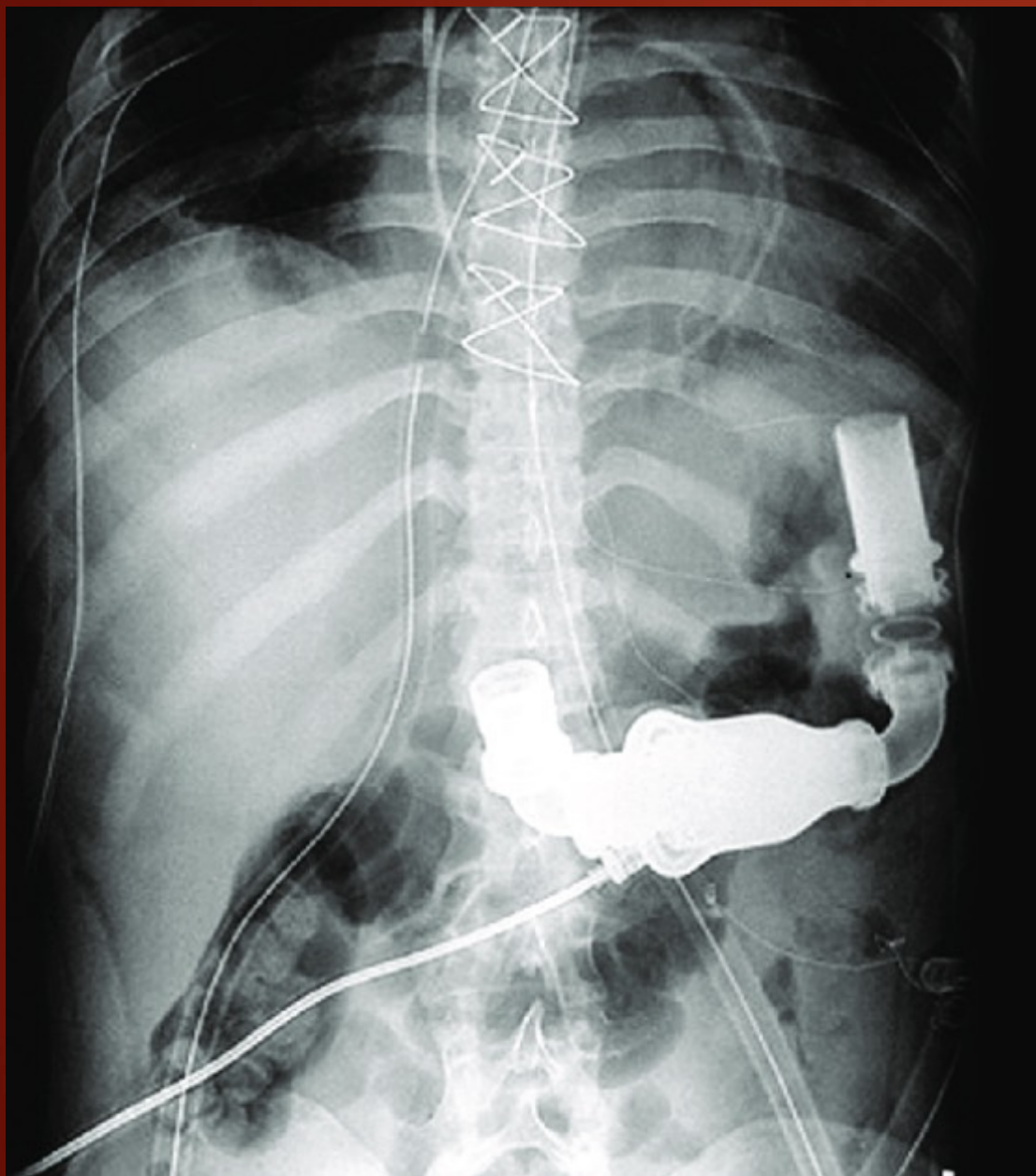
Objectives

- ▶ Describe purpose and function of Ventricular Assist Device
- ▶ Identify educational resources
- ▶ Understand differences in assessment of patient with a Ventricular Assist Device

What is a VAD?




- ▶ Ventricular Assist Device
 - ▶ Mechanical pump surgically attached to the left ventricle
 - ▶ Attached to a computer and power source outside of the body
- ▶ Pumps blood from the left ventricle to the ascending aorta
- ▶ Improves perfusion

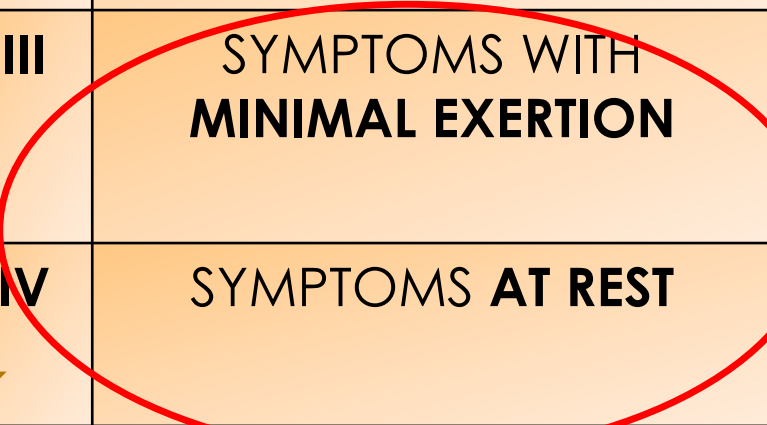


When Is It Time For A VAD


NYHA HEART FAILURE CLASSIFICATION



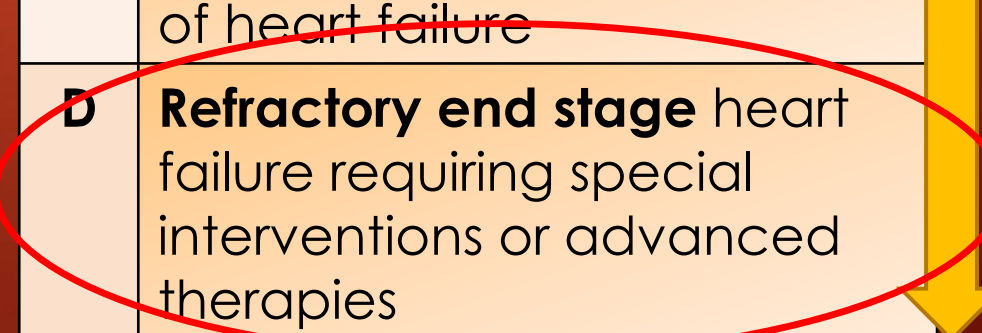
I	ASYMPTOMATIC
II	SYMPTOMS WITH MODERATE EXERTION
III	SYMPTOMS WITH MINIMAL EXERTION
IV	SYMPTOMS AT REST



ACC/AHA HEART FAILURE STAGES



A	No structural disease. High risk for developing heart failure
B	Structural disease without symptoms of heart failure
C	Structural disease with current or previous symptoms of heart failure
D	Refractory end stage heart failure requiring special interventions or advanced therapies



Implications of heart failure in the U.S.¹⁻⁴

5.7
million

Adults in the U.S. have heart failure^{1,2}

Up to 1.5 million are in the advanced stages

At least
25,000

Patients are appropriate candidates for advanced heart failure therapies³

Estimated
3,200

Donor hearts are available for heart transplants each year⁴

Supply of donor hearts is limited and heart transplantation is not an option for all patients^{3,4}

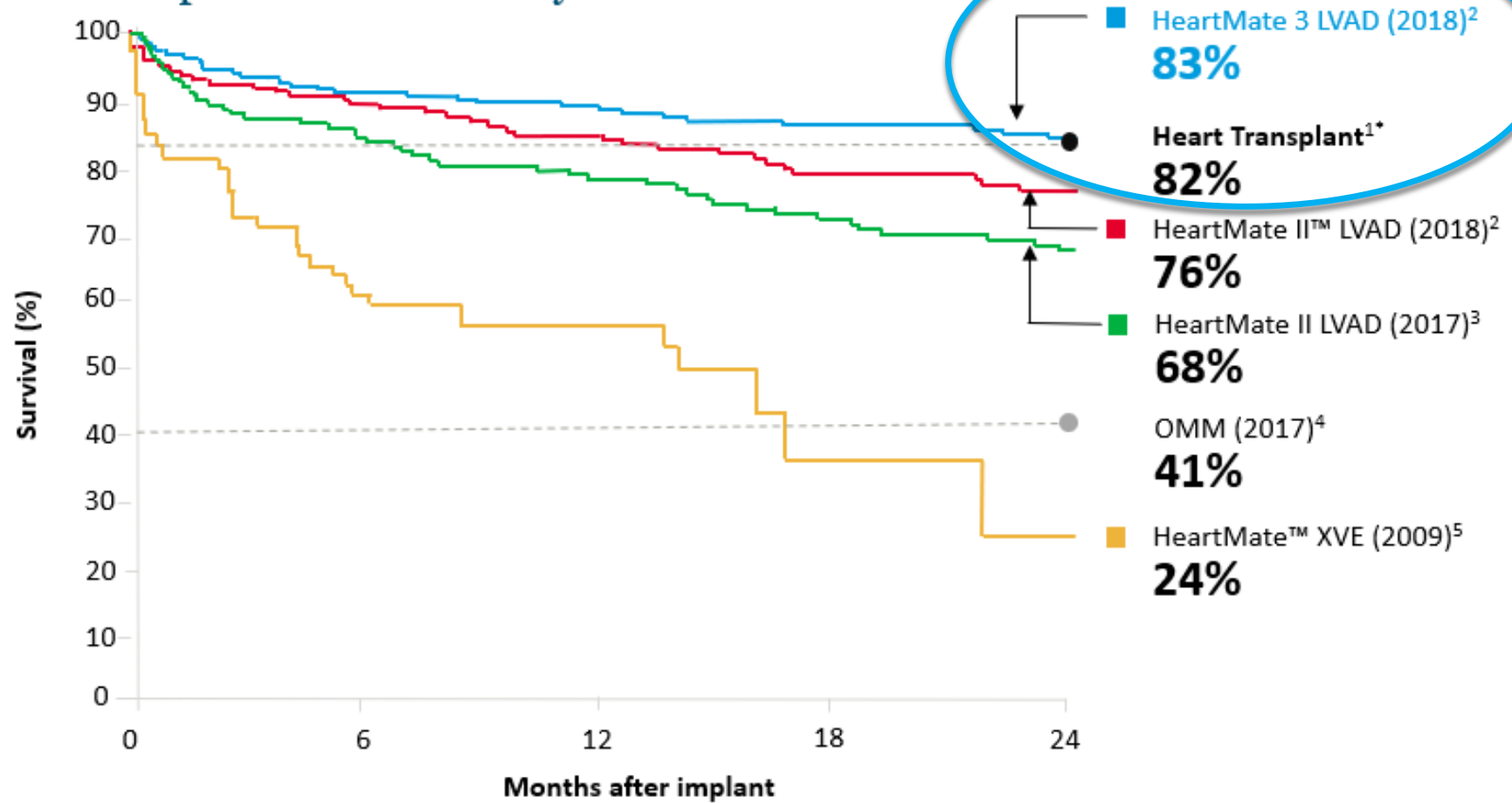
Over
270,000

Patients die of heart failure in the U.S. each year^{1,2}

About half of the people with heart failure die within 5 years of diagnosis^{1,2}

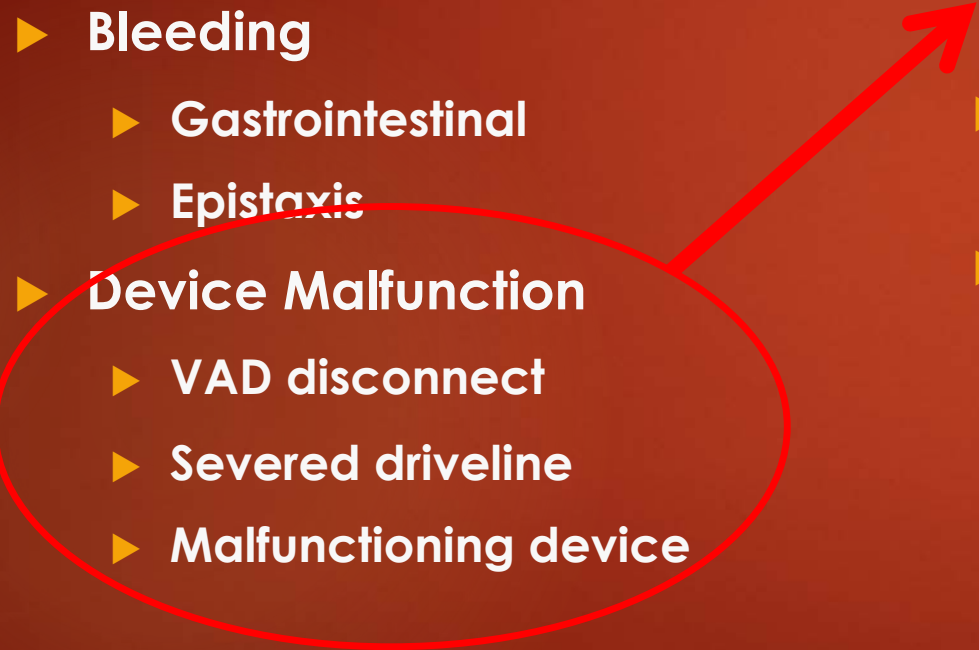
References: 1. Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics—2016 update: A report from the American Heart Association. *Circulation*. 2016;133(4):e38-e360. 2. Centers for Disease Control and Prevention (CDC) Heart Failure Fact Sheet. https://www.cdc.gov/dhdsdp/data_statistics/fact_sheets/fs_heart_failure.htm (accessed August 6, 2018). 3. Dunlay SM and Roger VL. Understanding the epidemic of heart failure: past, present, and future. *Curr Heart Fail Rep*. 2014;11(4):404-415. 4. UNOS (United Network for Organ Sharing). Heart Transplants, 1988-2017. <https://optn.transplant.hrsa.gov/data/view-data-reports/national-data/#> (Accessed Aug. 6, 2018).

Now comparable to transplant survival at 2 years^{1*}



Based on published data from multicenter experience and separate studies, which may involve different patient populations and other variables. Not a head to head comparison. Data presented for informational purposes only.

Common Causes of 911 Calls

- ▶ Shortness of breath
 - ▶ Heart failure
 - ▶ Sepsis
 - ▶ Bleeding
 - ▶ Gastrointestinal
 - ▶ Epistaxis
 - ▶ Device Malfunction
 - ▶ VAD disconnect
 - ▶ Severed driveline
 - ▶ Malfunctioning device
 - ▶ Primary pump malfunction is very rare
 - ▶ Contact implanting center/VAD team immediately
 - ▶ Assess if pump is running
 - ▶ Auscultate left chest wall over apex of heart
 - ▶ Continuous mechanical sound "hum" indicates pump is running
 - ▶ Assess the system controller
- 

Common Causes of 911 Calls

- ▶ Fall/Syncope

- ▶ Cardiac Arrhythmia/ICD Firing

- ▶ Hypoglycemia

- ▶ Dehydration

- ▶ Head Injury

- ▶ Stroke

- ▶ Hemorrhagic

- ▶ Embolic

- ▶ Arrhythmias can stop RV from filling the VAD decreasing/stopping CO

- ▶ Place on 12 lead monitor

- ▶ Treat per ACLS protocol

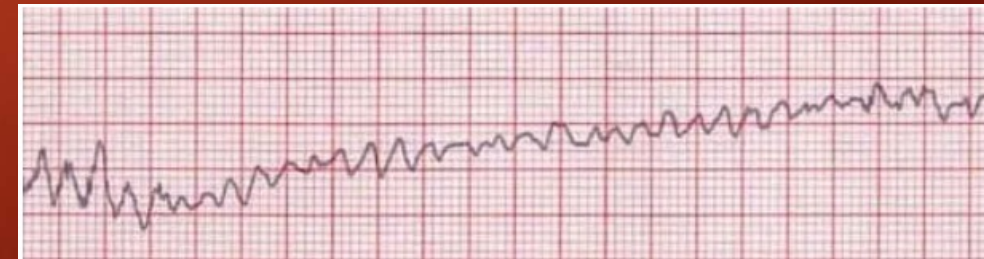
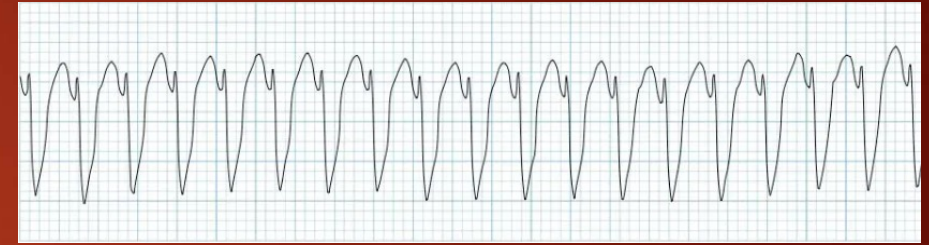
- ▶ Compressions suggested for patients:

- ▶ Loss of consciousness

- ▶ No VAD hum

- ▶ Doppler pressure <50mmHg

- ▶ End Tidal CO2 <20



Assessment of Vital Signs

- ▶ Blood pressure
 - ▶ Continuous flow device
 - ▶ May not have palpable pulse
 - ▶ Automatic blood pressure cuffs are unreliable
 - ▶ Use doppler to assess blood pressure if available
- ▶ Pulsatile vs nonpulsatile
 - ▶ Able to palpate consistent peripheral pulse = pulsatile
 - ▶ Doppler pressure = systolic blood pressure
 - ▶ NOT able to palpate consistent peripheral pulse = nonpulsatile
 - ▶ Doppler pressure = mean arterial pressure



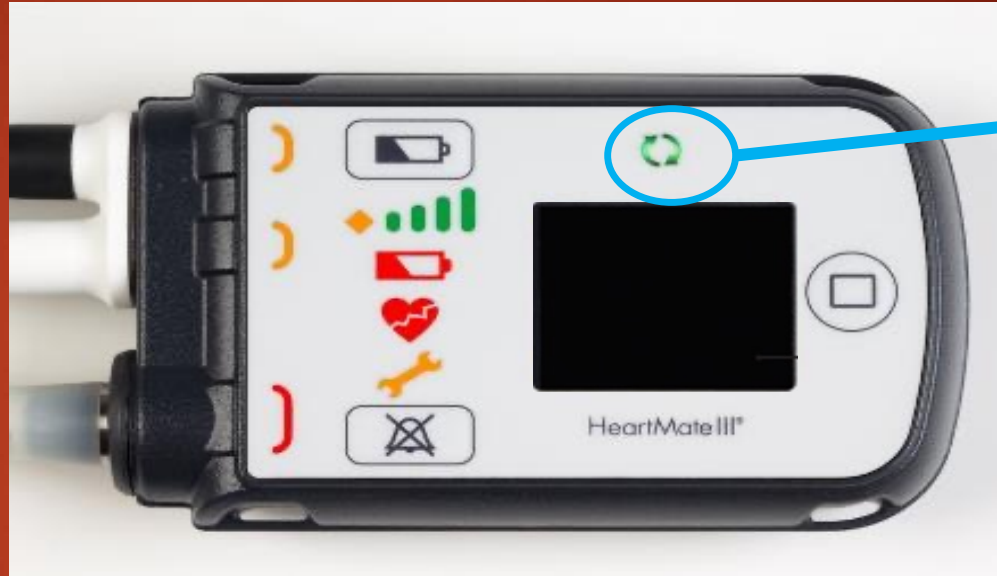
Assessment of Vital Signs

- ▶ Heart Rate
 - ▶ May not be able to palpate pulse
 - ▶ Place on ECG monitoring asap
 - ▶ May have interference from pump
- ▶ Pulse ox
 - ▶ Unreliable in nonpulsatile patients
- ▶ End tidal CO₂
 - ▶ If patient is unresponsive
 - ▶ ETco₂ ≤ 20 begin high quality manual CPR
 - ▶ No automatic compression devices



Assessment of VAD: Is It On?

HeartMate

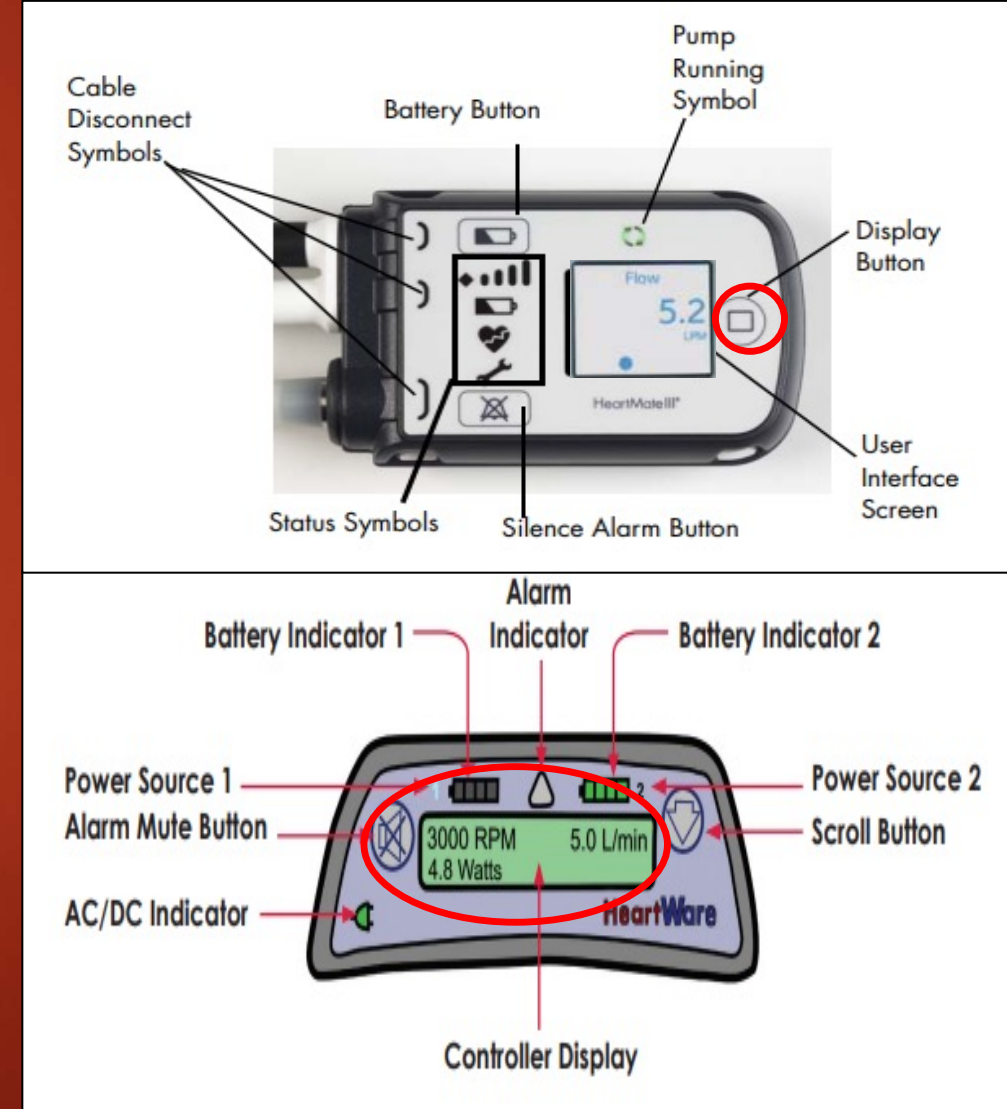


HeartWare



Assessment of VAD: Parameters (VAD Vital Signs)

- Speed (RPM)
 - Clinical range depends on device
 - Heartmate3 4700-6200
 - Heartmate2 8200-9600
 - Heartware 2400-3200
 - May see fluctuation up or down 50-100RPM in HeartMate devices
 - Ask patient or caregiver what their set speed is



Assessment of VAD: Parameters (VAD Vital Signs)

➤ Flow (LPM)

➤ Estimated amount of blood flowing through pump

➤ HeartMate 3 3-10LPM

➤ HeartMate 2 4-8LPM

➤ HeartWare 3.5-7LPM

➤ Power (watts)

➤ Measured amount of electricity used to power pump

➤ HeartMate 3 3-6watts

➤ HeartMate 2 4-8watts

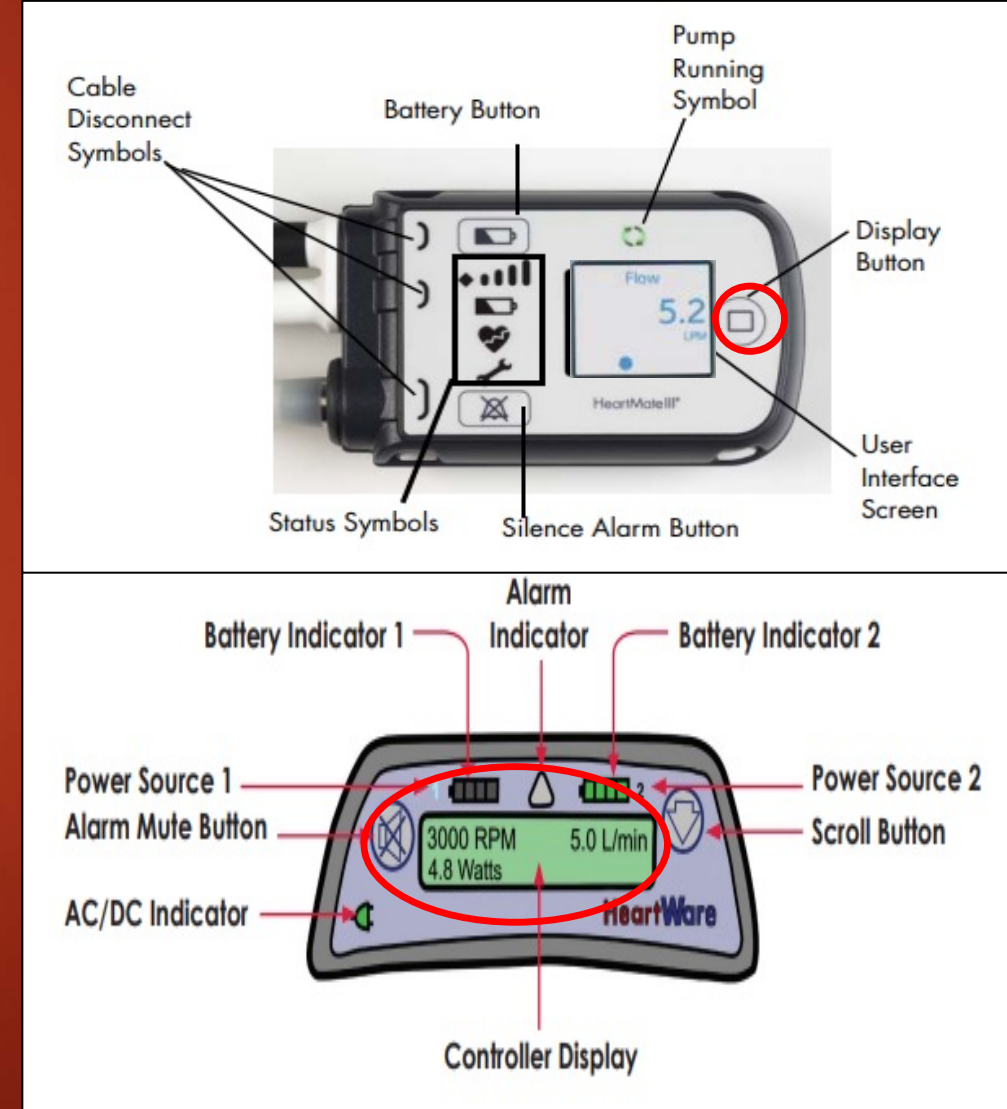
➤ HeartWare 2.5-7

➤ Pulsatility Index (PI)

➤ HeartMate only














➤ HeartMate 3 1-10

➤ HeartMate 2 4-7



Assessment of VAD: Alarms

HAZARD/HIGH PRIORITY → RED ALARMS → PUMP HAS STOPPED OR IN DANGER OF STOPPING

Priority	System Controller Screen	Active Symbols	Alarm Means	To Resolve Alarm
HAZARD	<div>Call Hospital Contact</div> <div>⌚ :07</div> <div>+</div> <div>Low Flow</div> <div>⌚ :03</div>	 <div>+</div> 	Pump is off. The Pump Running symbol is black.	<ol style="list-style-type: none"> 1. Immediately connect to a working power source (Mobile Power Unit™ or two HeartMate® 14 Volt Lithium-Ion batteries). 2. If connecting to power does not resolve the problem, press any button on the System Controller to attempt pump start and call your hospital contact immediately.
	<div>Call Hospital Contact</div> <div>⌚ :07</div> <div>+</div> <div>Low Flow</div> <div>⌚ :03</div>	 <div>+</div> 	Low flow, flow is less than 2.5 lpm	Call your hospital contact immediately for diagnosis and instructions.
	<div>Connect Driveline</div> <div>⌚ :02</div>	 <div>+</div>  <div>+</div> 	Driveline is disconnected. The Pump Running symbol is black.	<ol style="list-style-type: none"> 1. Immediately reconnect the Driveline to the System Controller and move the Driveline safety lock on the System Controller to the locked position. Also, check that the Modular In-Line connector is secure. 2. If alarm persists after reconnecting the Driveline, press any button on the System Controller to potentially resolve. 3. If the Driveline is connected and alarm persists, replace the System Controller with a configured backup System Controller. 4. If alarm persists, call your hospital contact immediately.
	<div>Connect Power Immediately</div> <div>⌚ :05</div> <div>+</div> <div>Backup Battery</div> <div>⌚ :01</div>	 <div>+</div>  <div>+</div> 	Both power cables are disconnected.	<ol style="list-style-type: none"> 1. Immediately connect to a working power source (Mobile Power Unit or two fully-charged HeartMate 14 Volt Lithium-Ion batteries). 2. If alarm persists, call your hospital contact immediately.
	<div>Call Hospital Contact</div> <div>Controller Fault</div>	 <div>+</div> 	System Controller Hardware Fault (Microcontroller Failure)	<ol style="list-style-type: none"> 1. No active symbols (constant audio tone). 2. Call your hospital contact as soon as possible for diagnosis and instructions.
	<div>Low Battery</div> <div>⌚ :06</div> <div>+</div> <div>Replace Power Immediately</div> <div>⌚ :02</div>		Low Battery, Power input is extremely low with less than 5 min. remaining.	<ol style="list-style-type: none"> 1. Immediately connect to a working power source (Mobile Power Unit or two fully-charged HeartMate 14 Volt Lithium-Ion batteries). 2. If alarm persists, call your hospital contact immediately.

HIGH PRIORITY ALARMS

Message on controller screen

Alarm indicator/sound



What it means

VAD Stopped
Connect Driveline

Driveline disconnected or malfunction/broken connector

VAD Stopped
Change Controller

Controller failure

Flashing Red

Controller Failed
Change Controller

LOUD, CONTINUOUS BEEPING

Controller failure

Critical Battery 1
Replace Battery 1

Unable to mute alarm











Limited time remaining on battery 1 or battery 2


Critical Battery 2
Replace Battery 2

Limited time remaining on battery 1 or battery 2

Assessment of VAD: Alarms

ADVISORY/MEDIUM PRIORITY → YELLOW ALARMS → CAUTION

Priority	System Controller Screen	Active Symbols	Alarm Means	To Resolve Alarm
ADVISORY	Connect Power ⌚ :04	 OR 	One of the two power cables is disconnected.	1. Promptly connect the disconnected power cable to power source (functioning Mobile Power Unit or two fully-charged HeartMate® 14 Volt Lithium-Ion batteries). 2. If alarm persists, call your hospital contact immediately.
	Replace Power + Low Battery ⌚ :02 ⌚ :06		Low battery—power input is low, with less than 15 min remaining.	1. Promptly connect to a working or different power source (Mobile Power Unit or two fully-charged 14 Volt HeartMate Lithium-Ion batteries). 2. If alarm persists, call your hospital contact immediately.
	Call Hospital Contact Controller Fault		System Controller Hardware Fault	Call your hospital contact as soon as possible for diagnosis and instructions.
	Call Hospital Contact Comm Fault		Communication Fault (Comm Fault)	Call your hospital contact as soon as possible for diagnosis and instructions.
	Call Hospital Contact Backup Battery Fault		System Controller Backup Battery Fault	Call your hospital contact as soon as possible for diagnosis and instructions.
	Call Hospital Contact Backup Battery Fault + 		System Controller Backup Battery Not Installed	Call your hospital contact as soon as possible for diagnosis and instructions.
	Call Hospital Contact Driveline Power Fault		Driveline Power Fault	Call your hospital contact as soon as possible for diagnosis and instructions.
	Call Hospital Contact Driveline Comm Fault		Driveline Communication Fault (Driveline Comm Fault)	Call your hospital contact as soon as possible for diagnosis and instructions.

Important! The Pump Running () symbol is lit green when the pump is running.

MEDIUM PRIORITY ALARMS

Message on controller screen

Alarm indicator/sound 

What it means

High Watts
Call

Flashing Yellow

A change in the status of your VAD is detected

Electrical Fault
Call

Intermittent tone

Gradual increase in volume over the first minute if alarm not muted.

A change in the status of your VAD is detected

Low Flow
Call

Alarm will get louder after 5 minutes if alarm is not muted.

A change in the status of your VAD is detected

Suction
Call

You are able to mute alarm for 5 minutes by pressing Alarm Mute Button.

A change in the status of your VAD is detected

Controller Fault
Call

Possible Controller Malfunction

Assessment of VAD

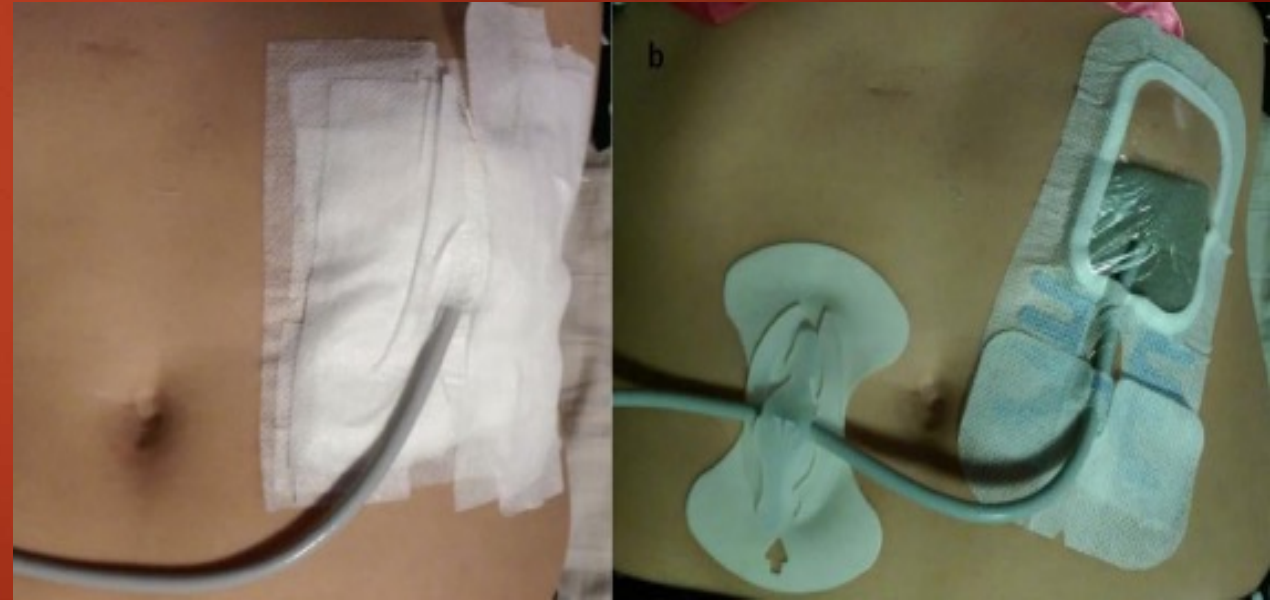
- ▶ Pump auscultation

- ▶ Smooth mechanical hum



- ▶ Driveline exit site

- ▶ Dressing types vary
 - ▶ Do not open dressing, assess outside for bleeding and drainage



HeartMate Components



HM3 Pump



HM2 Pump



System Controller



**14 V Li-Ion Batteries
and clips**



**Drive line
(modular
cable for
HM3)**



**Emergency
Bag**



**Mobile
Power Unit**



**Universal
Battery Charger**



Power Module



**Patient Tether
Cable**



**Ungrounded Patient
Tether Cable**



**Go Gear
Wearables**

HeartWare Components



Pump and driveline



Driveline cover



Controller



No external
power alarm
silencer (aka
pacifier)



Batteries and charger



AC Power adapter



Wearables



Assessment of Unresponsive Adult VAD patient

Rapid assessment. Check for signs of life. You may not feel a pulse.

DO NOT USE AUTOMATIC COMPRESSION DEVICE

Unresponsive VAD patient- **page VAD Coordinator**

Place stethoscope over heart

Hum is **ABSENT**

Check Pulse

NO Pulse

Pulse **Present**

Hum is **PRESENT**

Flow <2.5 L/min
MAP <50mmHg
Signs of poor perfusion



Start High Quality CPR/ACLS
Do not use Lucas Device
Defibrillate and administer
meds per protocol

**Re-check
Flow & BP
q2min**

Begin to
Troubleshoot VAD.
**Confirm
driveline is
connected** to
controller and
**check power
sources**

Flow >2.5LPM
No alarms,
MAP >50mmHg,
well perfused

Non-
cardiovascular
collapse:
Look for signs
of stroke or
non cardiac
causes

Flow <2.5LPM
MAP >50mmHg,
may have signs of
poor perfusion

**Low Flow / Unstable
State:**

- Rhythm- Defibrillate/
cardiovert per protocol
- Volume - Fluid bolus
- Consider
inotrope/pressor
- Search for reversible
causes

**BP &
Spo2 is
unreliable**

**PAGE
IMPLANTING
CENTER**

Stow before you go! Do you have the emergency bag with back up controller and batteries?

Resources

- ▶ Implanting centers
 - ▶ MyLvad.com
 - ▶ Hospital locator
- ▶ EMS Field Guides
- ▶ Mechanical Circulatory Support Emergency Guide app
 - ▶ Available in Apple and Android app store



PAGE IMPLANTING CENTER VAD COORDINATOR

Scan for an EMS troubleshooting guide for each device

MAP 60-90mmHg

**EMERGENCY
PROCEDURES
REFERENCE
SCAN CODE**



HEARTMATE 3

MAP 60-80mmHg

**EMERGENCY
PROCEDURES
REFERENCE
SCAN CODE**



HEARTMATE II

MAP 60-80mmHg

**EMERGENCY
PROCEDURES
REFERENCE
SCAN CODE**



HEARTWARE

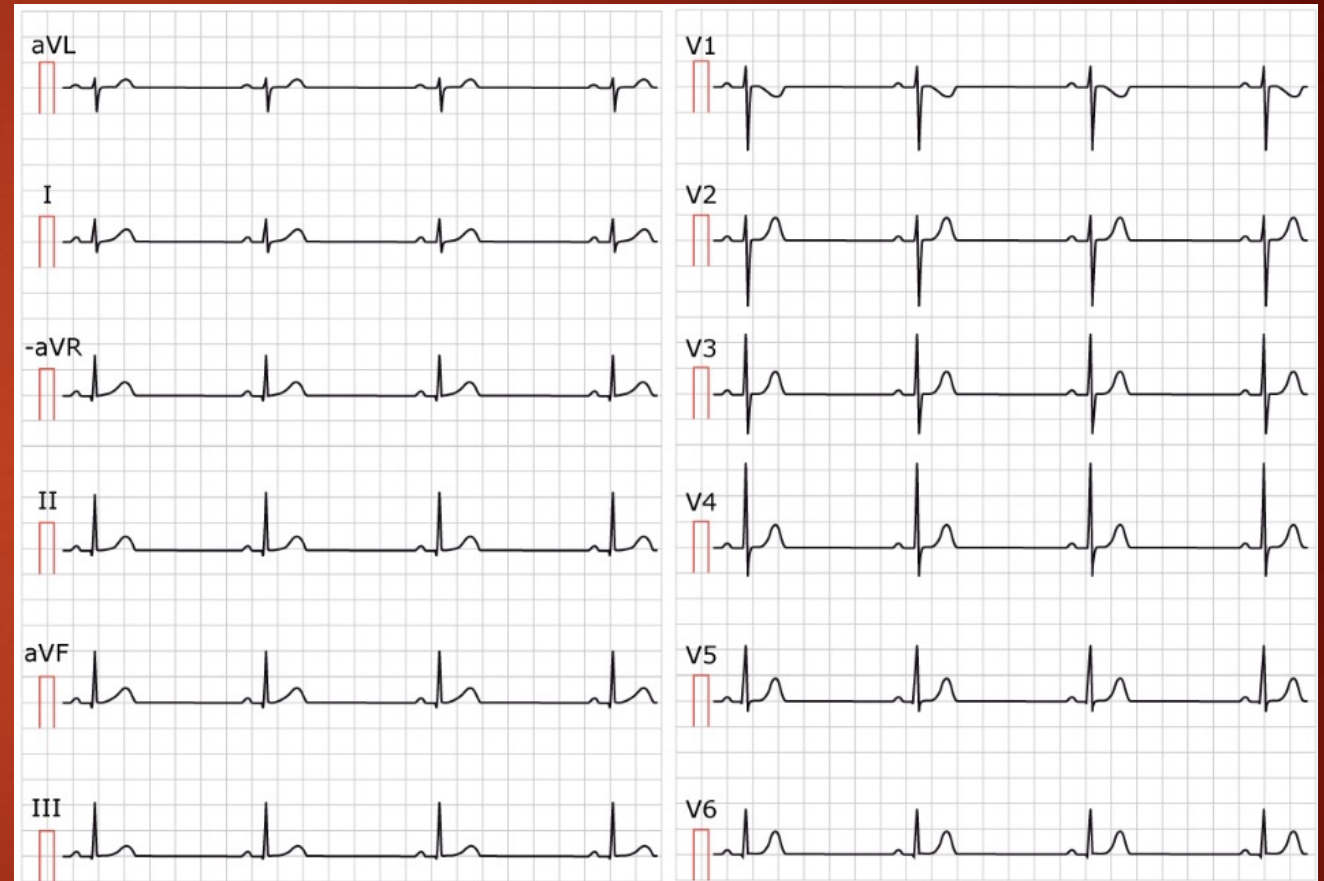
EMERGENCY TRANSPORTATION

- ▶ Transport to implanting center if able
- ▶ All modes of emergency transportation are acceptable
 - ▶ Patients and equipment may fly
- ▶ Avoid pulling, twisting, kinking driveline when securing patient in stretcher
- ▶ Take all backup emergency equipment with patient
 - ▶ Backup controller, charged batteries (with clips for HeartMate)
- ▶ Allow caregiver to travel with patient if possible



Case Study 1

- ▶ 56 yo M VAD, SOB, Altered LOC
 - ▶ Page implanting center enroute to patient
- ▶ Pale, VAD intermittently alarming “low flow”, difficult to arouse, spouse reports last known normal was 45 minutes prior
- ▶ No palpable pulse, hum is present, 12 lead sinus brady 38, RR 10, unable to obtain nibp, doppler pressure 55mmHg, no pulse ox reading, ETco2 30



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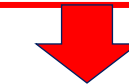
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Pulse **Present**

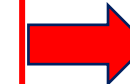
Hum is **PRESENT**

Flow <2.5 L/min
MAP <50mmHg
Signs of poor perfusion



Start High Quality CPR/ACLS
Do not use Lucas Device
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meds per protocol

**Re-check
Flow & BP
q2min**



Begin to Troubleshoot VAD.
Confirm driveline is connected to controller and **check power sources**

Flow <2.5LPM
MAP >50mmHg,
may have signs of
poor perfusion

Low Flow / Unstable State:

- Rhythm- Defibrillate/ cardiovert per protocol
- Volume - Fluid bolus
- Consider inotrope/pressor
- Search for reversible causes

Flow >2.5LPM
No alarms,
MAP >50mmHg,
well perfused

Non-cardiovascular collapse:
Look for signs of stroke or non cardiac causes

BP & Spo2 is unreliable

PAGE IMPLANTING CENTER

Stow before you go! Do you have the emergency bag with back up controller and batteries?

Case Study 1

- ▶ External pacing
 - ▶ Electrical capture
 - ▶ Mechanical capture?
- ▶ 12 lead monitor 70HR
- ▶ No further VAD alarms
- ▶ Transport to ER
 - ▶ Notify implanting center of transport

- Look for signs of improved perfusion
 - Improving mental status
 - VAD alarms resolve
 - Color/warmth
 - Cap refill
 - ETco2

Case Study 2

- ▶ 37 yo F VAD, unresponsive in their yard
 - ▶ Page implanting center enroute to patient
- ▶ Pale, unresponsive, perioral cyanosis, VAD constantly alarming, last known normal 10 minutes prior to arrival
- ▶ No palpable pulse, 12 lead with artifact HR76, unable to obtain bp or pulse ox, ETco2 15
- ▶ No VAD “hum”
 - ▶ PEA



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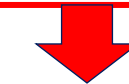
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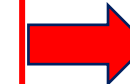
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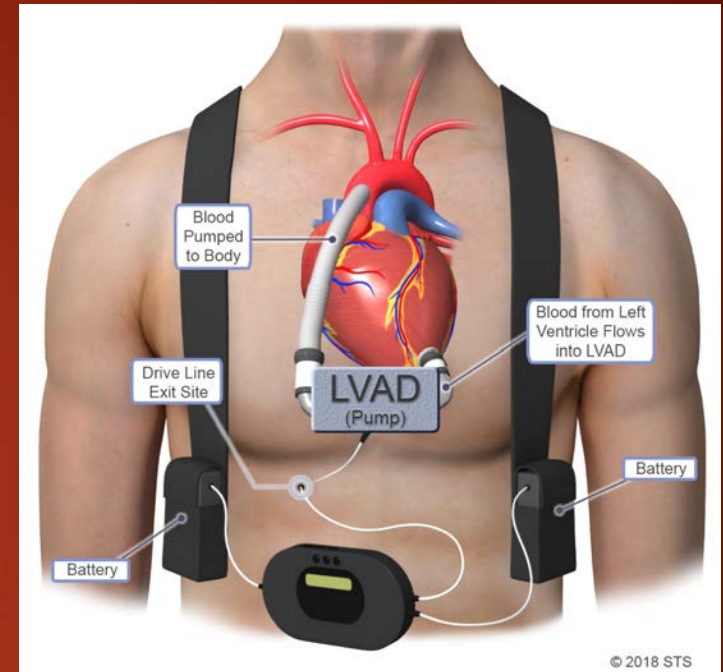
Case Study 2 continued

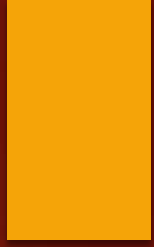
- ▶ Begin high quality CPR
 - ▶ No automatic compression devices
 - ▶ Follow ACLS protocols
- ▶ During 1st round of CPR ETco2 37, ROSC, bp 60/41
- ▶ VAD continues to alarm
 - ▶ Driveline disconnected/severed
- ▶ Medical treatment per protocols
- ▶ Immediate transport to implanting center
- ▶ Notify implanting center of transport



Summary

- ▶ Increasing numbers of patients being implanted with VADs
- ▶ ICCAC Field Guides and MCSEMG app useful resources for training
- ▶ Partner with implanting centers
- ▶ Not all calls for a VAD patient will be VAD related
- ▶ Automatic BP cuff and pulse oximetry are unreliable in non-pulsatile VAD patients
- ▶ Do not use automatic compression devices





THANK YOU