

# LVAD 101

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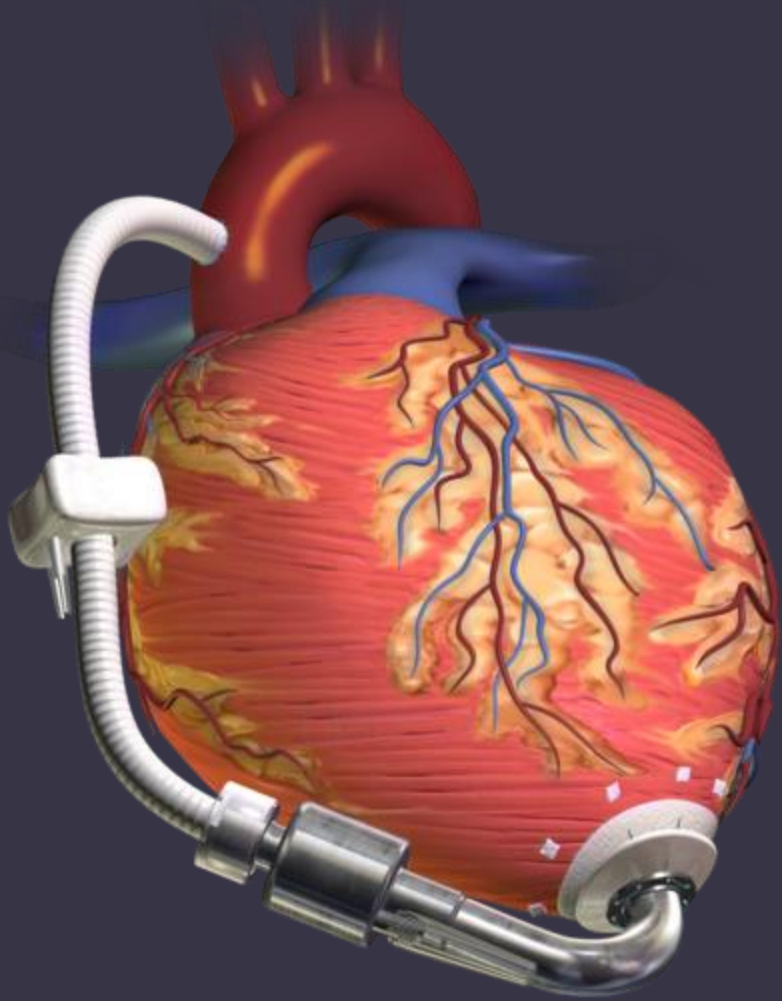
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# The Basics

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- An LVAD is a permanent, implantable mechanical circulatory support device which can
- significantly improve a patient's quality of life
- help to reduce heart failure symptoms

# Left Ventricular Assist Device

- For patients with end stage heart failure
  - NYHA Class IV
  - EF < 25%
  - CI < 2.2 L/min/m<sup>2</sup>
  - Progressive intolerance of GDMT
- Bridge to transplant, bridge to candidacy, or destination therapy



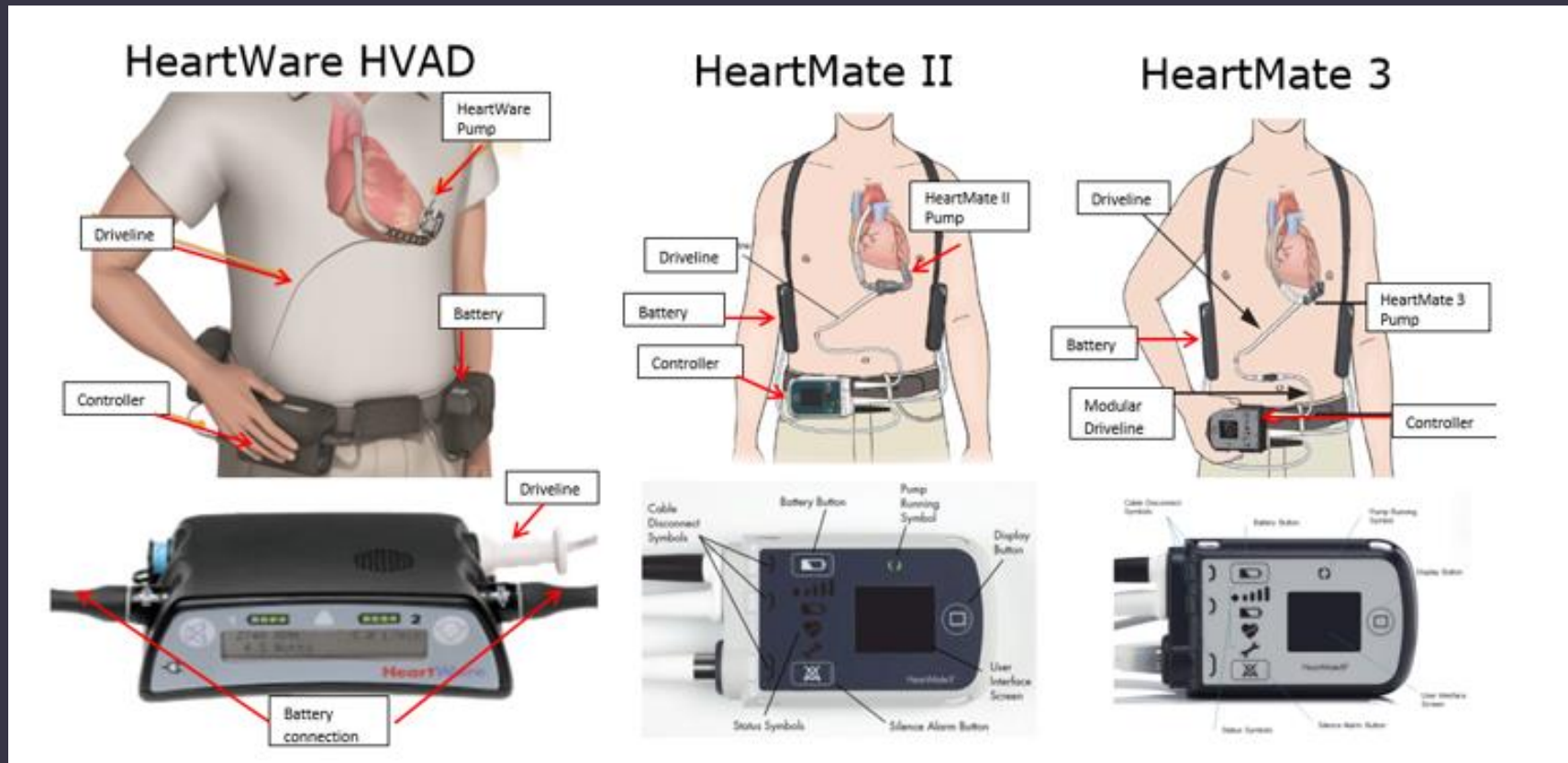
# Principles of Operation

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All LVADs require the following:

- ❖ Constant external power source
- ❖ Meticulous equipment management
- ❖ Emergency backup equipment
- ❖ Driveline exit site dressing
- ❖ Tailored assessment

# Types of LVAD



# LVAD Components

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- **Pump:** Implanted in the apex of the left ventricle and connected via an outflow graft to the ascending aorta
- **Driveline:** Connects system controller to the pump via an exit site in the abdomen
- **Controller:** Acts as a conduit from power sources to the pump, shows current system settings and parameters, displays alarm conditions
- **Power:**
  - **Batteries:** Portable power sources last from 4-17 hours depending on device
  - **Wall power unit:** An external AC unit that allows power from an outlet to be channeled into the LVAD



# Heartmate 3<sup>®</sup> System Components



Pump



Controller



Mobile power unit



Batteries & Battery Charger



Battery with Clip

# Altered Physiology = Altered Assessment

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BACK TO THE BASICS

# Continuous Flow Devices

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- ❖ HeartMate 3 LVADs have an artificial pulse
  - ❖ Every 2 seconds
    - ❖ *You may get a HR of 30 through palpation or pulse oximetry*
  - ❖ Prevents blood stagnation
- ❖ LVAD works alongside native heart
- ❖ Aim for aortic valve opening 1:3-4
  - ❖ Achieve optimal LV unloading
  - ❖ Prevent aortic valve stenosis
- ❖ Patient may not have a palpable pulse
- ❖ Difficulty obtaining BP by conventional means
- ❖ Narrow pulse pressure
- ❖ Unreliable pulse oximetry

# Key Principles

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## Preload Dependent

- Rely on proper fluid balance for pump to function
- Give fluids slowly as right heart is delicate post-VAD

## Afterload Sensitive

- Cannot work against high BP
- MAP goal 65-90mmHg

## Anticoagulated

- Warfarin with INR goal 2-3
- Never reverse without discussing with VAD team

## High Risk for

- Infection
- Thrombosis/stroke
- Bleeding
- RV failure
- Arrhythmias

# Physical Assessment

- ❖ Perfusion
  - ❖ Color
  - ❖ Capillary refill
  - ❖ Mentation
  - ❖ Skin temperature
  - ❖ Urine output
- ❖ Oxygenation
  - ❖ Work of breathing
  - ❖ Color
  - ❖ ABG/VBG
- ❖ Blood pressure
  - ❖ Doppler + Manual Cuff
    - ❖ Presumed to be MAP
  - ❖ Arterial line is gold standard
- ❖ Rhythm
  - ❖ Likely no palpable pulse
  - ❖ EKG – may have significant artifact
  - ❖ Telemetry



# Device Assessment

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## ❖ Alarms

- ❖ Audible
- ❖ Visual
- ❖ Display

## ❖ Running?

### ❖ HeartMate

- ❖ Green “circle of life” illuminated
- ❖ Hum auscultated

### ❖ HeartWare

- ❖ Power indicators illuminated
- ❖ Absence of alarms
- ❖ Hum auscultated

## ❖ Safety checks

- ❖ Driveline connection, integrity
- ❖ Power sources
  - ❖ Connected?
  - ❖ Adequate?

## ❖ Equipment

- ❖ Emergency backup available?
- ❖ Adequate power sources?

## ❖ Driveline

- ❖ Dressing intact?
- ❖ Driveline secured/safe?

# Parameters

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*Determine the patient's baseline*

## Speed

- Fixed number set by LVAD team
- HM3: artificial pulse will cause this number to fluctuate slightly

## Power

- Direct measurement
- Sudden or sustained increase in power (usually >10w) can indicate a thrombus, kink, or mechanical failure

## Flow

- Algorithm based on speed, power, and hematocrit
- Most important – what support is the patient getting?

## Pulsatility Index (PI)

- Measures power fluctuations throughout the cardiac cycle
- Can provide information on BP and volume status
- PI events = not necessarily suction. Will see speed drop to low speed limit and slowly increase. This may be caused by arrhythmias, volume changes, coughing, etc.

# Where Do I Start?

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WHEN AN LVAD PATIENT IS SUDDENLY IN YOUR CARE

# Assuming Care of an LVAD Patient

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- ❖ Determine Chief Complaint
  - ❖ Most issues are *patient issues*, NOT pump issues
- ❖ Call emergency number of managing center
- ❖ Ensure device is running
- ❖ Identify any alarms
- ❖ Ensure adequate equipment is on hand
  - ❖ Backup controller
  - ❖ Power
- ❖ Involve caregiver/family if available

**Remember: Your  
patient is NOT the  
LVAD**

# Changing Power Sources

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- Always check that batteries are adequately charged/wall unit is plugged in before switching sources
- Always change one power source (cable) at a time
  - HVAD has no backup battery – will shut off if both power sources are disconnected
  - HeartMate II and HeartMate 3 have backup batteries but these should never be used routinely, only in the event of a true power emergency
- Never force connections – this can damage the internal components
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# Ambulating

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- Secure driveline with anchor
- Do not pull, twist, or kink the driveline
- Place patient on battery power
- Ensure batteries are fully charged
- Store equipment securely in patient's wearable accessories



# Unconscious Patient

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Is the pump running (**green circle illuminated**)? Is there an audible hum?

If **yes**:

- Defibrillation/cardioversion for arrhythmias (patients typically have ICD)
- IV fluids if low flow, signs of poor perfusion
- ACLS medication management
- MAP via Doppler and cuff
- Treat non-VAD causes: stroke, hypoxia, hypoglycemia, etc.
- CPR last resort; optimize perfusion with medications and fluids

# Unconscious Patient

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Is the **pump running?**

**If no: (no audible hum)**

- Call emergency LVAD number
- Assess power and driveline – connect driveline, switch power sources
- If power and driveline are adequate, prepare for emergent controller exchange
- Support with fluids + inotropes/pressors
- If pump off for over 1 minute + evidence of low perfusion, CPR up and to the right

# Case Study

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- ❖ 62F, PMH of NICM with an EF of 10-20% s/p AICD, well-controlled asthma, HTN, HLD, hypothyroidism, depression
- ❖ Received LVAD 6/19
- ❖ Mostly unremarkable postoperative course
- ❖ Discharged home 7/1; recommendation was IPR but patient was unwilling to go
- ❖ First follow-up 7/11 in clinic: Feeling well with exception of some headaches

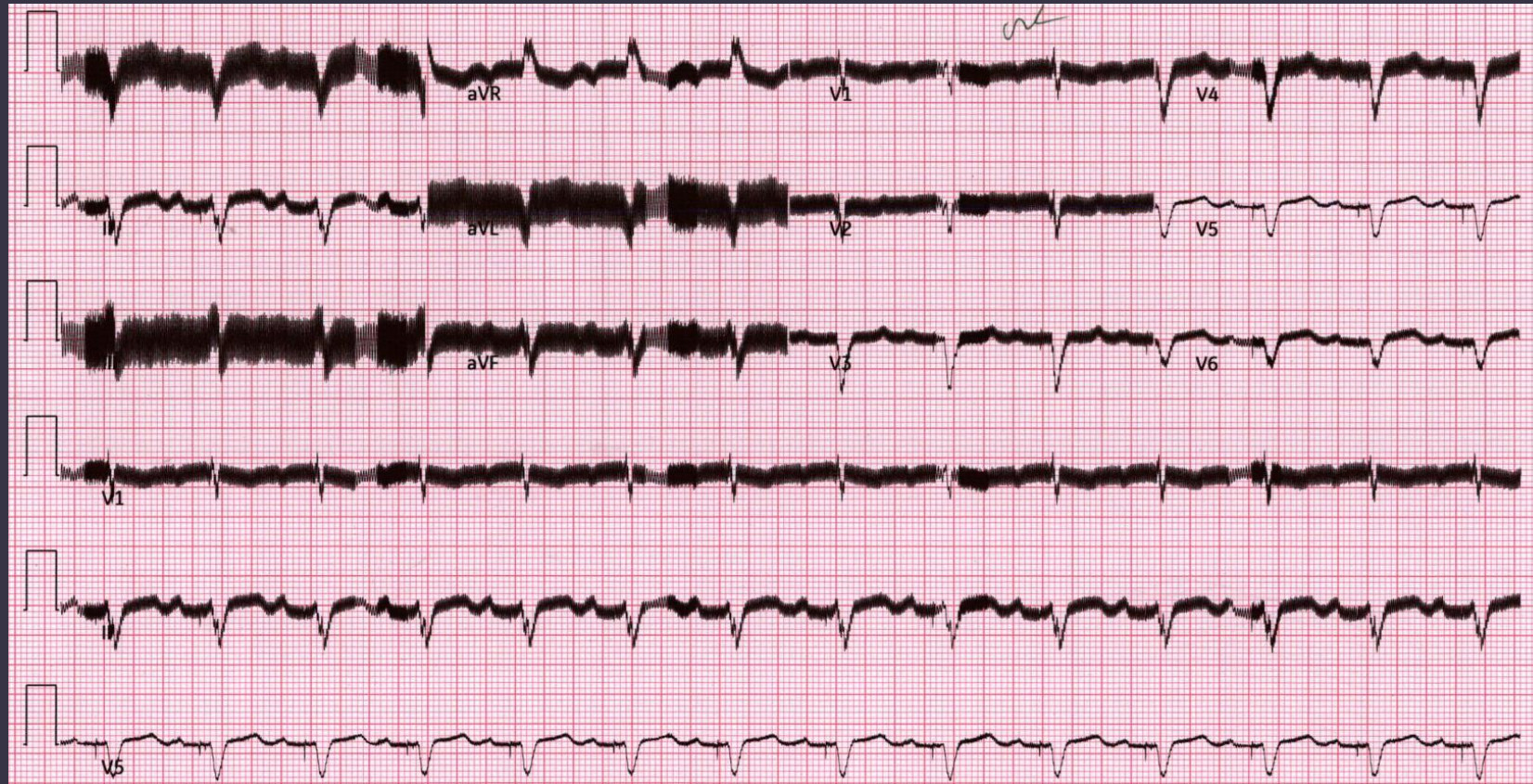
# Case Study

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- ❖ 7/28: Patient BIBA to HH c/o 8/10 CP radiating to jaw, beginning 7/27. Diaphoretic and pale.
- ❖ EMS crew calls emergency LVAD number with concern for MI
  - ❖ On-call physician does not feel this is a likely scenario; no ASA or NTG
  - **INR 1.56**
  - **Trop 0.170 → 39.953 (7/29)**
  - **LDH 325 → 592 (7/29)**
  - **Haptoglobin 326**
  - **EKG: A sensed V paced**
  - **Echo: poor windows, rare AV opening, LVIDd 5.51**
  - **CTA: dilated LV, “no complications of LVAD placement”**
  - **Meds: 324 ASA, heparin gtt**

# Case Study

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# Case Study

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- ❖ Outcome:
  - ❖ LHC on 7/29 shows distal OM2 occluded with thrombus
  - ❖ TEE on 7/31 confirms thrombus on non-coronary cusp of aortic valve, which was not opening
  - ❖ Patient given thrombolytics and started on Plavix
  - ❖ 8/2: discharged home
  - ❖ Repeat TEE weeks later shows resolution of thrombus; LVAD speed reduced to help prevent thrombus

# Key Takeaways

- ❖ Assess patient, not just numbers/equipment
- ❖ Assess for adequate power and a connected, intact driveline
- ❖ Patient problem is more likely than pump problem
- ❖ Involve patient/caregiver in troubleshooting
- ❖ Call LVAD team for guidance

**24/7: 505-843-8896**



# References

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Thank You!

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