Mechanical Circulatory Support for Cardiogenic Shock

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I have no disclosures

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What is Shock

- A state of inadequate end organ perfusion
- Signs and Symptoms of shock:

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- A state of inadequate end organ perfusion

- Signs and Symptoms of shock:
  - Altered mental status
  - Cold extremities
  - Lack of cap refill
  - Poor urine output

  - Metabolic acidosis
  - Elevated lactic acid
  - Elevated markers of end organ injury (elevated Cr, AST/ALT)

  - Low mixed venous
  - Poor cardiac function on Echo, or Thermodilution

Types of Shock

		Pre-load PCWP JVP	Pump Fn CO	After-load SVR	Perfusion O2 Sat
Hypovolemic	- Intravascular vol loss - hemorrhagic - fluid loss	↓	↓	↑	↓
Cardiogenic	- Arrhythmia - AMI, valve failure - cardiomyopathy - pericarditis/PE	↑	↓	↑	↓
Distributive	Vasodilatory-↓↓ SVR -septic shock/SIRS/TSS - Anaphylaxis - neurogenic shock - Drug/toxin - Addisonian crisis	↓/-	↑	↓	-/↑
Obstructive	- Tension PTX - Tamponade - PE	↑	↓	-/↑	-/↓

EM in 5

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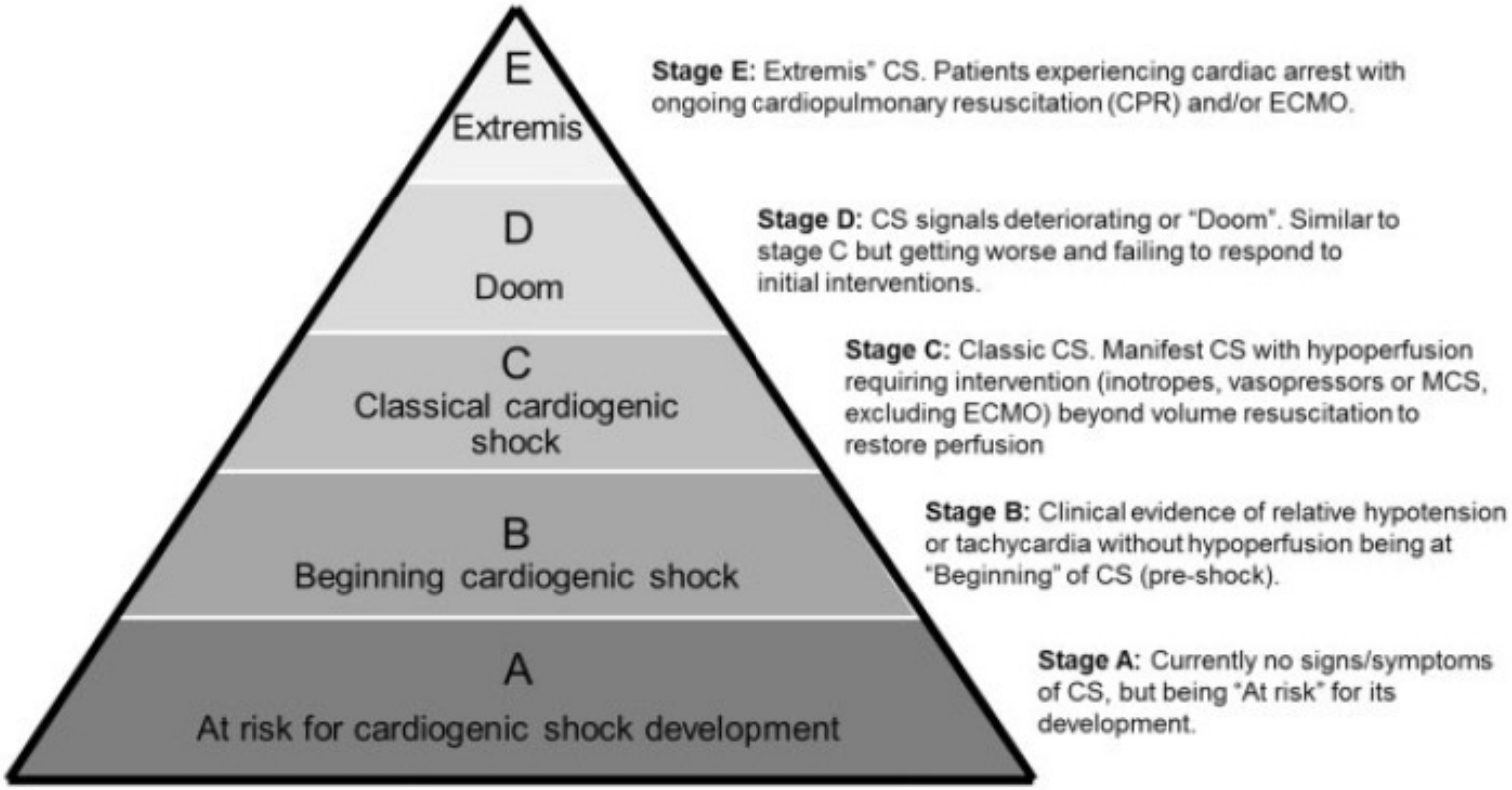
Cardiogenic shock

A state of critical end-organ hypoperfusion and hypoxia due to primary cardiac disorders despite adequate circulatory volume and LV filling pressure.



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Potential Treatments of Cardiogenic Shock

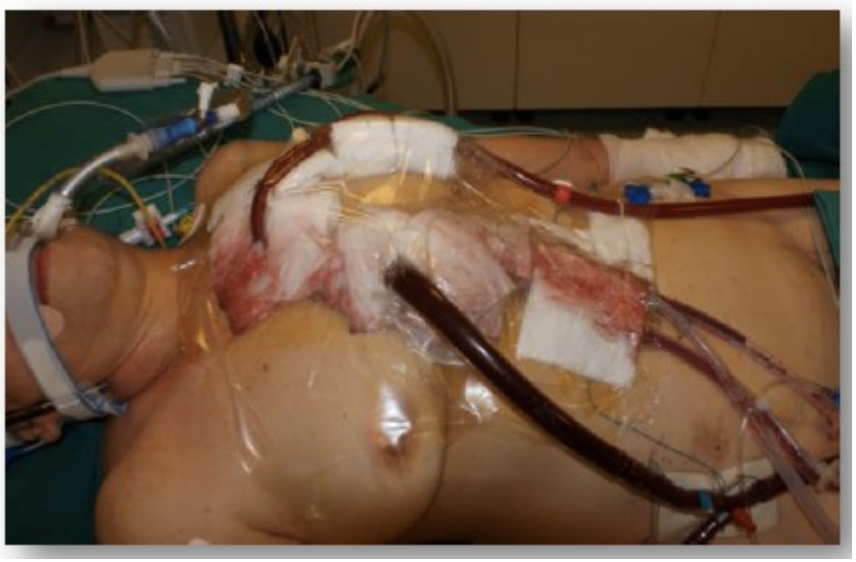
- Optimize Preload
  - Fluids or diuresis will depend on situation

- Inotropes

Potential Treatments of Cardiogenic Shock

- Optimize Preload
  - Fluids or diuresis will depend on situation
- Inotropes
- Mechanical Circulatory Support

Central access MCS



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Peripheral MCS

- Minimally invasive
- Quick recovery
- Ambulatory (axillary Impella, axillary IABP, NuPulseCV iVAS)
- Lower risk of infection, bleeding

Device selection

Scenario 1

- 64 yo female with h/o NICM (LVEF 20%), s/p AICD, CKD stage 2, presented with acute on chronic HF.
- BP 88/53 (65), HR 92
- TTE: severe global hypokinesis, LVEF 10-14%, moderate MR
- RHC: RA 13, PA 47/25 (32), PCWP 22, CO 4.2, CI 1.5
- Lactate 2.5

Scenario 2

- 70 yo male with h/o HTN, DM, CKD stage 3, tobacco abuse, COPD, TIA, presented with STEMI
- BP 86/62 (70), HR 100, short runs of VT
- LHC: 100 % proximal LAD, LVEDP 35
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- Lactate 5.7

Device selection

Scenario 3

- 60 yo female with h/o ICM (LVEF 20%), HTN, HLD, AICD, presented with acute on chronic HF.
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- TTE: severe global hypokinesis, LVEF 10%, sever RV dysfunction
- Lactate 3.4

Scenario 4

- 66 yo male with h/o CAD, HTN, HLD, presented with STEMI
- Vfib arrest on cath lab table
- Placed on VA ECMO with subsequent PCI to LAD. Antegrade perfusion catheter also placed.
- Patient develops leg ischemia on the side of VA ECMO.

Intra-aortic balloon pump

LV support provided in 2 ways:

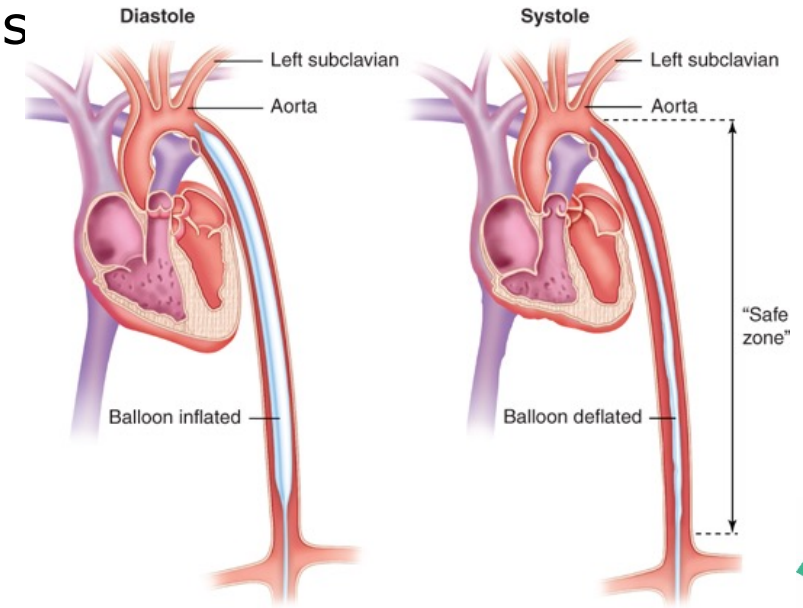
1. Inflation during diastole = increased diastolic pressure

   Since heart capillaries perfuse during diastole, increased diastolic pressure improves coronary perfusion

2. Deflation at the start of systole = negative pressure at the start of LV contractions

   Draws blood forward

   Decreases afterload



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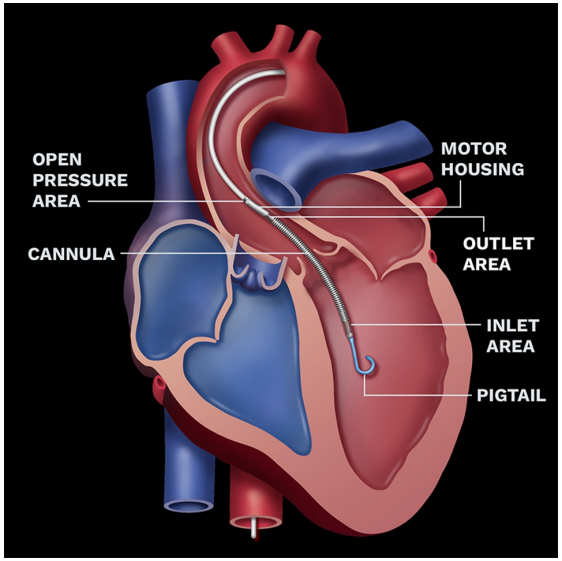
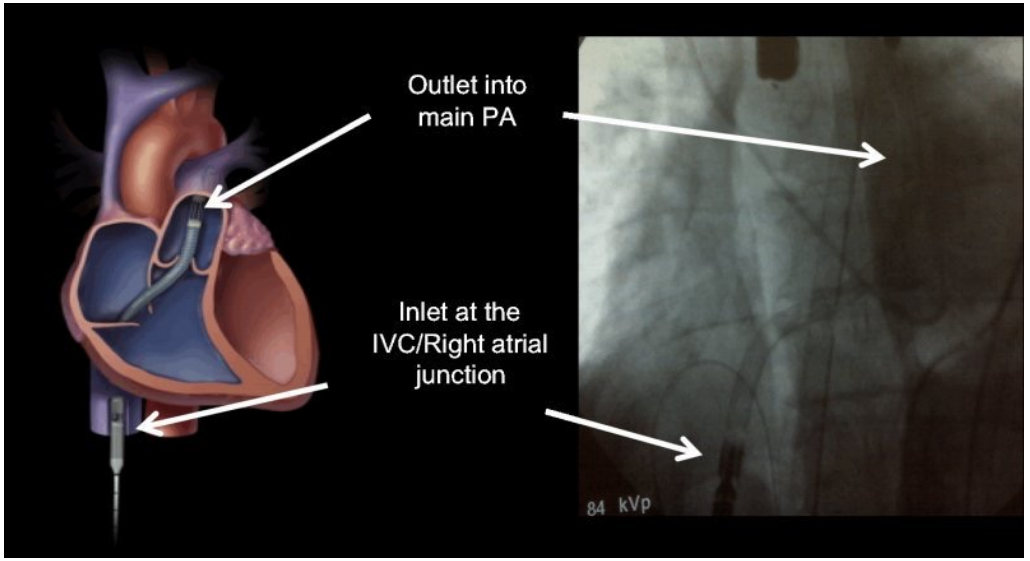
Impella



Impella LVAD (2.5, CP, 5.0)



Impella RP

Unload ventricles

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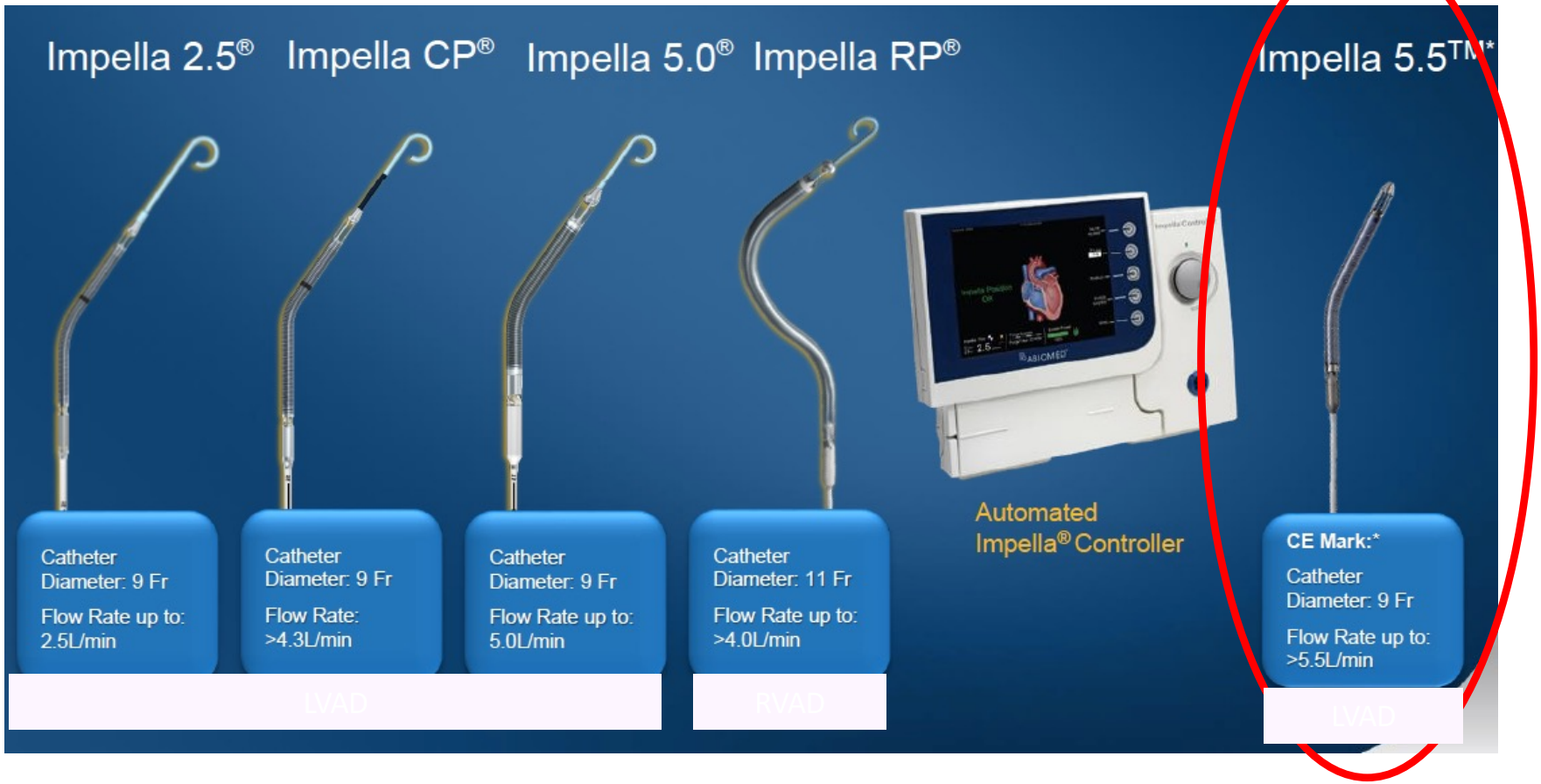
Impella family

Not approved in US as of 08/19



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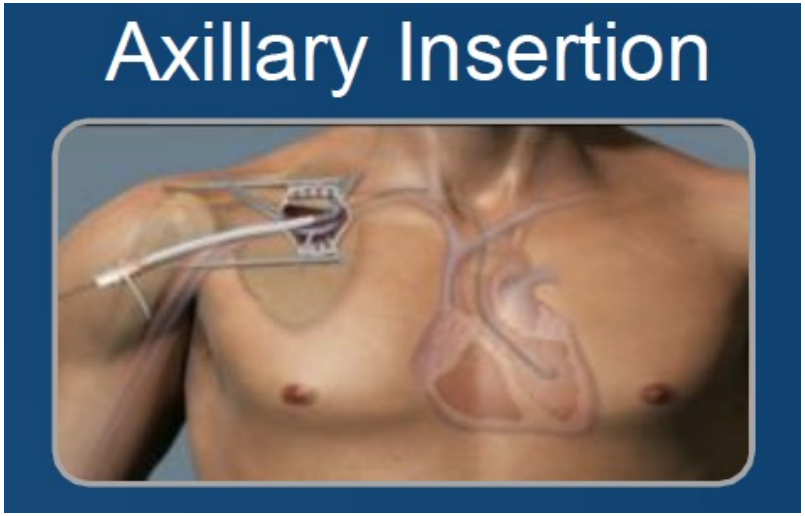
Axillary Impella



Limitations of Impella

Need for anticoagulation (purge and systemic heparin)

Limb ischemia

Hemolysis

Pump thrombosis

Development of HIT

Acquired von Willebrand disease

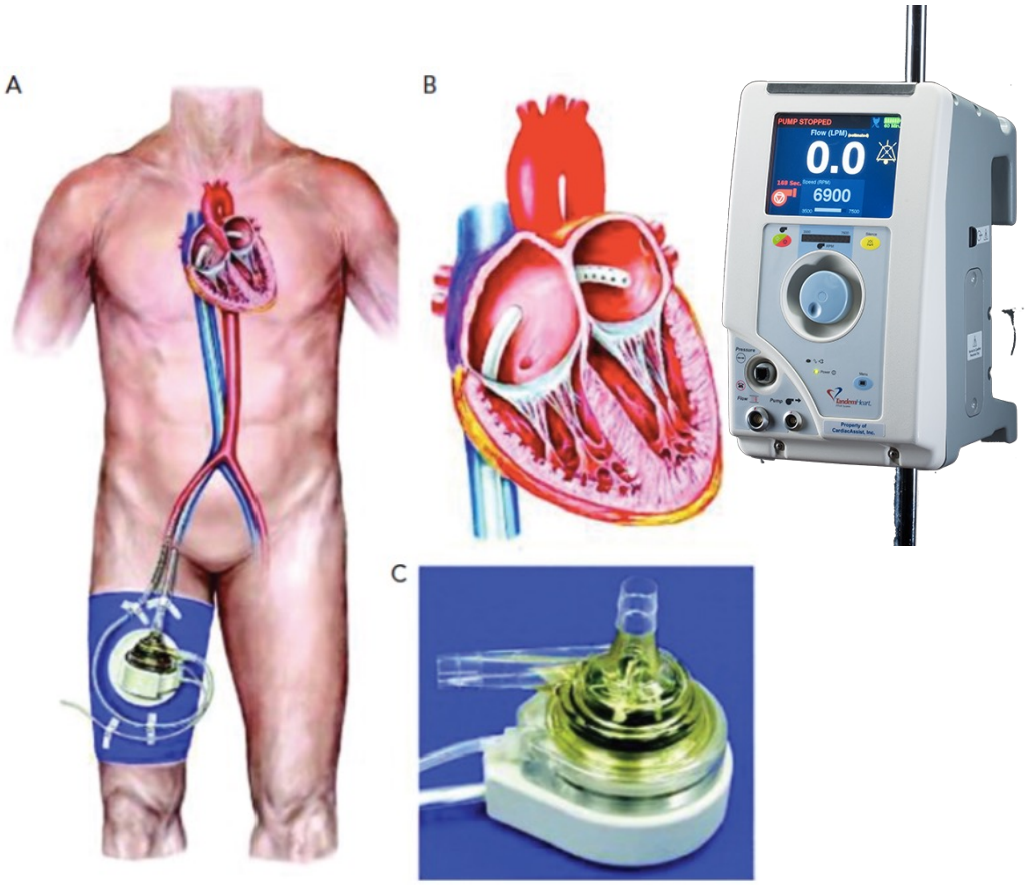
Absolute contraindication

a. Mobile LV thrombus,
b. Mechanical AV

Relative contraindication

a. Moderate to severe AI
b. Severe PAD
c. VSD
d. Bleeding diatheses, no tolerance to anticoagulation

TandemHeart



Limitations

- Need for anticoagulation
- Need for expertise for trans-septal puncture
- Limb ischemia
- Hemolysis
- Stroke
- Dislodgement of LA cannula to RA
- Contraindications
  a. Severe PAD
  b. Moderate to severe AI
  c. Bleeding diatheses

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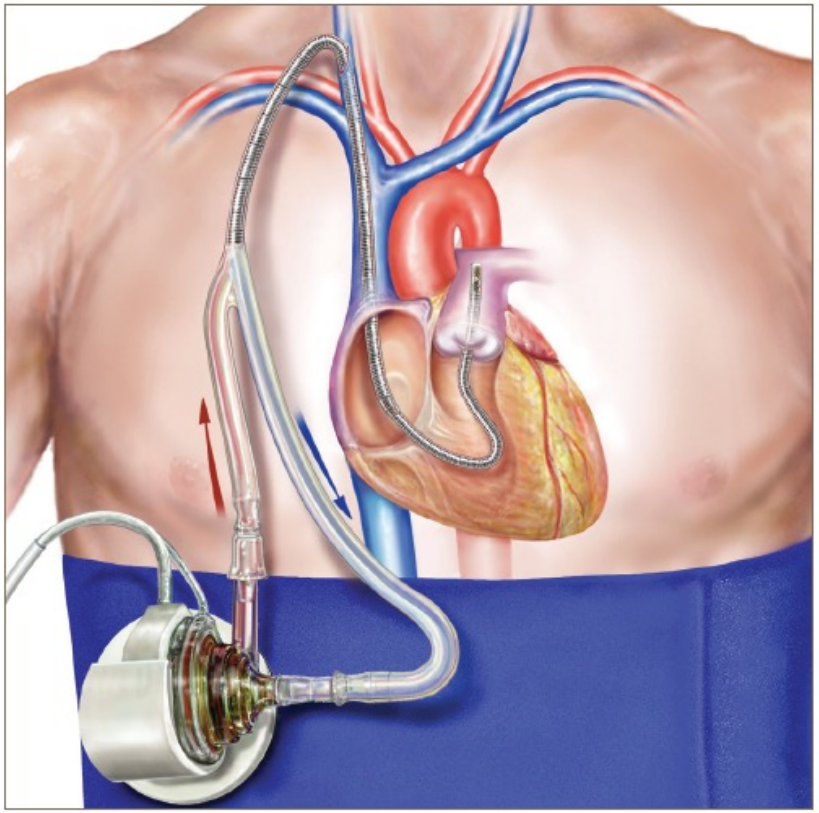
Tandem RVAD with Protek Duo cannula



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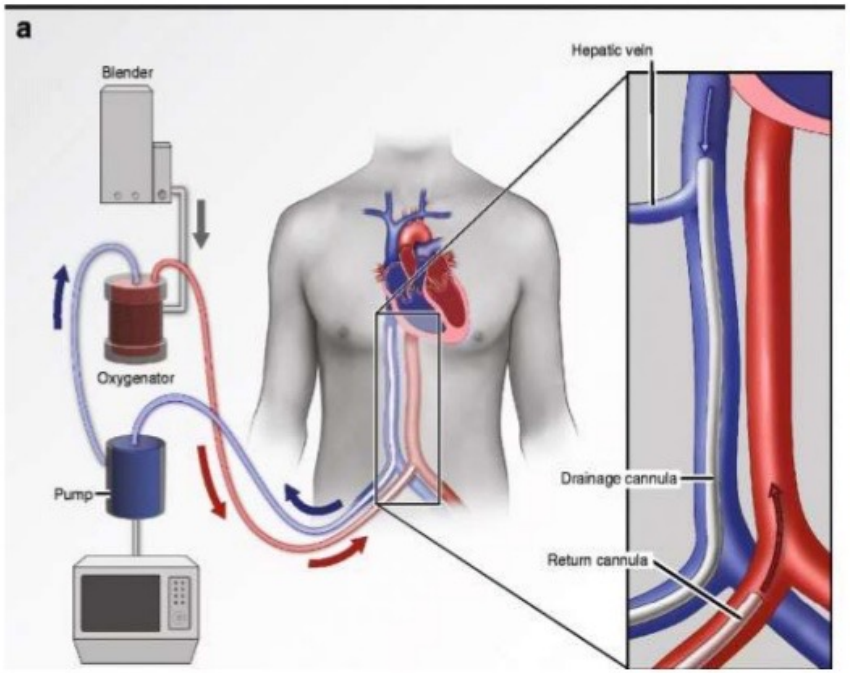
VA (Veno-arterial) ECMO - peripheral



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Before a patient is placed on ECMO

- ECMO has to have a destination
  - Bridge to transplant/surgery
  - Bridge to recovery
  - Bridge to decision

Patient Selection

Indications for use/Patient selection criteria:

Acute, **reversible** cardiac and/or pulmonary failure when the risk of dying from the condition is greater than the potential risks of ECMO

Neonates

Pediatrics

Adults

Each center develops institutional guidelines for ECMO use including indications and contraindications (relative and absolute)

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VA ECMO Patient Selection

Potential Indications

- Failure to wean from cardiopulmonary bypass
- Drug overdose with profound cardiac depression
- Myocarditis
- Early graft failure: post heart transplant
- Idiopathic acute heart failure as a bridge to decision
- Pulmonary embolism
- Cardiac or major vessel trauma
- Pulmonary hemorrhage
- Pulmonary trauma
- Acute anaphylaxis
- Peri-partum cardiomyopathy
- Sepsis

Contraindications

Absolute:

- Non-recoverable heart function and not a candidate for transplant or VAD
- Non-recoverable respiratory disease and not a candidate for transplant

Relative:

- Mechanical ventilation at high settings for ≥ 7 days
- Prolonged CPR > 45 mins
- Major pharmacologic immunosuppression
- Coagulopathies
- Irreversible MODS (chronic)
- Advanced age >70

VA ECMO Cannulation

Venous Cannula Sites (Drainage)	Arterial Cannula Sites (Reinfusion)
Peripheral	
• R/L Femoral Vein • Right IJ	• R/L Femoral Artery • RCCA (neonates) • Axillary Artery
Central	
• Right Atrium	• Aorta

VA ECMO

Advantages

- Robust circulatory/pulmonary support
- Unload RV
- End-organ perfusion pressure⇧⇧
- Bedside/ED insertion

Limitations

- Leg ischemia
- Limited mobility
- Need for anticoagulation
- Bleeding
- Stroke
- Harlequin syndrome
- **LV afterload⇧⇧**

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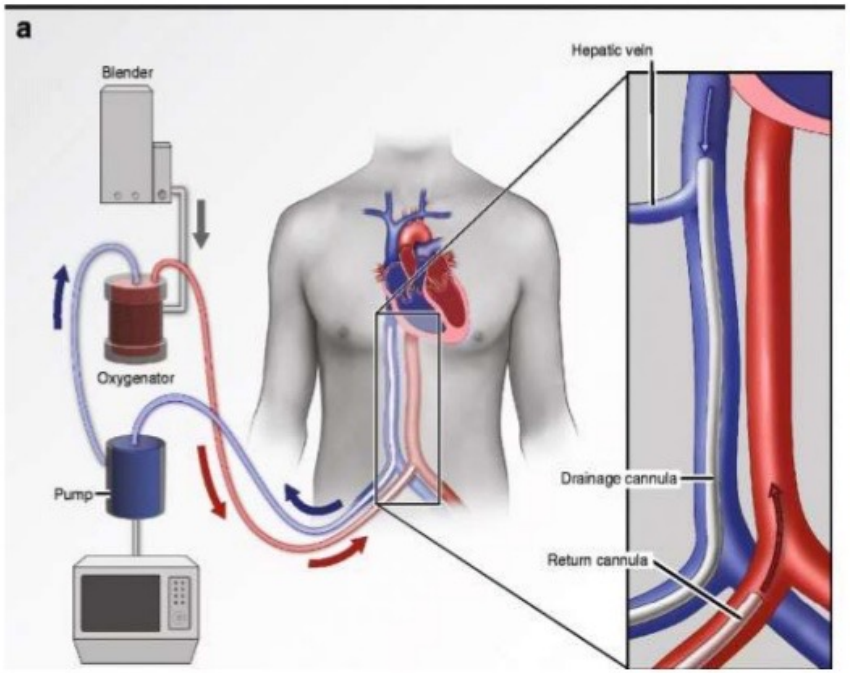

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Need for LV Unloading

ECMO will never capture 100% of cardiac output

If LV is failing, this can result in LV distention

- Distention results in compression of myocardial capillaries = myocardial ischemia.

Treatment: LV decompression

- Surgical drain
- Impella
- IABP

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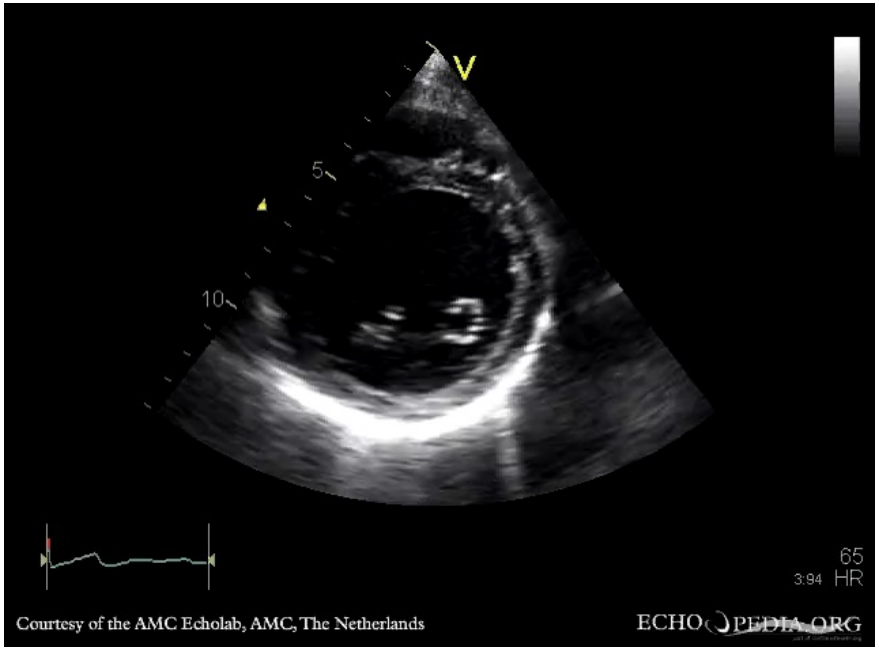

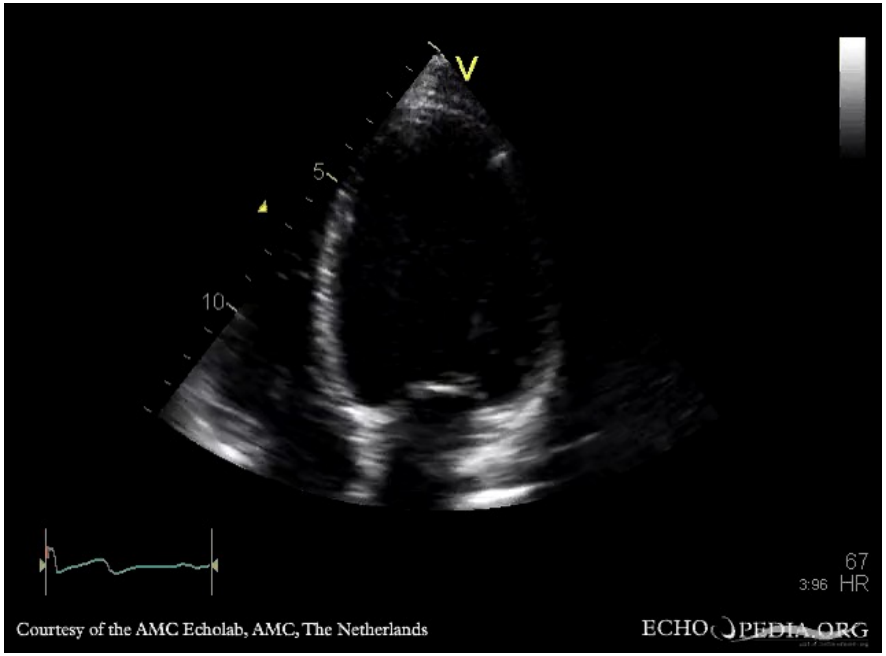

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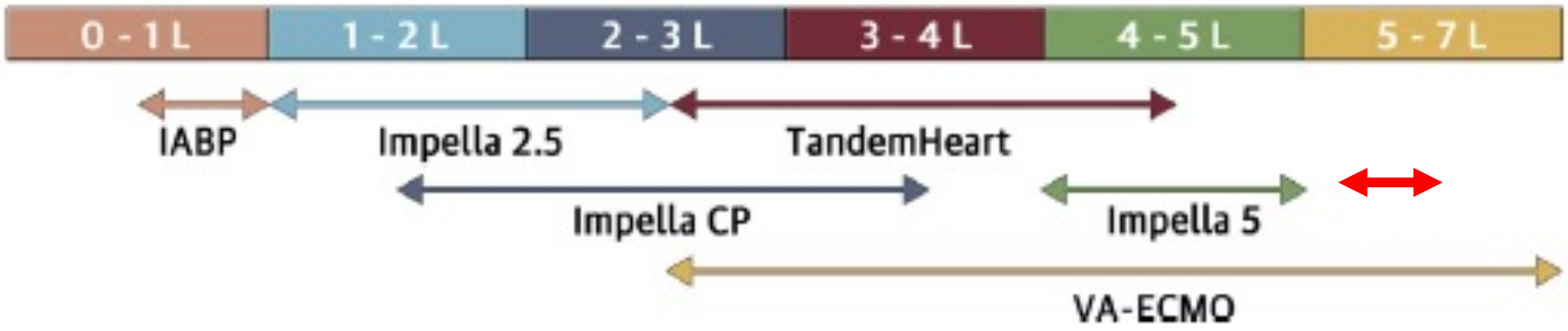
Device selection

- LV failure, RV failure, or biventricular failure
- Need for oxygenation
- Flow range
- Vascular access
  - Arterial access: femoral vs axillary
  - Venous access: femoral vs internal jugular
- Pump, sheath, catheter size
- Contraindications
- Potential complications

Flow range



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IABP, Impella CP, Impella 5.0, TandemHeart

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IABP (?), Bipella, VA ECMO

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Explant VA ECMO
Impella 5.5

Questions?

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