

VA ECMO 101: Indications, Configurations, Management Targets During Treatment



Objectives

- Indications for VA ECMO
- How does VA ECMO work?
- What needs to be monitored?

Disclosures

- No disclosures

UKHC ECMO Program

- Member of ELSO since 1994
- Designated Center of Excellence since 2012
- Currently providing ECLS support for
 - Neonatal
 - Pediatric
 - Adult

2020 Award
Recipient



UK VA ECMO 2022 Data

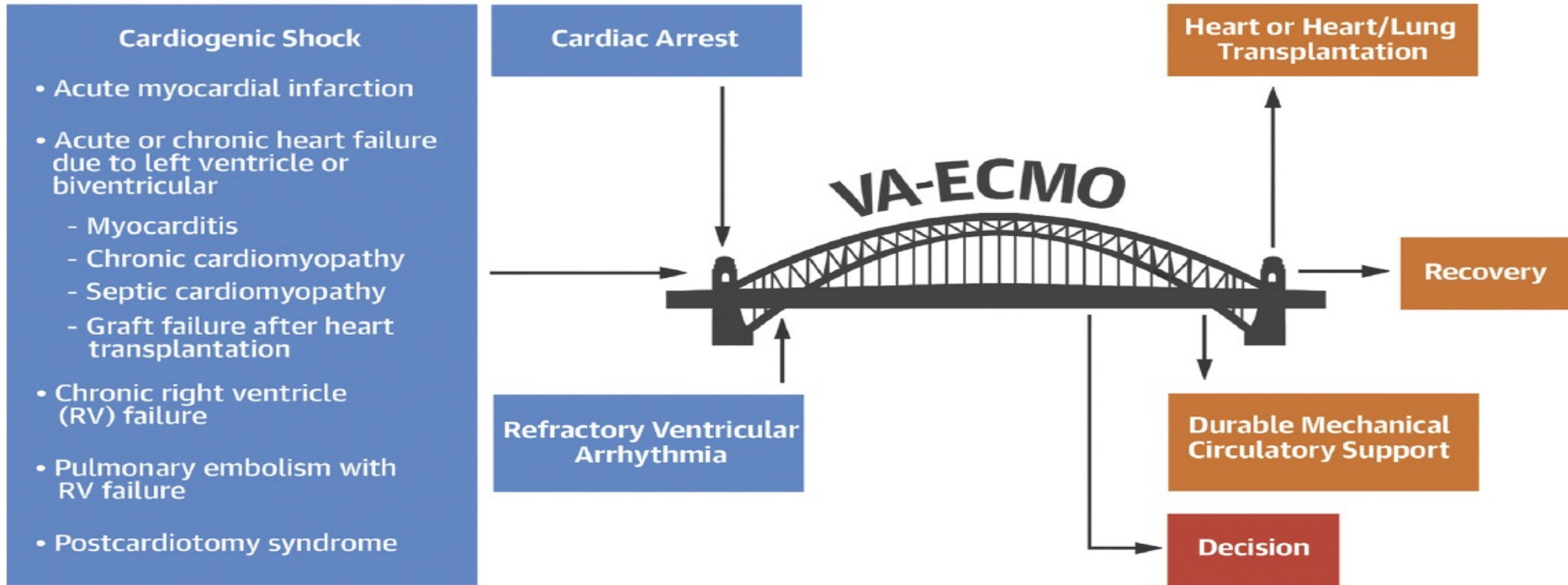
- 38 adult runs
- 2 transports
- ALOR – 3.92 days (median = 3, IQR = 5)
- ALOS – 15.42 days (median = 12, IQR = 18.25)
- CRRT Use – 23.7%
- Run survival – 47.37%
- Discharge survival – 34.21%

Annual Cardiac Adult Runs



What is the point?

CENTRAL ILLUSTRATION VA-ECMO Is a Bridge



Guglin, M. et al. J Am Coll Cardiol. 2019;73(6):698-716.

The fundamental premise underlying extracorporeal membrane oxygenation (ECMO) is that it is a bridge—to recovery, to a more durable bridge, to definitive treatment, or to decision. This figure shows indications for ECMO and the potential outcomes. RV = right ventricular; VA = venoarterial.

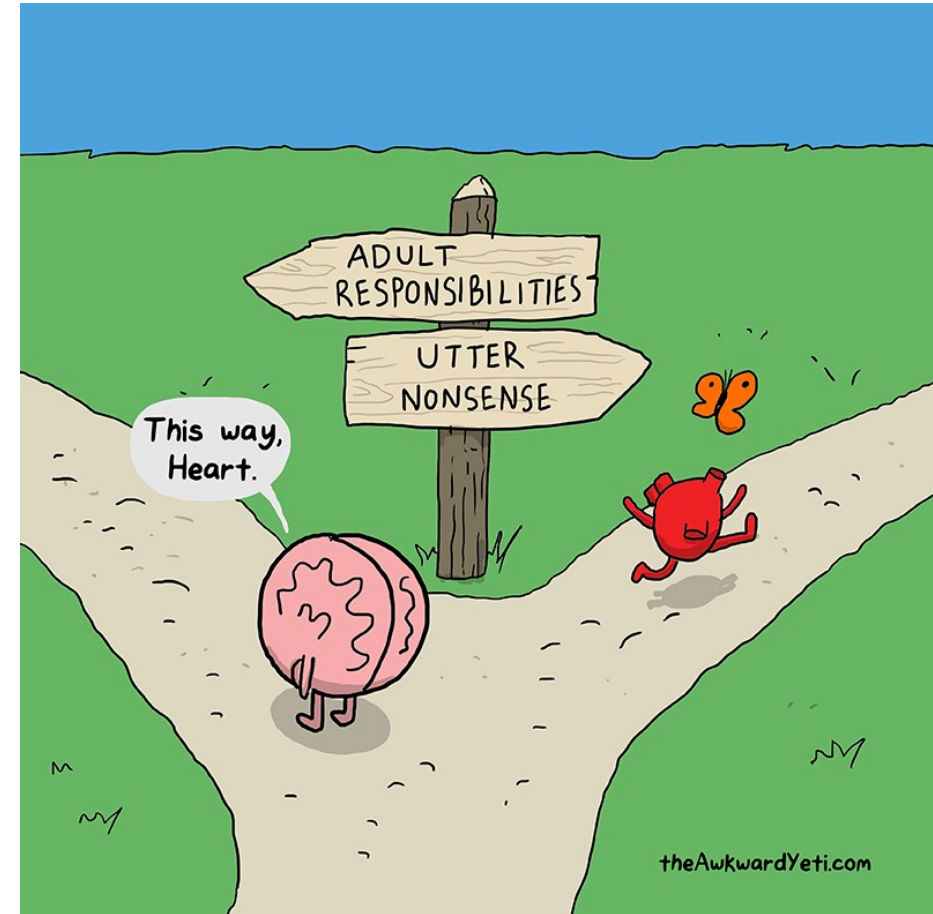
Indications for VA ECMO

- Cardiogenic shock
 - Acute massive pulmonary embolism
 - Acute MI
 - Post heart transplant/LVAD
 - Post cardiectomy with failure to separate from CPB
 - Post partum cardiomyopathy
 - Drug Intoxication
 - Sepsis associated cardiomyopathy
 - Trauma
 - Myocarditis
 - Bridge to transplant
 - ECPR salvage as bridge to treatment or decision

(ELSO Guidelines 2021)

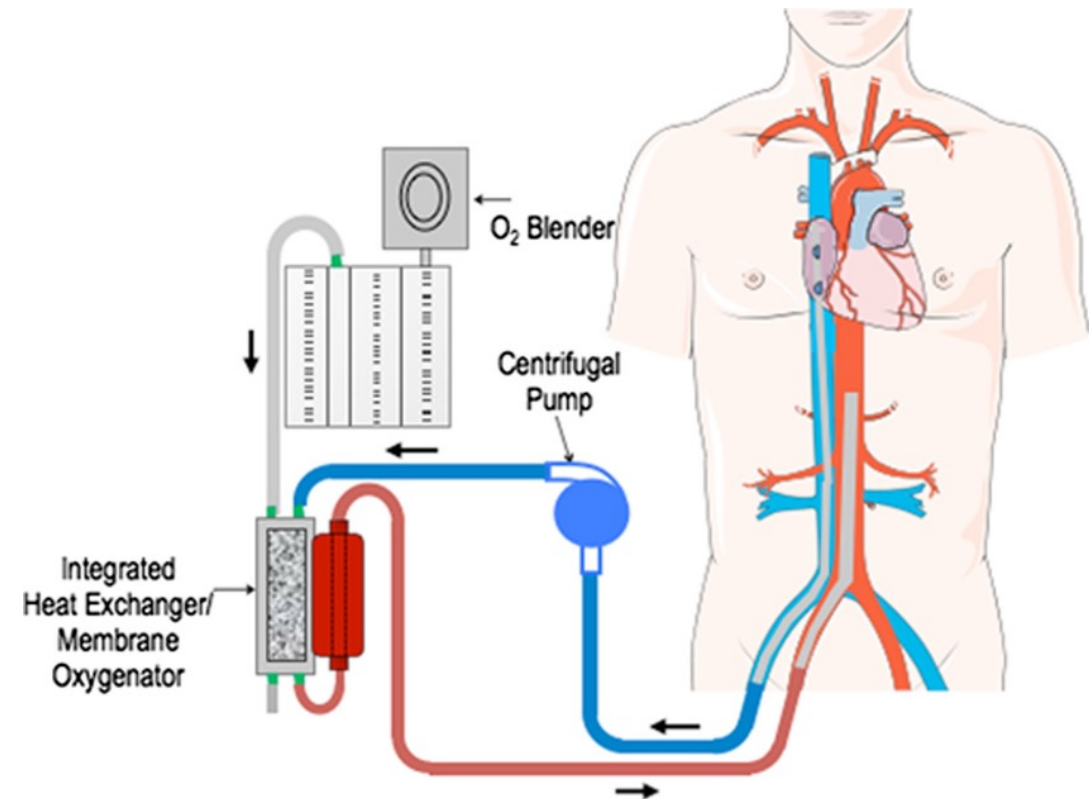
Contraindications

- Absolute:
 - Non-recoverable cardiac dysfunction
 - Non-recoverable neurological disease
 - Active Malignancy
 - Existing Multi-organ failure
 - Prolonged mechanical ventilation >7-10 days
 - Aortic Dissection and/or Aortic Valve dysfunction
 - Unwitnessed cardiac arrest or CPR >60 minutes
- Relative:
 - Age, comorbidities, poor end points



Function of ECMO

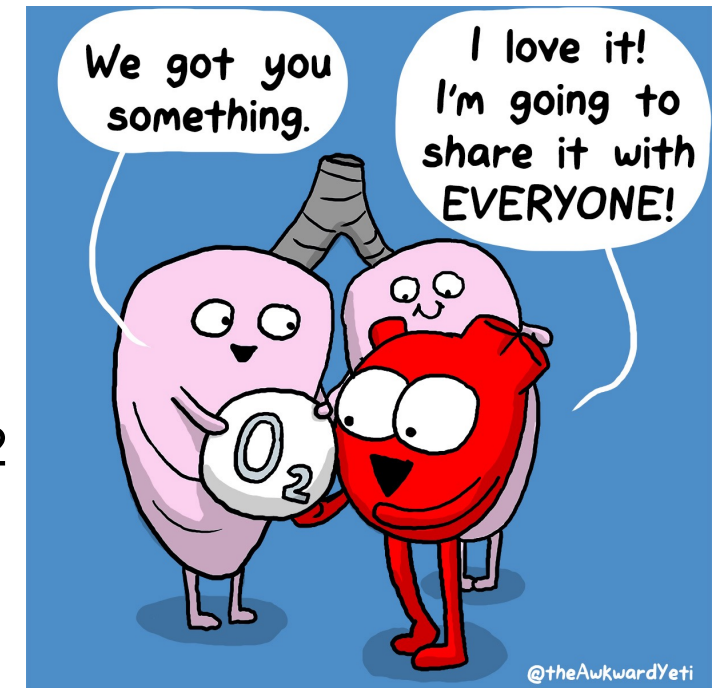
- ECMO can serve as a bridge to recovery, a destination therapy, or decision
- Oxygen Delivery and CO₂ Removal
 - Draining venous blood
 - Adding oxygen and removing CO₂ through an artificial lung to support normal aerobic metabolism
 - Return warmed, oxygenated blood to the arterial circulation.
- Preload dependent and afterload sensitive (centrifugal pump) paired with membrane oxygenator



https://www.researchgate.net/figure/Schematic-diagram-demonstrating-the-circuit-for-extracorporeal-membrane-oxygenation_fig2_267873972

Oxygen Delivery

- Normal O₂ delivery is **4-5 times more** than amount of O₂ consumption.
- $DO_2 = [1.36 \times Hb \times SaO_2 + (0.003 \times PaO_2)] \times Q$
- Delivery of oxygen (DO₂) to the tissues is determined by:
 - The amount of oxygen in the blood
 - The oxygen binding capacity of hemoglobin (1.36)
 - The hemoglobin (Hb)
 - The saturation of hemoglobin
 - The amount of dissolved oxygen in plasma (.003) AND PaO₂
 - The Cardiac Output (CO).



<https://theawkwardyeti.com/comic/oxygen/>

Oxygen Consumption

- **VO₂ is the maximum capacity of an individual's body to transport and use oxygen.**
 - $VO_2 = Q \times (CaO_2 - CvO_2)$ mlO₂/min
 - The C_nO₂ is $(1.34 \times \text{Hb} \times S_nO_2/100) + 0.003 \times P_nO_2$, where n = a or v
 - VO₂ is controlled by tissue metabolism.
 - VO₂ is decreased by rest, paralysis, hypothermia
 - VO₂ is increased by muscle activity, infection, seizures, hyperthermia, increased level of catecholamine's and thyroid hormone

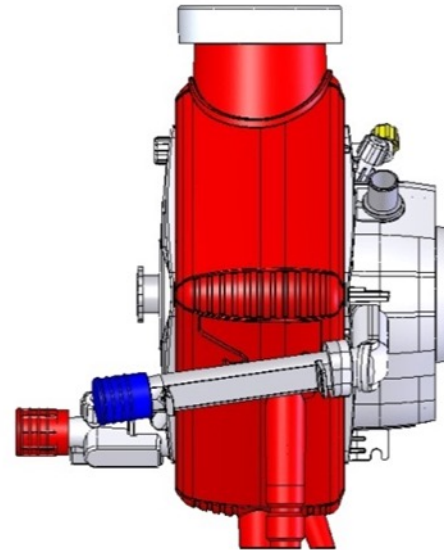


CardioHelp ECLS System

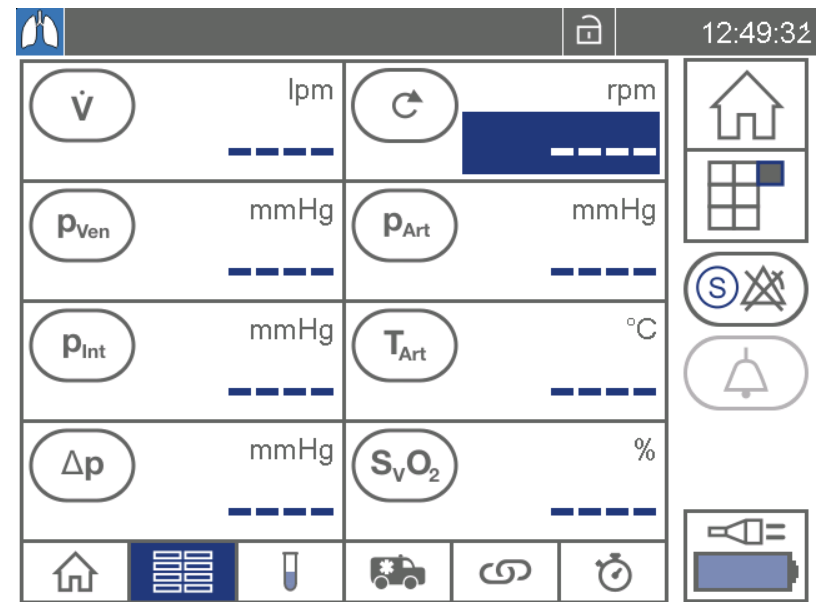
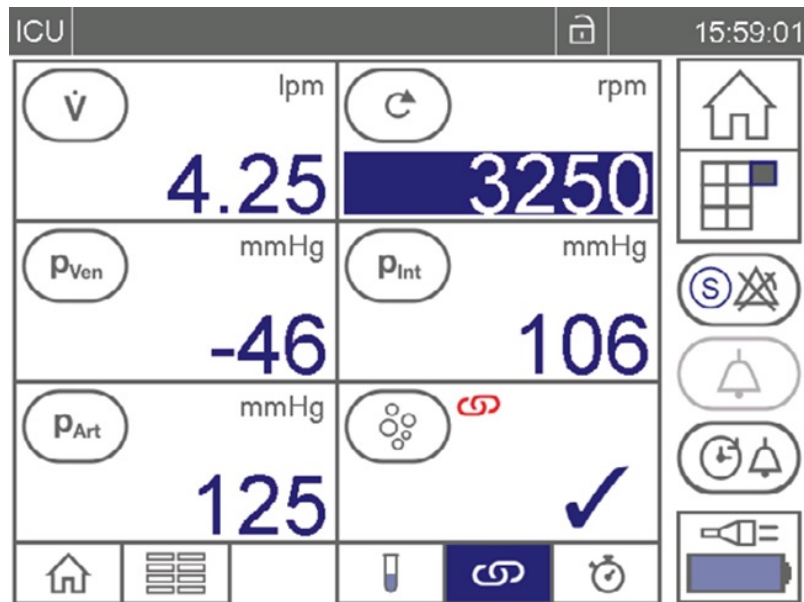
Control Console



Disposable Component



CardioHelp Display Screen



ECLS Equipment



- Maquet Rotoflow Centrifugal Console
- Flow Capability 9.9 LPM

Thoratec Centrimag Console



Veno-Arterial ECMO Cannulation

ELSO GUIDELINES FOR ADULT AND PEDIATRIC ECMO CIRCUITS

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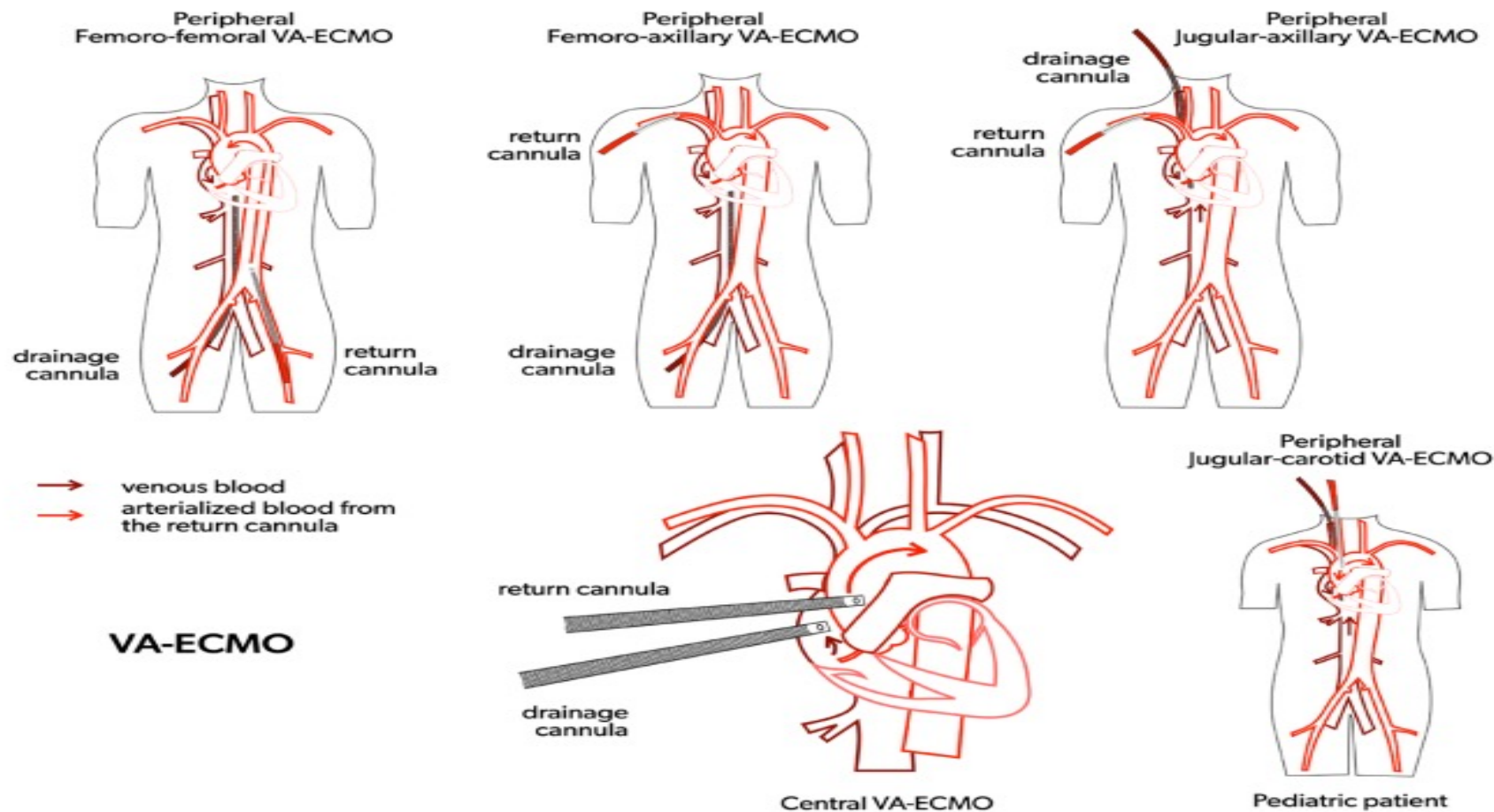


Figure 2. Venoarterial extracorporeal membrane oxygenation (VA ECMO) cannulation strategies.

Different Sites for VA ECMO Cannulation

Arterial Cannula	Location of Mixing	Arterial Catheter Site	Comments
Right Common Carotid	Aortic Arch	Avoid Right Radial	Right radial blood gases inaccurate due to sampling of immediate downstream arterialized blood
Right Axillary	Aortic Arch	Avoid Right Radial	Right radial sampling may not be reflective of circulation in other areas of body
Left Axillary	Aortic Arch	Avoid Left Radial	Left radial sampling may not be reflective of circulation in other areas of body
Femoral	Variable	Prefer Right Radial	Right radial helps detect North-South problems
Aorta	Aortic Root	Any	

ECLS Distal Perfusion




- Prevents lower limb ischemia in peripheral VA ECMO
- 5fr-9fr catheter shunt
- Supplies moderate flows
- Requires extra monitoring when moving patient

Summary of Monitoring for VA ECMO

	Monitor For:	Treatment:
Rhythm	Dysrhythmias may impair ventricular ejection	<ul style="list-style-type: none">• Antiarrhythmics• Cardioversion• Pacing• Ablation
MAP (mean arterial pressure)	Hypotension Hypertension	<ul style="list-style-type: none">• Adjust ECMO Flows• Vasopressor• Fluid bolus
Pulsatility	Lack of pulsatility: <ul style="list-style-type: none">i. Poor myocardial functionii. Excessive VA supportiii. Inadequate preloadiv. RV Failure	<ul style="list-style-type: none">• Adjust ECMO Flows• Add MCS support device• Start Inotrope• Decompression

Summary of Monitoring for VA ECMO (continued):

	Monitor For:	Treatment:
ECMO Flow	<p>Low flow:</p> <ol style="list-style-type: none"> i. Inadequate preload- fluid status vs mechanical obstruction ii. Excessive Afterload iii. Inadequate RPMs 	<ul style="list-style-type: none"> • Volume bolus • Relieve mechanical obstruction • Increase RPMs 
GAS exchange	<ol style="list-style-type: none"> i. Inadequate pO₂ or excessive CO₂ elimination ii. Oxygenator function iii. Upper body hypoxemia 	<ul style="list-style-type: none"> • Adjust ECMO flows for pO₂ • Adjust Sweep gas for CO₂ • Assess pre/post oxygenator gas for oxygenator function • Consider configuration change to VV or V-VA

Summary of Monitoring for VA ECMO (continued):

	Monitor For:	Treatment:
Oxygen Delivery	Decreasing SVo2 and rising Lactate H/H Signs of increasing consumption	<ul style="list-style-type: none"> • Increase ECMO flow • Transfuse PRBC • Antipyretics • Consider paralytics
Distal Limb Ischemia	Pulses cannulated limb- cyanosis, coolness, oximetry	<ul style="list-style-type: none"> • Placement of anterograde perfusion catheter
Anticoagulation	Depending on anticoagulant monitor appropriate lab work- aPTT/anti-Xa	
Temperature	Patient temperature	Water heater unit attached to ECMO circuit for temperature control

Questions?

- Thank you for your time and attention

References:

- Lorusso, R., Shekar, K., MacLaren, G., Schmidt, M., Pellegrino, V., Meyns, B., Haft, J., Vercaemst, L., Pappalardo, F., Bermudez, C., Belohlavek, J., Hou, X., Boeken, U., Castillo, R., Donker, D. W., Abrams, D., Ranucci, M., Hryniewicz, K., Chavez, I., ... Whitman, G. (2021). Elso interim guidelines for venoarterial extracorporeal membrane oxygenation in adult cardiac patients. *ASAIO Journal*, 67(8), 827–844.
<https://doi.org/10.1097/mat.0000000000001510>