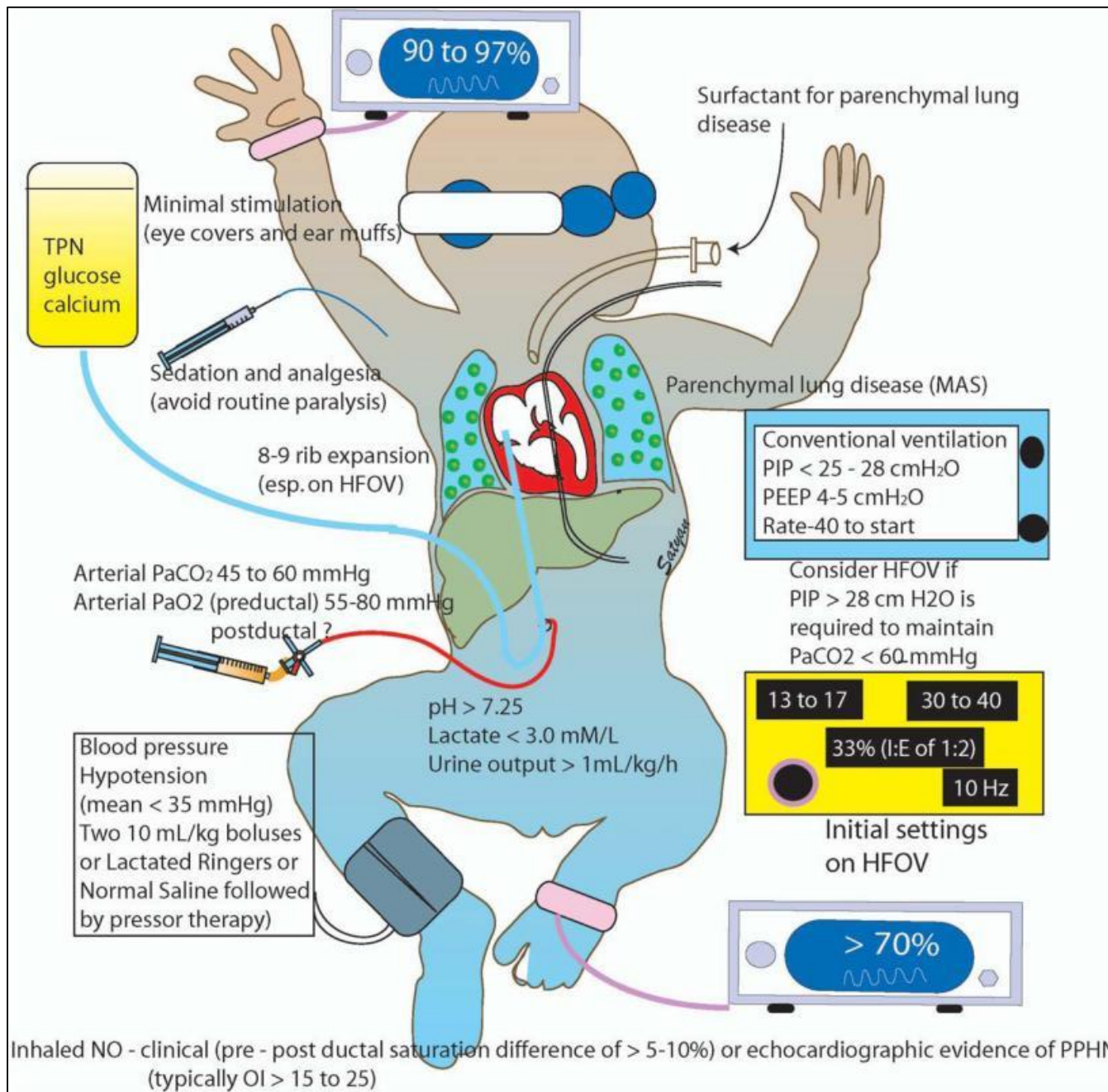
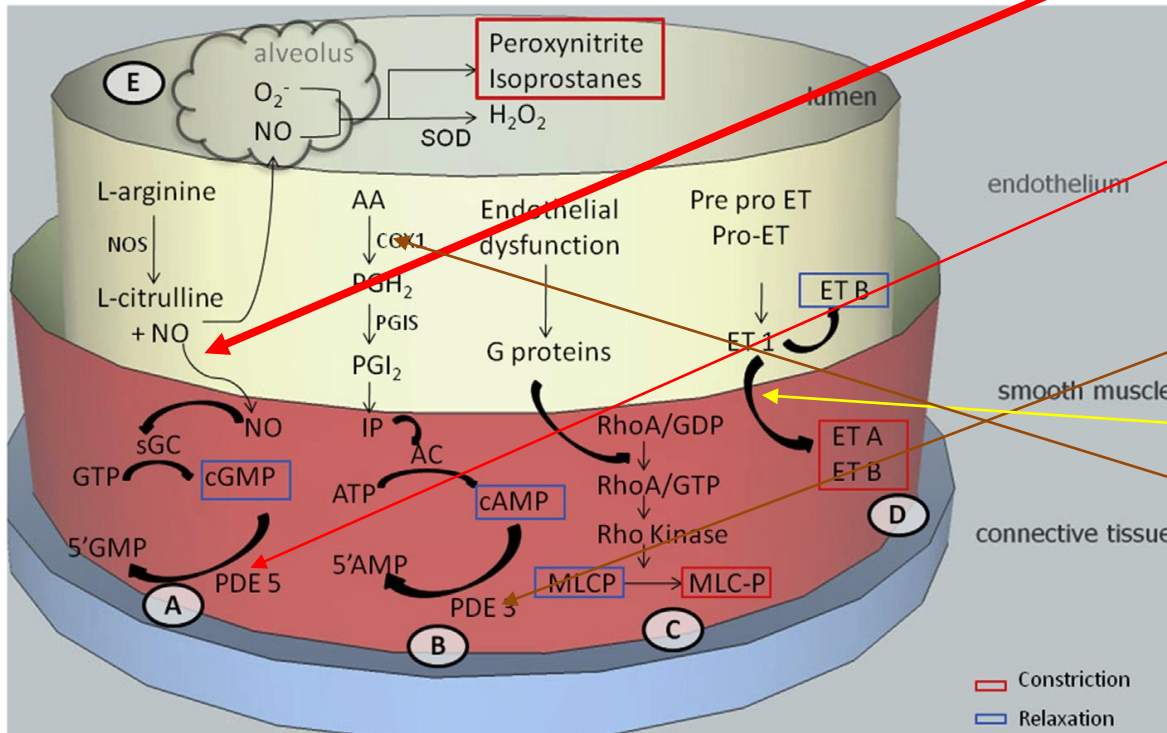


# PPHN Beyond Vasodilators





# Pulmonary Vasodilators



Nitric Oxide-Large RCTS and meta-analysis

Sildenafil- Large RCTS and meta-analysis

Milrinone-Case series

Bosenton -Small RCTS

Prostacyclins-Case series

## Guidelines for iNO use: Rule of 20

<b>Eligibility</b>	Near term/Term $\geq 34$ weeks, age $< 14$ days ECHO evidence Hypoxic Respiratory failure -OI $> 20$
<b>Starting dose</b>	<ul style="list-style-type: none"> <li>• 5-80 ppm has been tried</li> <li>• Peak improvement in PAP by cardiac catheterization at <b>20 ppm</b>- <i>Fineman et al</i></li> <li>• Fewer patient <math>&lt; 6\%</math> may respond to higher doses</li> <li>• 80 ppm-risk of Methemoglobinemia -35% of times</li> </ul>
<b>Monitoring</b>	Increase in PaO <sub>2</sub> $> 20$ mmHg or decrease in OI by <b>20%</b>

# Weaning iNO: Rule of 60

Weaning	Continue 20 ppm till weaning criteria met: FiO <sub>2</sub> < 0.6 and PaO <sub>2</sub> > 60 mmHg for 60 minutes
How to wean	20>15>10>5; every 6 hrly 5>4>3>2>1; every 2-4 hrly
Stop weaning	Increase in Fio <sub>2</sub> by >0.15
<b>Methemoglobin levels</b> 5-10 % - Dec iNO by 50% > 10% Discontinue iNO <b>Monitor NO<sub>2</sub> levels</b> 3-5 ppm – Dec iNO by 50% > 5 ppm Discontinue iNO	<b>Issues with NO</b> <ul style="list-style-type: none"> <li>• iNO in CDH- “to be or not to be”</li> <li>• Cost/Not always effective-40% may fail to respond</li> <li>• Does not decrease CLD or improve ND outcome</li> <li>• Concerns of adverse effects</li> <li>• Rebound Pulmonary hypertension</li> </ul>

# Dr Pratima

- What are the indications/Contra-indications for Neonatal ECMO and at what point of time you would alert the ECMO team?



Esperanza: The First Neonatal ECMO Patient (1975)

# Patient Selection

1. **Oxygenation Index**  $> 40$  for  $> 4$  hours.
2. Failure to wean from **100% oxygen** despite prolonged ( $> 48h$ ) maximal medical therapy or persistent episodes of decompensation
3. **Severe hypoxic respiratory failure** with acute decompensation ( $PaO_2 < 40$ ) unresponsive to intervention
4. **Severe pulmonary hypertension** with evidence of right ventricular dysfunction and/or left ventricular dysfunction
5. **Pressor resistant hypotension**

# Contraindications

## Absolute

- Grade 3-4 IVH
- Uncontrolled coagulopathy
- Lethal chromosome abnormality
- Irreversible organ damage

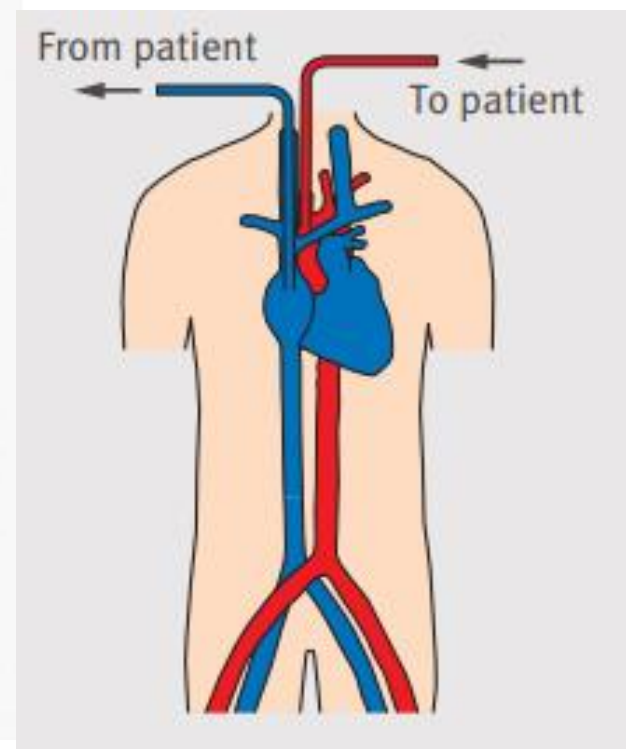
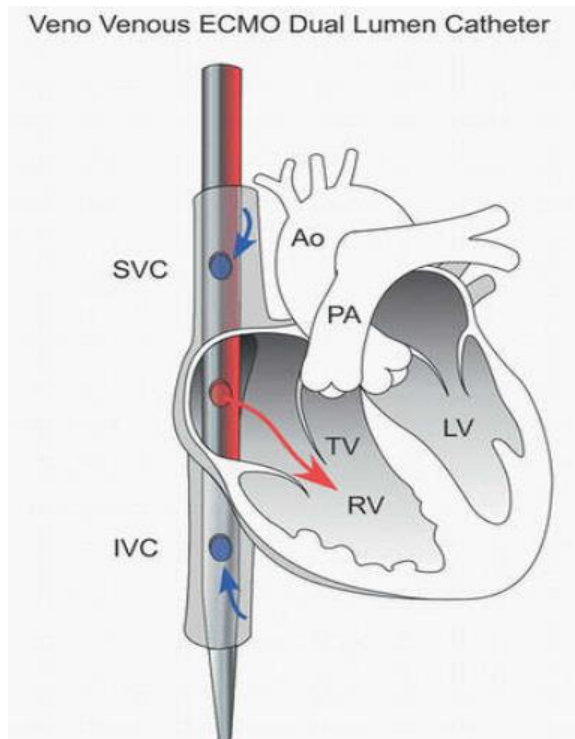
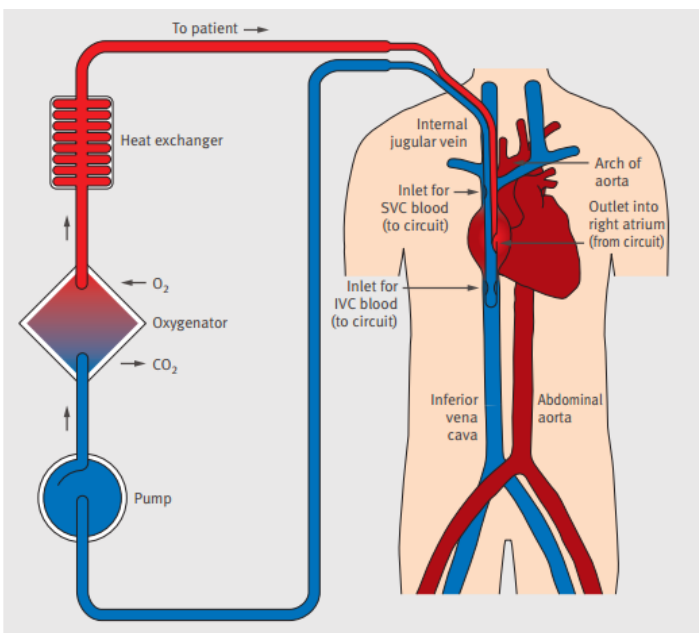
## Relative

- Gestational Age <34 weeks
- Weight < 2 kg
- Mechanical Ventilation >10-14 days



# Dr Raja Joshi

- What is V-V ECMO vs V-A ECMO? How do you choose which one is required?

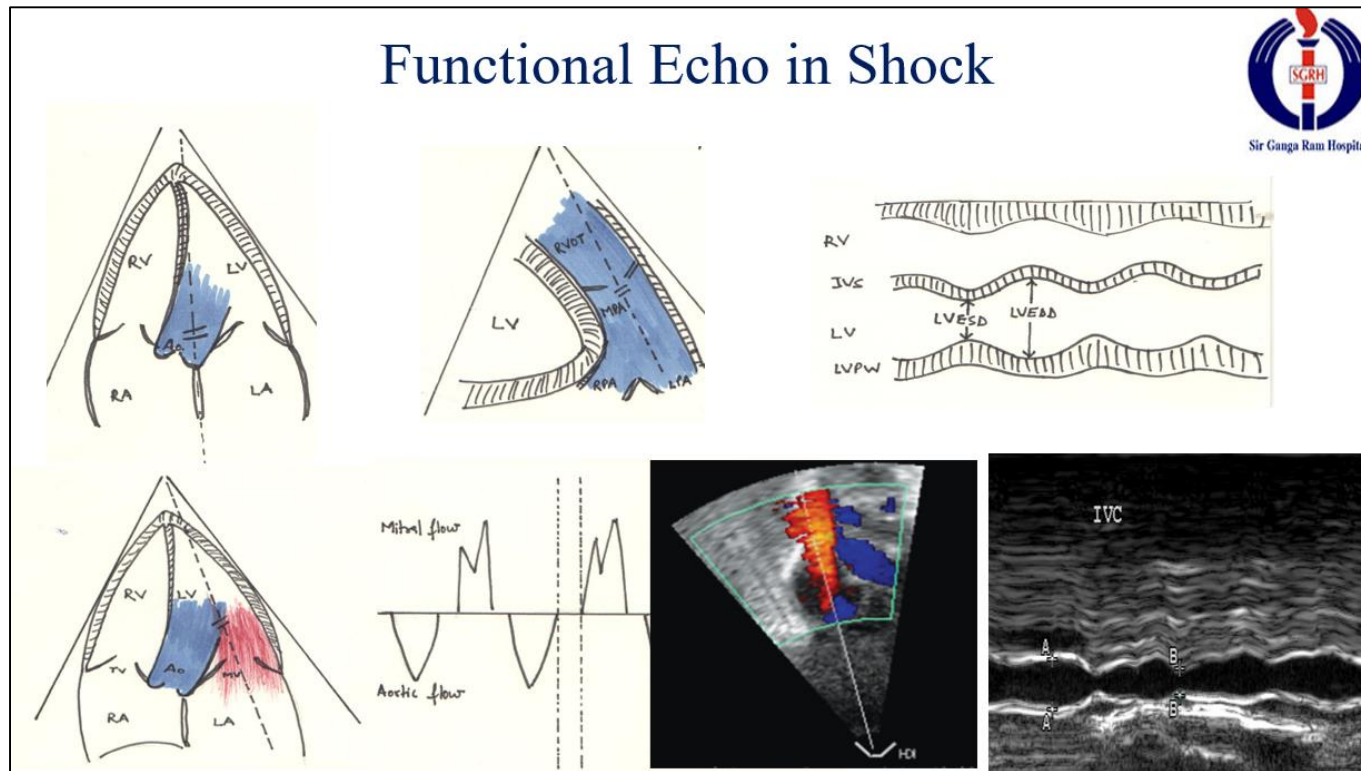


# VV vs VA

VV	VA
No direct cardiac support	Direct cardiac support
Spares carotid ligation(so quick initiation of ECMO possible)	Ligation of carotid artery involved
Provides pulsatile flow	Provides non pulsatile flow
Provides highly oxygenated blood to pulmonary bed, myocardium	Provides less oxygenated blood to myocardium- <b>stun myocardium</b>
Emboli to pulmonary circulation	Risk of embolization
<b>Survival</b> : Anderson et al 1993: 94% Gauger 1995: 92%(respiratory failure)	<b>Survival</b> : Anderson et al 1993: 87% Gauger 1995: 84%
Less Frequently used(n=8378)	More Frequently used (n=22344)

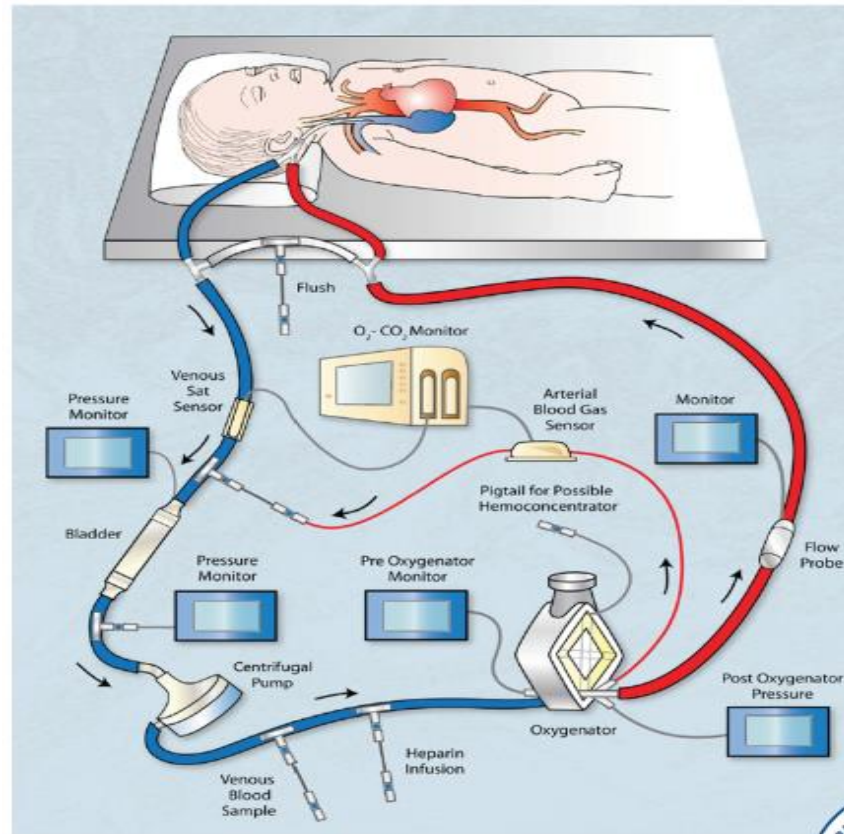
# Dr Mridul

- How do you assess cardiac functions to help decide on type of ECMO?



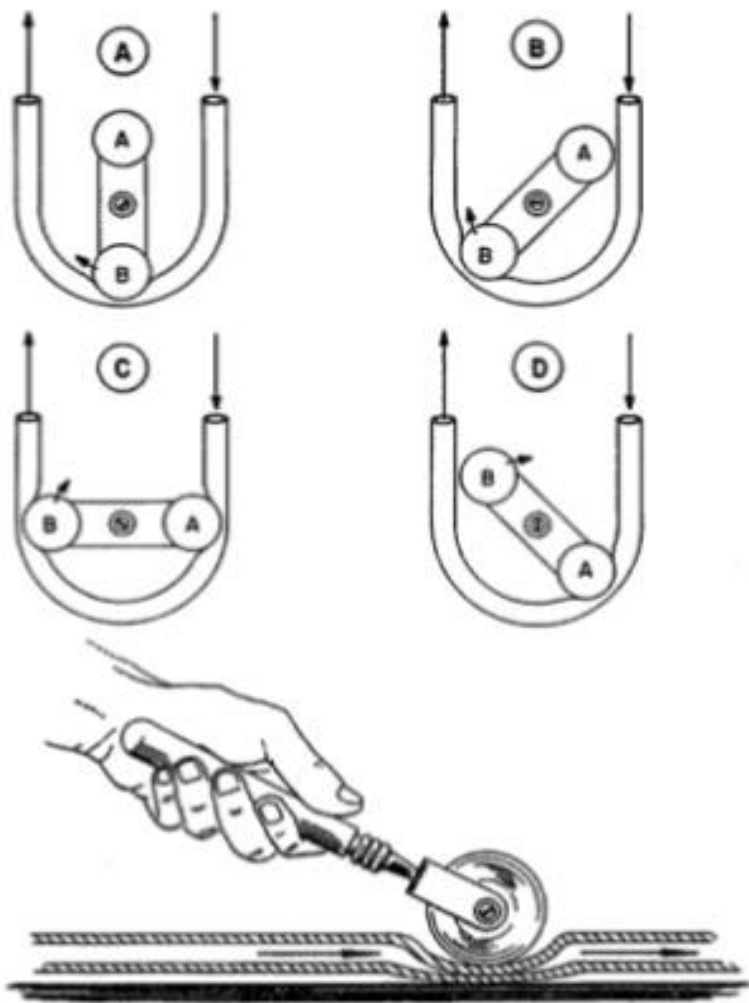
# Dr Pratima

- Can you briefly describe the ECMO circuit and the function of various components? Dr Pratima

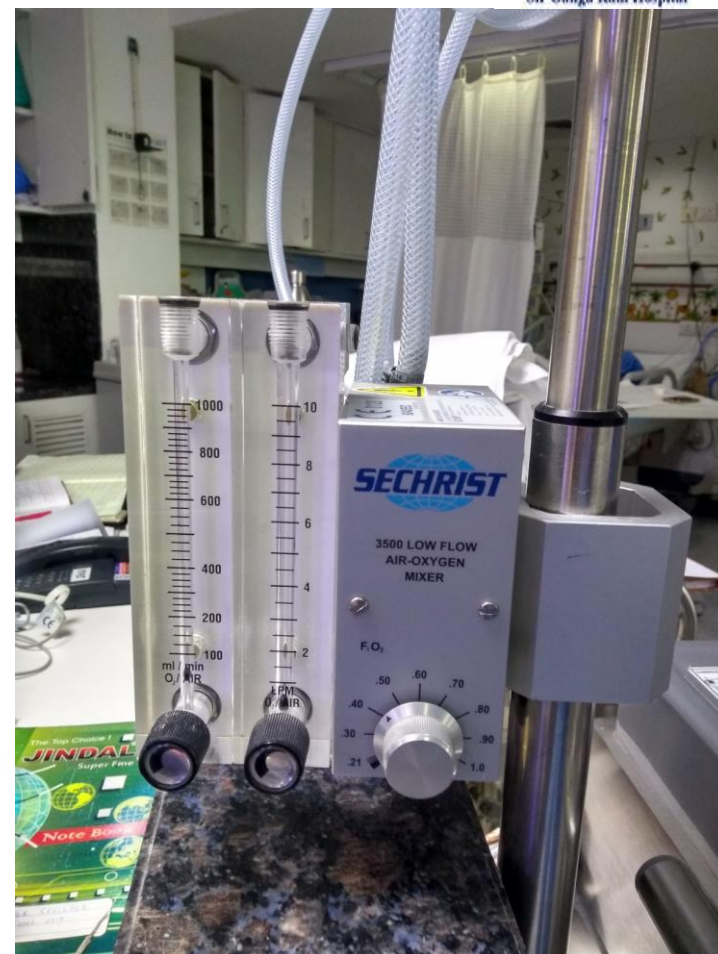
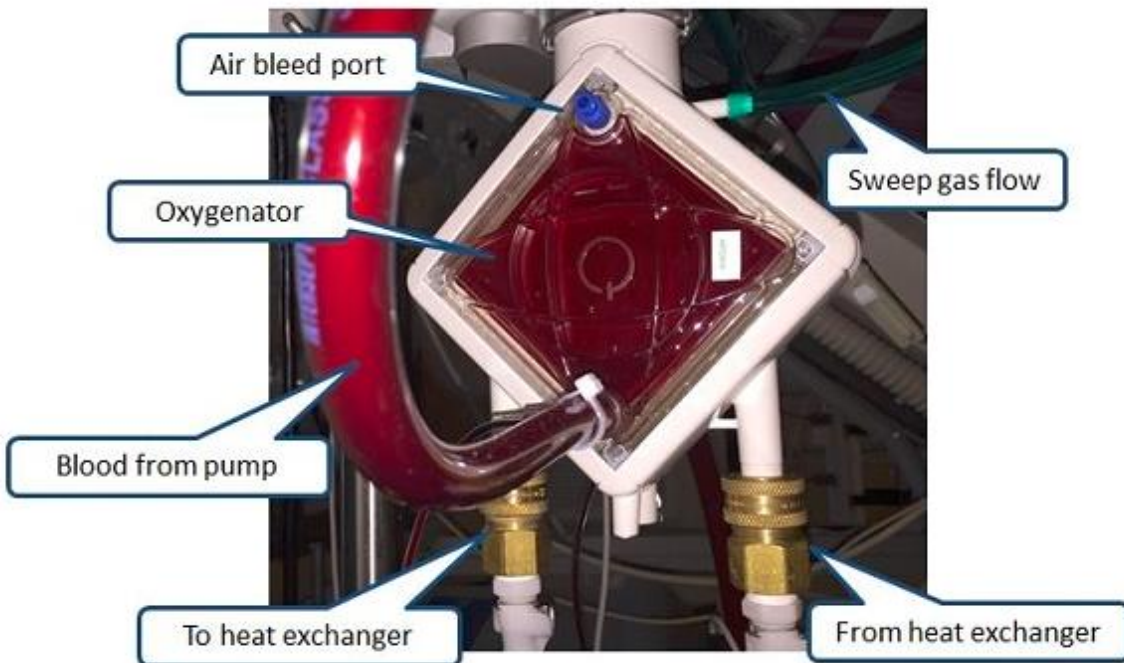


# Centrifugal motor/roller pump





	Roller pump	Centrifugal pump
Pump Mechanism	Positive displacement	Centrifugal force
Pump Inflow	Passive drainage	Active drainage
Retrograde flow	Not Possible	Possible
Pump Flow	More precise	More variable
Factors affecting pump flow	RPM, displacement volume	RPM, afterload , preload
Risk of tube rupture	Present	Rare
Hemolysis	Present: ++	Present : +



Solid Hollow fiber membrane (poly methyl pentene)

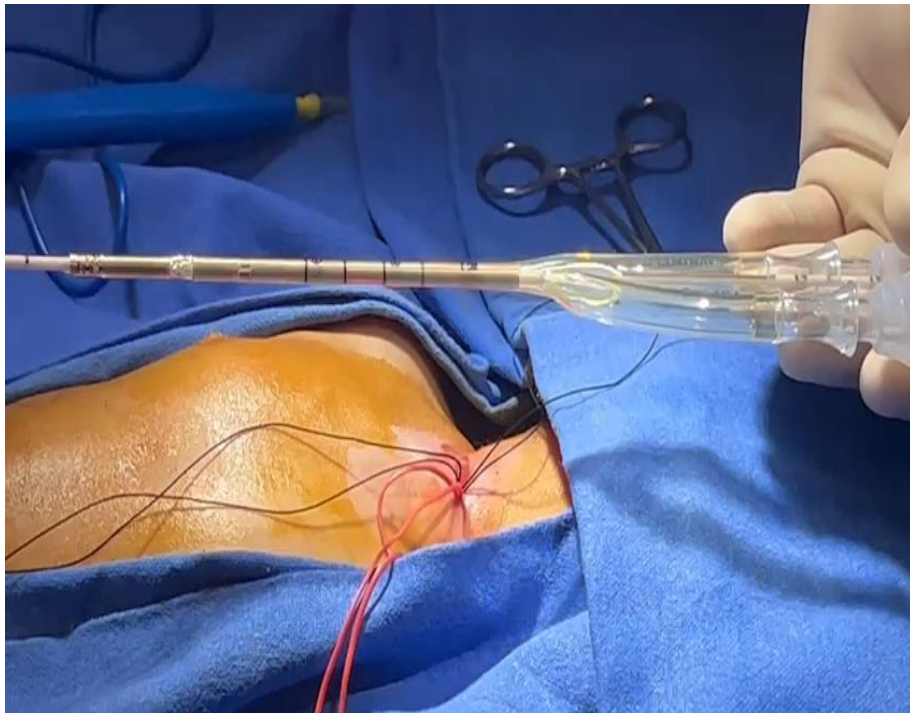




# Dr Raja Joshi



- How do you choose the catheter and cannulation site? Initiation, maintenance and weaning of ECMO



- Priming
- Calculation of blood flow/RPM
- Sweep rate
- $FsO_2$
- Monitoring
- Weaning –VV versus VA

## **1. Blood flow for cardiac support**

Access is venoarterial. Goal ECMO blood flow is about 100 mL/kg/min (80-140 mL/kg/min) in neonates. The best measure of adequate systemic perfusion is venous saturation greater than 70%, so flow should be adjusted to reach this goal accordingly. Achieving a desired flow is determined by vascular access, drainage tubing resistance, pump properties, intravascular volume, and systemic vascular resistance.

## **2. Blood flow and gas exchange for respiratory failure (VA or VV)**

The membrane lung and blood flow should be capable of oxygen delivery and CO<sub>2</sub> removal at least equal to the normal metabolism of the patient (i.e. an oxygen delivery of 6 mL/kg/min for neonates). This will usually equate to VV blood flows of 120 mL/kg/min for neonates. Oxygen delivery capability is determined by blood flow, hemoglobin concentration, inlet hemoglobin saturation, and membrane lung properties. Carbon dioxide removal always exceeds oxygen delivery when the circuit is planned for full support.

### **B. Circuit components**

The basic circuit includes a blood pump, a membrane lung, and conduit tubing. Depending on the application, additional components may include a heat exchanger, in-line pressure compliance reservoir (bladder), monitors, and alarms.

## Circuit related

1. Blood flow
2. Oxygenation
3. CO2 clearance
4. Anticoagulation
5. Circuit  
monitor/alarm/safety
6. Component

## Patient related

1. Hemodynamic
2. Ventilator  
management
3. Sedation
4. Blood volume/fluid  
clearance/HCT
5. Temperature
6. Renal, nutrition  
management
7. Infection and  
antibiotics
8. Bleeding/Clotting
9. Procedures
10. Neuroimaging
11. Neuromonitoring

# Weaning

- VA ECMO
  - when flow is less than 30-50 ml/kg/min
  - native heart and lung function may be adequate to allow coming off ECMO
- VV ECMO
  - once the lungs are open, the sweep flow can be weaned down (ideally to 0.1 L/min)

# Trial Off ECMO

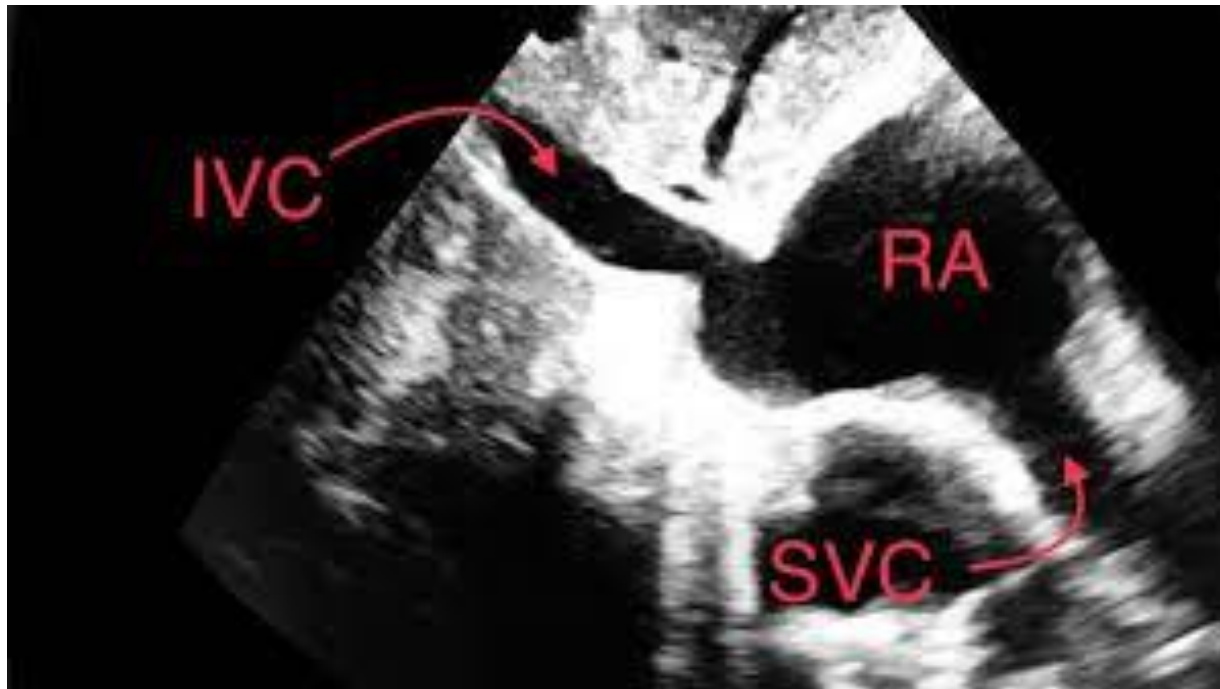
- VV ECMO
  - Normal cardiac function
  - Ventilatory setting are adjusted with  $FiO_2$  not  $> 0.5$  and  $PiP$  not  $>25$  and a  $PaO_2$  of  $>60$  mm hg.
  - Blood flow and anticoagulation are maintained while the membrane is isolated by discontinuing the sweep gas.
  - If baby maintains saturation and perfusion on same for an hour or more then decannulation can be planned.

- **VA ECMO**

- Either a low flow 20ml/kg/min or clamping infusion or drainage and then connecting them by AV bridge
- Ventilator settings are adjusted
- ECHO is used to assess cardiac function
- Anticoagulation is continued and blood lines are periodically clamped and unclamped
- If the trial off is successful then decannulation is planned

# Dr Mridul

- What is the role of cardiologist during Cannulation/Maintenance and Weaning?





# Dr Raja Joshi

- For how long you have been running the ECMO Program? What are the outcomes of ECMO in your unit?

# Key message

