SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

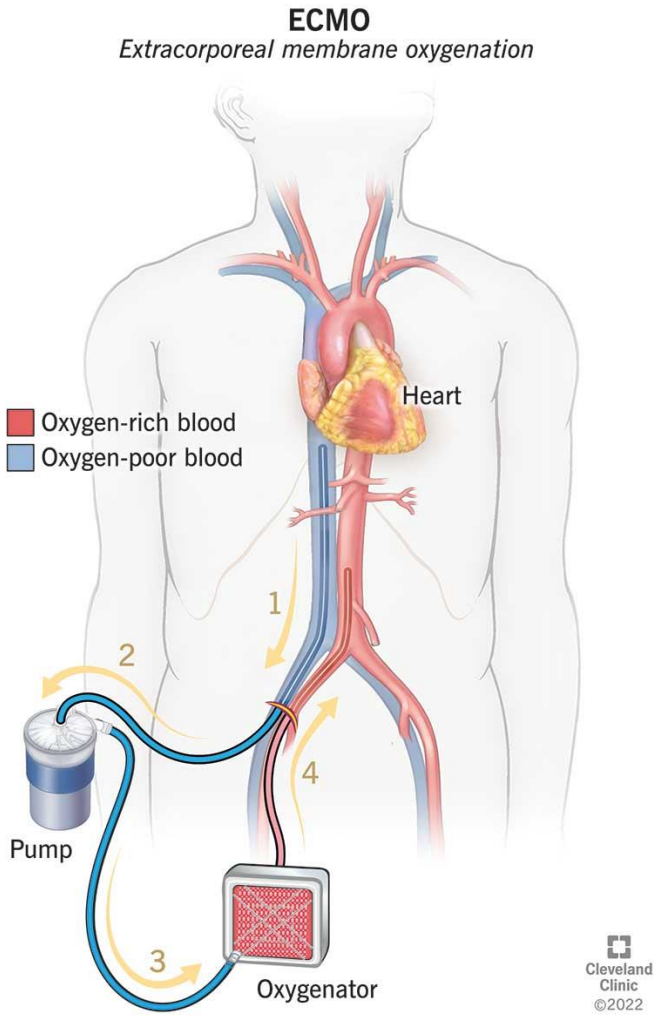
DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME: CPB & Perfusion Technology – II

TOPIC : Basics of ECMO

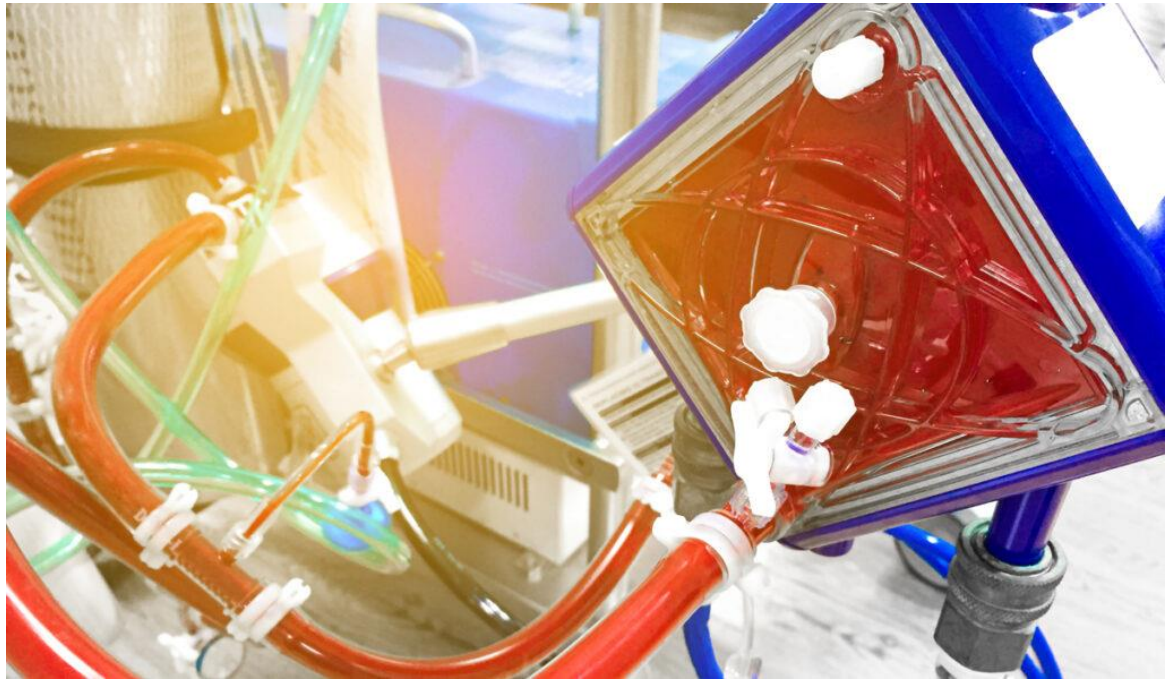
ECMO

- Extra- Corporeal membrane oxygenation (ECMO) is a ***closed system*** without a venous reservoir mostly using a centrifugal pump
- ***It is a technique used to provide support to patients with severe but potentially reversible pulmonary and / or cardiac failure, with recovery expected in two to four weeks***
- ECMO is a ***supportive therapy***



ECMO

A centrifugal pump and a membrane lung temporarily provide ***life support*** by taking over the functions of lungs or the entire cardiopulmonary system.

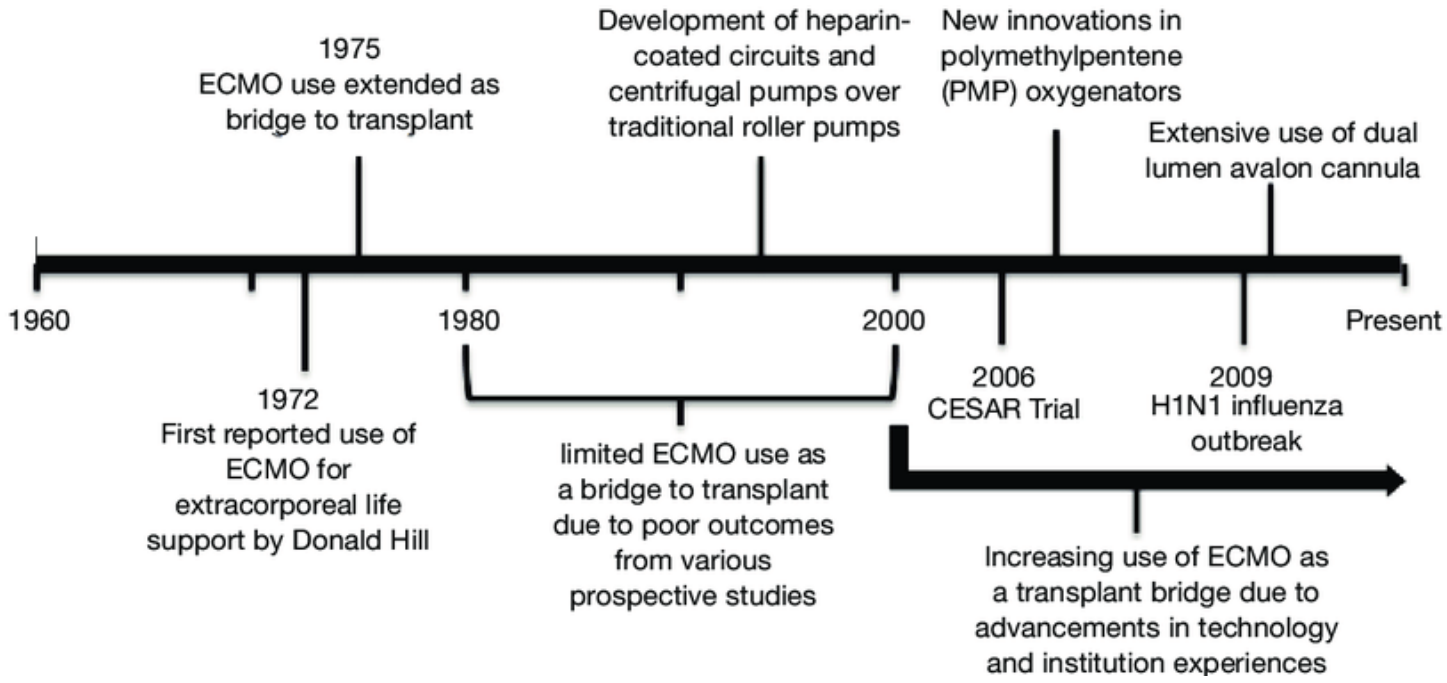


ECMO,

- Allows organs a time to heal
- Reducing the damaging effects of barotrauma
- Oxygen toxicity to lungs

HISTORY

- The first successful use of ECMO was reported by ***Hill*** for the treatment of ***posttraumatic ARDS*** in an adult patient in 1972.
- Following this early success, in 1979 ***Zapol*** conducted a randomized controlled trial of VA ECMO in adult patients in the USA.
- However, this trial was fundamental to the development of a number of treatment principles relating to ECMO

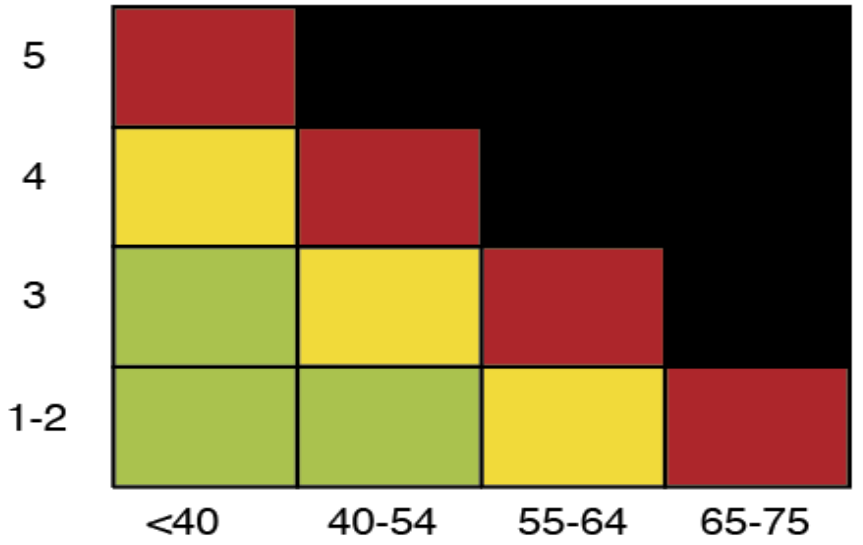


HISTORY

Treatment principles:

- Selecting patients before irreversible ventilator-associated lung injury has occurred
- The use of lung protective ventilation
- The use of low-range heparinization
- The use of veno-venous ECMO for respiratory support.

Eligibility chart

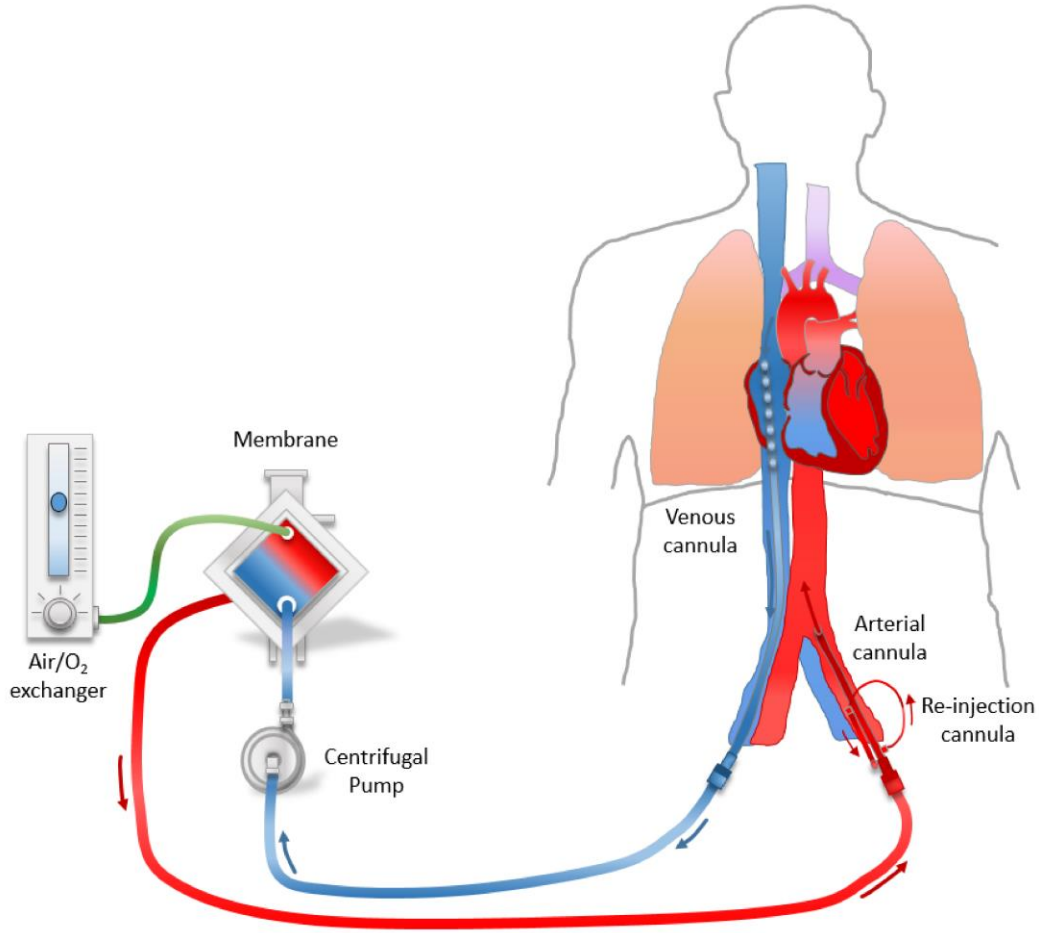


The chart indicates eligibilty and expected outcome for VV ECMO according to patient age and risk score (1-5) which is the diagnostic group 1, 2 or 3 plus presence of acute (+1) and/or chronic modifers (+1).

GREEN	Good expected outcome
YELLOW	Uncertain expected outcome
RED	Poor expected outcome
BLACK	Negligible benefit

USE OF ECMO

- ***Respiratory*** Support
- To provide primarily ***Circulatory*** Support
- Combined ***Cardio Respiratory*** support
- Bridge to ***LVAD***
- Bridge to ***Decision Making***
- ***ECPR*** (Extracorporeal Cardio Pulmonary Resuscitation)
- For primary ***Angioplasty*** Support
- ***Poisoning*** Cases



For cardiac support

- ECMO unloads the distended and poorly contractile Heart
- It decreases Ventricular wall stress
- It decreases Myocardial work load
- It creates favourable environment for myocardial recovery.

INDICATIONS FOR ECMO

Paediatric & Neonatal:

- Cardiac arrest
- Failure to wean from cardiopulmonary bypass
- Treatment of fulminant myocarditis

Adults:

- cardiac arrest, cardiogenic shock , cardiac trauma, drug overdose, hypothermia.
- pulmonary edema, pulmonary embolism, status asthmaticus, smoke inhalation

- ***Procedural support:***

–abdominal aortic graft replacement

–angioplasty, arrhythmia ablation, tracheal surgery

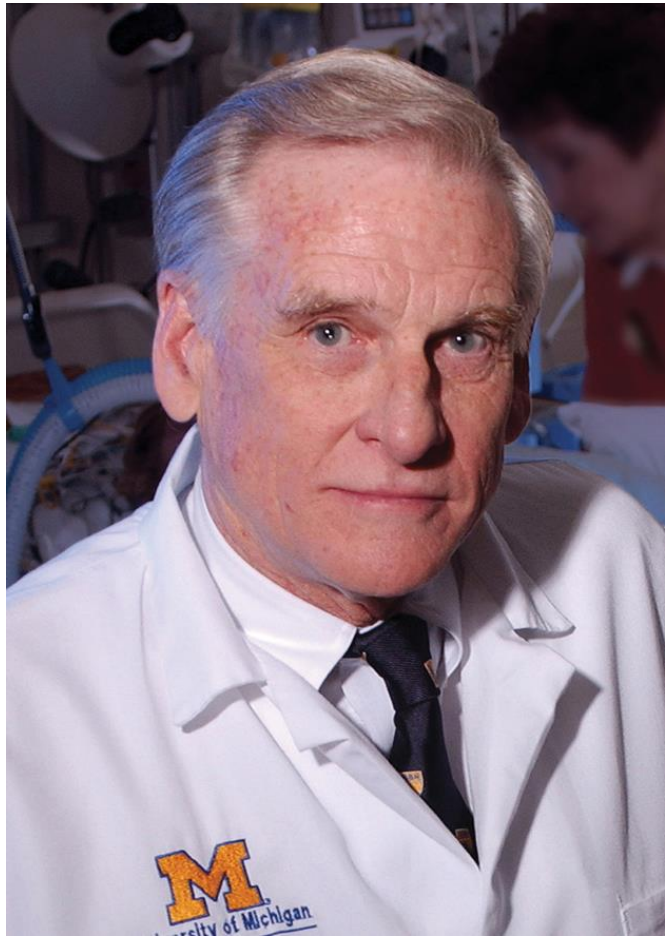
–cerebral arterio-venous malformation resection

–donor organ preservation, pulmonary embolectomy

–ventricular assist device placement

For Respiratory / Lung Support

ECMO for adults was pioneered by ***Bartlett*** and coworkers in 1988 at the University of Michigan.



Patient suitability for Lung support:

- Potential ***reversibility of the disease*** – only patients with acute and potentially reversible
- Etiology of respiratory failure.
- Duration of ventilation

For Respiratory / Lung Support

- The O2 and Co2 removal function of the lungs is replaced with a synthetic lung
- Reduces the need to ***use high – pressure ventilation*** and high inspired oxygen concentrations, both of these are harmful.
- Primary function of ECMO is to ***reverse the systemic hypoxia***
- VV – ECMO provides “rest” to lungs and provide optimal conditions for recovery of lung function

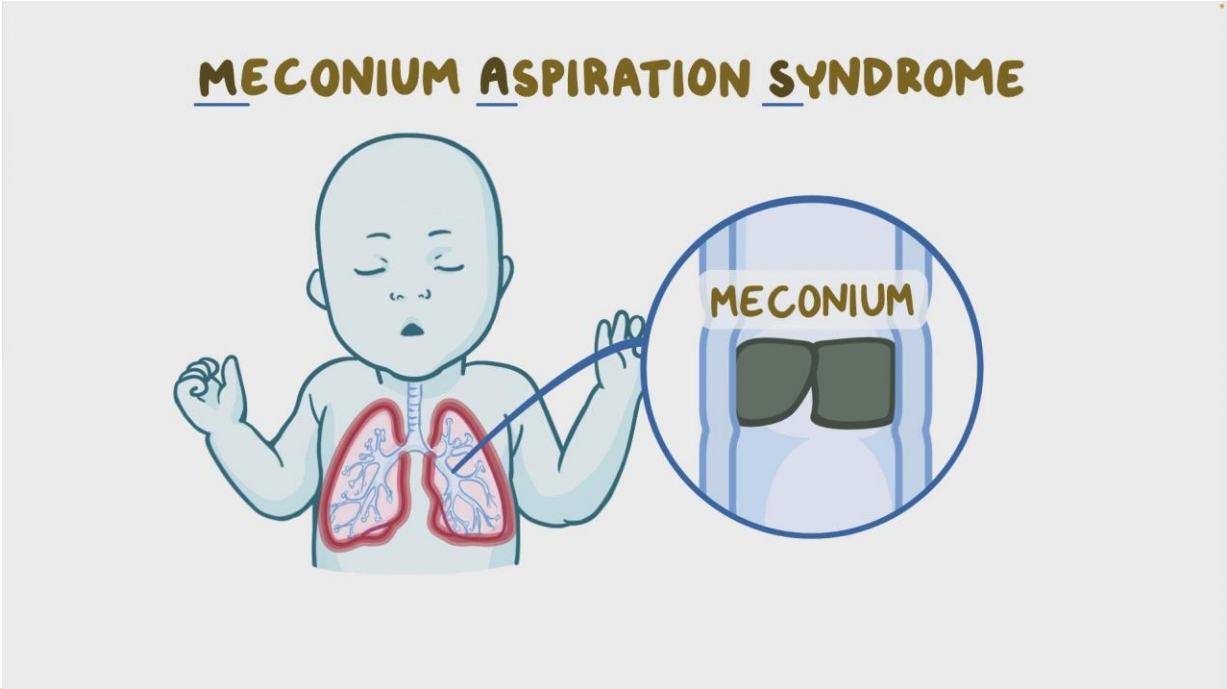
Indications For Ecmo

Paediatric & Neonatal:

- Meconium aspiration syndrome
- Persistent pulmonary hypertension of the newborn
- Congenital diaphragmatic hernia
- Severe pneumonia

Adults:

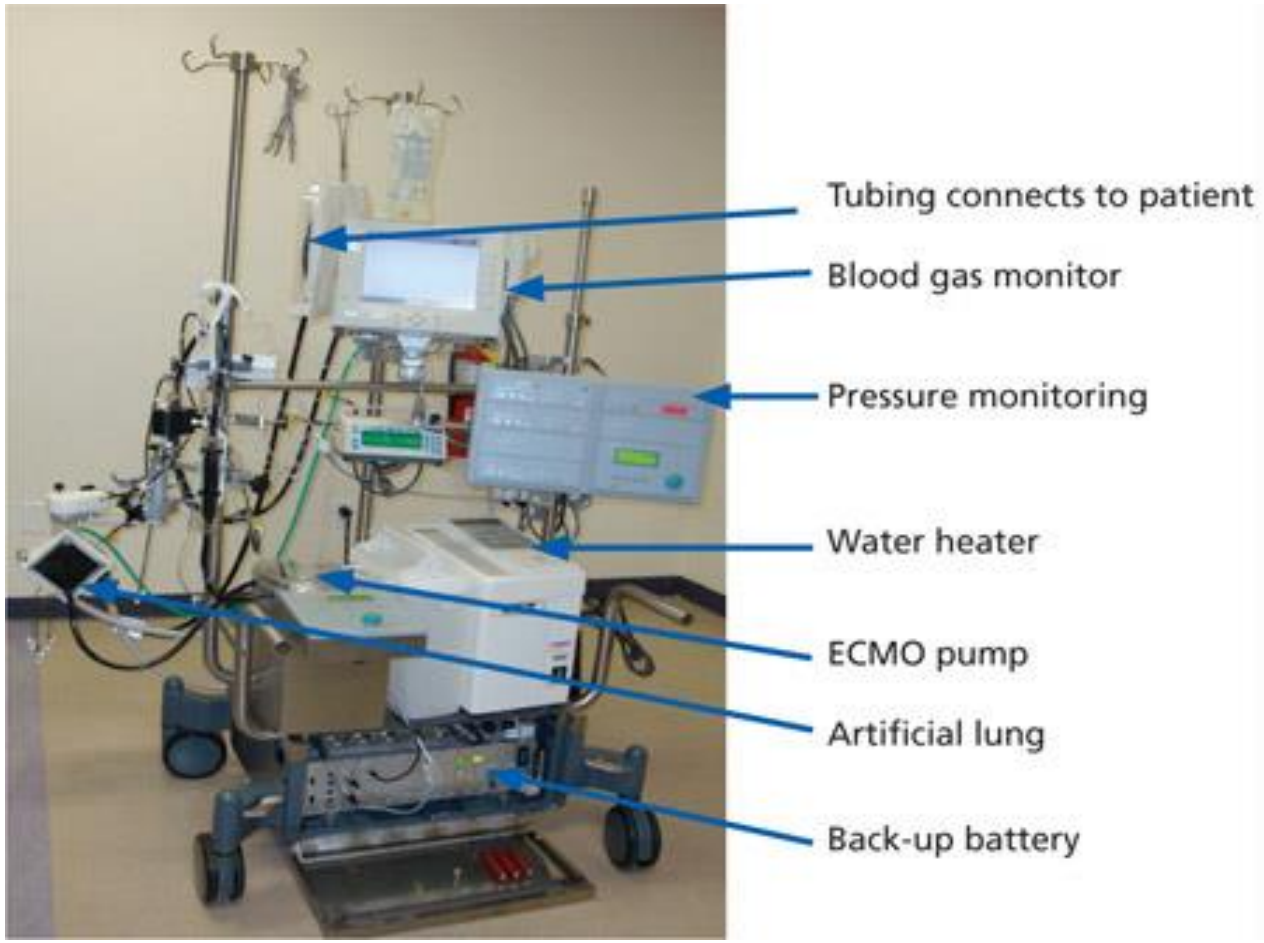
- Thoracic trauma involving lung contusion
- Smoke inhalation injury
- Severe bronchial asthma
- Severe pneumonia



ECMO components

Capital Equipment

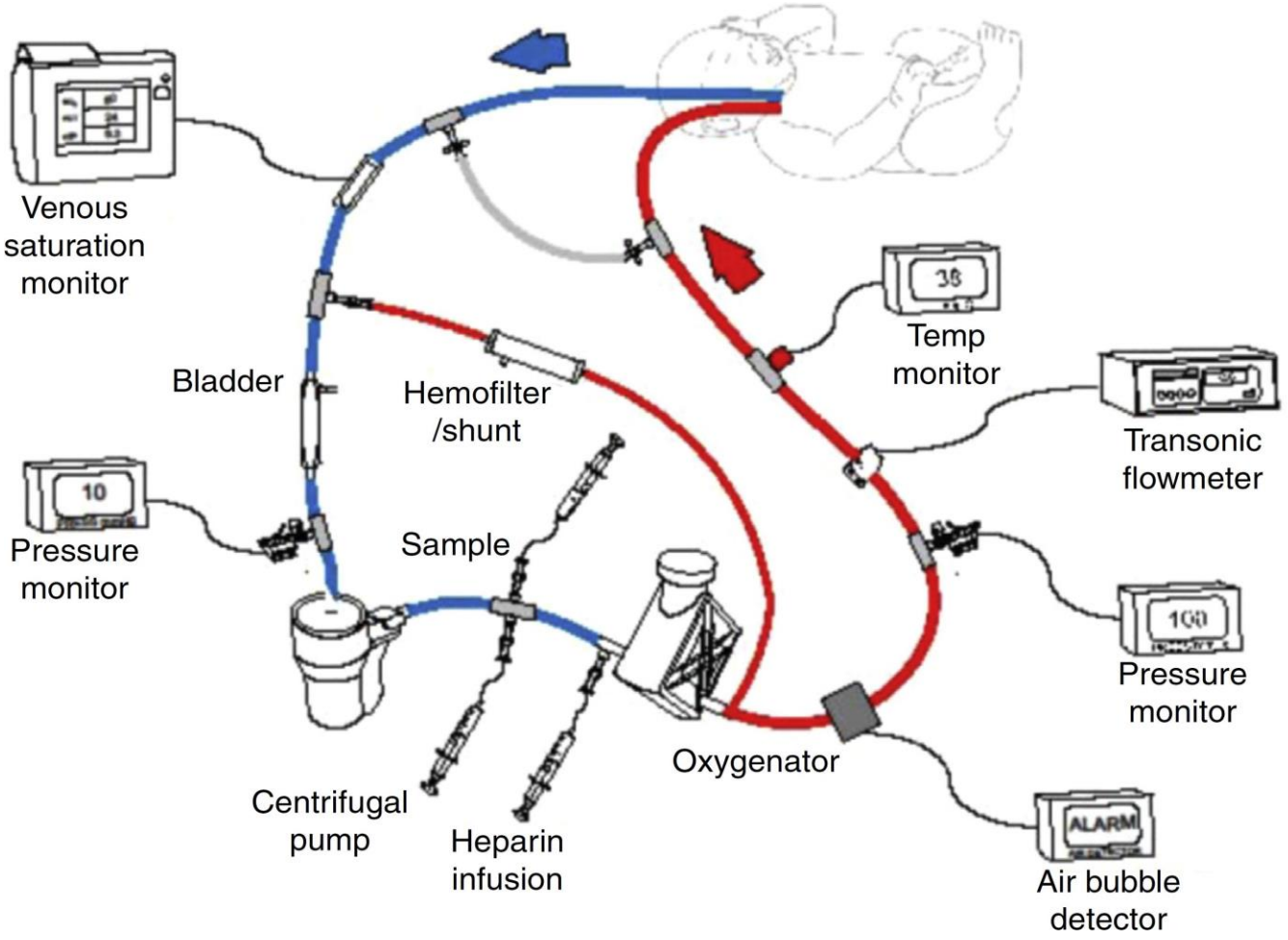
- Centrifugal pump console
- Drive cable
- Pump head / Drive unit
- Aquatherm / Hemotherm
- Oxygen cylinder
- Continuous venous saturation monitor
- ACT machine
- Pressure monitor with cables
- Pressure bag
- Tubing clamps
- Hand crank



ECMO components

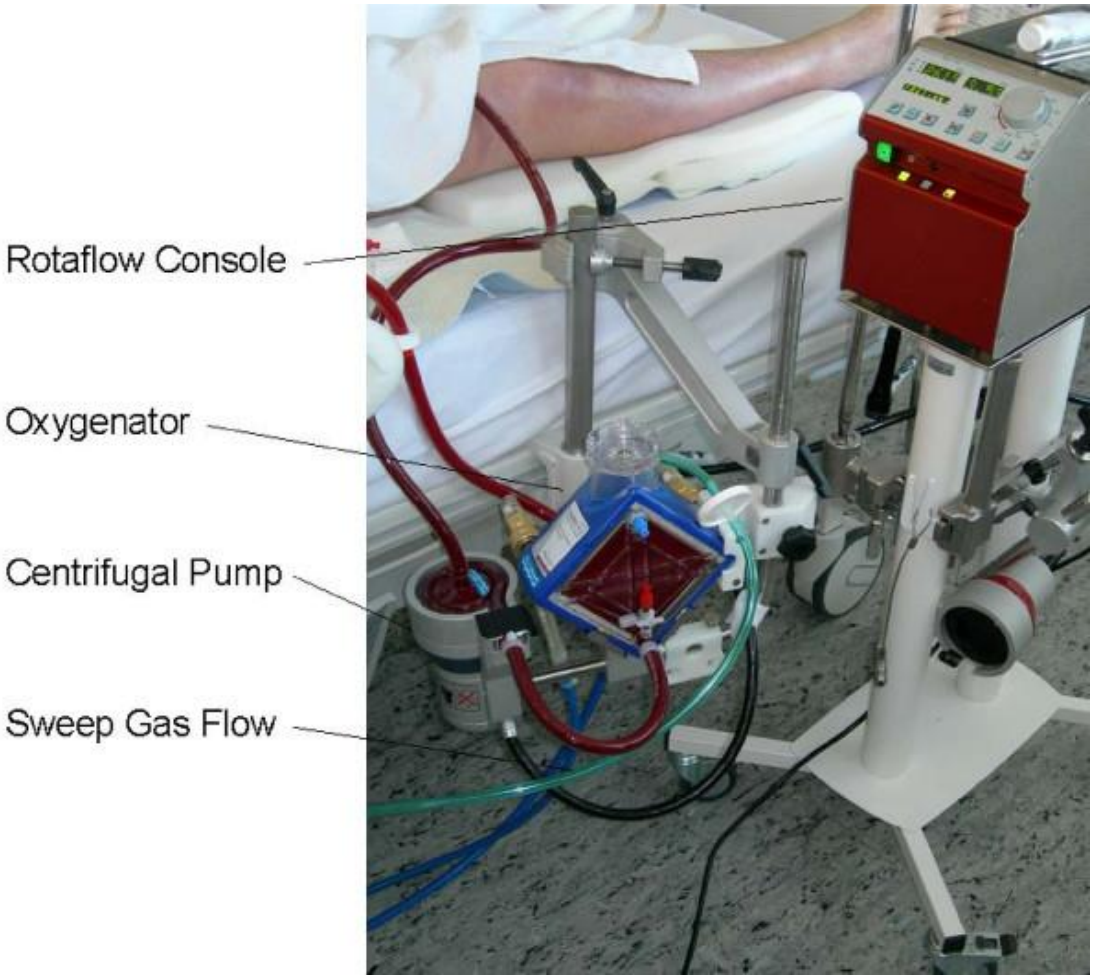
Other disposable components:

- Oxygenator
- Access cannulae
- Return cannulae
- Pressure transducers
- PM Lines
- Threeway stopcocks
- Quick prime sets
- Syringes 2ml / 5ml
- Sterile gloves
- Venous saturation probe
- ACT Catridges



Contents of ECMO Trolley

- Maquet Rota flow console
- Hand Crank
- Heater unit
- Blender
- Oxygenator holder
- Transducer holder
- IV pole
- Contact gel
- Metal clamp (4)
- 5 meter 1/4th tube (standby oxygen line)



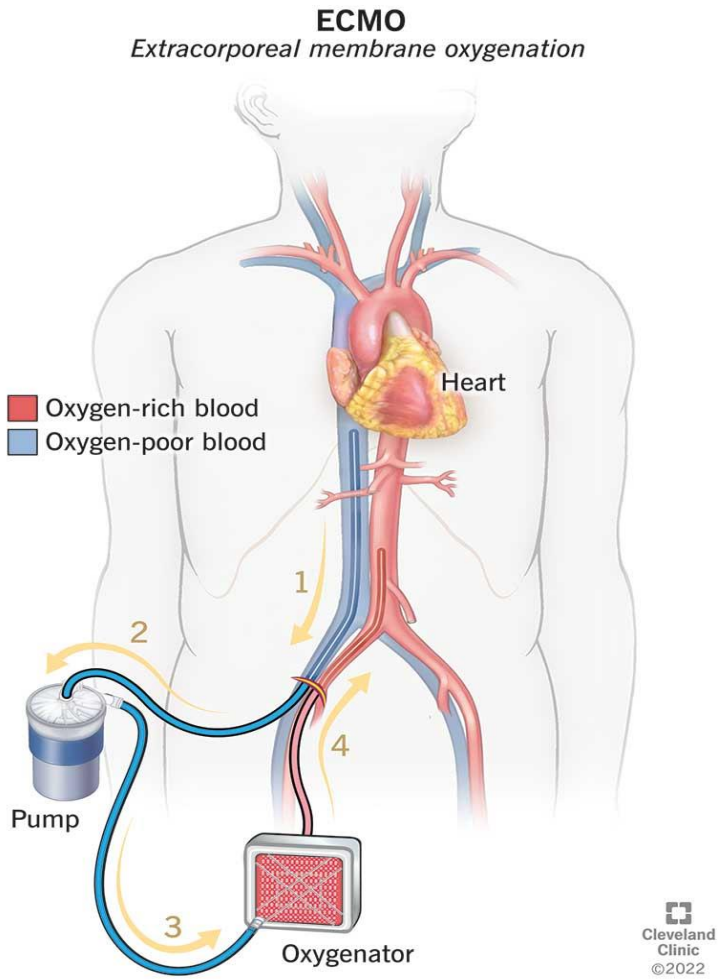
Connections

- Ensure ***power cord*** in
- Ensure A/C indicator light is on
- Ensure pump head drive ***line*** attached to drive ***console***
- ***Hand crank*** must be sited on the trolley
- The pump is set using a ***mechanical arm***.
- The pump head should be sited slightly higher than the oxygenator with the pump outlet positioning down (6'O clock)
- Pump head inlet – 30 degree facing upwards
- ***Oxygenator*** should be lower than patient in order to prevent depriming of circuit in case of pump failure

Types of ECMO

V-A ECMO:

- V –A or Veno– arterial ECMO, supports both heart and lungs function.
- The surgeon places two cannulae, one in large vein and one in a large artery so that blood can be taken out of vein and returned into artery.



Types of ECMO

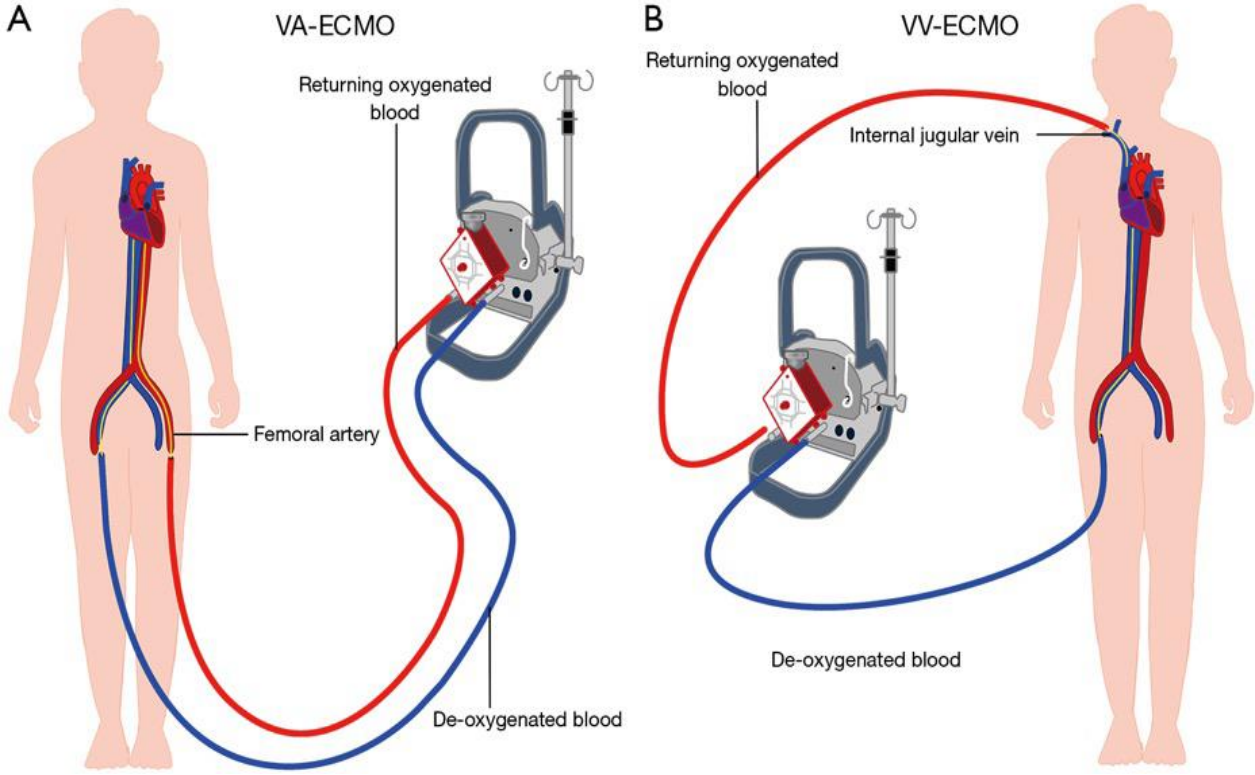
V –V ECMO:

- V –V or Veno– venous ECMO, supports lung function primarily.
- Surgeon places the cannulae in the large vein only.

Central cannulation for V-A ECMO:

- It is used for neonates and small children.

- Central cannulation is through an open chest with cannulae directly placed into the arch and right atrium.



Cannulation & Method

- Blood flow in the ECMO circuit is dependent on the size of the cannula.
- A shorter cannula with a ***greater internal diameter*** will provide ***higher flows*** through the ECMO circuit.

Cannulas can be placed via:

Cut down – cut down cannulation of the neck vessel is usually necessary in neonates and children

Percutaneous cannulation (Seldinger Technique) – used for VV ECMO in children over age two and in adults

Direct cardiac cannulation – used for patients who cannot come off CPB in the OR, using the CPB cannulas

Cannulation & Method

Three ways of accessing the major vessels for ECMO

Surgical central cannulation:

- Connecting an arterial cannula or Dacron graft to major vessels of thorax

- If cannula is connected directly to the aorta, the chest is usually left opened or closed by tunnelling the cannula like ICD tube

Surgical peripheral cannulation:

- It involves placing the cannulas in femoral vessels via cut down

- Dacron graft to right subclavian artery is used when no alternative is available to maintain perfusion to distal femoral artery.

ACT & Targeted Cannula Site

- A bolus of Heparin – ***50 to 100 units per kilogram***
- Given just prior to cannula placement
- Heparinization is to be done even the patient is coagulopathy and bleeding
- ACT of ***180 seconds – 220 seconds***

Targeted vessels:

VA – Central ECMO = RA to AORTA

VA – Peripheral ECMO = FV to FA

VA – Peripheral ECMO = FV to Axillary artery

VV – Peripheral ECMO = FV to IJV

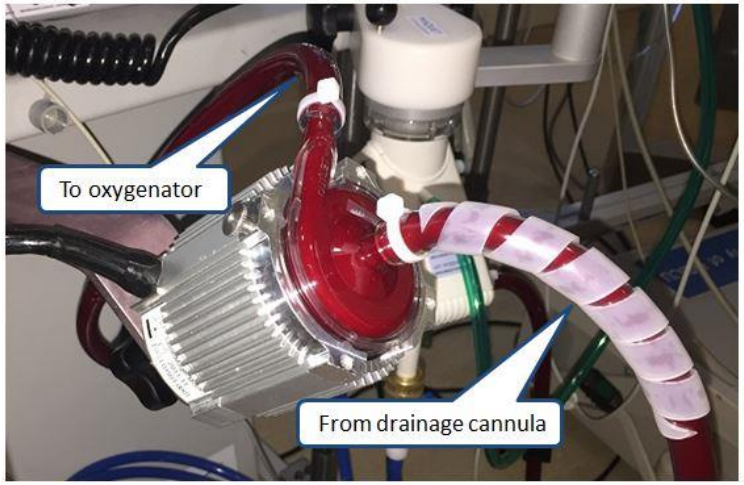
Cannulation sites varies with hemodynamic stability of patient, time of initiation whether its pre, intra, post op period.

CENTRIFUGAL PUMPS

- ***Centrifugal pumps*** – These utilize the spinning action of cones to create a constrained vortex, sucking blood into the pump head and expelling it from its outer edge.

- Centrifugal pumps must be used with venous line pressure monitoring to prevent excessive negative pressure and hemolysis.

- CentriMag (Levitronix), RotaFlow (Maquet) and BioConsole 550 (Medtronic Perfusion) are examples of centrifugal pumps commonly used for ECMO.



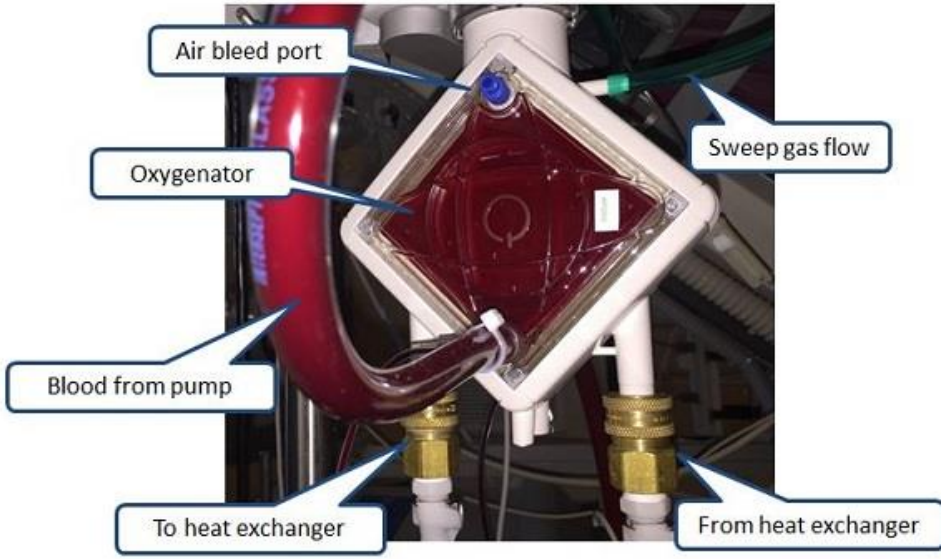
OXYGENATOR

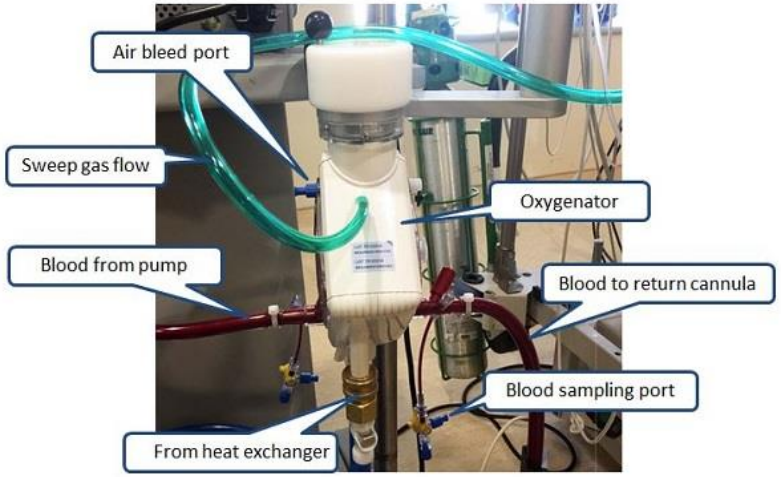
- These are more correctly termed ***"membrane lungs"*** as their function is gas exchange.
- Three types of oxygenators are commonly used:

silicone spiral coil oxygenators; polypropylene oxygenators; and poly-methyl pentene (PMP) oxygenators.

- The original silicone spiral coil oxygenator (Medtronic) has been largely superseded by PMP hollow fiber oxygenators (Medos, Maquet & Dideco).

- They have a lower resistance, lower priming volume and are more biocompatible.





HEAT EXCHANGER

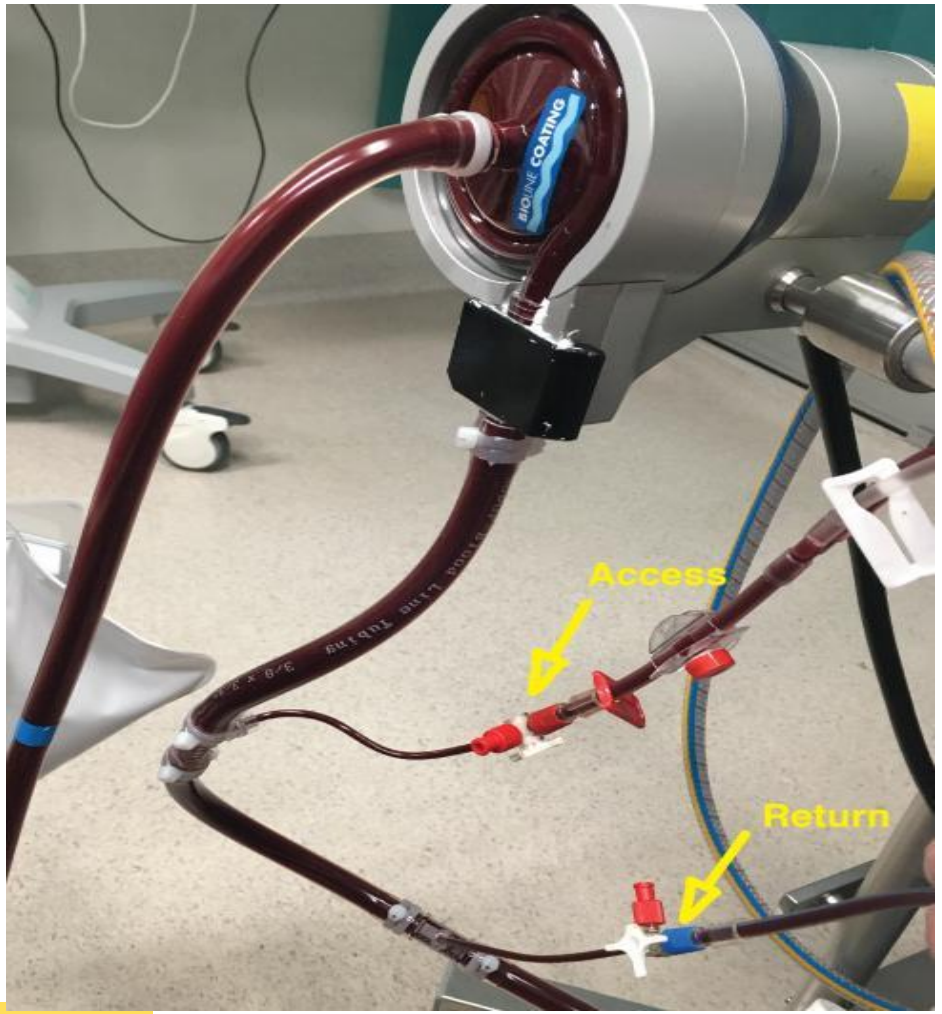
- This warms the blood before it is returned to the heart, thus allowing patient temperature regulation through the ECMO circuit.

- Most adult oxygenators have an integral heat exchanger.

BRIDGE

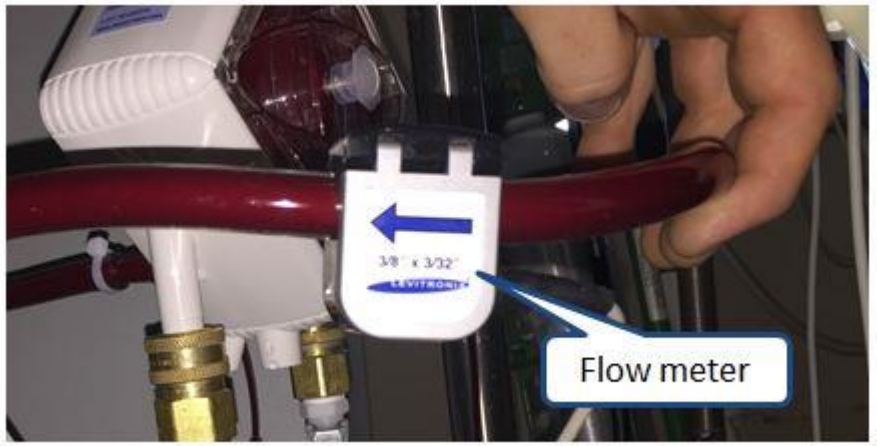
- This is a connecting channel between the arterial and venous limbs of the circuit.

- It is used as a bypass when it is necessary to isolate the patient from the circuit, i.e., blood can be re-circulated within the ECMO circuit in order to prevent stagnation and coagulation.



MONITORING AND SAFETY DEVICES

- ***Ultrasonic flow*** measurement devices are placed around the ECMO circuit tubing and ***alarm limits*** are set to warn of low or high flows.



- Drainage ***line pressure monitors*** are used to measure pressure in the venous draining cannula, which is usually negative. When the line pressure becomes very negative (i.e., more than –70 mmHg in an adult), it can cause a non-wire wound cannula to collapse and cause hemolysis.

- ***Blood gas analysis*** may be performed either by in-line monitoring or by intermittent sampling

Thank you

References:

ECMO Manual – Narayana Institute of Medical Sciences

https://ecmo.icu/daily-care-nursing-routine-crrt-and-plasmapheresis-connection/

http://icuecmo.ca/icuECMO_content/icuECMO_ECMO_circuit.html