ECMO ESSENTIALS

PART 1: INDICATIONS AND INITIATION

Clinical indications for ECMO support

What is ECMO

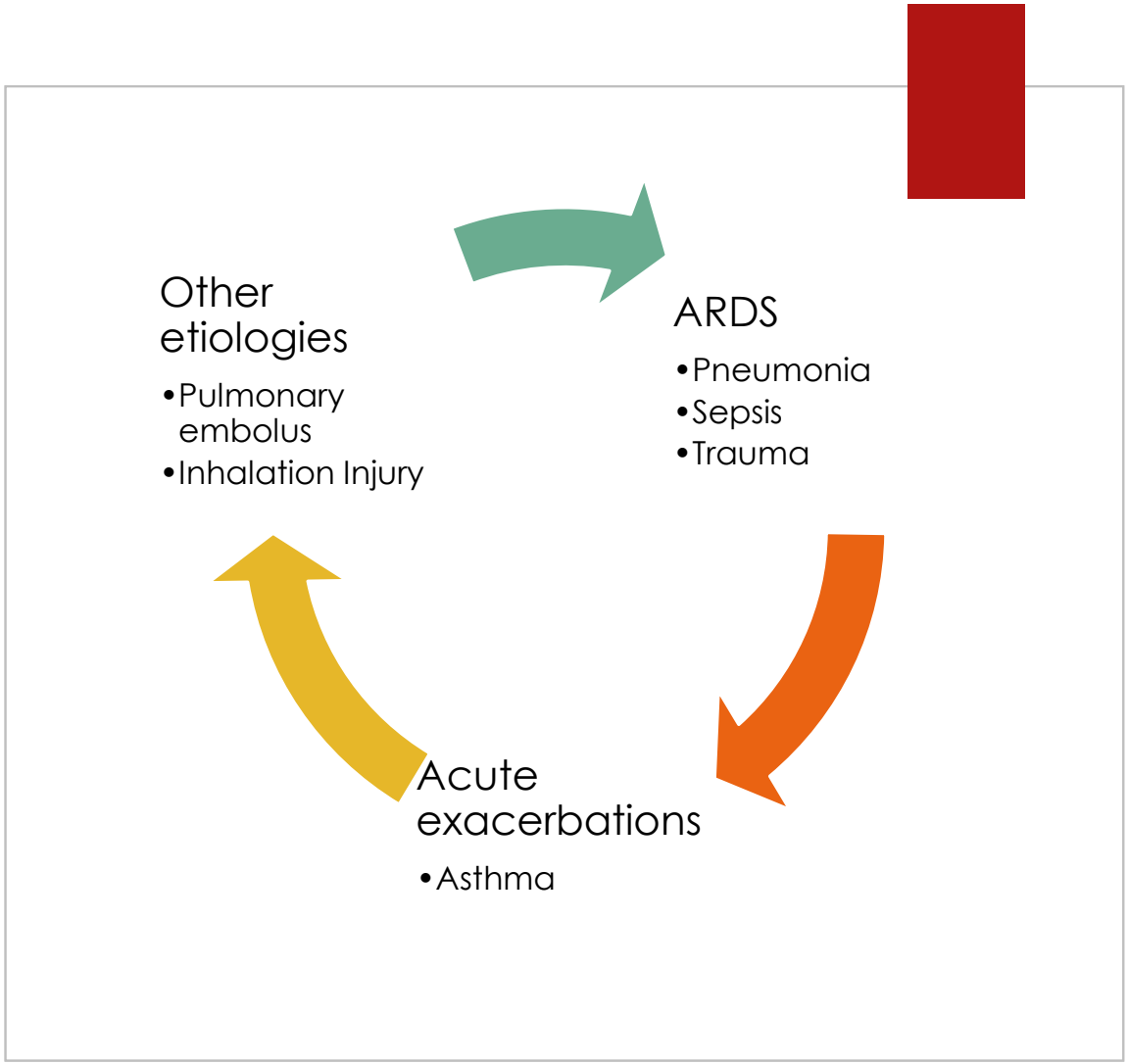
The use of a modified cardiopulmonary bypass circuit for temporary life support for patients with potentially reversible cardiac and/or respiratory failure (ELSO, 2018)

Provides a mechanism for gas exchange as well as cardiac support thereby allowing for recovery from existing lung and/or cardiac disease

Veno-Venous ECMO

- V-V ECMO is indicated for severe, reversible respiratory failure refractory to optimal medical management, including lung-protective ventilation and prone positioning.
- The main objective is to provide gas exchange while allowing injurious mechanical ventilation to be minimized to promote lung rest and recovery.

Common etiologies



Veno-Venous (VV) ECMO Indications:

Severe ARDS: PaO2/FiO2 ratio < 80 mmHg despite optimization.

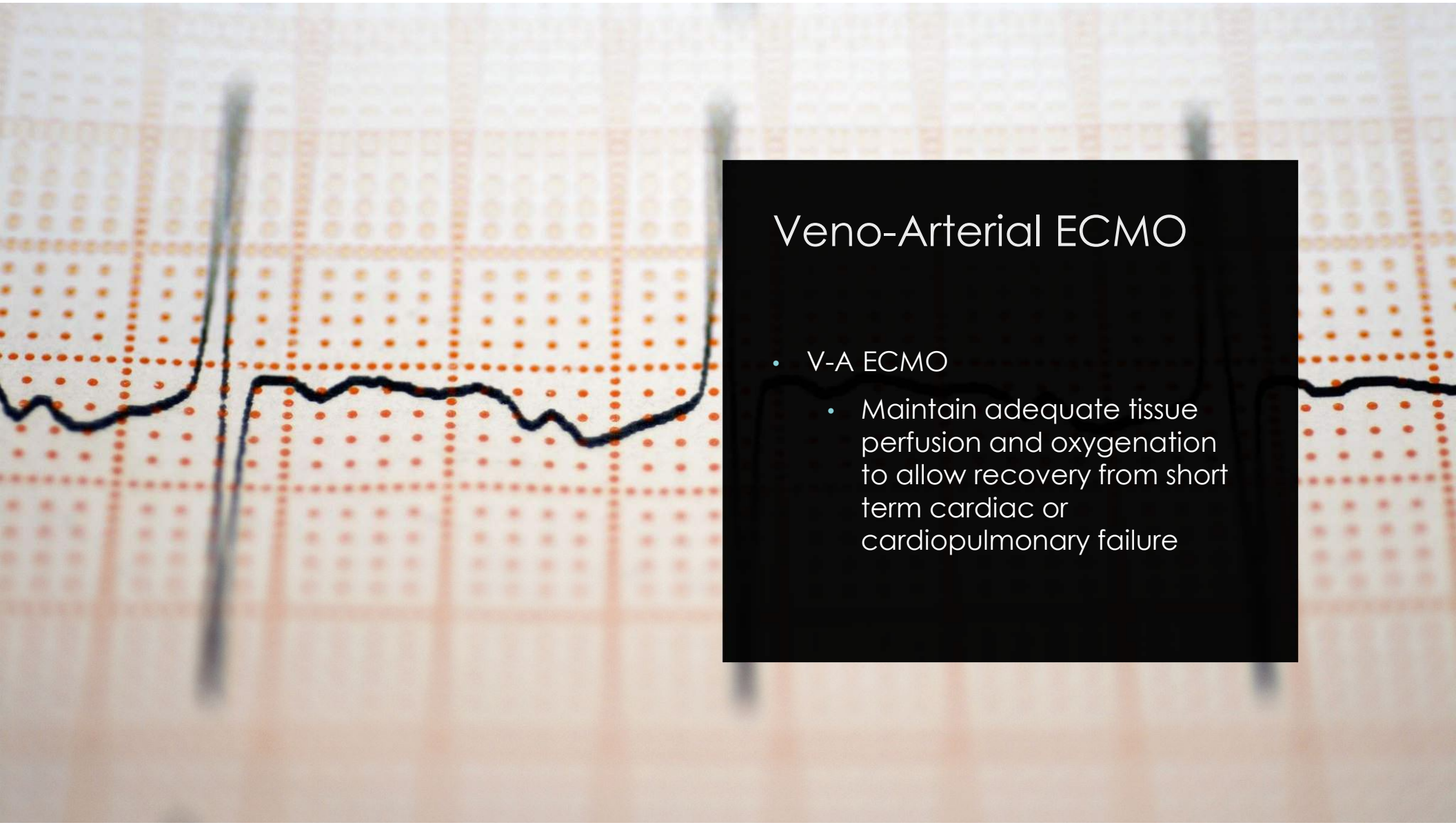
Hypercapnic respiratory failure: Severe respiratory acidosis with arterial pH < 7.25.

Refractory hypoxemia: Inability to maintain safe oxygen saturation on a ventilator.

Barotrauma prevention: High ventilator pressure threatening lung tissue.

Bridge to Recovery: Buying critical time for organs to heal.

Bridge to transplant: Lung failure patients awaiting available donor organs.



Veno-Arterial ECMO

- V-A ECMO
  - Maintain adequate tissue perfusion and oxygenation to allow recovery from short term cardiac or cardiopulmonary failure

Veno-Arterial (V-A) ECMO: Etiologies and Indications

Cardiogenic shock: Refractory to fluids, inotropes, and intra-aortic balloon pumps.

Post-cardiotomy shock: Inability to wean from cardiopulmonary bypass after surgery.

ECPR: Extracorporeal cardiopulmonary resuscitation during active cardiac arrest.

Acute myocarditis: Severe, reversible heart inflammation causing profound pump failure.

Bridge to device: Stabilization before ventricular assist device (VAD) implantation.

Bridge to recovery: Buying critical time for organs to heal.

System Differentiation:

V-V ECMO

Vs.

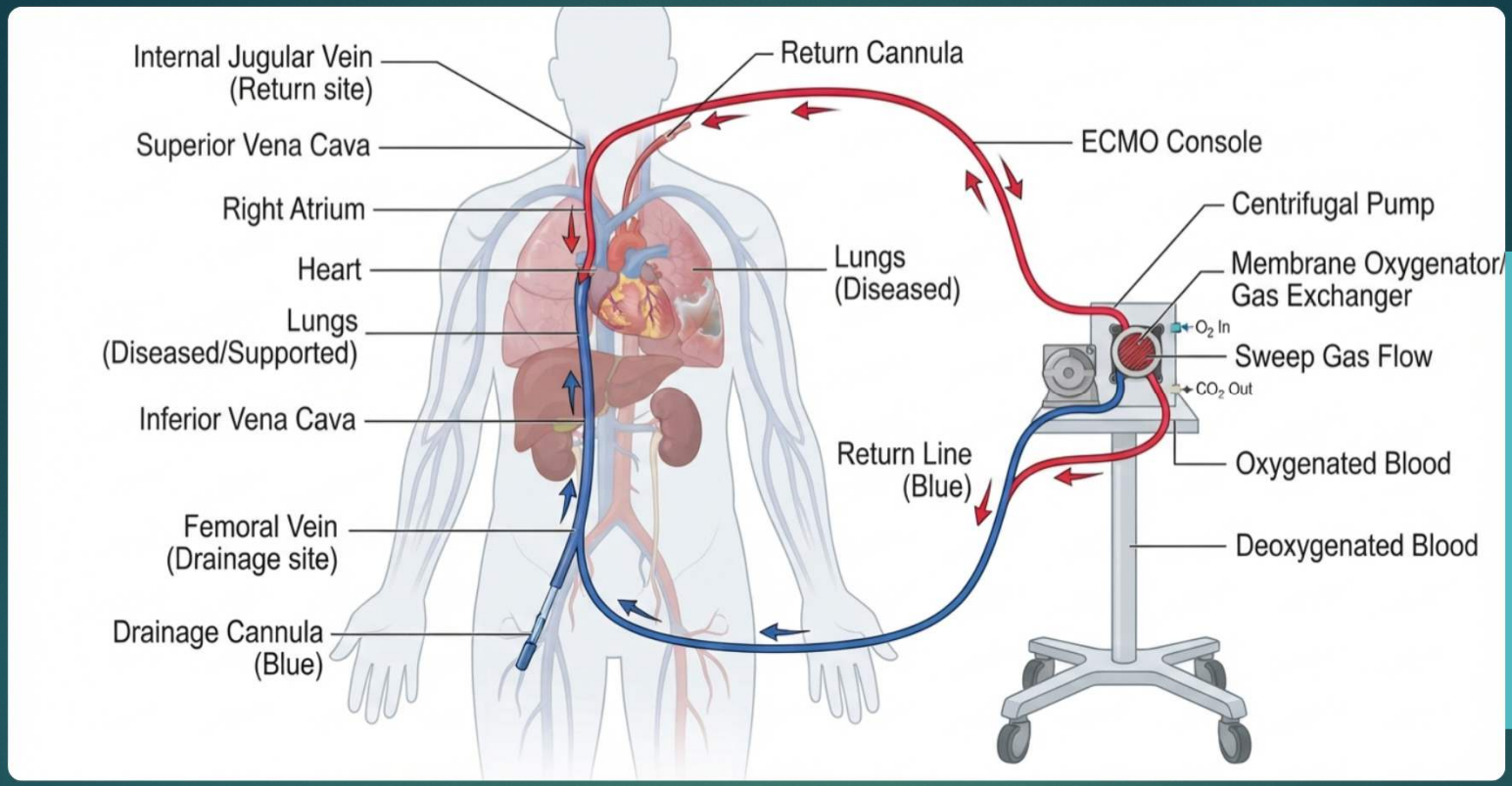
V-A ECMO

Patient Needs & Support Goals

- VV Goal: Gas exchange only (oxygenation and carbon dioxide clearance).
- VV Cardiac: Requires adequate, independent native cardiac output to function.
- VA Goal: Full hemodynamic support plus respiratory gas exchange support.
- VA Cardiac: Bypasses the heart pump to maintain systemic tissue perfusion.

Cannulation Approach

- VV Drainage: Blood taken from the vena cava or right atrium.
- VV Return: Blood returned to the right atrium via the internal jugular.
- VV Dual-Lumen: Single cannula placed in the right internal jugular vein.
- VA Drainage: Blood taken from the venous system (e.g., femoral vein).
- VA Return: Blood returned directly into a central or peripheral artery.
- VA Peripheral: Frequently utilizes the femoral artery and femoral vein sites.
- VA Central: Cannulation directly into the ascending aorta and right atrium.

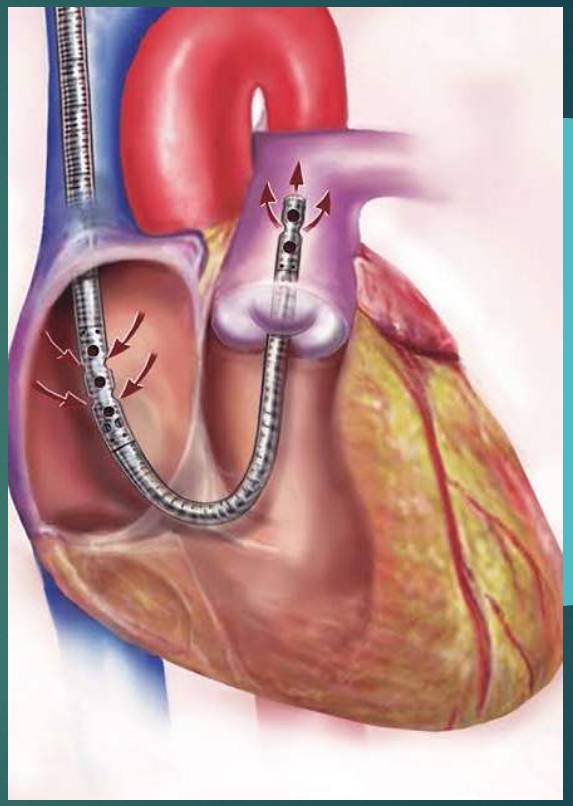


V-V ECMO Cannulation

Blood path from patient to circuit and back to patient

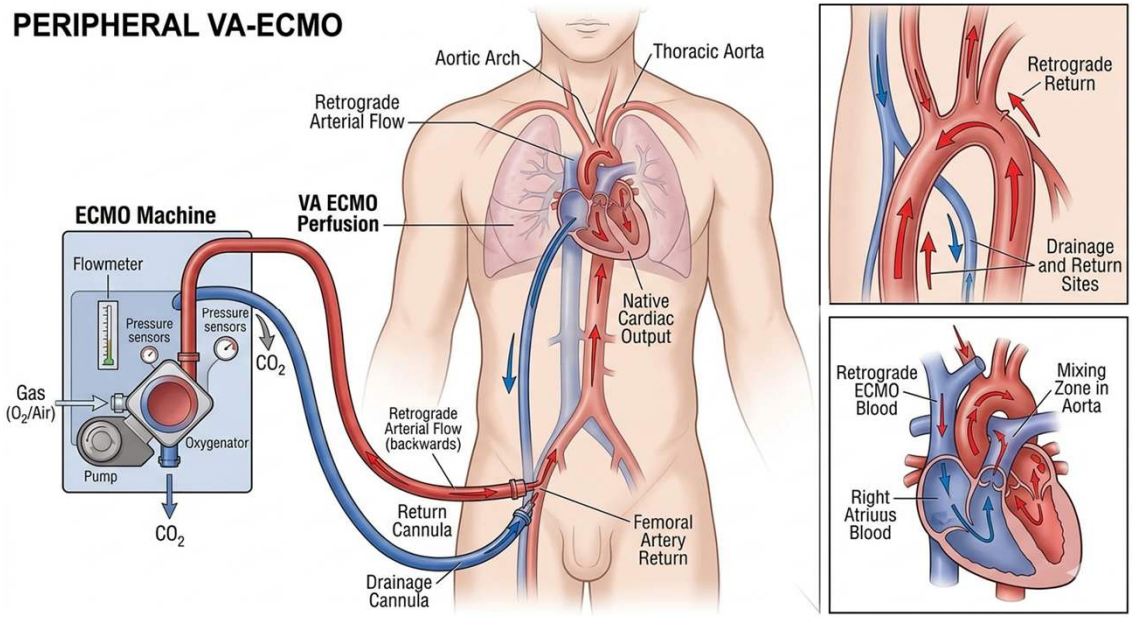
V-V Cannulation approach

Double lumen cannulation



V-A ECMO Cannulation

- V-A Peripheral Cannulation
- Blood path from patient to circuit and return to patient



Key Anatomical and Circuit Components of VA ECMO

- **Venous Drainage Cannula (Blue Line):** Inserted into a major venous access point (most commonly the **femoral vein**), this cannula is advanced up into the inferior vena cava (IVC) or right atrium. It drains oxygen-depleted blood from the body's systemic venous return.
- **The ECMO Console:** The drained venous blood enters the mechanical circuit, where a **centrifugal pump** drives the flow and passes it through a **membrane oxygenator**. This acts as an artificial lung, infusing the blood with oxygen (O_2) and sweeping away carbon dioxide (CO_2).
- **Arterial Return Cannula (Red Line):** Freshly oxygenated blood is actively pumped back into the patient's systemic circulation via an arterial entry site, typically the **femoral artery**.
- **Retrograde Flow Dynamics:** Because blood enters through a peripheral artery in the leg, the oxygenated pump flow travels **retrograde (backward)** up the descending aorta and aortic arch. This retrograde push generates a reliable, continuous systemic perfusion pressure that temporarily unburdens a failing heart or non-functional lungs.

Clinical features and differences between V-A and V-V

V-A

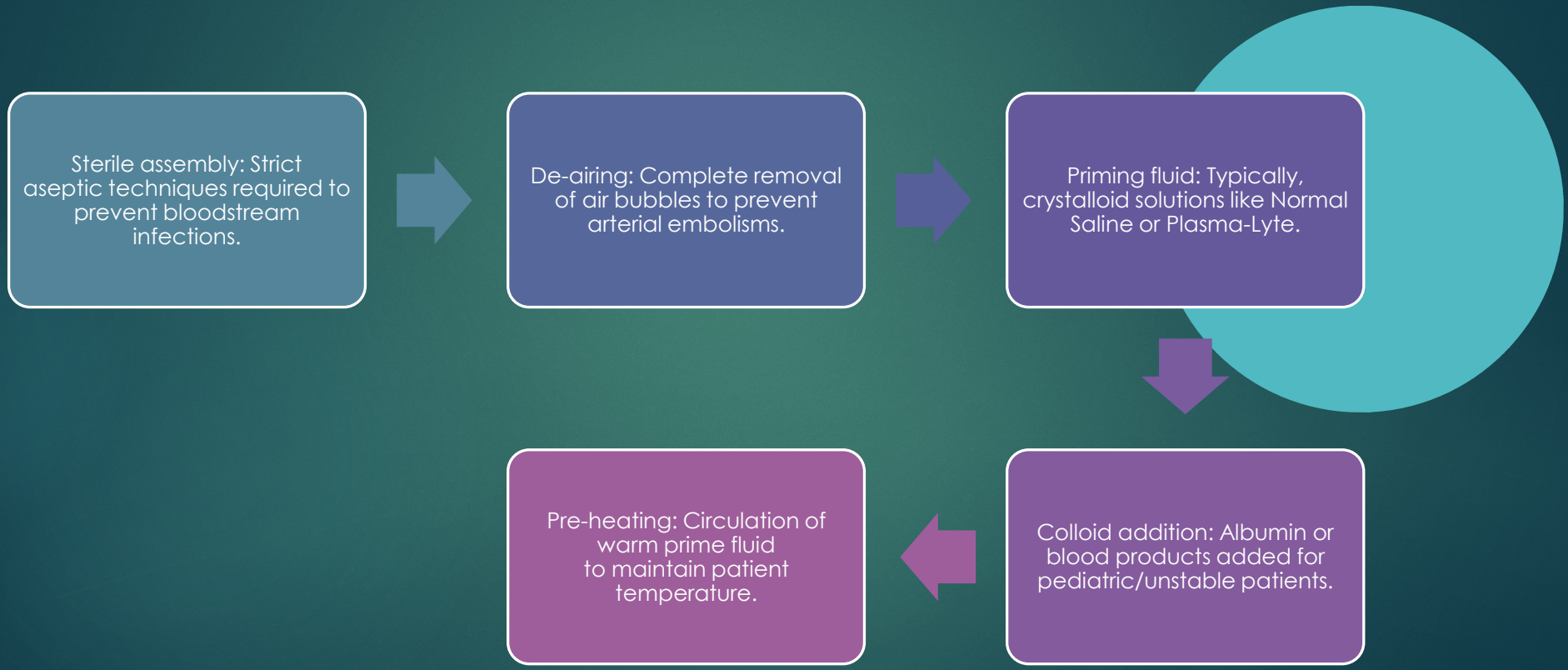
- Systemic Hemodynamics: Directly generates arterial blood pressure and provides mechanical circulatory support
- Circuit arrangement: Arranged in parallel with the patient's native cardiopulmonary system
- Drainage site: Large central vein (e.g., Femoral vein or Right Atrium)
- Return Site: Systemic artery (e.g., Femoral artery or Ascending Aorta)

V-V

- Systemic Hemodynamics: Does not generate arterial blood pressure or alter native cardiac output
- Circuit arrangement: Arranged in series with the patient's native cardiopulmonary system
- Drainage site: Large central vein (e.g., Femoral vein or Internal Jugular vein)
- Return site: Large central vein (e.g., Internal Jugular vein or Femoral vein)

Circuit Preparation, Priming, and Initiation

Circuit Preparation and Priming



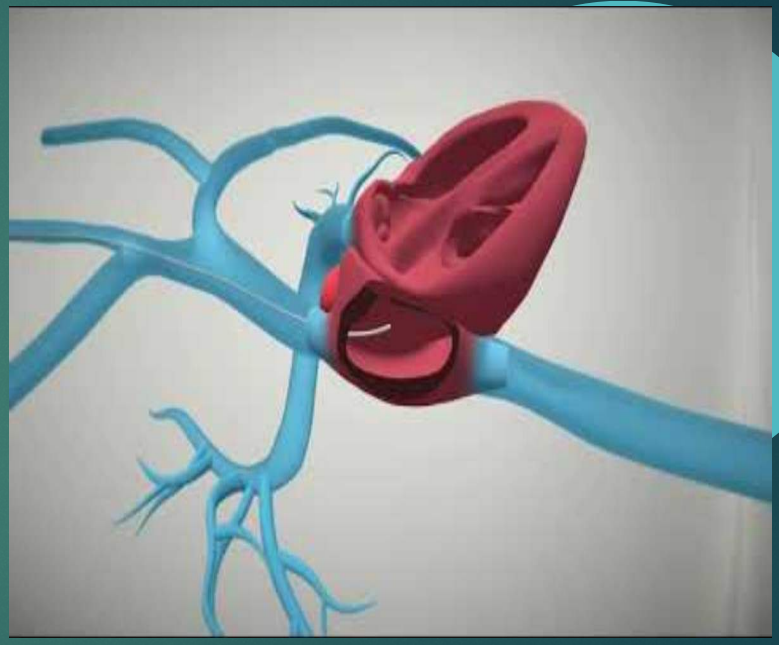
Initiation

- Anticoagulation: Intravenous heparin bolus administered prior to inserting large cannulas.
- Vessel dilation: Progressive dilation over a guidewire using the Seldinger technique.
- Image guidance: Fluoroscopy or echocardiography used to confirm accurate tip placement. Required during cannulation of double-lumen cannula such as Crescent or Protek Duo

Dilation process

The Serial Dilation Process

- Vessel Access: An introducer needle punctures the target vessel (typically the internal jugular or femoral vein), and a rigid guidewire is advanced into the bloodstream.
- Stepwise Upsizing: The clinical team passes a series of graduated Vascular Dilator Kits over the wire, starting at roughly 12 French (Fr) and advancing up to 28 Fr or larger.
- Tract Preparation: Each dilator creates a temporarily wider tract through the skin, subcutaneous tissue, and the actual vessel wall.
- Cannula Seating: Once the tract is expanded to the necessary diameter, the large-bore ECMO cannula can glide safely through the stretched vessel opening without tearing the surrounding tissue



Crucial Clinical Risks

- Vessel Laceration: Forcing a dilator forward without perfect guidewire alignment can kink the wire and puncture the back wall of the vessel, causing severe retroperitoneal or deep tissue bleeding.
- Loss of Wire: Accidentally removing the guidewire during dilator exchanges can lose the tract completely, requiring a brand new puncture and risking hematoma formation. [
- Air Embolism: Because massive venous tracts are held wide open during exchange steps, negative intrathoracic pressure (especially if a patient takes a deep breath) can draw large air bubbles directly into the central circulation

Initiation of ECMO

- Circuit checks: Confirming lines are free of kinks before starting rotation.
- RPM ramp: Slow increase in pump speed while monitoring line chattering.
- Gas sweep: Initiating gas flow through the oxygenator once blood flow stabilizes.