ECMO in Adults: Indications, Types, and Complications
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Introduction
Definition
ECMO refers to the life support system utilized in cardiopulmonary failure for gas exchange: remove carbon dioxide from the blood stream while repleting oxygen.

History
1950s: First clinical attempts at extracorporeal life support (unsuccessful beyond several hours as direct exposure of blood to oxygen lead to life threatening coagulopathy, hemolysis, and multi-organ failure).
1957: Kammermeyer invented the silicone membrane to aid in oxygenation without directly exposing blood to oxygen.
1972: First successful human use of ECMO
1980-2000: Silicone membrane or polypropylene hollow fiber oxygenators
2009: CEASR study recommends ECMO based management for severe but potentially reversible respiratory failure

Indications for ECMO
Life threatening but reversible Respiratory Failure
CESAR Trial used a Murray score of >3 (PaO2/FiO2 ratio, PEEP, dynamic lung Compliance, no. of quadrants infiltrated on Radiographs)

Contraindications to ECMO
Relative:
1. High Pressure Ventilation
2. High FiO2
3. Limited Vascular access
4. Organ Dysfunction that would limit benefit: metastasis, irreversible brain injury

Absolute:
• Preexisting condition precluding use of anticoagulation
**Imaging Modality Uses Key Characteristic**

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<th>Imaging Modality</th>
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<td><strong>Plain Radiograph</strong></td>
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<td>- Frequent evaluation of cannula positioning</td>
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<td>- Pleural disease such as pneumothorax and hemothorax</td>
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<td>- Parenchymal disease such as ARDS and pneumonia</td>
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<td>- Evaluation of quadrants for Murray scoring</td>
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<td><strong>Intravascular Ultrasonography</strong></td>
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<td>- During initial placement of ECMO cannulas to ensure appropriate positioning</td>
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<td><strong>Ultrasound +/- Doppler</strong></td>
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<td>- Arterial waveforms for partial or complete occlusion</td>
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<td>- Deep Venous Thrombosis</td>
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<td>- Hematomas at cannulation site</td>
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<td><strong>CT</strong></td>
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<td>- Pulmonary/Abdominal infection</td>
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<td>- Aortic stasis thrombus</td>
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**VV ECMO Cannulas**

- **Recirculation**: Shunting of arterial blood back into the venous lumen, 20% to 50%

**Mediastinal VA ECMO**

Illustration and frontal radiograph showing the arterial return cannula ( ) within the aorta and the venous return cannula ( ) within the right atrium. Central VA ECMO is used when there is failure to wean from cardiopulmonary bypass immediately after cardiac surgery.

**Peripheral VA ECMO**

Illustration and frontal abdomen radiograph demonstrating peripheral insertion of ECMO cannulas with a femoral arterial return cannula ( ) and a femoral venous drainage cannula ( ).

**Mediastinal VA ECMO with LV Drain**

Frontal radiograph and CT images showing an aortic return cannula ( ), venous drainage cannula ( ), and a left ventricular drain ( ). The LV drain is used for decompression after myocardial injury. Sagittal images from a noncontrast CT better demonstrate the aortic cannula, venous cannula, and LV drain.
Cannula insertion site hematoma

44 year old male with central VA ECMO. Mediastinal hematoma (→) tracking along the arterial cannula with the tip in the aortic arch (●). The left femoral artery and vein are the insertion sites for this patient on peripheral VA ECMO. A small hematoma (→) is present at the insertion site.

Imaging considerations: Pulmonary Embolism

Because of near total cardiopulmonary bypass, it is very difficult to image patients on ECMO for pulmonary embolism using standard protocols.

For example, in this 50 year old male with cardiogenic shock status post coronary bypass, multiple attempts were made to evaluate for PE using bolus tracking.

Peripheral VA ECMO
Arterial (←) and venous (→) cannulas

Initial attempts with bolus tracking

Multiple attempts were made at evaluating the pulmonary arteries using bolus tracking with the results as seen to the right.

There is insufficient opacification of the pulmonary circulation secondary to siphoning by ECMO.

The main pulmonary artery measures 70 Hounsfield units.

Pulmonary embolus visible after disabling ECMO

The ECMO circuit was put on minimal flow status for a short period (35 seconds) to allow for near physiologic circulation.

CT subsequently demonstrates a large central pulmonary embolism.

Arterial Stasis Thrombus: Aorta

The ECMO circuit was put on minimal flow status for a short period (35 seconds) to allow for near physiologic circulation.

CT subsequently demonstrates a large central pulmonary embolism.
THANKS!