ECMO TROUBLESHOOTING by Nick Mark MD & Jonah Rubin MD

onepagericu.com
@nickmmark
@JonahRubinMD

Link to the most current version →

CIRCUIT PROBLEMS

CANNULA DISPLACEMENT compromises the circuit and can cause an air embolism, major bleed, and reduced blood flows. Follow **ECMO emergency protocol** ⚠ and consider massive transfusion.

CIRCUIT THROMBOSIS: Clots in the tubing can increase flow resistance. Clots in oxygenator may also impair gas exchange. Acutely or over time, this may lead to **OXYGENATOR FAILURE.** Anticoagulation may prevent clot formation.

CHATTER is visible shaking of the tubing from variable venous drainage when the pump is trying to drain more than what native venous return allows. Pump may repeatedly start/stop causing **CUT OUTS. Options**: Reduce RPM, administer fluids, assess cannula positioning

AIR EMBOLISM can cause immediate pump, oxygenator, or circuit failure. Follow **ECMO emergency protocol** ⚠ and place head down. Locate source to prevent further entrainment. If venous source, may place in left lateral position and aspirate from drainage cannula

50cc syringes can be used to remove air from the circuit
Clamps are used emergently to stop blood flow

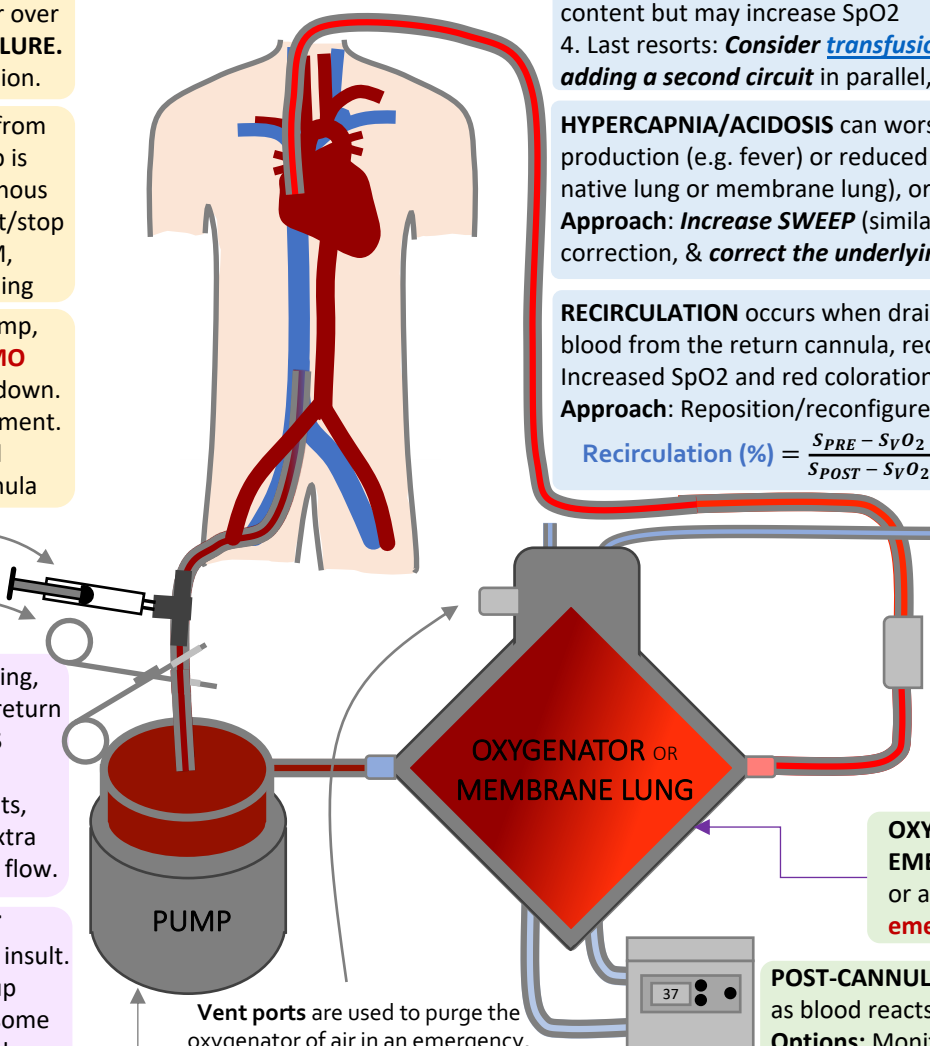
PUMP PROBLEMS

INADEQUATE FLOW can occur from kinking, cannula malposition, decreased venous return (± **CHATTER**), and **CIRCUIT THROMBOSIS** (same RPM yielding less LPM flow).
Approach: ***Treat the cause***! Some patients, especially with high BMI, may need an extra venous drainage cannula to achieve goal flow.

PUMP FAILURE may occur from **CIRCUIT THROMBOSIS, AIR EMBOLISM,** or other insult. Follow **emergency protocol** ⚠ . A backup pump should be readily available. With some ECMO products, a mechanical crank can be used temporarily until a new pump is available.

ECMO EMERGENCY PROTOCOL ⚠

Team should train/practice & have necessary supplies at bedside
- Clamp drainage & return lines
- Call for help
- Return to pre-ECMO vent settings
- Exchange of oxygenator or entire circuit may be needed



Vent ports are used to purge the oxygenator of air in an emergency. Tilt & open vent to purge.

GAS EXCHANGE PROBLEMS

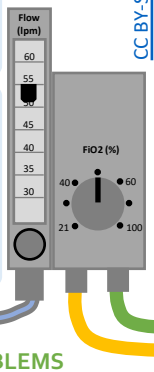
HYPOXEMIA is common as oxygenated blood always mixes with deoxygenated native circulation, although this may not reflect insufficient oxygen delivery. A low SpO2 may be tolerable, however SpO2 < 85% may be critical.
Options:
1. ***Increase flow*** – may be limited by **CHATTER,** diminishing returns if flow >7LPM
2. ***Increase F_DO_2*** – diminishing returns when post-oxygenator SpO2 is ~100%
3. ***Reduce native cardiac output*** (e.g. beta-blocker) – does not change oxygen content but may increase SpO2
4. Last resorts: ***Consider*** ***transfusions*** to increase CaO2 (given shunt physiology), ***adding a second circuit*** in parallel, or ***recruiting native lung*** with ventilator

HYPERCAPNIA/ACIDOSIS can worsen with increased CO2 production (e.g. fever) or reduced clearance (worsening function of native lung or membrane lung), or impaired renal compensation.
Approach: ***Increase SWEEP*** (similar to minute ventilation) for acute correction, & ***correct the underlying cause*** (fever control, RRT, etc.)

RECIRCULATION occurs when drainage cannula draws oxygenated blood from the return cannula, reducing the efficiency of the circuit. Increased SpO2 and red coloration of venous drainage may be noted.
Approach: Reposition/reconfigure cannulas, reduce flow (if tolerable)

$$\text{Recirculation (\%)} = \frac{S_{PRE} - S_VO_2}{S_{POST} - S_VO_2} \times 100$$

"Normal" recirculation is up to ~25%)



MEMBRANE/OXYGENATOR PROBLEMS

RISING TRANSMEMBRANE PRESSURE: At constant flow, this indicates worsening resistance (usually thrombosis) & therefore worsening function, of the oxygenator. Check a post-membrane ABG to assess oxygenation. Ultimately may require oxygenator exchange.

OXYGENATOR FAILURE may occur from **AIR EMBOLISM, CIRCUIT THROMBOSIS** (most common), or any serious mechanical insult. Follow the ECMO **emergency protocol** ⚠ to ***exchange oxygenator***.

POST-CANNULATION SYNDROME is a SIRS-like inflammation as blood reacts to the oxygenator at 24-48 hrs of initiation.
Options: Monitor, consider steroids, in cases with vasoplegia requiring high dose pressors consider methylene blue