**Management of ECMO the first 24 hours**

**Lines:**
1)Pulmonary artery catheter
2)Right Radial arterial line
3) Foley catheter
4) additional lines prn
**ECMO cannulas**- 16 French Edwards percutaneous Fem Flex into common femoral artery and 21 French Medtronic percutaneous venous into common femoral vein. Both over micro-puncture access, wire and subsequent dilators.
**ECMO cannula placement** on opposite legs **if not** then must have arterial retrograde perfusion of the cannulated lower extremity 5 fr to 8 fr
**Mechanical ventilation** must be optimized at 7-10 L/ kg per minute with a mode a ventilation of SIMV with a rate of 10 and hundred percent fractional concentration of oxygen and a peak end expiratory pressure (PEEP) of five. Adjust Vt to keep Peak airway pressure < 40 mmHg.
**ECMO settings (initial) oxygen concentration and sweep** on the ECMO circuit should be 1.0. The **sweep** flow should be 6 L per minute or greater
**ECMO flows** slowly (over several minutes) titrate the flows up from 2 L/min to greater than 4 L/min. The more flow the better while watching for suction events/extreme cavitation. Flows can be improved as pH corrects, pressors are weaned and the patient is stabilized—volume should not be needed –if so think cannula malposition, vessel perforation ( i.e. bleeding) or volume entrapment of Left side of the heart (need emergent left sided decompression)
**Arterial blood gas** must be drawn from right radial a-line—if unable to do so contact surgeon. ABG's attained every hour x 3 then every 3 hours x 3 and then reevaluate.
**Complete blood counts** should be obtained every three hours unless active bleeding then more frequently
**Blood pressure goals** mean arterial pressure (MAP) 70-110 mmHg
**Contractility/Inotrope agents** should be weaned aggressively too off
**Pressers** should be weaned aggressively to maintain MAP > than 70 mmHg
**Chest x-ray** obtained immediately post cannulation and each day
**Urine output goal** > than 0.5 mL's /kilogram /hour → if not then call
ECMO lines **should have "**chatter" **should not** be "jumping rope"
**Prophylactic antibiotics** with vancomycin low dose i.e. no more than 750 mg iv bid and maybe less depending on baseline Cr; add cefepime for 3 days due to emergent intubation and subsequent risk of aspiration.
**Anticoagulation:** no heparin until assured Hct is stable x 2; Hct 3 hours apart; once Hct stable initiate heparin at 500 units/hr –no titration except on a daily basis on ICU rounds or surgeon request. Titrate anticoagulation to PTT only and limit it to 1x/day unless clinical instability.
**How do you measure success?** MAP > 70 with diminishing pressor requirement; urine > .5cc/kg/hr; PAO2 > 70; pH> 7.35 **(all criteria must be met)**

**Management of ECMO related challenges**

**Pulmonary Edema** (require immediate left sided cardiac decompression procedure: rashkind ASD, Impella (CP percutaneous or subclavian 5.0 surgical), or surgical central addition of left sided drainage cannula Y'd into system (in that order)

**Hypoxia**- due to inadequate drainage i.e. pulmonary edema? Inadequate ECMO flow or oxygenation? Non-functioning native lungs requiring more mechanical vent support?
If O2 < 70 check ECMO flows (goal is greater than 4 L/min? If not why not?) Consider manipulating mechanical ventilator as we need to optimize oxygenation through native anatomy—ie Increase FiO2, increase Vt, increase PEEP, paralyze (in that order) recheck ABGs every 30 minutes until stable PAO2 > 70.

**Hyperoxemia** If O2 > 110 wean vent FiO2 by an appropriate amount and recheck in 30 min by ABG; repeat until FiO2 on vent at 40%. Do not wean ECMO oxygen concentration or flows for this w/o consultation.

**Hypercarbia**- usu due to inadequate sweep on ECMO if isolated finding. If CO2 > 40 increase sweep by double and recheck ABG in 30 min. Otherwise usu dealing with hypoxima or hypotension or both **before this**

**Hypocarbia/Alkalosis** NOT really a problem but if pH > 7.5 and CO2 < 30 decrease sweep by 50%. **Do not** decrease mechanical ventilator minute ventilation unless ECMO flow < 1 with pH > 5.o and CO2 < 30 then it's time to wean ECMO and maybe the ventilator (it depends)

**Bleeding** (cannula site, airway, GI, retroperitoneal): if bleeding requiring transfusion – stop anticoagulation and consider hard reverse with blood factors (this last step depends on severity); if cannula site place purse string sutures; if GI bleeding reverse anticoagulation and give blood factors and scope emergently; if retroperitoneal may need to de-cannulate --if still requiring ECMO then place cannulas centrally. It is poor form to bleed to death in a hospital and once bleeding starts it is very hard to stop as a DIC pathway is initiated (for reasons we do not fully understand).

**Sudden low flow (no flow)** notify surgeon; air embolism to circuit???? Purge through stopcock and restart—this can happen from the normal air management of venous lines. If clot then replace circuit either with existing cannulas or take to OR for emergent central cannulation—if you have to do CPR consider discontinuation of all lifesaving therapies.

**"jumping rope" with intermittent low flow** this is a volume challenge; wean pressor; give blood to maintain Hct > 30; consider failing LV with engorgement of volume (this usu presents as hemoptysis/pulmonary edema and requires left sided decompression (see Pulmonary edema above)

**Hypotension** rule out the usual suspects- hypoxia, volume, bleeding once these ruled out the most common cause especially in the early phase of care is vasodilation—1 gm CaCl iv; vasopressin at 0.4 u/min; levophed NEVER more than 10 mg/min w/o notifying surgeon

**Hypertension** sedation/agitation? Wean pressors NOT inotropes; if stuck then consider Milrinone vs SNP

**Ischemic leg** verify leg is ischemic; loss of pulses by Doppler can be a technical/equipment error of due to no pluses with continuous flow. Understand what a truly ischemic leg looks like (cold, white, no cap refill); Assuming ischemic requires retrograde perfusion immediately with a 5-8 french catheter t'd of the arterial inflow cannula. Then call vascular surgery for fasciotomy consult (ASAP). If leg still ischemic or retrograde catheter is in place call Vascular surgery place ECMO cannulas centrally (r just wean of ECMO if no longer needed) and revascularize LE. If moving cannulas is too risky or patient is otherwise dying leave in place and follow the "life before limb" rule.

**Arrythmia** atrial tachycardia (not sinus) amiodarone; Ventricular tachycardia amiodarone and immediately cardiovert; if recalcitrant to cardioversion iv CaCl (1 gram); lidocaine 100mg ivp and start lidocaine infusion from 1-4 mg/hr; try to wean all IV catechols ASAP.

**Weaning ECMO** only done after 24 hours of support- a separate protocol will be used- if need it sooner call surgeon.