Children's Hospitals and Clinics of Minnesota

ECMO Clinical Policy and Procedure

Recommendations for When to Transfer Patients to an ECMO Center

Neonates - <28 days of age

For consultation with a neonatologist, call 612-813-6295.
All criteria for transfer assume an effort to stabilize with appropriate use of mechanical ventilation and inotropic therapy. These are not criteria for ECMO (see separate document); they are an attempt to identify patients with a high likelihood of benefiting from ECMO, at a point where transfer is reasonably safe.

- An OI (oxygenation index) >25. (>15 for diaphragmatic hernia patients).
  OI = (MAP x FiO2 x 100) divided by PaO2
  Ex. OI = (15 x 1.00 x 100) / 60 =25
- Mean airway pressure of >15 cm H20 (>12 for diaphragmatic hernia patients)
- Amplitude or Peak Inflating Pressure of >35 (>25 for diaphragmatic hernia patients)
- Failure to improve within 4-6 hours of high frequency ventilation or nitric oxide to an OI <25
- A plasma lactate >25 mg/dl (>3mM/L), and not improving on moderate inotropic therapy.
- Persistent hypotension, acidosis (pH <7.25, base deficit > 5, or lactate >25 mg/dL), or mixed venous saturation <70% despite an Inotropic Equivalent >35.
  Inotropic Equivalent = DOPamine(mcg/kg/min) + DOButamine(mcg/kg/min) + EPInephrine(100Xs mcg/kg/min) + NORepinephrine(100Xs mcg/kg/min) + ISOproterenol(100Xs mcg/kg/min) + MILrinone(15Xs mcg/kg/min).
- Patients with congenital diaphragmatic hernia, sepsis, shock, or poor myocardial function are prone to rapid deterioration, including death, prior to meeting ECMO criteria. These patients should be transferred early, depending on the distance from the ECMO center.

Recommended studies prior to transfer (if time allows) to rule out exclusions to ECMO:

- Cardiac ultrasound
- Cranial ultrasound
- Plasma lactate

Exclusions to Neonatal ECMO

1. Gestational age < 34 weeks
2. Birth weight or current dry weight <1700 grams
3. Serious ongoing hemorrhage
4. Coagulopathy that is unlikely to resolve with transfusion therapy. Ex. Liver failure.
5. Recent (<3 days) intracranial hemorrhage > Grade I germinal matrix hemorrhage
6. Irreversible lung disease, or high pressure mechanical ventilation >14 days
7. Cardiac lesion that cannot be corrected or palliated
8. Lethal condition incompatible with long life, including trisomy 13 and 18.
9. Evidence of serious brain injury or asphyxia, may be difficult to define but some experts recommend using:
    a. Severe neurological syndrome persisting after respiratory and metabolic resuscitation (i.e stuporous, flaccid, and absent primitive reflexes)
    b. Plasma lactate > 225 mg/dL (25 mM/L). Note > 225 mg/dL is highly predictive of death, whereas > 135 mg/dL (15mM/L) is highly predictive of adverse neurological outcome.
    c. Base deficit > 30 on 2 ABGs.
11. Disseminated herpes disease
12. Renal agenesis or irreversible renal failure

Infants, Children, and Young Adults (30 days to 25 years)

For consultation with a pediatric critical care physician call 612-813-6266. We recommend transfer to an ECMO center when a patient age 30 days – 25 years reaches any one of the following levels of severity with cardiac and/or respiratory failure. Patients with rapidly escalating support require earlier transfer. The time needed to transport from a Twin Cities hospital and initiate ECMO support is no less than 2 hours hours.

- **Any one** of the below signs of hypoperfusion or severe cardiac dysfunction, following appropriate volume resuscitation (≥ 60 ml/kg and/or CVP > 10) and inotropic/ vasopressor support:
  - __ Plasma lactate > 25 mg/dl (> 3 mM/L) and not improving.
  - __ SVO_2 < 65%.
  - __ Rapidly deteriorating or severe ventricular dysfunction.
  - __ Intractable arrhythmia with poor perfusion.
  - __ Inotropic equivalent (IE) >40. IE = DOPamine(mcg/kg/min) + DOBUTamine(mcg/kg/min) + EPInephrine(100Xs mcg/kg/min) + NORepinephrine(100Xs mcg/kg/min) + Isoproterenol(100Xs mcg/kg/min) + Milrinone(15Xs mcg/kg/min) + VASOpressin (10X mUnits/kg/min)
  - __ Accidental Hypothermia: core temp < 32 degrees centigrade, cardiac arrest, non-perfusing rhythm, or hemodynamically unstable

- **Any one** of the following signs of severe respiratory failure with predicted high mortality rate:
  - __ Oxygenation Index >20. (Sensitivity 90%, Specificity 92% for needing ECMO). OI = MAP x FiO_2 x 100 divided by PaO_2
  - __ Ventilation Index >25. (Sensitivity 90%, Specificity 96% for needing ECMO). VI = (PIP X PaCO2 X rate) divided by 1,000. (Doesn't work for HFOV)
  - __ Severe Air Leak unresponsive to other therapies
  - __ Hypercarbic respiratory failure with pH <7.20 despite mechanical ventilation with peak inflating pressure > 35 cm H20.
  - __ Murray Score >2.5 in patients 12-25 years old.

Components of the Murray Lung Injury Score. The final value is obtained by dividing the aggregate sum by the number of components that were used (1-4).

Chest roentgenogram score	No alveolar consolidation Alveolar consolidation confined to 1 quadrant Alveolar consolidation confined to 2 quadrants Alveolar consolidation confined to 3 quadrants Alveolar consolidation confined to 4 quadrants	0 1 2 3 4
Hypoxemia Score Assumes 100% FiO_2 for 20 minutes	PaO_2/FiO_2 >300 PaO_2/FiO_2 225-299 PaO_2/FiO_2 175-224 PaO_2/FiO_2 100-174 PaO_2/FiO_2 <100	0 1 2 3 4
PEEP Score (when ventilated)	PEEP $\leq$ 5 PEEP 6-8 cm H_2O PEEP 9-11 cm H_2O PEEP 12-14 cm H_2O PEEP >15 cm H_2O	0 1 2 3 4
Respiratory Compliance Score (Tidal Volume/PIP-PEEP)	Compliance > 80 mL/cm H_2O Compliance 60-79 mL/cm H_2O Compliance 40-59 mL/cm H_2O Compliance 20-39 mL/cm H_2O Compliance < 19 mL/cm H_2O	0 1 2 3 4

EXCLUSIONS FROM PEDIATRIC ECMO:

Any one of the following underlying imminently fatal or irreversible disease states excludes the patient from ECMO:

__ Severe CNS injury, asphyxia, or hemorrhage
__ End-stage malignancies or advanced AIDS
__ Severe acquired or congenital immunodeficiency
__ Major burn
__ Advanced liver failure
__ Evidence of ongoing uncontrolled bleeding.
__ Severe fibrosis on lung biopsy
__ Severe pulmonary disease ventilated aggressively for > 14 days
__ Lethal condition incompatible with long life, including trisomy 13 and 18.
__ Disseminated herpes disease

References:

ECMO Extracorporeal Cardiopulmonary Support in Critical Care, 4th Edition ELSO 2012.

ELSO General Guidelines for all ECLS Cases, April 2009

ELSO Patient Specific Supplements to the ELSO General Guidelines, April 2009

Peek GJ, Mugford M, Tiruvoipati R, et al: Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial. *Lancet.* 2009 Oct 17;374(9698):1351-63

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