Indications, Contraindications and Patient Selection Criteria for ECLS

VV ECLS

Indications for VV ECLS:

The Patients indicated for V-V ECLS are with a condition which is potentially reversible, acute severe lung failure who continue to deteriorate despite optimal 'lung protective' conventional mechanical ventilation (low Vt, limited Pplat) or other advanced rescue therapies (prone position, inhaled pulmonary vasodilators, high frequency oscillation, extracorporeal CO2 removal). ECLS should be considered before refractory lung failure or multi-organ failure develops.

Standard Criteria for starting VV ECLS:

a. **Murray score 3 – 4** (see below table)
b. **Hypoxemia: P/F < 10 Kpa** on FiO2 0.9 or higher
c. **Hypercapnia: PaCO2 > 11 Kpa** or pH < 7.20
d. **Corrected Minute Ventilation: > 10 L/min**
e. **Pplat > 30 cm H2O**, in absence of high pleural pressures
f. **Static Compliance of respiratory system: < 20 ml/cm H2O**
g. **Less than 7 days of high pressure mechanical ventilation**

Pathologic conditions that may require VV ECLS:

- ✓ Severe ARDS
- ✓ Severe Air Leak Syndrome
- ✓ Pulmonary contusion
- ✓ Inhalation Injuries (gastric contents, near drowning, smoke)
- ✓ Status Asthmaticus, Airway Obstruction
- ✓ Acute graft failure following lung transplant
- ✓ Alveolar Proteinosis

Although the definition of ARDS is broadly accepted, severe lung failure that may require VV ECLS may be recognised by some of the following features:

- ✓ **Severe hypoxemia** (P/F < 10 for >1 hr)
- ✓ **Severe respiratory acidosis** (pH < 7.20 for > 1 hr)
- ✓ **Pplat > 30 cm H2O** in absence of high pleural pressure (e.g., abdominal distension)
- ✓ **Murray Score* > 3.0**

Murray Lung Injury Score:

Score	0	1	2	3	4
P/F ratio >	40	30 – 40	20 – 30	10 – 20	< 10
Compliance	> 80	60 – 80	40 – 60	20 – 40	< 20
PEEP (cmH2O)	< 5	6 – 8	9 – 11	12 – 14	> 15
CXR infiltrates: (Quadrants)	none	1	2	3	4

Compliance (ml/cmH2O) = tidal volume/Pplat – PEEP

Total score/4 = Murray Lung Injury Score

'Berlin Definition of severe ARDS'

a. Respiratory failure in patients with <1 week of a known clinical insult or new or worsening respiratory symptoms
b. Bilateral opacities on chest imaging, not fully explained by effusions, lobar/lung collapse or nodules
c. Respiratory failure not fully explained by cardiac failure or fluid overload
d. Degree of hypoxemia (P/F < 13.5 [100mmHg] with PEEP > 5cmH2O)

Secondary variables:

a. Radiographic severity: opacities in 3 or 4 quadrants of the chest radiograph
b. PEEP > 10cmH2O
c. Static compliance of respiratory system < 40cmH2O
d. Minute ventilation standardised at PaCO2 of 5.4kPa: > 10L/min (min ventilation x PaCO2/5.4, surrogate marker for increased dead space)

The above mentioned variables were not found to change the mortality prediction compared to using severe hypoxemia (P/F < 13.5 Kpa) alone.
The article suggests that more stringent hypoxemia criteria (e.g. P/F < 10 Kpa) may be appropriate if the patient is being considered for extracorporeal life support.

(JAMA 2012; 307(23):doi:10.1001/jama.2012.5669)

Contraindications for ECLS:

Exclusion criteria for ECLS are given below. In an emergency setting, it may not be possible to identify all the conditions that would normally exclude patients from ECLS. At the discretion of the Consultant Intensivist or Cardiothoracic Surgeon, ECLS may be commenced emergently and if contraindications become obvious at a later time, ECLS should be withdrawn.

Absolute Contraindications for VV ECLS:

- ✓ Progressive non-recoverable lung disease, not amenable to transplantation
- ✓ Chronic severe pulmonary hypertension with right ventricular failure
- ✓ Advanced malignancy
- ✓ Chronic organ dysfunction
- ✓ Lung Failure associated with Bone Marrow transplantation
- ✓ Contraindication to anticoagulation therapy
- ✓ Recent spinal cord or central nervous system trauma or haemorrhage

Relative contraindications for VV ECLS:

- ✓ Mechanical ventilation with FiO2 > 0.9 and Pplat > 30 cmH2O for > 7 days
- ✓ Age > 70 yrs
- ✓ Body weight: > 140 kg
- ✓ Trauma with multiple bleeding sites
- ✓ Significant immunosuppression
- ✓ Recent diagnosis of haematological malignancy

VA ECLS

Indications for VA ECLS:

Veno-arterial ECLS is used for short-term support in patients with severe Cardiac (or heart and/ or lung) failure where volume therapy, vasoactive drugs and Intra-Aortic Balloon Counter-pulsation (IABC) have failed to provide adequate systemic perfusion. The decision to deploy VA ECLS is often made urgenty in patients with acute circulatory shock not responding to conventional support therapies, cardiopulmonary resuscitation or not weaning from intraoperative cardiopulmonary bypass. If it is possible, the patient should be reviewed by Cardiology, Cardiothoracic Surgery and Critical Care Medicine prior to initiation of VA ECLS.

Indices of tissue hypo-perfusion include systemic hypotension, mental status changes, oliguria, core – peripheral temperature gradient, skin mottling, myocardial ischemia and increased serum lactate concentration. In patients with satisfactory arterial oxygenation and haemoglobin concentration, inadequate systemic perfusion can be inferred by mixed venous oxygen saturation less than 70%.

Deoxygenated blood is drained from the inferior or superior vena cava and oxygenated blood is returned to the Femoral artery, Carotid Artery or Auxiliary Artery (peripheral VA ECLS) or Ascending Aorta (central VA ECLS).

Peripheral VA ECLS can be deployed rapidly (femoral artery and vein cannulation) and is appropriate when native lung function is satisfactory and sternotomy or cardiac surgery is not applicable. Central VA ECLS is most often employed in patients who fail to wean from conventional intra-operative cardiopulmonary bypass after cardiac surgery. In patients with heart failure and poor native lung function, central VA ECLS is preferred to peripheral VA ECLS to avoid poorly saturated blood from the dysfunctional native lungs being ejected into the proximal aorta.

Pathologic conditions that may require VA ECLS:

- ✓ Post-cardiotomy cardiogenic shock
- ✓ Ischaemic cardiogenic shock
- ✓ Bridge to decision regarding suitability for therapy (e.g., revascularisation) or for longer term support (e.g. VAD,
- ✓ transplantation)
- ✓ Acute decompensation of Dilated Cardiomyopathy
- ✓ Massive pulmonary embolism
- ✓ Acute fulminant myocarditis
- ✓ Sepsis with profound cardiac depression
- ✓ Overdose of cardiac depressant medication
- ✓ Acute Graft failure after heart transplantation
- ✓ Anaphylactic shock

Contraindications for ECLS:

Exclusion criteria for ECLS are given below. In an emergency setting, it may not be possible to identify all the conditions that would normally exclude patients from ECLS. At the discretion of the Consultant Intensivist, Cardiologist or Cardiothoracic Surgeon, ECLS may be commenced emergently and if contraindications become obvious at a later time, ECLS should be withdrawn.

Absolute Contraindications for VA ECLS:

- ✓ Progressive non-recoverable cardiac disease, not amenable to transplantation or VAD
- ✓ Aortic valve regurgitation
- ✓ Aortic dissection
- ✓ Un-witnessed cardiac arrest

- ✓ Advanced malignancy
- ✓ Chronic organ dysfunction
- ✓ Contraindication to anticoagulation therapy
- ✓ Recent spinal cord or central nervous system trauma or haemorrhage

Relative contraindications for VA ECLS:

- ✓ Age > 70 yrs
- ✓ Body weight: > 140 kg
- ✓ Trauma with multiple bleeding sites
- ✓ Significant immunosuppression
- ✓ Recent diagnosis of haematological malignancy

References:

1. ARDS Definition Task Force, Ranieri VM et al. Acute respiratory distress syndrome: the Berlin Definition. JAMA. 2012 Jun 20;307 (23):2526-33. doi: 10.1001/jama.2012.5669.
2. "The Mater ECLS program" Retrieved March 06th 2014 from http://www.mater.ie/services/depts/c/critical-caremedicine/ecmoecls/Microsoft%20Word%2020Indications%20and%20Contraindications%20of%20ECLS.pdf.
3. A. Noah Moronke et al., (2011), "Referral to an Extracorporeal Membrane Oxygenation Center and Mortality Among Patients With Severe 2009 Influenza A(H1N1)", JAMA. 2011;306 (15):doi:10.1001/jama.2011.1471., JAMA, Published online October 5, 2011.
4. Philip J. Wolfson, (2003), "The Development and Use of Extracorporeal Membrane Oxygenation in Neonates", Ann Thorac Surg 2003;76:2224-2229.
5. Galletti PM, Richardson PD, Snider MT. A standardized method of definind the overall gas transfer performance of artificial lungs. Trans ASAIO 18:359, 1972.
6. Bartlett RH. Physiology of Extracorporeal support. ECMO: Extracorporeal Cardiopulmonary support in Critical care- 4th edition. Annich GM et al, editors, Extracorporeal Life Support Organization, 11-31, 2012.