Veno-Venous ECMO Support

Chris Cropsey, MD
Sept. 21, 2015
Objectives

• List indications and contraindications for ECMO
• Describe hemodynamics and oxygenation on ECMO
• Discuss evidence for ECMO outcomes
• Identify common problems with ECMO support
• Understand ultra lung protective ventilation
What is ECMO?

- Bypass of the lungs [or heart / lungs]
- Circuit is comprised of:
  - Inflow (venous) line
  - Pump
  - Oxygenator
  - Outflow (arterial) line
  - Warmer
ECMO Circuit
ECMO components

• Centrifugal pump
  • Flow dependent on resistance, so minimize drugs that cause vasoconstriction, anxiety.

• Oxygenator
  • Fibers composed of PMP, allows barrier between oxygen and blood for gas exchange
  • Can induce inflammatory response
Cannulation Methods

Indications for ECMO Support

- PF ratio <60 or PF ratio <100 with PaCO2 100mmHg for >1 hour despite maximal therapy

- Common
  - Severe pneumonia
  - ARDS
  - Pulmonary contusion
  - Severe hypoxemia following cardiopulmonary bypass
  - Acute graft failure following lung transplant

- Other:
  - Alveolar proteinosis
  - Smoke inhalation
  - Status asthmaticus
  - Airway obstruction
Absolute Contraindications

- Age > 70 yrs
- Non-recoverable respiratory disease
- Non-recoverable neurological disease or intracranial hemorrhage within the previous 6 months
- Chronic severe pulmonary hypertension
- Active malignancy, graft vs host disease or significant immunosuppression
- Advanced liver disease Childs class C not undergoing transplant
- AIDS as defined by:
  - Secondary malignancy, prior hepatic or renal (Crt > 250umol/l)
  - Impairment or need for salvage anti-retroviral therapy
- Severe right or left heart failure (LVEF< 25%)
- Cardiac arrest
Relative Contraindications

- Trauma with multiple bleeding sites
- Multiple organ failure
Evidence

• First trials in adults in 1970s. No improvement in long term outcomes, with multiple methodological problems (No lung rest)
• Use in adults limited to select centers through the 90s.
• Published data for adults still limited, but improving
• Big increase H1N1 in 2009
Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Giles J Peek, Miranda Mugford, Ravindranath Tiruvoipati, Andrew Wilson, Elizabeth Allen, Mariamma M Thalanyi, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration
RR of death or permanent disability 0.69 with \( P=0.03 \) in 180 patient RCT for severe ARDS (H1N1)
The PRESERVE mortality risk score and analysis of long-term outcomes after extracorporeal membrane oxygenation for severe acute respiratory distress syndrome

<table>
<thead>
<tr>
<th>Matthieu Schmidt</th>
<th>Elie Zogheib</th>
<th>Hadrien Rozé</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xavier Repesse</td>
<td>Guillaume Lebret \n Charles-Edouard Luyt</td>
<td>Jean-Louis Trouillet</td>
</tr>
<tr>
<td>Nicolas Bréchot</td>
<td>Ania Nieszkowska</td>
<td>Hervé Dupont</td>
</tr>
<tr>
<td>Alexandre Ouattara</td>
<td>Pascal Leprince</td>
<td>Jean Chastre</td>
</tr>
<tr>
<td>Alain Combes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 164 Consecutive adults for respiratory ECMO
- 64% ICU survival
- 60% 6-month survival
- Risk factors for death included age, high plateau pressures, low PEEP, and high BMI
ELSO registry report 2012

- Data from 2011.
- 507 adult VV patients
- 58% survival to discharge

V-V ECMO patients, by year

Paden, Matthew; Conrad, Steven; Rycus, Peter; Thiagarajan, Ravi
DOI: 10.1097/MAT.0b013e3182904a52
Management

• Anticoagulation
  • Patients on ECMO must be anticoagulated with heparin or a direct Xa inhibitor. Anticoagulation monitored closely with heparin assay, ACT, or PTT determined by ECMO intensivist
  • Can be held in the setting of uncontrolled hemorrhage
  • Bleeding complications (CVA, retroperitoneal hemorrhage, anemia) common, so vigilance is required
Management

• Lung rest
  • Crucial to effectiveness of therapy – don’t abuse lungs!!
    • Peak pressures under 20 cm H₂O
    • TV often too small to prevent alarms. Work with RT to find solution (CPAP circuit only)
    • Can extubate if neuro allows for pulmonary toilet, maintenance of airway
    • Tolerate SaO₂ >80-85% as long as DO₂ is adequate

• Infection
  • Difficult to diagnose
  • Circuit can cause SIRS
  • Fluid warmer maintains central temperature
  • Serum markers may be used (CRP, procalcitonin)
Management

• Mechanical problems
  • Frequently a true emergency
  • Damage to circuit: may require emergent replacement of circuit
    • Call for help
    • Return vent to pressures necessary for temporary support
    • May require support with high dose pressors, CPR until flow re-established
  • Thrombosis, air lock, pump failure
    • Be prepared to provide support to ECMO specialist, perfusion
• Critical Illness
  • Most important: is still a critically ill patient. Excellent ICU care will play as important a role in recovery as ECMO. Be vigilant, precise.
Management

• Monitors
  • Pre and post pump pressure monitors.
    • Typical pre pump <100mmHg, but no absolute number
      • Trend upward raises concern for hypovolemia, thrombosis
    • Post pump <350 mmHg, but also trend is more important
      • Sharp increases can indicate kinked cannula, problems with site, thrombosis
  
• ABGs
  • Usually done at least Q2 Hrs early on
  • Goal pH 7.35-7.45, regardless of PaCO2
  • Often low PaO2 due to mixing, but OK if clearing lactate
Summary

• ECMO should be considered for patients with severe respiratory failure
• Cannulation and maintenance requires high levels of vigilance
• For well-selected patients, survival benefit likely exists
• Mechanical problems unique to ECMO can be life threatening; plans must be in place preemptively
• Plan for exit strategy before starting
Case Scenario

- 39 y/o M, severe pneumonia
- ABG on 100% FiO2: 7.07/108/61
- Currently on PEEP 15, PIP 39, prone positioning
- Norepinephrine at 8 mcg/min
Does this patient meet criteria for ECMO?

1. Yes
2. No
Which of the following would be a contraindication to ECMO if present?

1. Uncontrolled diabetes mellitus
2. Active AIDS
3. Severe asthma
4. History of osteosarcoma as a child, without residual disease
You elect to place the patient on ECMO. Which of the following describes the best ventilation strategy?

1. Volume control mode, FiO₂ 80%, TV 6 ml/kg, PEEP 10, PIP 38, SaO₂ 96%
2. Pressure control mode, FiO₂ 40%, PEEP 10, PC 10, SaO₂ 83%
3. APRV mode, FiO₂ 60%, P_{high} 32, P_{low} 0, T_{high} 4.5, T_{low} 0.5, SaO₂ 92%
Questions?