ECMO in a Community ICU

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No Off-label Use
Objectives

WHAT is ECMO

WHY use ECMO

HOW to ECMO

WHO to ECMO

SHOULD you ECMO
What is ECMO

• High risk of death
• Temporary heart/lung support
• Reversible cause
What ECMO can do

• Oxygenate
• Remove Carbon dioxide
• Perfuse
• Regulates temperature
ECMO doesn't CURE
VA-ECMO
VV-ECMO
Bicaval
Double-lumen
VV-ECMO
The blender can adjust the composition of the sweep gas.

The pump delivers venous blood from the patient to the oxygenator.

As blood flows through the oxygenator, gas exchange occurs across the semipermeable membrane.

Oxygenated blood is delivered back to the patient.
Why use ECMO
Esperanza.
The first neonatal ECMO survivor, 1975
ELSO
Failed Trials

- Zapol, 1979
- Morris, 1994
- Little used in adults
Vocal Advocates

- Limited training
- Intensive anticoagulation
- Excessive volume and pressure during mechanical ventilation.
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 Thalanany, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration.
• Only 75% of pts in ECMO arm received (68 of 90) actually received ECMO
H1N1 Aftermath

• 2009-2011 over 1000 papers published
• AZ ECMO Trial
How To ECMO
Getting the right type

- Getting the right type
- Getting the right size
- Cannulation
  - Not the same as CVC or arterial line
  - Size exposes your technique
  - Never underestimate the damage you can do
Respiratory failure

- Hypoxic
  - Hemodynamically stable
    - Venovenous ECMO with double-lumen cannula

- Hypercapneic
  - Hemodynamically unstable
    - Venoarterial ECMO
  - Hemodynamically stable
    - Extracorporeal carbon dioxide removal or venovenous ECMO

Possible outcomes:
- Clinical improvement: bridge to recovery
- Eligible candidate: bridge to transplant
- Multiorgan failure: bridge to no therapy, palliative withdrawal
Understanding Oxygen Delivery

- Components of Oxygen Delivery
  - Blood flow
  - Hct
  - Inlet Hgb saturation
  - Oxygenator properties
- Carbon dioxide removal always exceeds oxygen delivery
Understanding Oxygen Delivery

- Metabolic rate drives oxygen consumption
- O2 Delivery = CO x CaO2
- Oxygen content (CaO2) = (SaO2 x Hgb x 1.34) + 0.003 x PaO2
- EBF/CO, Recirculation blood flow, native lung function
- SaO2 usually 80-90%, PaO2 40-50
Controls

- **Blood Flow** -- RPM, Preload, Afterload, Resistance
- **Sweep Gas** -- Increases delivered oxygen partial pressure (FDO2)
- **Gas Flow rate** -- Controls carbon dioxide removal
- **Temperature**
- **Ventilator** -- LTV vs Lung rest vs Extubate
Monitoring

- Pulmonary artery catheter
- BIS monitoring
- Pulse-oximetry multiple limbs
- Labs
  - Patient ABG, Pre- / Post-Pump ABGs
  - Lactic acid
  - Plasma free hemoglobin
  - Fibrinogen
Problems

- Bleeding, bleeding, bleeding
  - 43% of patients
  - Cannulation / Surgical sites
  - Intracranial hemorrhage
  - Gastrointestinal hemorrhage
Problems (cont)

- Clotting including HIT
- Renal Failure
- Pump Thrombosis
- Mechanical Failure
- Limb ischemia
- Infection
Best Practices

• Consider ECMO Early
• Don’t Use the Lungs
• Minimize Sedation
Organized Program

• Daily Multidisciplinary Rounding
• Monthly multidisciplinary ECMO Conference
• Monthly Operational Meeting
• Level 1 ECMO Call System
• ECMO Database
• Credentialling
• Operational Committee
Culture of Safety

• Checklists
• Order sets
• Continuous team training
• Simulation
• Review Your Work
• Partner with ELSO
Who to ECMO
Getting the Right Patient

• Toughest Part

• Somebody will benefit from ECMO
  • Does ECMO fix the problem
  • Not too sick to benefit (duration, severity of organ failure)

• Comorbidities

• Has an “out” clause
Generally Favored (Respiratory)

- ARDS (PaO2/FiO2 100-150)
- Status asthmaticus
- Exacerbation of COPD (PaCO2 >80, pH <7.15)
- Primary graft dysfunction following lung transplantation (within 7 days)
- Pulmonary vasculitis (Goodpasture’s, ANCA-associated, Autoimmune)
Generally Favored (Cardiac)

• Myocardial infarction-associated cardiogenic shock
• Pulmonary embolism with cardiogenic shock
• Drug overdose with profound cardiac depression or arrhythmia
• Extracorporeal cardiopulmonary resuscitation
• Acute fulminant myocarditis
• Postcardiotomy or post-heart transplant cardiogenic shock
• Primary graft failure after transplant
• Bridge to VAD or transplant
Absolute Contraindications

- Uncontrolled active hemorrhage
- Terminal illness
- Irreversible or end-stage heart or lung failure in patients who are not candidates for transplant
Relative Contraindications

• More than 7 adys of mechanical ventilation

• Multiorgan failure (especially renal failure)

• Irreversible neurologic injury

• Malignancy, solid-organ transplant, or immunosuppression

• Contraindications for anticoagulation
Soft Contraindications

- Advanced age
- Weight
- Pregnancy/Postpartum
- Trauma
Making the Decision

- Clinical Triggers for evaluation
- Decision support
- Often very limited time
- Often limited information
- Review all decisions
- Shares cases / Review Registry
- Be willing to be wrong
Should you ECMO
Getting the Ethics right

• How old is too old...or better yet...how young is too young?
• Concrete resuscitation cutoff vs. a graded response?
• Only Reverse the Reversible.
• Define “Quality of Life”. How do we determine “Quality of Life”? Who decides this in the heat of the moment? The doctor or the family?
• What is the real goal of resuscitation? Should we only resuscitate people who were previously healthy and have a chance of 100% recovery?
• MD paternalism vs. patient autonomy = “The Tyranny of Choice.”
Is ECMO the right device

- Refractory Cardiogenic Shock (RCS)
- ECMO
  - Quick placement for acute resuscitation
  - Reestablish perfusion
  - No left ventricular unloading
  - Generates high afterload
  - Impaired coronary perfusion
  - Regional hypoxia
Is ECMO the right device

- Impella
  - Miniature rotary pump
  - Fully unloads left ventricle
  - Reduces EDV/EDP
  - Reduces myocardial oxygen demand
Key Points

• Two configurations are used in adults: venoarterial, which can provide cardiac or cardiopulmonary support; and venovenous, which provides respiratory support only.

• ECMO is used in adults who are at very high risk of death without it.

• Because ECMO patients must receive anticoagulation, bleeding is a common complication. Others are infection, renal failure, and thrombosis.

• ECMO may provide “lung rest,” allowing lower tidal volumes and pressures and lower fractions of inspired oxygen to be used in mechanical ventilation, strategies associated with lower mortality rates.
## Overall Outcomes

<table>
<thead>
<tr>
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<th>Total Patients</th>
<th>Survived ECLS</th>
<th>Survived to DC or Transfer</th>
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<td><strong>Neonatal</strong></td>
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<tr>
<td>Respiratory</td>
<td>27,728</td>
<td>23,358</td>
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<td>Cardiac</td>
<td>5,810</td>
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<td>ECPR</td>
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<td><strong>Adult</strong></td>
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<td><strong>Total</strong></td>
<td>65,171</td>
<td>46,490</td>
<td>38,636</td>
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Avalon Catheter
## What We Control

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<tr>
<th>Variable</th>
<th>Importance</th>
<th>Initial Setting</th>
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<tr>
<td><strong>Pump Speed (rpm)</strong></td>
<td>Blood flow: oxygenate and perfuse</td>
<td>To achieve 50-100 mL/kg/min</td>
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<td><strong>Sweep gas flow rate</strong></td>
<td>Ventilate (CO₂)</td>
<td>1:1 gas:blood flow</td>
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<tr>
<td><strong>F₂O₂</strong></td>
<td>Analogous to F₁O₂</td>
<td>100% oxygen</td>
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<td><strong>Mechanical ventilation</strong></td>
<td>Minimize lung injury</td>
<td>Lung rest</td>
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<td><strong>Anti-coagulation</strong></td>
<td>Circuit clotting</td>
<td>UFH for ACT 180-200 or aPTT 60-80</td>
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