Extracorporeal Life Support (ECLS) as a Bridge to Decision in Lung Transplantation

Gabriel Loor, MD
Baylor St. Lukes Medical Center
Surgical Director Lung Transplantation
Co-chief Section of Adult Cardiac Surgery
Overview

• Background
• Technical
• Outcomes

• Should the patient proceed to ECMO?
• If so should they proceed to transplant?
# Current landscape

## Recipient condition at time of transplant

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>2010</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td>Hospitalized in ICU</td>
<td>150</td>
<td>267</td>
</tr>
<tr>
<td>Hospitalized, not ICU</td>
<td>148</td>
<td>242</td>
</tr>
<tr>
<td>Not hospitalized</td>
<td>1487</td>
<td>1530</td>
</tr>
<tr>
<td>Hospitalization unknown</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vent/ECMO at transplant</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vent + ECMO</td>
<td>22</td>
<td>63</td>
</tr>
<tr>
<td>Vent only</td>
<td>130</td>
<td>64</td>
</tr>
<tr>
<td>ECMO only</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>Neither</td>
<td>1626</td>
<td>1895</td>
</tr>
</tbody>
</table>

4.7% of patients on ECMO

Valapour et al. OPTN/SRTR 2015 Annual Report
Current landscape

Valapour et al. OPTN/SRTR 2015 Annual Report
Patient presentation

• 48 yo male with history of CF, multiple exacerbations
• Progressive decline in lung function
• Presents with fevers, cough and shortness of breath
• High flow oxygen and face mask insufficient
• Hypotensive, elevated creatinine
Patient presentation

- Noninvasive or invasive ventilation
- End organ support
- Reversibility?
- Waitlist candidacy, urgent listing
- ECMO?
- Bridge to transplant versus bridge to decision?
Indications for ECMO

• Refractory hypoxemia/hypercapnia despite optimal ventilator support and medical management
Goals for ECMO

- Optimization
- Time
Balancing risk and benefits

Aggressive medical management (100% FiO2, PEEP, iNO, ionotropes, paralytics, steroids, prone)

ECMO risks (Bleeding, stroke, limb complications, immobility)
Absolute contraindications

- Ineligible for transplant with an irreversible pulmonary process
- Irreversible end-organ Sepsis and bacteremia
- Contraindication to anticoagulation
- Uncontrolled metastatic disease
- Terminal illness not otherwise treatable with transplant
- Acute intracerebral hemorrhage or stroke
Relative contraindications

- Age greater than 65 years
- Limitations in vascular access
- Obesity (body mass index >30)
- Frailty
- Prolonged ventilatory support (ie, >7 days)
- Allosensitization with prolonged anticipated waitlist time.
Additional considerations

• Timing (early consideration)
• Bridge to recovery/decision/transplant?
• Multidisciplinary team (surgeon, medicine, critical care, social, PT...)
• Ambulation
• Resources and institutional perspective
• Family perspectives
Technical considerations

VV - Veno-venous
VA – Veno-arterial
VVA - Veno-venous-arterial
Veno-venous ECMO Support

- Inability to oxygenate or remove CO2
- Normal cardiac function
- Normal or moderate pulmonary vascular resistance
**Veno-venous ECMO Support**

**Inflow – Oxygenated blood**

- Subclavian/IJ

**Patient**

**Outflow – Deoxygenated blood**

- Femoral vein

ECMO oxygenator
Advantages of VV SCV-fem

• Seldinger cannulation – familiar
• Less recirculation
• Predictable oxygenation
Disadvantages of VV SCV-fem

• Immobility
• Venous complications especially if no TEE
Veno-arterial ECMO

- Refractory hypoxemia/hypercapnia despite optimal ventilator support and medical management
- Poor cardiac function or severe hemodynamic shock
- Elevated pulmonary vascular resistance
Veno-arterial ECMO Support

Disadvantages

- Limb complications
- Immobility
- Harlequin syndrome
Central sport model
Management ECMO

- Rest lungs <6cc/kg
- PEEP 5-10mmHg
- Assess for recovery periodically
- Attempt extubation
- Consider early trach
- Optimize coag status, nutrition, physical therapy

- Optimize end organ perfusion
- Palliative care consult
- Goals of care
- Family and multidisciplinary team discussions

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Texas Heart Institute
Complications of ECMO

- Bleeding
- Physical deconditioning
- Renal dysfunction
- Infection
- Access complications
What is the likelihood of transplant and if transplanted what is the likelihood of a successful outcome?
Outcomes

Hayanga et al Cardiothoracic Transplantation and Mechanical Circulatory Support

Extracorporeal membrane oxygenation as a bridge to lung transplantation in the United States: An evolving strategy in the management of rapidly advancing pulmonary disease

Awori J. Hayanga, MD, MPH, Jonathan Aboagye, MD, MPH, Stephen Esper, MD, MBA, Norihisa Shigemura, MD, PhD, Christian A. Bermudez, MD, Jonathan D’Cunha, MD, PhD, and Jay K. Bhama, MD
Outcomes

Hayanga et al JTCVS 2015
Outcomes

- Patients bridged had higher risk of dialysis dependent renal failure.
- Patients >35 yo and those with CF or “other diagnosis” did worse.

Hayanga et al JTCVS 2015
Does volume matter?

- Adjusted hazard ratio for mortality of 2.74 for patients bridged with ECMO in a low-volume center (ie, 1-5 transplants/year) versus a high-volume center (ie, >15 transplants/year).

Hayanga et al Interactive Cardiovascular and Thoracic Surgery 2016
Vienna, Austria - 90% success rate for bridging to transplantation
24% rate of in-hospital mortality after transplantation
Median bridging time was 5.5 days (range of 1-63 days)
Those who survived the initial 3-month period after transplantation had a 5-year survival rate equivalent to non-bridged patients (63% vs. 72%, P=0.33)
Emphasizes the importance of selecting patients likely to tolerate ECMO.
Underscores the significance of optimizing patients

Lang et al. Transplantation April 2012 93(7)
Parameters associated with outcomes

- 50% success rate to transplant
- Median time on ECMO was 33 days (17-55 days)
- Identified several potential risk factors for post transplant mortality after ECMO bridging:
  - Higher bilirubin levels
  - Pulmonary artery pressures
  - Sequential organ failure assessment (SOFA) scores.
  - A bilirubin level $>$3 mg/dL and a SOFA score $>$9 predicted a uniformly fatal outcome.

Weig et al. Clinical Transplantation 2013
Organ Allocation Waiting Time During Extracorporeal Bridge to Lung Transplant Affects Outcomes

Stefania Crotti, MD; Giorgio A. Iotti, MD; Alfredo Lissoni, MD; Mirko Belliato, MD; Marinella Zanierato, MD; Monica Chierichetti, MD; Guendalina Di Meo, MD; Federica Meloni, PhD; Marilena Pappalettera, MD; Mario Nosotti, MD; Luigi Santambrogio, MD; Mario Viganò, MD; Antonio Braschi, MD; and Luciano Gattinoni, MD
Parameters associated with outcomes

Crotti et al Chest 2013
Outcomes with ECMO and retransplantation

Extracorporeal Life Support as Bridge to Lung Retransplantation: A Multicenter Pooled Data Analysis

Stéphane Collaud, MD, MS, Christian Benden, MD, Christoph Ganter, MD, Sven Hillinger, MD, Isabelle Opitz, MD, Didier Schneiter, MD, Reto Schuepbach, MD, Ilhan Inci, MD, and Walter Weder, MD

Divisions of Thoracic Surgery and Pulmonary Medicine, Medical Intensive Care Unit and Surgical Intensive Care Unit, University Hospital of Zurich, Zurich, Switzerland

- Inter-transplant year >2
- Awake versus not awake ECMO
Awake ECMO is better when possible

Awake Extracorporeal Membrane Oxygenation as Bridge to Lung Transplantation: A 9-Year Experience

Mauer Biscotti, MD, Whitney D. Gannon, MSN, Cara Agerstrand, MD, Darryl Abrams, MD, Joshua Sonett, MD, Daniel Brodie, MD,* and Matthew Bacchetta, MD*

Division of Cardiothoracic Surgery, Department of Surgery, and Division of Pulmonary, Allergy, and Critical Care Medicine, Department of Medicine, Columbia University Medical Center, New York, New York

- 9-year experience at Columbia Presbyterian
- 55% success rate for bridging to transplant
- Several factors associated with survival to transplant:
  - inotrope or vasopressor use
  - simplified acute physiology II score
  - Ambulation
  - Cystic fibrosis had the most favorable prognosis
  - Need for renal replacement
  - Interstitial lung disease had the worst rate of survival after transplantation.
<table>
<thead>
<tr>
<th>Favorable factors</th>
<th>Unfavorable factors</th>
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<tbody>
<tr>
<td>Age &lt;50</td>
<td>Age &gt; 60</td>
</tr>
<tr>
<td>Normal or marginally elevated total bilirubin</td>
<td>Total bilirubin &gt;3</td>
</tr>
<tr>
<td>Normal or mildly elevated pulmonary artery pressures</td>
<td>Severe pulmonary hypertension</td>
</tr>
<tr>
<td>&lt; 14 day duration on ECMO</td>
<td>Prolonged ECMO &gt; 14 days</td>
</tr>
<tr>
<td>Low SOFA score (&lt;6)</td>
<td>Prolonged mechanical ventilation</td>
</tr>
<tr>
<td>Non-invasive ventilation</td>
<td>Prolonged immobility on ECMO</td>
</tr>
<tr>
<td>Ability to participate in physical therapy (ie. Awake ECMO)</td>
<td>Sofa score &gt; 9</td>
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<tr>
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<td>Major bleeding, infectious or end-organ complications</td>
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<td>Renal replacement therapy</td>
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<td>Retransplant interval &lt;1 year</td>
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THANK YOU!

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