The Future of ECMO and Why it Matters to You!

By Curt Froehlich, MD
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Disclosures

• Curt Froehlich, MD has NO financial relationships with commercial interest to disclose
• I do teach for ELSO (AND I TEACH ALOT!)
• I WILL be discussing off label use of FDA approved equipment
• I WILL introduce equipment NOT FDA approved and will acknowledge when doing so

Disclosures

• I am a believer
• I believe in improving the availability of these services
• I AM NOT:
  • Nephrologist
  • Pathologist
  • Hematologist
  • Cardiologist
  • Surgeon

Learning Objectives

A. Be able to name the patient population first supported with ECMO
B. Describe at least 2 intangible benefits of ECMO
C. Name 3 future applications of ECMO

Outline

• History of ECMO
• ECMO Today
• Extracorporeal Life Support Organization (ELSO)
• Why does ECMO matter?
• ECMO Lessons
• The future of ECMO
• Neo/Pedi ECMO at University Hospital
What is ECMO?

- Stands for: ExtraCorporeal Membrane Oxygenation?
- Should it stand for Extremely Costly Midnight Operation?
- What is it?
  - A way in which the lungs or the heart and lungs can be artificially supported for prolonged periods of time
  - What is prolonged?
    - 2 weeks?
    - 3 months?
    - 9 months?

ECMO in 2015

Slide Courtesy of Enrique Diaz-Guzman, MD
ECMO in 2015

Slide Courtesy of Enrique Diaz-Guzman, MD

ECMO in 2015

Slide Courtesy of Enrique Diaz-Guzman, MD

ECMO in 2015

Slide Courtesy of Rodrigo Diaz, MD

ELSO

- Extracorporeal Life Support Organization
- Organization of national and international centers
- Formed by Dr. Bartlett and others in 1989
- 278 international centers in 2015 and growing rapidly
- Provides collaboration
- Each patient a "data point"

Overall Patient Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Surv ECLS</th>
<th>Surv to DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonatal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>28,271</td>
<td>23,791(84%)</td>
<td>20,978(74%)</td>
</tr>
<tr>
<td>Cardiac</td>
<td>6,046</td>
<td>3,750 (62%)</td>
<td>2,497 (41%)</td>
</tr>
<tr>
<td>ECPR</td>
<td>1,188</td>
<td>786 (66%)</td>
<td>489 (41%)</td>
</tr>
<tr>
<td>Pediatric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>6,929</td>
<td>4,579 (66%)</td>
<td>3,979 (57%)</td>
</tr>
<tr>
<td>Cardiac</td>
<td>7,668</td>
<td>5,084 (66%)</td>
<td>3,878 (51%)</td>
</tr>
<tr>
<td>ECPR</td>
<td>2,583</td>
<td>1,432 (56%)</td>
<td>1,070 (41%)</td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>7,022</td>
<td>5,209 (76%)</td>
<td>4,576 (58%)</td>
</tr>
<tr>
<td>Cardiac</td>
<td>6,522</td>
<td>3,661 (56%)</td>
<td>2,708 (42%)</td>
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<tr>
<td>ECPR</td>
<td>1,985</td>
<td>791 (40%)</td>
<td>589 (30%)</td>
</tr>
<tr>
<td>Total</td>
<td>69,114</td>
<td>49,063 (71%)</td>
<td>40,764 (59%)</td>
</tr>
</tbody>
</table>

Neonatal Respiratory Cases

- Cumulative Runs
- Annual Runs
Why Does ECMO Matter?

- Patient Benefits
- Educational Benefits
- Institutional Benefits
- “I thought ECMO is for the sickest of the sick?”
- “Isn't ECMO a last resort?”

ICU Care is Bad

- Post intensive care syndrome
  - ICU acquired weakness
  - Cognitive dysfunction
  - Mental health problems
- What can ECMO offer?

ARDS Outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>3 Months</th>
<th>6 Months</th>
<th>12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned to work —</td>
<td>33/83 (39)</td>
<td>26/82 (32)</td>
<td>40/82 (49)</td>
</tr>
<tr>
<td>no., total no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returned to original work —</td>
<td>30/13 (77)</td>
<td>23/26 (88)</td>
<td>31/40 (78)</td>
</tr>
<tr>
<td>no., total no. (%)</td>
<td></td>
<td></td>
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</tbody>
</table>

Delirium and ICU Outcome

- Defined by a fluctuating level of attentiveness
- Often treated with ↑ pharmacologic sedation (‘vicious cycle’)
- Masked by deep sedation (i.e., pharmacologic coma)
- Associated with ↑ ICU mortality and poor neurocognitive outcomes

Slide Courtesy of Ira Cheifetz

Frontera, Neurocrit Care, 2011.
Slide Courtesy of Ira Cheifetz
Iatrogenic = doctor prescribed

Ventilators are not for sick lungs

- Positive pressure ventilation is not physiologic
- Disease is not homogenous
- Lung injury with each breath
  - Increased inflammation
  - Increased lung water
  - Reduced compliance
    - All lead to higher ventilator settings
    - Vicious cycle

ECMO is for sick lungs

- Location:
  - ICU
  - Duration > 24 h

- Locations:
  - EMS/ED
  - OR
  - Duration < 24 h

Ventilator

- Airway protection
- Surgery
- AMS/Seizure
- Drug overdose

ECMO

- Primary/secondary lung disease
- Pneumonia
- Trauma/Sepsis
- Heart failure
“Don’t hurt the patient. Be persistent, it’s just a matter of time.”

-Palle Palmer

Consolidated lungs can recover

Impossible to keep the lungs open despite extreme ventilatory settings.
Small or no tidal volumes.
After 30-45 days tidal volumes started to increase in this patient.

20th birthday 4 days before decannulation

Two years after decannulation:
Back in highest volley ball league
Educational Benefits

“Management of extracorporeal life support (ECLS) is the ultimate in applied physiologic care of critically ill patients.”

— Robert Bartlett, MD

Institutional Benefits

Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial


Interpretation: We recommend transferring of adult patients with severe but potentially reversible respiratory failure, whose Murray score exceeds 3:8 or who have a pH of less than 7:30 on optimum conventional management, to a center with an ECMO-based management protocol to significantly improve survival without severe disability. This strategy is also likely to be cost effective in settings with similar services to those in the UK.

Ventilators are for healthy lungs

Slide Courtesy of Matt Paden

ECMO is for sick lungs

Slide Courtesy of Matt Paden

What has ECMO Taught Me?

ECMO Lessons

- Initial: 6.78/188/148/27/-11
- 0250: 6.82/174/209/28/-10.7/iCa 1.3
- 0317: 6.76/187/81/26/-13.7/iCa 1.27
- 0433: 6.78/-/-/125/-/-/iCa 1.24
- 0602: 6.68/-/125/-/-/iCa 1.29
- 0704: 6.56/190/54/17/-24.4/iCa 1.28
- 0902: 6.68/-/142/6.7/1.18
- Pupils Fixed and Dilated
ECMO Lessons

History

- 3 ½ year old male from El Paso with resp distress/ hypoxia. Seen at urgent care multiple times
  + Fever, emesis and decreased PO.
  + Abdominal pain X2.
- In ED + Bilat infiltrates and sats on the mid 80’s. Intubated and sent to PICU.
  Transferred to University Hospital for an ECMO evaluation.

Hospital Course

- Placed on HFOV
  - MAP 38-40/42AMP 60 Hz 60 FIO2 100% with sats mid 90-s down to mid 70’s
    - 0130 7.24/47/61 OI 62
    - 0200 7.29/41/40/-7 OI 100
  - Never had UOP
- Decision to place on VV ECMO
Oxygenation Index

Trachsel, AmJRCCM, 2005.

CXR

Future of ECMO?

Future of ECMO?

FIGURE 1. Artificial pleural circuit lung venous extracorporeal life support (VEXCLS) versus drainage is accomplished by jugular venous drainage cannula. Blood is pumped by Mura Pump, Ann Arbor, Michigan, USA, a collapsible blood rotary pump. Blood is then oxygenated (Facema, Ann Arbor, Michigan, USA) and warmed prior to being returned to the sheep via an umbilical venous cannula.
ECMO?

ECLS Research: Cardiac Perfusion

Home ECMO?

Early ECMO vs. Intubation
Are You Crazy?

Daniel Brodie, MD
23rd Annual Children’s National Medical Center Symposium
ECMO & the Advanced Therapies for Respiratory Failure
Keystone, CO, February 27th, 2013

AT Usage in Pediatric Severe Sepsis: PHIS Database (39,000 patients)

Adult Respiratory Cases

Borrowed from Jim Fortenberry, MD.

* * *
UHS Neonatal/Pediatric Extracorporeal Therapies

- Designed to maximize neonatal/pediatric experience
  - Neonatal ECMO
  - Pediatric ECMO
  - CRRT
  - Plasmapheresis (with Pathology)
  - Erythrocytapheresis (with Pathology)
  - Call (210) 358-2500 for referrals

Future Therapies?

UHS Neonatal/Pediatric Extracorporeal Therapies

- Dr. Armijo-Garcia
  - Medical Director of Pediatric ECMO and Advanced Technologies for University Health System

- Dr. Ted Wu
  - Associate Director

- Dr. Syed Shah
  - Neonatal ECMO Team

- Dr. Don McCurnin
  - "Godfather" of ECMO

Conclusions

- Ventilators are for healthy lungs
- ECMO is for sick lungs
- ECMO is not just a “last ditch effort”
- Applications of ECMO are rapidly evolving
- Having an ECMO program has intangible benefits
- Centers are pushing the boundaries and redefining “standard” ECMO care

With Thanks

- Veronica Armijo-Garcia
- Ted Wu
- Rick Taylor
- Tom Mayes
- Don McCurnin
- Steve Seidner
- Nancy Ray
- Mickey Ryerson

- Kendra
- Casey
- Rheana
- Our entire team of specialists

With Thanks

- Mazen Arar
- Ikuyo Yamaguchi
- Danny Ranch
- Naveen Mittal
- Ian Mitchel
- John Doski
- UHS Blood Bank
11/13/2015

Remember……

HATERS GONNA HATE

Borrowed from Peter D. Wearden, MD, PhD

Remember……

TRADITION


More Thanks!

Extracorporeal Life Support Organization

- Pathology
- Hematology
- Neonatology
- Cardiology
- General Surgery
- CT Surgery

- Jim Fortenberry
- Matt Paden
- Robert Bartlett
- ELSO
- Perfusion (Josh, Haven)

YIKES!
I'm in Delaware!

Questions?

When God is going to do something wonderful, He begins with a difficulty. If He is going to do something very wonderful, He begins with an ICMD machine.