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GREECE

Nothing to disclose
Extracorporeal Life Support (ECLS, ECMO)

- support of heart and/or lung function with mechanical devices

- temporary (days to weeks)
- partial or total
- bridge to recovery, bridge or replacement
INTENTION TO TREAT

ECMO

Bridge to
- Survival
- Decision

Bridge to
- Recovery
- Bridge
- Transplantation
- Long-term support
indications

• acute severe cardiac or pulmonary failure unresponsive to optimal medical management with recovery expected to a few days up to a month
historical perspective

• In 1972, Hill et al published the first report of ECMO use in an adult with post-traumatic respiratory failure.(1)

• Increased interest in ECMO use in newborns and children with respiratory failure was spurred in the 1980s when Bartlett et al and O’Rourke et al showed improved outcomes for these populations.(2)


different techniques depending on indication

• ECMO for cardiac support
  – VA via neck or groin
  – VA through sternotomy for post-cardiotomy

• ECMO for respiratory support
  – VA or VV via neck or groin
  – VV double lumen cannule
  – AV (limited flow) for CO\textsubscript{2} removal
CIRCUIT CONFIGURATION FOR VA AND VV ECMO


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Figure 1.
VV ECMO
Differences Between VA and VV ECMO

- **Venoarterial (VA) ECMO**
  - Higher PaO2 is achieved.
  - Lower perfusion rates are needed.
  - Bypasses pulmonary circulation
  - Decreases pulmonary artery pressures
  - Provides cardiac support to assist systemic circulation
  - Requires arterial cannulation

- **Venovenous (VV) ECMO**
  - Lower PaO2 is achieved.
  - Higher perfusion rates are needed.
  - Maintains pulmonary blood flow
  - Elevates mixed venous PO2
  - Does not provide cardiac support to assist systemic circulation
  - Requires only venous cannulation
• in VA ECMO the ECMO system works in parallel with the native heart/lungs whereas in VV ECMO the system is in series with the heart and lungs
ELSO registry data
(July 2011)

<table>
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<th></th>
<th>Total</th>
<th>Surv ECLS</th>
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<td>Respiratory</td>
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<tr>
<td>ECPR</td>
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<td><strong>Total</strong></td>
<td>46,509</td>
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Runs by Year

ELSO registry data (July 2011)
UK adult ECMO study

CESAR

180 ARDS pts, 30 centers
randomization

90 conventional
28 d survival 50%
6 m survival 47%

90 optimal + ECMO
28 d survival 76%
6 m survival 63%

Adult Respiratory Cases

ELSO registry data (July 2011)
In a study, conducted in Australia and New Zealand, 68 patients suffering from influenza A (H1N1) with ARDS and treated with ECMO were evaluated.

The patient population in the ECMO cohort was exceptionally ill, with a mean PaO\textsubscript{2} to FiO\textsubscript{2} ratio (P/F ratio) of 56 on an average of 18 cm H\textsubscript{2}O of positive end-expiratory pressure prior to initiation of ECMO therapy.
ECMO for ARDS due to H1N1

Australia / New Zealand

201 intubated ARDS pts in 15 centers

68 were put on ECMO

77% survival to discharge
Cardiac Cases By Year
16 years old and over

ELSO registry data (July 2011)
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Runs</th>
<th>% Survived</th>
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<td>Congenital Defect</td>
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<tr>
<td>Cardiac Arrest</td>
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<td>Cardiogenic Shock</td>
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<tr>
<td>Other</td>
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ELSO registry data (July 2011)
NOVALUNG
AV fistula (low flow) for CO2 removal
newer oxygenators with low pressure drop requiring minimal priming volume and having minimal foreign surface contact
ECMO in post-cardiotomy pts

- ECMO after failure of medical treatment and IABP usually resulted in delayed application

- in acute terminal collapse, organ damage should not be evaluated but rather prevented by rapid restoration of circulation
Different patients, different treatments

- Invasiveness of Device
- Duration
- Cost

**Devices:***
- ECMO
- Thoratec B5000 EXCOR
- BVS 5000
- Impella LD
- Impella LP5
- Centrimag (Levitronix)
- TandemHeart
- Impella 2.5
- IABP

**Categories:***
- 1st, 2nd, and 3rd generation implantable devices
- 2nd and 3rd generation extracorporeal and paracorporeal devices

**Support Levels:***
- Full Support
  - 7 l/min
- Partial Support
  - 1 l/min
LVAD – Centrimag as Bridge to Surgery (post AMI VSD closure)
ECMO as a bridge to high-risk rotablation of heavily calcified coronary arteries

Dardas et al, Herz 2012
Freedom from death of any cause after ECMO for postcardiotomy cardiogenic shock.
Mean FU were 0.82 years for all patients and 3.2 years for hospital survivors.
post-cardiotomy ECMO: a half of the half story...

- successful weaning from the system is possible for half of the patients
- more than 50% of the weaned patients die during the hospital stay
- hospital survival thus is limited to 25%
- half of those pts are dead by the end of the 1st year

- despite progress in intensive care management and ECMO hardware components, in-hospital mortality has not significantly changed during the last decade for post-cardiotomy adult pts
Univariate and multivariate analyses of in-hospital mortality

- Age > 70 years
- Body mass index > 30
- Diabetes
- Renal insufficiency
- log EuroSCORE > 20
- Smoker
- CAD
- Isolated CAD
- s/p AMI
- s/p PCI

Mortality ↓

Mortality ↑

Odds ratio

ECMO Predictors for In-Hospital Death

- acute liver failure
- acute renal failure
- anaerobic metabolism (lactates)
- AMI
main complications:

• leg ischemia

• bleeding

• CVAs
Leg complication during percutaneous ECMO support despite distal leg perfusion. Levitronix Centrimag flow of 5.50 L/min at 5200 RPM.
loading v. unloading

- IABP use
- LVAD if LV fails
- RVAD if RV fails

an oxygenator can be added or removed at any stage

- VV ECMO if gas exchange, pulmonary, parenchymal insufficiency

it can be switched to VA if needed
thoracic (v. peripheral) approach

advantages

• larger cannulae - better flows
• avoidance of peripheral vessel complication (e.g. leg ischemia)
• avoidance of retrograde flow in the aorta (coronaries and brain receive blood with higher PaO₂)
• disease specific support (LVAD, RVAD, BVAD +/- oxygenator or ECMO with the CPB cannulae)

disadvantage

• repeat thoracotomy for cannulae removal
**Biventricular** support with the third generation, magnetically levitated, extracorporeal, centrifugal pump *Centrimag, Levitronix*. *LVAD* flow 5.57 L/min, *RVAD* flow 4.92 L/min. An *oxygenator* has been incorporated into the *LVAD* circuit. Hemofiltration was also temporary applied.
Cardiogenic shock in acute *de novo* heart failure

- **Refractory CS in non surgical patients**
  - Percutaneous LVAD or ECMO as bridge to decision and further aetiological treatment

- **Refractory CS in surgical patients (failure to wean, postcardiotomy)**
  - Short or intermediate-term VAD or ECMO support as bridge to reoperation/intervention, BTR, BTT, to bridge, or to long-term MCS.

- **Refractory CS in ACS**
  - Short-term VAD or ECMO support as bridge to PCI, or CABG, or other operation, during PCI or CABG, after PCI or CABG as BTR, BTT, bridge to bridge or to long-term support.

- **Refractory CS in acute myocarditis**
  - Short or intermediate-term support as BTR, BTT, bridge to bridge or to long-term support.
Advances in ECMO technology and positive outcomes of recent studies suggest that the time is right for a renaissance in ECMO use.