When should VA ECMO be considered?

- Refractory cardiogenic shock
- If the process is:
  - Severe (mortality > 80-90%)
  - Acute
  - Potentially reversible

Definition

Refractory Cardiogenic shock:
Shock persists despite volume administration, inotropes and vasoconstrictors, and intra-aortic balloon pump (IABP)

Etiology of cardiogenic shock

- Acute myocardial infarction
- Myocarditis
- Peripartum Cardiomyopathy
- Decompensated chronic heart failure
- Post cardiotomy shock
- Septic Shock with cardiac compromise
- Biventricular failure
- Refractory malignant arrhythmias

No disclosures
Cardiogenic shock/AMI – quick facts
- The median time from MI to onset of cardiogenic shock 5.5 hours and 75% of patients developed shock within 24 hours.

Incidence of shock complicating AMI
Overall incidence 5-8%
- The majority of patients have a STEMI, but CS occurs in 2.5% (NSTEMI)
- 40-50,000 cases/year

Risk factors
- Older age
- Anterior MI
- Hypertension
- Diabetes mellitus
- Multi-vessel coronary artery disease
- Prior MI or diagnosis of heart failure
- STEMI
- Left bundle branch block on the electrocardiogram (ECG)

Symptoms/signs
- Signs of systemic hypoperfusion (eg, cool extremities, oliguria, and/or alteration in mental status)
- Severe systemic hypotension
- Respiratory distress due to pulmonary congestion.

RCS– quick facts
- In-hospital mortality due to refractory cardiogenic shock (RCS) remains in excess of 50%
- Medical therapy using inotropic agents and vasopressors is often ineffective for adequate hemodynamic support.

What works/what doesn't
Methods

• Randomized, prospective, open-label, multicenter trial
• 600 patients with CS complicating acute myocardial infarction, randomly assigned to
  - IABP, (301 pts) or
  - no IABP (299 pts)
  plus early revascularization
• The primary end point → 30-day all-cause mortality.

Results

• At 30 days
  119 patients in the IABP group (39.7%)
  and
  123 patients in the control group (41.3%)
  had died (P = 0.69).

What is ECMO?

• ECMO stands for Extracorporeal Membrane Oxygenation.
• The ECMO circuit acts as an artificial heart and lung

ECMO Circuits

VA-ECMO

VV-ECMO

ECMO?

ECMO stands for Extracorporeal Membrane Oxygenation. The ECMO circuit acts as an artificial heart and lung.
Very short historic background

• 1956 – first heart-lung machine was used by Dr. Gibbon.
• 1971 – first successful ECMO placed by Dr. Hill
• 1975 – first newborn ECMO in CA by Dr. Bartlett
• 1980 – first ECMO center in the world started by Dr. Bartlett at the University of Michigan
• Currently 90+ ECMO centers in the US

ECMO: Advantages:

- Immediate application
- Biventricular support
- Oxygenation
- Refractory malignant arrhythmias do not affect the flow
- Bridge to more durable devices (LVAD)

ELSO

Contraindications to VA ECMO

- absolute
  - Unrecoverable heart and not a candidate for transplant or VAD
  - Chronic organ dysfunction (emphysema, cirrhosis, renal failure).
  - Compliance (financial, cognitive, psychiatric, or social limitations) for further therapies if needed

Contraindications to VA ECMO

- relative
  - Contraindication for anticoagulation?
  - Advanced age?
  - Obesity?

VA ECMO – and what next?

Bridge to Recovery (most common):
- Acute MI after revascularization,
- Myocarditis,
- Postcardiomyotomy
- Drug intoxication

Transplant/Long term VAD:
- Unrevascularizable acute MI,
- Chronic, decompensated heart failure
Outcomes

Cardiac – 7850 pts
56% survived ECLS
41% survived to DC
ECPR 2379 -> 30% survived to DC

Study design

- Retrospective review of adult patients who required an MCS due to CS
- The etiology of RCS included acute MI in 49% acute decompensated HF in 27%.
- VA ECMO was chosen in cases of unknown neurologic status, complete hemodynamic collapse or severe coagulopathy.

Study results

- 90 pts received an MCSD for refractory CS (RCS), 21 (23%) of whom had active CPR.
  - Mean age was 53±14 years, 71% M, 60% had IABP
  - short-term VAD in 49% and VA ECMO in 51%.
  - Median length of support was 8 days
  - Myocardial recovery in 18% and heart transplantation in 11%.
  - Survival to hospital discharge was 49%.
  - Ongoing CPR to be an independent risk factor for mortality

ECMO for cardiogenic shock

81 pts
42% survival to discharge
34% survived 11 months
Risk of ICU death
- Female gender
- CPR during insertion
- 24hr urine output < 500
- Hepatic failure
ECMO Program at Minneapolis Heart Institute/Abbott Northwestern Hospital

Evolution of ECMO Program at ANW

ANW Shock-ECMO Team

Evolution of ECMO Program at ANW
- Daily multidisciplinary rounding
- Monthly multidisciplinary ECMO conference
- M&M
- Monthly operational meeting
- Level 1 ECMO call system
- Unified approach to access/cannula sizes
- ECMO database, research projects, presentations, publications
- ECMO sym lab
- Training for RNs/paramedics
- Credentialing

How does it work at ANW...

Management of an ECMO patient
Management of the patient
- Hemodynamic management
- Fluid and electrolyte
- Hematology
- Anticoagulation
- Respiratory
- Renal
- Neurologic
- Nutrition

Hemodynamic monitoring
- ECG/HR
- A-line/saturation
- S-G catheter
- Cerebral perfusion
- EEG

Knowing about complications...
- Bleeding
- Ischemia → limb, cerebral
- Infection
- Pulmonary complications

ANW ECMO Experience 2012-2015
ECLS Registry Report
Center Specific Summary
January, 2016
Abbott Northwestern Hospital (212)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Total</th>
<th>Survived ECMO</th>
<th>Survived to ICU or Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>22</td>
<td>15 100%</td>
<td>13 60%</td>
</tr>
<tr>
<td>Cardiac</td>
<td>81</td>
<td>55 68%</td>
<td>44 54%</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>4 100%</td>
<td>4 100%</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>75 70%</td>
<td>62 57%</td>
</tr>
</tbody>
</table>
Survival to Discharge

ECPR - survival

Pilot In-House eCPR

- Monday-Friday, 0800-1700
- Target Start Date - Sept 1, 2015 (modified 11-23-15)

Criteria:
- Age 18-75 (was 65)
- Arrest of cardiac origin - VF/VT
- ETCO2>20
- Patient on H4000/5000/5200 or in CVICU

Process:
- AHF & Intensivist go to all codes at the above locations and time, within LESS than 10 minutes
- ECMO candidacy to be determined by AHF & Intensivist
- Level 1 ECMO call placed by AHF MD or the intensivist (ext #31290 or #33535)
- Patient to be transported to the cath lab with LUCAS device and ongoing CPR
- ECMO to be initiated in CV Lab - target time from arrest to initiation of ECMO 60 minutes or less

Cardiogenic shock outcomes:

Survival
- Total of 37 patients:
- Age – mean 61, 28 males (75%)
- Mean time on support 5 days
- Median LOS – 13 days
- 13 pts (35%) died during in-hospital course.
- 24 pts (65%) survived the index admission
- 9/24 pts (24%) – discharged home

Outcomes: Survival

- Majority of deaths occur within the first 15 days (~33%).
- Another 10-11% between 15 days and 4 months.

Long term survival (n=37)

Among those who were discharged from initial hospitalization, survival rate 87.5% with a median follow-up time of 450 days
Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean duration of ECMO support for RCS (days)</td>
<td>5.6</td>
</tr>
<tr>
<td>Mean length of stay (days)</td>
<td>13 (8, 28)</td>
</tr>
<tr>
<td>Renal replacement therapy during index admission (%)</td>
<td>30</td>
</tr>
<tr>
<td>Long term HD</td>
<td>0</td>
</tr>
</tbody>
</table>

Outcomes: ECMO → LVAD

<table>
<thead>
<tr>
<th>Bridge to LVAD</th>
<th>Yes (n=9)</th>
<th>No (n=53)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years), mean (± SD)</td>
<td>50.4 (± 17.3)</td>
<td>59.6 (± 12.3)</td>
<td>0.057</td>
</tr>
<tr>
<td>Male, (%)</td>
<td>7 (77.8)</td>
<td>36 (67.9)</td>
<td>0.55</td>
</tr>
<tr>
<td>Hypertension, (%)</td>
<td>3 (60.0)*</td>
<td>16 (47.1)†</td>
<td>0.59</td>
</tr>
<tr>
<td>Diabetes, (%)</td>
<td>1 (11.1)</td>
<td>12 (22.6)</td>
<td>0.43</td>
</tr>
<tr>
<td>History of CAD, (%)</td>
<td>1 (11.1)</td>
<td>17 (32.1)</td>
<td>0.20</td>
</tr>
<tr>
<td>History of CHF, (%)</td>
<td>5 (55.5)</td>
<td>13 (24.5)</td>
<td>0.058</td>
</tr>
<tr>
<td>Cardiac arrest, (%)</td>
<td>3 (33.3)</td>
<td>24 (45.3)</td>
<td>0.50</td>
</tr>
<tr>
<td>ECMO duration (days)</td>
<td>7 (6, 10)</td>
<td>5 (9, 7)</td>
<td>0.034</td>
</tr>
<tr>
<td>Median admit EF (%)</td>
<td>22 (10, 40)</td>
<td>25 (10, 60)</td>
<td>0.006</td>
</tr>
<tr>
<td>In-hospital death, (%)</td>
<td>2 (22.2)</td>
<td>24 (46.2)</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Case 1

- 50 years old female, no PMH, started to feel dizzy, while teaching karate class
- 911 called, anterior and lateral ST elevation, in ambulance progressive hypotension, clammy, cardiac arrest while pulling into ambulance bay of ANW
- Manual CPR started, then LUCAS initiated
- Cath lab → coronary angiogram → coronary dissection

Case 1

- Dissection of LCx into LM and LAD
- Unsuccessful PCI
- Not a surgical candidate
- Decision about ECMO placement with on-going CPR with LUCAS and adequate MAPs

Outcomes - ECMO & QOL

Case 1

- Prior hx of CHF
- Longer ECMO support
- Lower initial EF
- Worse renal function

No difference in in-hospital survival
Case 1 – hospital course
- Shock liver, acute renal failure requiring CVVH-D
- ARDS
- Rhabdo – bilateral fasciotomies
- Day 2 – CT head demonstrated bilateral cerebellar infarcts
- Multiple family and multi-disciplinary meetings...

Case 1 – hospital course
- Sedation weaned to off and patient starts following simple and complex commands
- EF still less than 10%
- Decision to move with permanent LVAD
- Resolution of pulmonary edema
- Return of renal function to normal
- Transmetatarsal amputation R foot
- Rehab, back to work, driving!

A year later...status post heart transplantation - doing well!

Case 2
- 54 years old male, no PMH, significant family hx of CAD
- Presents with sudden onset CP while at work
- 911 called, cardiac arrest in ED, CPR initiated
- cath lab → coronary angiogram

Case 2
- Despite successful PCI with DES to LM persistent cardiogenic shock requiring multiple pressors and inotropes
- Rising lactate levels
- 2D echo...
Case 2 – initial ECHO

ECMO

Case 2 – ECHO 5 days later

Case 2 – f/u
- Successful explantation of ECMO circuit
- Final EF 30% with moderate MR
- NYHA class 1
- On HF therapies and ICD

Conclusions
When in doubt... call us! We are available 24/7

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24/7 - 612-863-3911
Ask for HF doc on call

Thank You!