Role of ECMO in Heart Failure

Kunal Kotkar, MD
Division of Cardiothoracic Surgery
Disclosures

• I have nothing to disclose
Washington University/Barnes-Jewish Hospital
Acute Extracorporeal Circulatory Support

Including VV and VA ECMO. All patients are managed in CT ICU
Impella utilization for Cardiogenic Shock (CS)

![Graph showing number of Impella insertions for Cardiogenic shock (CS) from 2010 to 2018. The number of insertions fluctuates over the years, with a peak in 2013 and a dip in 2015.](image)
Types of Insertion Impella and the flow with CS

<table>
<thead>
<tr>
<th>Impella Type</th>
<th>N</th>
<th>Insertion Site</th>
<th>Impella Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impella 2.5</td>
<td>46(29%)</td>
<td>Femoral Artery</td>
<td>2.2 L / min</td>
</tr>
<tr>
<td>Impella CP</td>
<td>57(36%)</td>
<td>Femoral Artery</td>
<td>3.0 L / min</td>
</tr>
<tr>
<td>Impella 5.0/LD</td>
<td>53(33%)</td>
<td>Axillary A/Asc Ao</td>
<td>4.0 L /min</td>
</tr>
<tr>
<td>Impella RP</td>
<td>3(2%)</td>
<td>Femoral vein</td>
<td>3.3 L /min</td>
</tr>
</tbody>
</table>
Scenarios: consider “ECMO”

1. **Acute Coronary Syndrome, shock status, Low EF**
   - Chronic, unknown ischemic background
     - Ex: RCA total occlusion, Left side disease progression, unknown baseline cardiac function
   - Late presentation with VSD, pulmonary edema (L to R shunt)
   - Late presentation with Papillary muscle rupture with severe MR pulmonary edema

2. **Post cardiotomy (cardiac surgery) cardiogenic shock**
   - Requested to place an Percutaneous Ventricular Assist device (PVAD)

3. **Acutely decompensated chronic heart failure**

4. **RV failure**
   - RCA territory infarction

5. **Pulmonary emboli**
Scenario 1: Acute Coronary Syndrome CS

- One or two new lesions -> ROUTINE PCI (with Impella assist)
  - NO ECMO

- Acute progression of new lesion with baseline CAD
  - Shock presentation, Low BP
  - PCI with Impella/IABP assist.
  - Leave Impella (14 Fr) in.
  - Stays on DOB 10 mcg/min/kg, Norepinephrine 20mcg, phenylephrine,
  - Low BP, Anuric, LFT rising, Lactate rising

Extremely low chance of survival

30-50 % survival, If ECMO (ECPELLA) are introduced in timely manner
Before you place an Impella in....

- BJH/WU FACT: 100% mortality with limb ischemia more than a few hours
  - Fasciotomy (bleeding)
  - Removal of Impella, VA ECMO (surgery)
  - Non-viable leg muscle -> amputation, comfort care

- 14 Fr (4.7mm) Peel-away sheath and Repositioning sheath (IMPELLA CP)
  - No Impella to less than 6mm common femoral artery without ECMO
    - Contraindications: Severe PVD, ESRD, High dose of Vasopressors
  - If <5mm, consider distal perfusion cannula (No evidence)
Bilateral antegrade perfusion of the superficial femoral artery to prevent limb ischaemia during combined use of Impella CP left ventricular assist device and extracorporeal life support

Lukasz Kizner Christian Flottmann Dieter Horstkotte Jan Gummert

ECMO as bridge to recovery

• Reduces end organ damage
• Provides cardiac/oxygenation support
• Unloads the heart
Scenario 1: Acute Coronary Syndrome CS

- Late presentation
  - Post infarct VSD (Left to right shunt)
  - Papillary muscle rupture (Severe MR)

- PA pressure reduction
- Better End-organ perfusion (uop, liver perfusion)
- Inotropic Vasopressor can be reduced
- Semi-elective surgery

30-50% survival with conventional surgery

Excellent ECMO indication

Extremely low chance of survival
Senario 1: Acute Coronary Syndrome CS

- Late presentation
  - Post infarct VSD (Left to right shunt)
  - Papillary muscle rupture (Severe MR)

  **30-50% survival with conventional surgery**

  **Excellent ECMO indication**

- PA pressure reduction
- Better End-organ perfusion (uop, liver perfusion)
- Inotropic Vasopressor can be reduced
- Semi-elective surgery

Extremely low chance of survival
Scenario 2. Post Cardiotomy shock

- Potential causes being poor myocardial protection, Suboptimal decision making
- Excellent support with VA ECMO
- Technique: Central or peripheral VA ECMO with partial flow/Impella 5.0/LD)
- Central cannulation is desired, but also early chest closure is ideal
ECMO as bridge to recovery or decision

• Excellent end organ protection
• Unloading of heart
Scenario 3: Acute decompensation of HF

- Acute deterioration, shock of ADHF due to NICM
- Vulnerable: PICC line/ICD wire infection, URI, UTI, EP procedures, tachyarrhythmia, prosthesis infection
- Stepwise upgrading
  - IABP
  - Impella CP
  - Impella 5.0
  - ECMO
- Refer before patients get sicker
Scenario 3: Acute decompensation of HF

• If patients are treated well, chances for HTX is better since organ allocation change (10/2018) but social and financial challenges
ECMO as bridge to LVAD/Heart transplant

- Preserves end organ perfusion/recovery
- Unloads the heart
- Temporary LVAD
Scenario 4: RV failure

• RV infarct
• During / after LVAD surgery
• Post cardiotomy
Scenario 4: RV failure

• Classic RV failure treatment is diminishing....
  • Volume loading, inotropic support
    • Oxygenation issues, long hospital stay

• RV mechanical support options
  • IMPELLA RP: higher mortality rate in post approval study
    • Patients need to be sedated and intubated
    • Difficult insertion and positioning
    • Hemolysis, possible thrombosis formation
  • Extracorporeal RVAD ± oxygenator
    • Percutaneous
    • Direct Pulmonary artery cannulation (WITH LVAD SURGERY)
Scenario 4: RV failure, PERC RVAD 1 CANNULA

Key design features include:
• Friction fit introducer & hemostasis cap to minimize blood loss during insertion
• Coaxial wire-wound design for kink resistant inner (16 Fr or 18 Fr) and out (29 Fr or 31 Fr) lumens
• Omni-directional flow ports for consistent performance without repositioning
• Tapered introducer and cannula for gentle insertion through internal jugular vein
• Radiopaque disks for better visualization under fluoroscopy
Scenario 4: RV failure, PERC RVAD 2 CANNULAE

• Percutaneous Pulmonary Artery cannulation
  • IJ- RA – RV- PA
  • Venous drainage in RA

• Pros
  • Better venous drainage
  • No mixing

• Cons
  • Fluoroscopy
  • Risk of RV/PA perforation
Scenario 4: RV failure, PERC RVAD 2 CANNULAE
ECMO as bridge to recovery

- Reduces inotropic /pressor support
- Unloads the RV
- Helps with early extubation and mobilization
Scenario 5: Pulmonary embolism

- Acute massive PE with cardiogenic shock
- Peripheral or central VA ECMO indication
- Resuscitate patient condition with systemic heparin
- ECMO is not eliminated even after tPA
Utilization of Veno-Arterial Extracorporeal Membrane Oxygenation for Massive Pulmonary Embolism

Chetan Pasrija, MD, Anthony Kronfl, BS, Praveen George, MD, Maxwell Raithel, BS, Francesca Boulos, MD, MPH, Daniel L. Herr, MD, James S. Gammie, MD, Si M. Pham, MD, Bartley P. Griffith, MD, and Zachary N. Kon, MD

Division of Cardiac Surgery, University of Maryland School of Medicine, Baltimore; Department of Internal Medicine, University of Maryland School of Medicine, Baltimore; Department of Shock Trauma Critical Care, University of Maryland School of Medicine, Baltimore, Maryland

Table 2. Clinical Variables Before Cannulation (n = 20)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac arrest</td>
<td>5 (25)</td>
</tr>
<tr>
<td>CVA before cannulation</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Systemic thrombolytic agents</td>
<td>7 (35)</td>
</tr>
<tr>
<td>RV strain</td>
<td></td>
</tr>
<tr>
<td>Troponin, ng/mL</td>
<td>1.3 (0.7–2.1)</td>
</tr>
<tr>
<td>NT-proBNP, pg/mL</td>
<td>3,670 (630–13,400)</td>
</tr>
<tr>
<td>RV dysfunction by TTE</td>
<td>Severe (Severe–Severe)</td>
</tr>
<tr>
<td>Hemodynamics</td>
<td></td>
</tr>
<tr>
<td>Heart rate, beats/min</td>
<td>127 (122–135)</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td>95 (92–113)</td>
</tr>
<tr>
<td>Inotropic/vasopressor agents</td>
<td>15 (75)</td>
</tr>
<tr>
<td>Respiratory status</td>
<td></td>
</tr>
<tr>
<td>Respiratory rate, breaths/min</td>
<td>25 (20–30)</td>
</tr>
<tr>
<td>FiO2, %</td>
<td>100 (55–100)</td>
</tr>
<tr>
<td>Intubation</td>
<td>15 (75)</td>
</tr>
</tbody>
</table>

Values are n (%) or median (interquartile range).

CVA = cerebrovascular accident; FiO2 = fraction of inspired oxygenation; NT-proBNP = N-terminal prohormone of brain natriuretic peptide; RV = right ventricular; SBP = systolic blood pressure; TTE = transthoracic echocardiogram.

Fig 1. Flow chart describing therapeutic strategy and survival after veno-arterial extracorporeal membrane oxygenation (VA-ECMO) support. (PE = pulmonary embolism.)
Scenario 5: PULMONARY EMBOLI

• Peripheral or central VA ECMO indication
• Resuscitate patient condition with systemic heparin
• ECMO is not eliminated even after tPA
• New percutaneous PE devices: INARI
• Early detection and implementing the right treatment is the key
ECMO as bridge to recovery

- Acute resuscitation
- Hemodynamic stability
- RV unloading
- End organ preservation
Summary

• Even if you can successfully eliminate reasons for shock
  • Patients still need time to recover
  • Need to maintain their end-organ function
  • Less complications with mechanical circulatory support

• ECMO is powerful tool beyond anything else
  • “double-edged sword”
  • Timing and methods are important

• Wash U/BJH shock team
Washington University Shock Team
Our specialists at Barnes-Jewish Hospital are ready to provide life-saving support to community hospitals that need to partner for ECLS resources.
800-252-DOCS (3627)

Indications for Extracorporeal Life Support (ECLS)
ECMO/Percutaneous Ventricular Assist Device
If your patient meets any criteria below, call the Washington University Shock Team at Barnes-Jewish Hospital for consult or transfer.
800-252-DOCS (3627)

Cardiogenic Shock
- Non-improving hemodynamic status:
  1. Cardiac index <2.0 L/min/m²
  2. Vasoactive Inotropic Score >20
  3. Escalating inotropic and vasoactive medication doses:
     - Norepinephrine >.1 mcg/kg/min, or >15 mcg and/or
     - Epinephrine >.15 mcg/kg/min, or >10 mcg and/or
     - Vasopressin >.04 mcg/min, or
     - Dopamine or dobutamine >7.5 mcg/min/kg
  4. Patient who needs or is already placed on ECMO
  5. Signs of end-organ ischemia:
     - No pulse or no Doppler signals

- Signs of End-Organ Malperfusion
  1. Altered mental status due to brain hypoperfusion
  2. Worsening lactic acidosis (Increased lactate >3.0)
  3. Liver enzyme increase or signs of acute liver failure
  4. Acute oliguria or anuria with acute creatinine increase

Respiratory Shock
- Severe hypoxemic (or mixed hypoxemic/hypercapnic) respiratory failure despite ventilator optimization and use of adjunctive ARDS therapies:
  1. PF ratio of <100 for >3 hours
  2. pH <7.5, PaCO2 ≥60, PaO2 <60
  3. Plateau pressure >25, PEEP >10, peak pressure >40
  4. Acute severe asthma with persistent pH <7.25 despite ventilator optimization, nebulization and steroids
  5. Advanced lung disease with active listing for lung transplantation, with input from lung transplant team

Contraindications to ECLS
1. Functional debility at baseline
2. Advanced chronic lung disease (other than asthma) on home O₂ w/o active listing for lung transplantation
3. Prolonged period of mechanical ventilation (generally >7 days)
4. Terminal cancer
5. Bleeding diathesis/hypocoagulability
6. DNR status
Thank you for your time.