ECMO…. In the Emergency Department

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Objectives
At the end of this presentation, the participant will be able to:
- Understand the differences between Venovenous (VV) and Venoarterial (VA) Extracorporeal membrane oxygenation (ECMO)
- Identify patients who may benefit from VA-ECMO for cardiogenic shock
- Set up an effective mechanism for ECMO initiation in the ED

“Nobody deserves to die in the hospital without a trial of ECMO”
– Dr. Daniel Herr, MD

Out-of-hospital Cardiac Arrest Review
- Out-of-hospital cardiac arrest outcomes remain poor despite advancements in ACLS protocols and with conventional CPR (C-CPR)
  - ROSC < 40%
  - Survival to discharge 7-11%\(^1\)
  - Favorable neurological outcome 3-5%\(^2\)
- Improved outcomes with
  - Therapeutic hypothermia post-ROSC \(^3,4\)
  - Rapid defibrillation\(^5\)
  - Cardiocerebral resuscitation \(^6,7,8\)
  - Rapid PCI\(^9\)
  - ECLS/ECMO Assisted CPR (E-CPR) \(?)\)

ECMO Overview
- Venovenous ECMO (VV ECMO)
  - Primary goal: Support during reversible respiratory failure
  - Indications (ARDS, severe PNA, ILD, etc.) \(^10\)
    - Refractory hypoxemia - P:F ratio< 80 for over 6 hrs
    - Refractory hypercapnia with acidemia – pH < 7.15 – 7.20
    - Excessively high P\(_{\text{PLAT}}\) >35-45 cm H\(_2\)O
  - Cannulation
    - Bicaval, dual-lumen Avelon\(^{\text{TM}}\) catheter through the right internal jugular vein (23 or 27 French)
    - Dual insertion through the right IJ and femoral vein
- Venoarterial ECMO (VA ECMO)
  - Primary goal: Support during reversible cardiac failure/shock (CS)
    - Bridge to recovery, transplantation, destination therapy, or decision
  - Indications
    - Refractory cardiogenic shock\(^{11,12}\)
      - Hypotension (SBP<80-90; MAP > 30mmHg from baseline)
      - End-organ dysfunction
      - Cardiac index < 1.8 - 2.2 L/min/m\(^2\)
      - PCWP > 18 mmHg
    - AHA: No specific hemodynamic recommendations\(^{13}\)
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- ESC/EATS: No specific hemodynamic recommendations
- ELSO: No specific hemodynamic recommendations

  o Cannulation
    - Central cannulation to ascending aorta performed in the OR
    - Peripheral cannulation in femoral vessels performed at the bedside
      - Catheter size: 17 Fr arterial, 21 Fr venous
      - Arterial cannula rests in distal aorta
      - Provides retrograde flow
  
  o Improved physiology in cardiogenic shock
    - Decreased pulmonary artery pressure
    - Increased end organ perfusion
    - Increased PaO₂ over VV ECMO

  o ECMO flow rates
    - Goal: Arterial pulse pressure ≥ 10 mmHg
    - Begin with 1.5 – 2 L/min, titrate to 3-6 L/min
    - May require vasopressor/inotropic support, goal MAP > 65

  o Additional considerations
    - Therapeutic hypothermia rapidly initiated through heat exchanger
      - Target core body temp: 32-34°C
    - Anticoagulation required
      - Unfractionated heparinization: body weight adjusted
    - Mechanical Ventilation
      - Lung protective ventilation (6-8cc/kg TV)
    - Monitor for distal limb ischemia

**Extracorporeal Life Support assisted CPR (E-CPR)**

- Indications
  - Down time is “brief”
  - Condition is reversible – coronary occlusion, drug induced, refractory arrhythmias
  - Condition is amenable to transplantation or revascularization

- In-hospital cardiac arrest
  - Chung et. al (2012): In-patients with acute CS treated with ECMO
    - Study: Prospective observational study of 134 patients
      - STEMI: 37 (27.6%)
      - Non-STEMI: 16 (11.9%)
    - Protocol initiated if C-CPR failed to ROSC after 30 minutes, contacted after 15 minutes
    - On pump within 25-30 min from cardiac arrest
    - **STEMI group outcomes significantly better**
  - Shin et. al (2011): In-patients with a cardiac cause of arrest
    - Improved survival to discharge
    - Improved 6-month survival with minimal neurologic impairment
    - When CPR > 30 min: E-CPR survival (19.2%) > C-CPR (1.3%)
• Out-of-hospital cardiac arrest
  o Inter-hospital variation in availability and protocol
  o Can be performed in the ED - Bellezzo et. al (2012)
    ▪ Case series
      • Staged approach to ECLS initiation
      • 18 patients – 8 patients transitioned to ECLS
    ▪ Inclusion
      • Persistent arrest despite standard efforts
      • CS (SBP < 70 mmHg) refractory to medical treatment
    ▪ Exclusion criteria
      • Asystole
      • Prolonged downtime without CPR (> 10 min)
      • Prolonged transport time (>10 min)
      • Prolonged arrest time (>10 min)
      • Suspicion of shock due to sepsis or hemorrhage
      • Pre-existing neurological disease prior to arrest
    ▪ Outcomes
      • Survival to discharge, full neuro recovery: 5 (63%)
      • Non-survivors: mean ECLS time: 48.4 hrs
  o Kagawa et. al (2012)
    ▪ Study: Retrospective review
    ▪ Inclusion: Age 18 – 74, +/- Vfib, CPR initiated < 15 min from collapse, arrest, No ROSC within 20 min of C-CPR
      • 81 ACS patients
        o 61 received intra-arrest PCI
        o 20 did not receive PCI
    ▪ Cardiac arrest followed by ECMO, PCI, and/or hypothermia
      • 30-day survival: 29%
      • Favorable neurologic outcome: 24%
    ▪ Intra-arrest PCI, time interval from collapse to pump, and in hospital cardiac arrest were associated with 30-day survival
• What does this mean to you?
  o Skeptics (Lyon RM, 2012)
    ▪ ECLS cost prohibits wide-spread adoption
    ▪ Limited data for utilization of VA ECMO in cardiac arrest, and on which patients will benefit
  o Proponents
    ▪ It is possible, data appears favorable for salvage therapy
    ▪ Goal: Bridge to revascularization or further intervention
    ▪ Algorithmic and team based result required
    ▪ Good patient selection leads to improved outcomes
Selected References


