ECMO: Caveats of Therapy and Special Considerations for Medication Management

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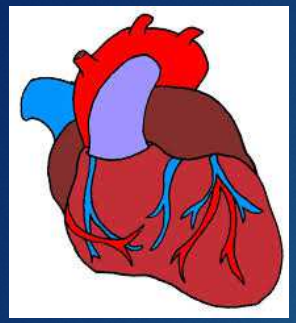
OBJECTIVES

- Define ECMO and indications for therapy utilization
- Identify the patient population ideal for ECMO therapy
- Understand the special considerations/complications associated with ECMO therapy
- Explain the potential alteration of pharmacokinetics from ECMO
- Describe the evidence behind utilizing ECMO therapy

ECMO

- ECMO = **E**xtra**C**orporeal **M**embrane **O**xygenation
  - AKA: extracorporeal life support/extracorporeal lung assist
- Prolonged cardiopulmonary support
- Blood is pulled from vascular system and passed through oxygenator/heat exchanger to be reinfused into circulation
- Hgb becomes saturated with O_2 while CO_2 is removed

Haft J, Bartlett R, Parsons P, et al. "Extracorporeal *membrane oxygenation* (ECMO) in adults". 10/2/2013. www.uptodate.com. Accessed on 10/30/2014.



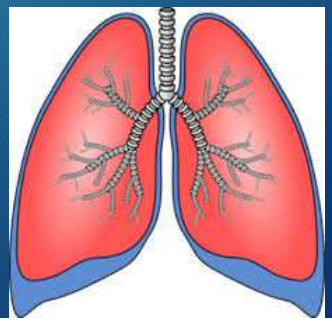
Types of ECMO

Veno-arterial

- Blood is pulled from RA & returned to arterial system, bypassing lungs AND heart
- Provides respiratory and hemodynamic support
- Venous cannula placed in IVC or RA for drainage & arterial cannula placed in RFA for infusion
- **RCA*** or subclavian artery for infusion
  - Severe PAD or prior FAR

Veno-venous

- Blood is pulled from vena cava or RA & returned to RA, bypassing lungs
- Provides respiratory support only
- Venous cannula placed in RFV for drainage and RJV for infusion



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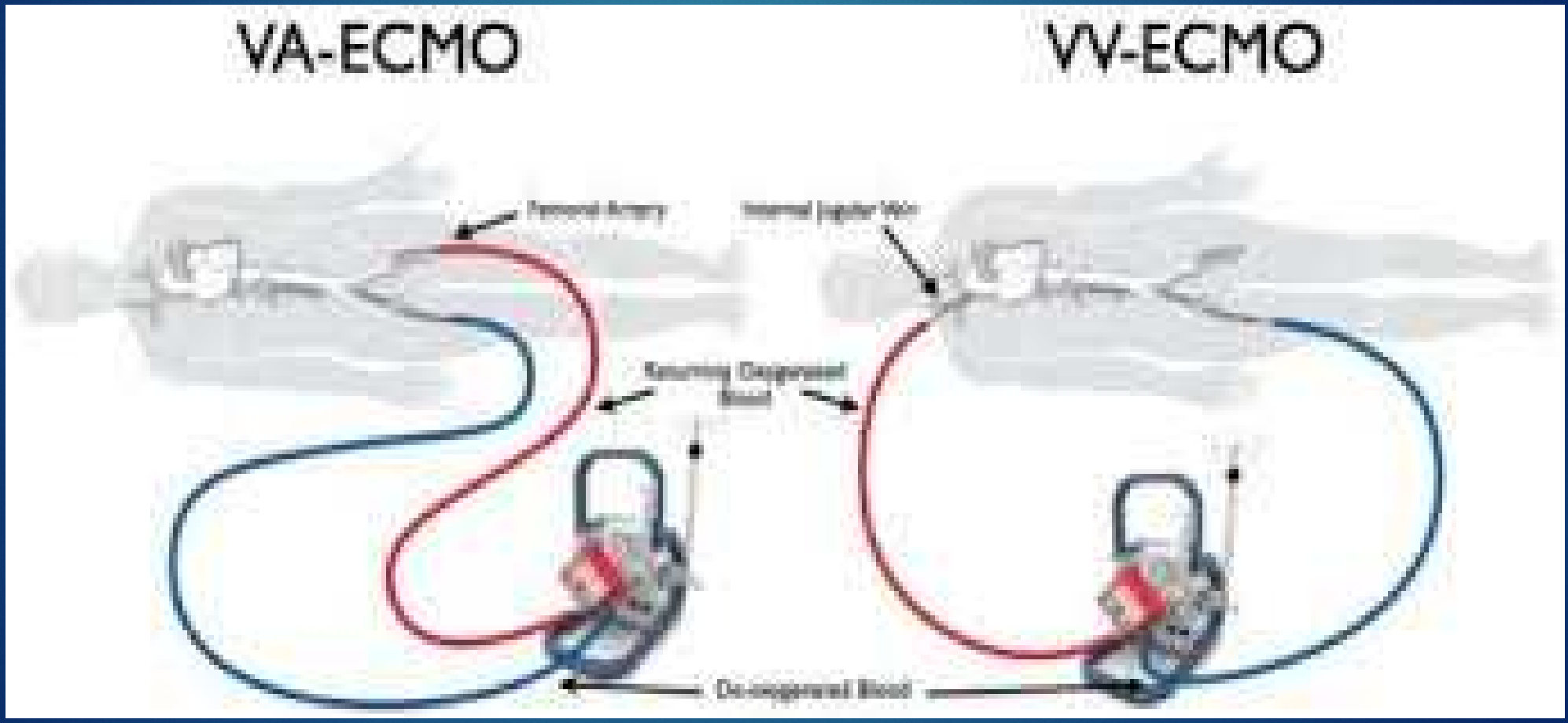

http://www.pic2fly.com/Extracorporeal+Membrane+Oxygenation+Adults.html

Indications for ECMO

- Respiratory = veno-venous
  - Severe ARDS
  - Graft failure s/p lung transplant
  - Bridge to lung transplant
  - Trauma
  - Asthma

Buscher, Hergen. "ICN ECMO Presentation". Sydney Intensive Care Network meeting. 17th March 2011. www.intensivecarenetwork.com. Accessed 10/31/2014.

Indications for ECMO

- Cardiac = veno-arterial
  - Cardiogenic shock
  - S/p cardiotomy (unable to be weaned off bypass)
  - Graft failure s/p heart transplant
  - Bridge to heart transplant/VAD
  - Myocarditis
  - ECMO-CPR
  - PE

Buscher, Hergen. "ICN ECMO Presentation". Sydney Intensive Care Network meeting. 17th March 2011. www.intensivecarenetwork.com. Accessed 10/31/2014.

Target Patients

- Respiratory:
  - Reversibility, ventilation <7 days, age<65 years old, no end-stage disease
- Cardiac:
  - Avoid if VAD/transplant is contraindicated
- Avoid irreversible causes & if anticoagulation is contraindicated
  - Active bleeding, recent intracranial injury, etc.

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Special Considerations of ECMO

- Anticoagulation:
  - Foreign surface of circuit + blood = hypercoaguable state
  - **UFH** is DOC
  - ECLS circuit prime (NO releasing polymers)
  - Bolus 50-100 units/kg, then continuous infusion once ACT < 300 seconds
  - ACT target: 180-220 seconds
    - PLT administration, increase U/O, & RRT = ↑UFH

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Special Considerations for ECMO

- Blood flow
  - VV = maximum rate
  - VA = adequate perfusion but enough to provide sufficient preload
- LV monitoring
  - Inotropes
- Diuresis
  - Fluid restriction = concentrated solutions

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Complications from ECMO

- Bleeding: 30-40%
  - PLT consumption & anticoagulation
- Precautions: sx technique, PLT >100K, target ACT
- Treatment:
  - Sx wounds: electrocautery, exploratory sx w/VAC
  - TXA/amicar
  - Hold UFH = ↑ risk of circuit thrombosis
  - PCC or rFVIIa*
  - ↓ target ACT (170-190 seconds)

Lequier L, Annich G, Al-Ibrahim A, et al. ELSO Anticoagulation Guideline. Extracorporeal Life Support Organization. 2014.

Complications from ECMO

- Thromboembolism
  - VA > VV
  - Pressure gradient change
  - UFH & vigilant observation
  - Primed circuit at bedside – 20%
- HIT
  - Argatroban
- VA
  - Pulmonary hemorrhage
  - Cardiac thrombosis
  - Coronary/cerebral hypoxia

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Pharmacokinetics in ECMO

- Limited data
  - Neonates most studied
- Drug sequestration
  - Large surface area
  - Older circuits/lipophilic meds = ↑ sequestration
  - Release of isolated meds post-infusion

Shekar K, Fraser J, Smith M, et al. "Pharmacokinetic changes in patients receiving extracorporeal membrane oxygenation". Journal of Critical Care. 2012. (27), 741.e9-741.e18

Pharmacokinetics in ECMO

- Increased Vd (hydrophilic*)
  - Circuits = PK compartment
  - Hemodilution, inflammation, fluid shifts, renal dysfunction, fluid retention
- Reduced CL
  - Renal dysfunction
  - Liver perfusion
    - Meds with high E
  - ↓ Pulmonary blood flow*
    - Sedatives/analgesic
  - Predisposes patient to drug toxicity

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Evidence for ECMO

- Respiratory:
- CESAR trial
  - N=180
  - Survival: ECMO vs conventional tx
  - 63% vs 47%
- Cohort study examining H1N1 pts w/ARDS
  - N=75 matched pairs of pts
  - Hospital mortality: ECMO vs conventional tx
  - 23.7% vs 52.5%
- Observational & uncontrolled trials
  - Survival rate on ECMO: 50-71%

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Evidence for ECMO

- Cardiac:
- Observational studies & case series
  - VA for cardiac arrest, cardiogenic shock, or post cardiotomy
  - Survival rates: 20-43%
- Two observational studies
  - VA for cardiac arrest vs CPR alone = ↑ survival
- Retrospective cohort study
  - Long-term survivors of VA have better health & social functioning
    - Chronic HD, advanced HF, or recovered from ARDS

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Take Home Points

- Anticoagulation is a big deal
  - If HIT suspected, know which agent to use
  - Use caution before recommending rFVIIa
- Veno-arterial ECMO = bigger risks
- Concentrated drips for fluid restriction
- More data on adult ECMO pharmacokinetics needed

PATIENT CASE

- JS is 84 year old male s/p redo CABG X 5 with MVR and redo AVR
- PMH: HTN, CAD, GERD, Dyslipidemia, T2DM, asymptomatic prostate CA, A.fib, & carotid disease
- Post-op, pt unable to extubate from ventilator
- O_2 saturation continued to drop
- Started on ECMO

Patient Case

- What type of ECMO would we use? (Cardiac function: optimal)
- What anticoagulant would we recommend?
- HIT is now suspected in patient
  - AST/ALT: 7539/2010
- What anticoagulant would we now recommend?
- Pharmacy has been asked to max concentrate drips
  - What CRUCIAL resource will you use to make these drips??!!

Patient Case Answers

- Veno-venous ECMO should be used because patient's cardiac function was fine post-op
- UFH is anticoagulant of choice
- Angiomax for severe hepatic dysfunction
- Formweb
  - Critical Care
    - IV Stability Guidelines/Max Concentrations

Questions

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http://www.dreamstime.com/stock-photography-crazy-dentist-image7466852

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