WHEN SHOULD I THINK ABOUT AN ECMO CONSULT?

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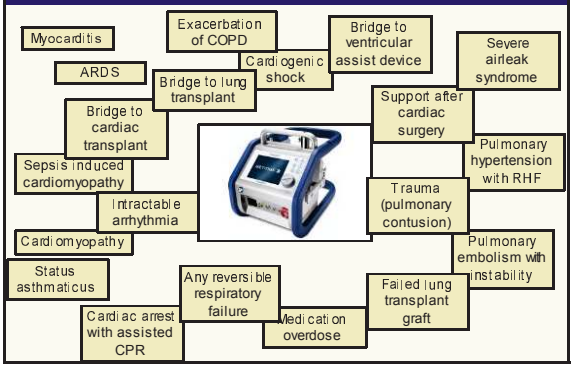
FIRST DISCLOSURE

No financial disclosures to report

SECOND DISCLOSURE

- Decisions regarding who and who not to place on extracorporeal membrane oxygenation (ECMO) are extremely challenging.
- Every patient is different, (seriously).
- Institutionally, most decisions are made by discussions with multiple ECMO care providers.

INDICATIONS FOR ECMO



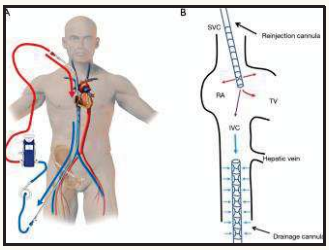
INDICATIONS FOR ECMO

WHAT'S THE POINT OF ECMO?

- "ECMO is a bridge, not a destination"
  - The goal is to create the physiologic "space" for improvement in reversible processes.
- "ECMO is a fancy ventilator"
  - Sam Mandell MD

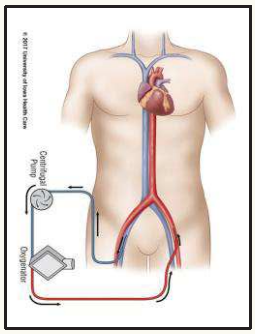
TWO "KINDS" OF ECMO

1. Veno-Venous extracorporeal support
   - Adults with severe, acute respiratory failure refractory to conventional therapy
   - "Lung Bypass"



TWO KINDS OF ECMO

2. Veno-Arterial extracorporeal support
- The presence of both cardiac and respiratory insufficiency.
- "Heart + Lung Bypass"



VV ECMO FOR RESPIRATORY FAILURE

- We are "pretty sure" that VV-ECMO has a role in severe respiratory failure with a correctable etiology in adults.
- To date, 4 randomized control trials have studied the effectiveness of ECMO in this population
  - Zapol WM et al. JAMA 1979
  - Morris AH et al. Am J Respir Crit Care Med 1994
  - Peek GJ et al. (CESAR trial). Lancet 2009
  - Combes A et al. (EOLIA trial). NEJM 2018

VV ECMO for Respiratory Failure

CESAR TRIAL

Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Glen J Peek, Miranda Mugford, Ravindranath Tiruvoipati, Andrew Wilson, Elizabeth Allen, Marianna M Thalanany, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration

- UK based, RCT, n=180 patients randomized to "conventional management" or "referral to consideration for treatment by ECMO"
- 18-65y, severe RF (Murray score >3 or pH <7.2) and a potentially reversible failure

Peek GJ et al. *Lancet*. 2009;374:1351-63

CESAR TRIAL

TABLE 2. Murray score[18]

Variable	Score				
	0	1	2	3	4
PaO_2/FiO_2 (on 100% oxygen) in mm Hg	≥300	225-299	175-224	100-174	<100
CXR (quadrant)	Normal	1	2	3	4
PEEP (cm H_2O)	≤5	6-8	9-11	12-14	≥15
Compliance (mL/cm H_2O)	≥80	60-79	40-59	20-39	≤19

Abbreviations: CXR = chest X-ray; FiO_2 = fraction of inspired oxygen; PaO_2 = partial pressure of oxygen; PEEP = positive end-expiratory pressure

- Exclusion:
  - High peak inspiratory pressure (>30 cm H2O)
  - High FiO_2 (>80%) for >7 days
  - Intracranial hemorrhage or other contraindication to heparin
- Outcome = death or severe disability at 6 months

CESAR TRIAL

- Results
  - ECMO referral group had a reduced risk death or disability at 6 mts (RR 0.69; 95% CI 0.05-0.97, p=0.03)
- Issues
  - The benefit shown was referral to the ECMO center, not ECMO itself.
  - The ECMO center was a single hospital (Glenfield Hosp) therefore hard to generalize
  - Conventional treatment at outside hospitals was not standardized/protocolized (contradicts ARDSnet)
  - Only 75% of patients "referred for consideration for treatment by ECMO" got ECMO
  - Conclusions hard to interpret and not earth shattering

ONE MONTH LATER…

CARING FOR THE CRITICALLY ILL PATIENT

JAMA-EXPRESS

Extracorporeal Membrane Oxygenation for 2009 Influenza A(H1N1) Acute Respiratory Distress Syndrome

The Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators*

Context The novel influenza A(H1N1) pandemic affected Australia and New Zealand during the 2009 southern hemisphere winter. It caused an epidemic of critical illness and some patients developed severe acute respiratory distress syndrome (ARDS) and were treated with extracorporeal membrane oxygenation (ECMO).

Davies A et al. *JAMA*. 2009;302:1888-95

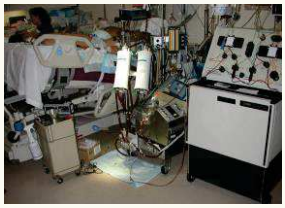
ECMO AND H1N1

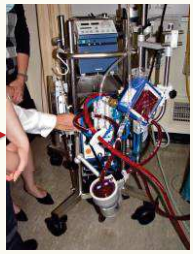
- Observational "trial" of those with H1N1-associated ARDS treated with ECMO
- N=68 patients in Australia and New Zealand
- Median 34.4 years old, 50% females
- Median duration of ECMO 10 (7-15) days
- 71% survival to ICU discharge

Historically less <50% survive

Davies A et al. *JAMA*. 2009;302:1888-95

SIMULTANEOUSLY THE TECHNOLOGY GOT EASIER





Room-sized 1990's.

Pole-sized 2009.

EOLIA TRIAL

The NEW ENGLAND JOURNAL of MEDICINE

MAY 24, 2018

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

A. Combes, D. Hajage, G. Capellier, A. Demoule, S. Lavoué, C. Guervilly, D. Da Silva, L. Zafrani, P. Tirot, B. Veber, E. Maury, B. Levy, Y. Cohen, C. Richard, P. Kalfon, J. Bouadma, H. Mekontso, E. Schortgen, G. Lebreton, J. Bréchard, N.D. Ferguson, E. Fan, A.S. Slutsky, D. Brodie, and A. Mercat, for the EOLIA Trial Group, REVA, and ECMONet*

- International, RCT with severe ARDS
  - PaO_2/FiO_2 ratio < 50 mmHg for >3h OR
  - P/F ratio < 80 for >6h OR
  - ABG with pH <7.25 with $PCO_2 \geq 60$ mmHg for >6h
- Randomized to VV-ECMO or conventional therapy.
- ❖ Cross-over to ECMO was possible.
- Primary outcome = 60 day mortality

Combes A et al. *NEJM.* 2018;378:1965-75

EOLIA TRIAL

- Results:
  - Trial stopped due to futility (240 enrolled, needed 331)
  - 28% of the control crossed over to ECMO with 43% surviving
  - No statistical difference in 60d mortality between the groups
    - RR of death 0.76; 95% CI 0.55-1.04; p=0.09

EOLIA TRIAL

From the NEJM editorial:

"The routine use of ECMO in patients with severe ARDS is not superior to the use of ECMO as a rescue maneuver in patients whose condition has deteriorated further. This conclusion comes with the important caveat that to achieve similar results, clinicians ought to use all other evidence-based interventions…while reserving ECMO for patients whose life-threatening hypoxemia persists despite these efforts"

Hardin CC and Hibbert K

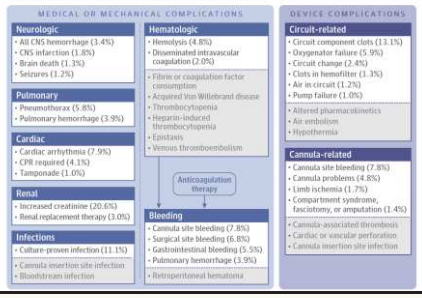
Combes A et al. *NEJM*. 2018;378:2032-2034.

BUT WAIT, MORE EOLIA

- If you take into account the crossover patients with a survival rate of 0-33%, the RR risks of death with ECMO is 0.74 to 0.62, p<0.001 and p=0.045, respectively
- Another RCT is likely not possible
  - CESAR enrolled at 0.03 patients/unit/month
  - EOLIA enrolled at 0.06 patients/unit/month
  - If you use these rates and have 100 participating sites, it would take 9 to 17 years to gain power

ECMO COMPLICATIONS

Figure 2. Selected Complications Associated With Adult Respiratory Extracorporeal Membrane Oxygenation (ECMO)

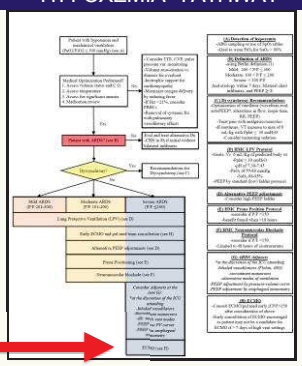


Brode D et al. *JAMA*. 2019;322:557-568

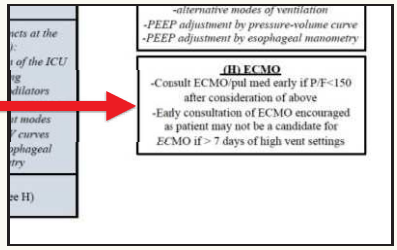
VV ECMO FOR RESPIRATORY FAILURE

- So the conclusion is a firm maybe, but most likely yes in those with severe hypoxemia and failed validated, evidence-based therapies.

SO AT HMC, END OF THE HYPOXEMIA PATHWAY



SO AT HMC, END OF THE PROTOCOL



HMC INDICATIONS FOR VV-ECMO

- Severe hypoxemia RF (P/F<100) despite maximal therapy on RF pathway
- Severe hypercarbia RF (pH ≤ 7.2) despite maximal therapy on RF pathway
- Patient must have potentially reversible pulmonary disease
  - Bacterial or viral pneumonia, aspiration pneumonitis, ARDS with reversible etiology, severe pulmonary contusions, major air leaks resulting from chest trauma, smoke inhalation, severe asthma

HMC CONTRAINDICATIONS TO VV-ECMO

- Premorbid medical condition that is not reversible with poor prognosis (metastatic cancer, end stage COPD, neurologic event with poor prognosis)
- Active intracranial or epidural hemorrhage
- Active or ongoing hemorrhage secondary to trauma, GI bleed
- Prolonged mechanical ventilation with high levels of support
  - >7 days of MV with peak airway pressures >30 cm H2O and/or FiO_2 >80% (not absolute)
- Advanced age (no absolute age contraindication)

VA ECMO for Cardiac Failure (and Respiratory Failure)

VA ECMO FOR CARDIAC FAILURE

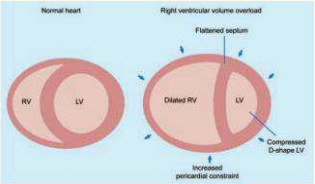
- Even more controversial than VV-ECMO
- Indications
  - Severe hypothermia with impaired cardiac output
  - Massive pulmonary embolism
  - Reversible, acute cardiac failure (e.g. myocarditis or blunt myocardial injury)
  - Trauma patients requiring pneumonectomy
  - eCPR
  - Reversible septic shock

SEVERE HYPOTHERMIA

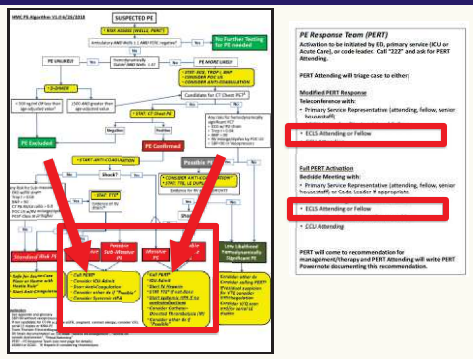
- Hypothermia defined by core body temperature:
  1. Mild (32-35C)
  2. Moderate (28-32C)
  3. Severe (<28C)
     - Reduce myocardial contractility
     - Risks of ventricular fibrillation
- VA-ECMO allows for rapid rewarming and hemodynamic normality during warming process.
  - Rewarm as fast as 10C per hour
  - As patient rewarms (28-32C) risks of atrial fibrillation and ventricular arrhythmias

MASSIVE PULMONARY EMBOLISM

- A massive pulmonary embolism may rapidly increase right heart pressure demanding right heart output with eventual failure (and low LV efficiency) = LOW BP
- Bridge to catheter directed or systemic therapy

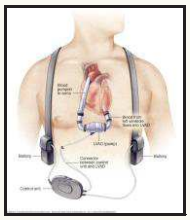


MASSIVE PULMONARY EMBOLISM



ACUTE CARDIAC FAILURE

- Failure = cardiogenic shock with reversible etiology
  - Despite optimization of intravascular volume, inotropes, and vasoconstrictors, and intra-aortic balloon pump, if appropriate
- Common disease states
  - Acute myocardial infarction with anticipated recovery after revascularization
  - Myocarditis
  - Peripartum cardiomyopathy
  - Post-cardiac surgery
- A bridge to transplant or implantable circulatory support



ECPR

- Emergent VA-ECMO following out of hospital cardiac arrest
- Even more complicated and controversial
- Common inclusion criteria
  - Non-elderly patients
  - With initial cardiac rhythm of VF or VT
  - OR PEA with reversible cause
  - With a fixed duration of prehospital CPR
  - Without life-limiting condition
  - With effective CPR (end-tidal $CO_2 \geq 10$ mmHg)

SUMMARY

- Decisions regarding ECMO are very complicated
- Hypoxemic respiratory failure is the most evidenced based indication for VV-ECMO after other interventions have been utilized
- VA-ECMO is more complicate, with less evidence, and evolving
- If you are not sure, call!

THANK YOU

QUESTIONS?

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