Introduction to VV ECMO

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Disclosures

- None
Objectives

Upon completion of this educational activity, you will be able to:

1. Describe the indications, contraindications, and selection guidelines for VV ECLS.
2. Discuss clinical indications for establishment of ECLS support.
Educational Need/Practice Gap

• Indications for VV ECLS are not unequivocal. The initiation of VV ECLS is a highly invasive procedure. Providers need to be aware of the classic indications and patient management strategies for VV ECLS in severe acute respiratory failure.
The desired change/result in practice is to be aware of the different indications and initial treatment targets for VV ECLS.
Veno-venous ECMO

- Calendar year ending 2017, Extracorporeal Life Support Organization (ELSO) registry:
  - ~12k VV ECMO, compared to ~11k VA ECMO.
  - VV ECMO: 66% survived ECLS, 57% until DC or transfer
  - VA ECMO: 56% survived ECLS, 40% until DC or transfer

These numbers have doubled compared to 2010.
Veno-venous ECMO

- Used for respiratory failure after failing all conventional ventilator:
  - Hypoxemic, ie Murray score 3 or above (PaO2/FiO2 ratio, lung compliance, PEEP and cxr abnormalities)—calculator score
  - Hypercapnic with pH below 7.20
  - Make sure lungs are dry with diuresis OR ultrafiltration
Indications for VV ECMO

- Hypoxemic resp failure with P/F ratio below 100 mm Hg despite optimization of ventilator settings *. The Berlin consensus document on ARDS suggest ECMO when P/F ratio is below 70 mm Hg.

- Hypercapnic resp failure with arterial pH below 7.20

- Ventilatory support as a bridge to lung transplantation

- Preferably less than 7 days on ventilator (ie, minimize risk of fibrotic stage ARDS prior to initiation of VV ECMO).

- Use either as treatment for severe ARDS or as a bridge to lung transplant
Strategies to maximize gas exchange prior to ECMO initiation

- Ventilator settings: ARDSnet criteria
- Nimbex drip (first 48 hrs after ARDS onset, duration 48 hrs, PaO2/FiO2 below 150 mm Hg)
- Prone ventilation (first 24 hours, PaO2/FiO2 below 100 mm Hg)
- Inhaled nitric oxide or inhaled flolan
- Dry lungs, appropriate antimicrobial Rx
Ventilator injury to the lung

- ARDS net recommendation:
  - Keep plateau pressure 30 cm H2O or less to minimize barotrauma
  - Tidal volume ~ 6 mL/kg ideal body weight to minimize volutrauma
  - PEEP 5-12 to minimize atelectotrauma
VV ECMO indications

• When maximum ventilator strategies fail to provide adequate oxygenation or ventilation, add VV ECMO.

• VV ECMO will allow oxygenation and ventilation which will minimize ventilator injury to the lung
Indications for VV ECMO

• Hypoxemic respiratory failure with P/F ratio below 100 mm Hg despite optimization of ventilator settings *. The Berlin consensus document on ARDS suggest ECMO when P/F ratio is below 70 mm Hg.

• Hypercapnic respiratory failure with arterial pH below 7.20

• Ventilatory support as a bridge to lung transplantation
Contraindications (relative) to VV ECMO

- Contraindication to anticoagulation
- CNS injury
- Poor functional status prehospitalization
- Baseline advanced lung disease or cancer with poor prognosis
- Age
Ventilator setting when on VV ECMO

- Many advise Plateau pressure below 20 to allow “lungs to rest” and to maximize venous return/Cardiac output

- FiO2 0.4

- My approach: goal is maximize ECMO and vent settings to allow us to adequately oxygenate patient (ie, PaO2 above 55 mm Hg).
  
  - If unable to adequately oxygenate patient, then increase plateau pressure to 28-29 by increasing PEEP, or Inspiratory time. And increase vent FiO2 to 50%.
  
  - Ok to minimize ventilator minute ventilation as sweep on VV ECMO will normalize pH (do NOT correct PCO2, rather keep pH 7.35-7.45)
VV ECMO

- Can be accomplished with 2 catheters: femo-femoral or IJ-femoral vein.
  
  OR

- Single catheter via IJ vein (Avalon catheter)
2 catheter VV ECMO

Ventetuolo, C: Extracorporeal Life Support in Critically Ill Adults. AJRCCM, 190 (5): 497-508
Single catheter VV ECMO

Dual lumen veno-venous

Ventetuolo, C: Extracorporeal Life Support in Critically Ill Adults. AJRCCM, 190 (5): 497-508
Evidence for VV ECMO

- Efficacy and economic assessment of Conventional ventilatory support versus Extracorporeal membrane oxygenation for Severe Adult Respiratory failure (CESAR): a multicentre randomised controlled trial
  
CESAR trial

• 180 patients that met criteria, 1:1 randomization:
  - Murray score 3 or above, OR pH below 7.20
  - less than 7 days on ventilator
  - age 18-65

Exclusion: intracranial bleeding, on high vent settings >7 days, or "any contraindication to continuation of active treatment"
**CESAR trial**

- 180 patients were randomized VVECMO vs conventional Rx.
- ~70/90 in each arm had 1-2 organ failure, the rest 3 or more
- 68 patients (75%) actually received VVECMO
- 50% had 48 hours or less ventilator support, the rest less than 7 days
6 months survival, p=0.03
Pitfalls of CESAR trial

- Much more ECMO patients received steroids than conventional rx.

- 22 patients assigned to ECMO did not receive it (some died, some got better before transfer to ECMO center)

- Much more ECMO patients got protective ventilation than conventional rx (not required)
VV ECMO

• Complications:
  – ICU complications **PLUS**: thrombocytopenia, catheter infection, bleeding, thromboembolism from catheter/oxygenator site, oxygenator thrombosis
VV ECMO

- When all else fails (including dry lungs)
- Less than 7 days on vent
- No CNS injury, no contraindication to anticoagulation
- Can be as treatment option OR as a bridge to lung transplant
ECMO for severe ARDS randomized clinical trail

- Randomly assigned patients with very severe ARDS (P/F ratio below 50 mm Hg for > 3 hrs; P/F ratio below 80 mm Hg for more than 6 hrs; or pH below 7.25 with PCO2 above 60 mm Hg for more than 6 hrs)

- Primary end point was 60 day mortality

- Complications: similar except more bleeding requiring transfusion (46% vs 28%) & more thrombocytopenia (27% vs 16%) in ECMO group

- No significant difference in 60 day mortality between the two groups.
ECMO for severe ARDS

Figure 2. Kaplan–Meier Survival Estimates in the Intention-to-Treat Population during the First 60 Days of the Trial.

Combes, A et al: NEJM, 378(21): 1965-75, 2018
ECMO for severe ARDS

• This trial was stopped early because of efficacy between the 2 arms of the study, although the actual survival difference of 11% was not significant.

• VV ECMO resulted in improved oxygenation, more days free of renal failure, lower rate of ischemic stroke and mortality benefit was almost reached significance.

• This study does not definitively support the routine use of ECMO of all patients with ARDS, it does support the early use of ECMO in those for whom conventional therapy does NOT improve oxygenation.

Combes, A et al: NEJM, 378(21): 1965-75, 2018