COVID-19 ECMO
Experiences and Management

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COVID-19 ECMO Preliminary Findings

- 15 COVID-19 ECMO Patients
  - 7 currently on support
  - 7 decannulated
  - 1 expired during cannulation
  - 5 extubated
  - 3 transferred out of ICU with intact neurological function
  - 2 home
Pre-ECMO Management

- ARDS Protocol
- Rapid placement on ECMO if failing lung protective ventilation, paralysis, proning
- Excess fluid removal
- Low-dose Heparin infusions if elevated D-dimer
Criteria is much stricter than normal
Anticipate limited resources

- Younger age, previously healthy, no severe chronic end-organ failure
  - Oldest COVID-19 ECMO patient is 56
- Failed lung protective ventilation (TV < 6ml/kg IBW, Pplat < 30)
- Perfusion compromised by acidosis (pH < 7.2, CO2 > 70)
- Trial of neuromuscular blockade
- Trial of prone positioning
- P/F ratio < 100
  - Or progressively declining to <150 despite 3-4 proning trials
Patient characteristics

- Age 16 – 56
- Male: 56, 55, 52, 50, 49, 46, 45, 44, 44, 37, 30
- Female: 55, 52, 16, 47(dec)
- Most with DM, HTN, and obesity
- 73% with BMI over 30
- 86% Hispanic
- 80% DM
Cannulation

• Team
  – Cardiac Surgery/Anesthesia
  – ECMO MD
  – ICU

• Location
  – ICU Room

• VV
  – Fem-Fem
  – 25F IVC multistage drain
  – 19F-21F return to RA
  – Placed using TEE

• Heparin Bolus
  – Initially 50 units/kg
  – Increased to 100 units/kg or greater after first set of cases
  – Increased clotting

• Full protective PPE, PAPRs, N95
Bronchoscopy in COVID-19 ECMO Patients

• Total of 9 performed
• Prepare room so patient can be without intervention for one hour
  – Medications, CRRT fluids, ventilator alarms
• Full neuromuscular blockade
  – Bolus followed by infusion
• Place adaptor with one-way valve allowing bronch
  – Clamp ETT
• Single provider performs procedure
• Post-Bronchoscopy
  – Only the provider that performed bronchoscopy will be able to enter room for one hour
Tracheostomy

- Total of 6
- Prepare room so patient can be without intervention for one hour
- Minimize number of staff in room
- Bronch MD (handles bronch and withdrawal of ETT)
  - Vent on stand by during trach insertion
- Cardiac Surgeon (percutaneous trach, partial open with electrocautery)
- Continue Bivalirudin or Heparin through procedure
- Post-procedure oozing
  - Prolonged direct pressure to site
Ventilator Management

- TV < 4ml/kg IBW
- Pplat < 24
- RR 10
  - Initially
- PEEP
  - For patients with high PEEP, decrease PEEP to 10-12 over 12 hours
- Verticalization
  - Kreg Bed
Anticoagulation

- Higher initial heparin bolus
- Heparin responders without thrombotic complications
  - PTT goal 75-100
  - Moderate intensity
- Bivalirudin for those with thrombosis or unresponsive to heparin
  - PTT 75-95
  - Using high doses of 0.3 – 0.7
Anticoagulation

- Low dose aspirin if TEG MA high and patient thrombotic
- High rate of circuit exchange despite heparin in target range
- High rate of CRRT filter clotting
- 50% of patients thrombotic complications
- 50% of patients on bivalrudin

One patient with massive PE
  - On heparin with PTT 62
  - Given TPA for PEA arrest with good result
  - Currently on VVA for RV failure - improving
  - 21 days VV, 5 days VVA – total of 26 days on ECMO support
Thrombotic complications

- PE x1 on heparin PTT 62, trial TPA infusion and heparin
  - Then TPA infusion and bival due to clotting on heparin/TPA
- Circuit changes emergent on 3 patients, despite at PTT goal
- Early thrombosis in circuit on 40%
- Early clotting in cannula in 2 patients
Anticoagulation Post-Decannulation

- 4 days IV Heparin or Bivalirudin
  - Drop PTT goal to 50-70
  - Low-intensity Heparin protocol
- Transition to Lovenox after 4 days
  - If D-dimer is still elevated
- Upon discharge
  - Transition to Eliquis prior to discharge
  - Follow up with hematology in 2 weeks
  - D-dimer testing and length of Eliquis determination
CRRT

- High flow pre-filter replacement fluid
  - Roughly 6L pre-filter replacement fluid for cytokine removal

- 11 out of 15 placed on CRRT – investigational protocol
  - When machines and replacement fluid available

- General decrease in inflammatory markers
  - Ferritin, CRP, D-dimer

- Indications
  - Volume removal without compromising ECMO circuit flow
  - AKI
Proning

• Prone all patients before ECMO

• Prone those on ECMO who do not improve after 2 days
  – Improves P/F ratio in most

• One patient required proning after decannulation
Secondary Infections

- Staph MSSA
- Klebsiella
- Pseudomonas
  - Total of 2
  - Developed into MDR in one
Convalescent Plasma

- Given to 2 patients
  - 46m htn, etoh with Covid brain: encephalopathy, seizures treated with anti-seizure medicine
    Appeared to improve after receiving plasma – lungs and brain

  - 30m hypothyroidism - plasma x2, lack of improvement on VV ECMO
    Plasma given beginning of ECMO run, then after 10 days
    Currently on trial off ECMO expect to decannulate tomorrow after 19 days VV ECMO
COVID-19 Brain Preliminary Findings

- Neurologic dysfunction in 30% of patients
- Seizures
  - Total of 3 patients
  - Improved or resolved with treatment (Vimpat, Keppra)
- Encephalopathy
  - Total of 1 patient
  - Presented as hallucinations
  - Improved with time
- Subcutaneous EEG
  - Better signal than scalp EEG
  - Implanted in 5 COVID-19 ECMO patients
  - 2 patients currently sedated
Subcutaneous EEG

Implanted into subgaleal space

Inserted in 5 COVID-19 ECMO patients

-FDA IDE obtained

Mild bleeding controlled with pressure
Subcutaneous EEG

Found seizures when scalp EEG did not
Subcutaneous EEG

Main Screen
Conclusions

- ECMO may successfully support patients with severe COVID-19 lung failure and multi-organ dysfunction
- Stricter criteria, early CRRT, increased anticoagulation, frequent proning
  - 7 have come off ECMO after 7-19 days, 1 death cardiac tamponade
  - 5 extubated
- Increased thrombotic complications (about 50%)
- Stuttering course – clinical and serologic
- Later findings of neurologic dysfunction that has been treatable (about 30%)
- Of the 7 who are still on VV ECMO, 4 appear to be progressing, 3 are limping along at 1 week and 4 weeks
- Too early to accurately assess survival rates, preliminary experience suggests favorable outcomes with VV ECMO in carefully selected patients
STAY SAFE AND HEALTHY

PPE Works!

ECMO Works!