Use of Extracorporeal Membrane Oxygenation Support for Stage IV Lung Injury: A Case Report

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Situation:

- 24 y/o Female
- 91kg, 172cm
- Trailer Fire, unresponsive on scene
- Sustained 37% TBSA full thickness burns with a Grade IV lung inhalation injury
- Severe respiratory acidosis
VV ECMO Strategy:

- 17Fr percutaneous venous cannula in RIJ
- 25Fr multi-stage venous cannula in RFV
- CardioHelp-I with 5.0 HLS Bioline disposable
- TEE confirmed cannula position, preserved EF, no PFO, or valvular anomalies
VV ECMO Course – 166 hours

- Taken to the OR
VV Course

- Initial Goals:
  - Fluid replacement - Parkland Formula & BSA – 300cc/hr LR for 24hr post initial burn
  - Minimum u/o >30cc/hr
  - 2x daily Bronch with nebulized heparin
- Oliguric, K+ >7.0, elevated PTT despite off systemic anticoagulation
- Hypotensive → increasing pressor requirements (vaso, then NE)
- Rising Lactate 9.0, peaked at 15.0
- Cardiac arrhythmias
Etiology of Metabolic Acidosis

- Ischemic Bowel?
- Low Cardiac Output?
- Use of High Dose Vasopressors?
- Anemia and Inadequate Oxygen Delivery?
- Cyanide Poisoning?
Day 1 - 2

- **Evaluation**
  - Bedside exploratory laparotomy → NO ischemic bowel
  - Heart Failure Cardiology Consult with Echo
    - Bedside TEE → under-filled, hyper-dynamic LV
    - Team Concluded VA ECMO not indicated

- **New Goals**
  - ↑ Volume resuscitation including FFP gtt at 150cc/hr
  - Increase Transfusion Trigger
  - Wean vasopressors
  - 2nd Treatment for cyanide poisoning – sodium thiosulfate
VV ECMO Course Day 3 - 6

Day 3 – improving hemodynamics
- volume resuscitation reduced → FFP drip stopped
- improving lactate

Day 4 – successful wean trial
- elected to continue support until proning for back debridement was completed
- Laparotomy closure in OR

Day 5 - 6 – Debridement and excision of back burns in OR
Severe hemorrhage
- 41 RBCs, 9 platelets, 37 FFP over next 24 hrs
- Procedure EBL 4L
Successful decannulation despite hemorrhage within 18 hours post procedure
Assessment of Endothelial Damage
DAMPs (Damage Associated Molecular Patterns) & Shed Glycocalyx

- Hemorrhagic shock and severe burn result in the release to circulation of Damage Associated Molecular Patterns (DAMPs)
  - DAMPs → endotheliopathy, loss of endothelial glycocalyx → increased endothelial permeability and systemic inflammation
- We measured mitochondrial DNA (mtDNA) and shed syndecan 1 (a component of glycocalyx) and compared to healthy donor plasma
  - Beginning measurements: mtDNA content was 20x control
  - Following blood and plasma transfusions: mtDNA content was reduced to 3x control
- Plasma levels of mtDNA and shed syndecan 1 decrease in the course of RBC and FFP transfusion
- Administration of FFP and RBCs may decrease 3rd spacing in patients with severe endothelial injury

Discussion

- VV ECMO – corrected the respiratory acidosis via CO2 removal
- Burn patients experience severe endothelial Injury caused a massive third spacing and hypovolemia
- In this case worsening metabolic acidosis occurred subsequent to hypovolemia and possible poisoning.
  - Central Venous monitoring or Pulmonary Artery pressure monitoring could have been beneficial in diagnosis
- DAMPs, Syndecan 1 and mtDNA may prove to be a good assay for evaluating treatment of glycocalyx injury
  - Addition of FFP continuous infusion may have contributed to reduced capillary leak
- Heparinization while on ECMO during surgery (should consider stopping heparin prior to surgery).
Conclusions:

- Inhalation burn patients have a high mortality rate.
- VV ECMO can be used to support Grade IV inhalation injuries/Gas exchange.
- The hemodynamic monitoring is essential.
- Aggressive treatment of capillary leak, and improving oxygen delivery is imperative to worsening metabolic acidosis.
- mtDNA and syndecan 1 may prove to be a good assay for evaluating treatment of glycocalyx injury.
References
