

Assessing the delivery of prescribed clearance in pediatric ECMO patients <20 kilograms requiring CRRT through in-line hemofiltration



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Introduction

- Acute kidney injury (AKI) during Extracorporeal Membrane Oxygenation (ECMO) is common, affecting 40-61% of patients (1).
- Many of these patients require continuous renal replacement therapy (CRRT).
- In 2016, we changed our protocol for CRRT on ECMO in patients <20kg, shifting to using the in-line filter within the ECMO circuit to provide hemodialysis.
- The main reasons for the change were to streamline CRRT procedure and mitigate risks associated with additional extracorporeal volume when adding a CRRT machine.

Methods

- We performed a retrospective chart review of all patients on CRRT with ECMO since 2014.
- At Children's of Alabama, ECMO uses an adult oxygenator to minimize hemolysis and clotting of their oxygenator and circuit.
- To achieve the 500mL/min blood flow required for the oxygenator, they use a shunt within the circuit.
- Within the shunt lies a hemodialysis filter (MinnTech HPH 400, Medcomp, Minneapolis, MN)
- This provides us the ability to deliver CVAHD (continuous veno-arterial hemodialysis) or CVVHD (continuous veno-venous hemodialysis) without the addition of a CRRT machine.
- We use this filter as well as two Alaris IV pumps (one to deliver dialysis fluids and one to remove ultrafiltrate) to provide clearance in all patients <20kg (Figures 1, 2).
- Patients at COA with AKI or chronic kidney disease are prescribed 24mL/kg/hr of clearance across all continuous modalities to start.
- We defined appropriate delivery of clearance and fluid removal if we:
 - successfully delivered the prescribed dialysis fluid
 - were able to meet our hourly fluid removal goals

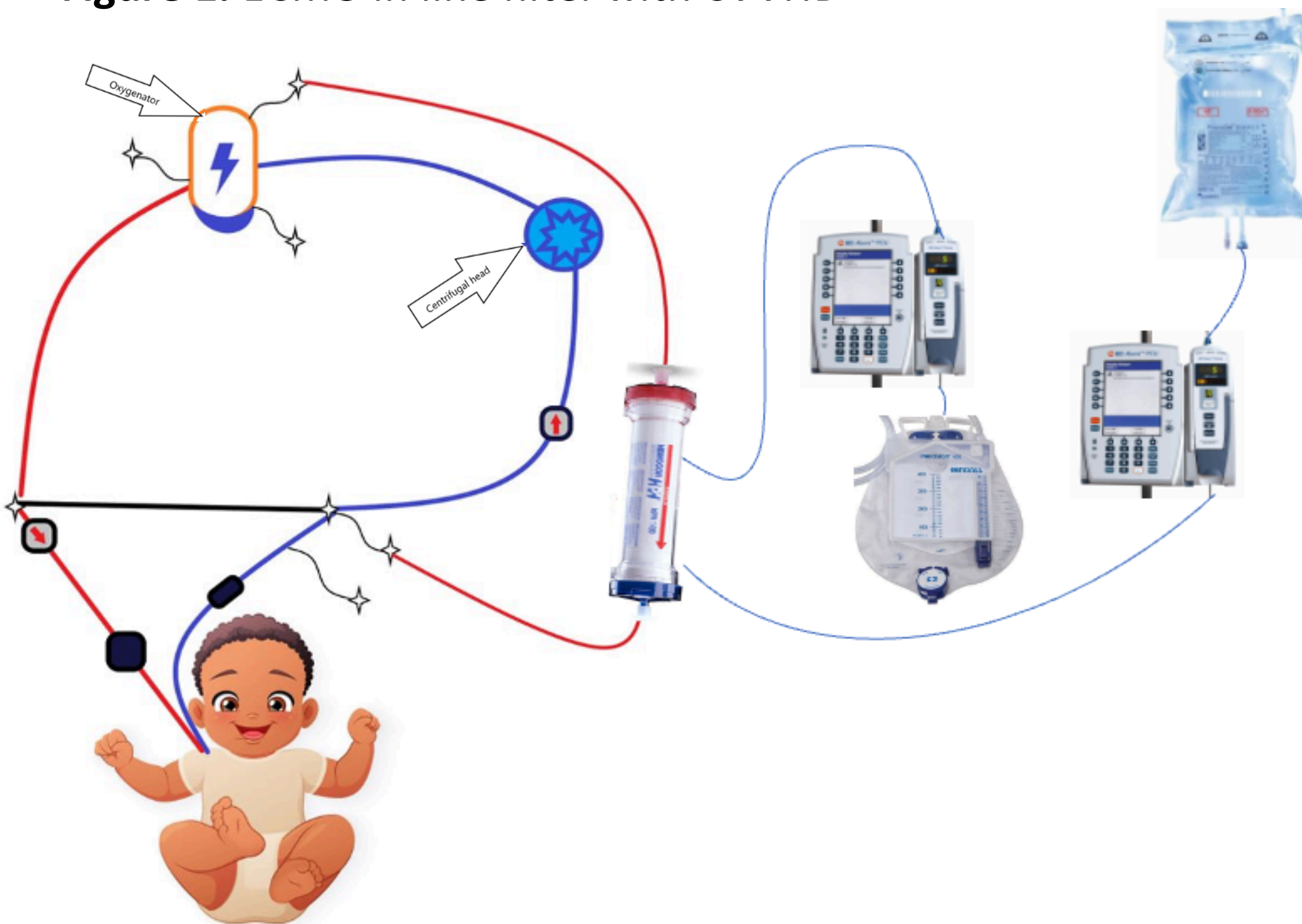
Results

- 117 infants and children have been placed on ECMO and CRRT at our institution.
 - 35/ 117 (29.9%) were performed using a traditional machine
 - 82/117 (70.1%) were performed using in-line filter
 - 81/82 (98.8%) of patient runs using the in-line filter received appropriate clearance and fluid removal.
 - 1 patient had bleeding issues, causing significant uremia, requiring increased clearance from our standard and was placed on CRRT machine.

Table 1: ECMO patients requiring CRRT since 2014 at COA

| | ECMO w/ external CRRT machine | ECMO w/ in line filter |
|--|-------------------------------|-------------------------|
| Patient ECMO runs | 35 (29.9%) | 82 (70.1%) |
| Patient days | | |
| Median (IQR) | 6.0 (4, 12) | 6 (3, 12.75) |
| Total days | 369 | 763 |
| Patient age | | |
| Median (IQR) | 13 (6.9, 15.6) years | 14.6 (3.65, 138.7) days |
| Patient weight (kg) | | |
| Median (IQR) | 49.6 (22.35, 70.1) | 3.27 (2.8, 5) |
| Chronic Diagnosis | | |
| *Cardiac | 4 (11%) | 19 (23%) |
| *Endocrine | 1 (3%) | 1 (1%) |
| *Genetic | 4 (11%) | 6 (7%) |
| *GI | 2 (6%) | 0 |
| *Hematology/Oncology | 5 (14%) | 2 (3%) |
| *Neurology | 1 (3%) | 0 |
| *Psychology | 1 (3%) | 2 (3%) |
| *Pulmonary | 0 (0%) | 19 (23%) |
| *Renal/Urology | 2 (6%) | 9 (11%) |
| *Rheumatology | 1 (3%) | 0 |
| *Skeletal/muscular | 1 (3%) | 1 (1.4%) |
| *No chronic diagnosis | 13 (37%) | 23 (28%) |
| Diagnosis leading to ECMO | | |
| *Congenital and acquired cardiac abnormalities | 9 (25.7%) | 22 (26.8%) |
| *Congenital diaphragmatic hernia | 0 | 18 (21.9%) |
| *Multiorgan failure due to infectious reason | 14 (40%) | 13 (16%) |
| *Respiratory failure/pulmonary hypertension | 12 (34.3%) | 28 (34.1%) |
| *Other | 0 | 1 (1.2%) |
| Reason for CRRT | | |
| *Ammonia | 1 (2.9%) | 1 (1.4%) |
| *Electrolytes | 13 (37.1%) | 31 (43.7%) |
| *Fluid provision | 2 (5.7%) | 8 (11.3%) |
| *Fluid overload | 13 (37.1%) | 18 (25.4%) |
| *Ingestion | 2 (5.7%) | 0 |
| *Peritoneal dialysis failure | 0 | 3 (4.2%) |
| *Rhabdomyolysis | 2 (5.7%) | 1 (1.4%) |
| *Tumor lysis | 1 (2.9%) | 0 |
| *Uremia | 1 (2.9%) | 9 (12.7%) |
| *Unknown | 0 (%) | 0 |
| Unit | | |
| *CVICU | 10 (28.5%) | 26 (31.7%) |
| *NICU | 1 (2.9%) | 45 (54.9%) |
| *PICU | 24 (68.6%) | 11 (13.4%) |
| Survival | 16 (45.7%) | 24 (29.3%) |

Figure 1. ECMO in line filter with CVVHD



References

1. Hansrivijit, P., Lertjitbanjong, P., Thongprayoon, C., Cheungpasitporn, W., Aeddula, N. R., Salim, S. A., Chewcharat, A., Watthanasuntorn, K., Srivali, N., Mao, M. A., Ungprasert, P., Wijarnpreecha, K., Kaewput, W., & Bathini, T. (2019). Acute Kidney Injury in Pediatric Patients on Extracorporeal Membrane Oxygenation: A Systematic Review and Meta-analysis. *Medicines (Basel, Switzerland)*, 6(4), 109. <https://doi.org/10.3390/medicines6040109>

Conclusions

- In patients <20kg, CRRT via ECMO in-line filter can achieve prescribed clearance and fluid balance goals.
- This strategy obviates the need for a CRRT machine, eliminating the complexities associated with additional machinery and extracorporeal volume in this smaller patient population.
- This strategy also decreases the need for RN resources, as there is no additional extracorporeal set up or maintenance.
- At COA, we estimate a cost savings of 75%.



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