Identifying the Limb at Risk in Pediatric Patients on Extracorporeal Membrane Oxygenation

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Introduction

- Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) is increasingly used to support patients in cardiopulmonary shock
- Pediatric patients on extracorporeal membrane oxygenation (ECMO) have increased risk of lower extremity complications and nearly 50% have limb ischemia requiring intervention (1)
- Previously investigated factors for limb ischemia include younger age, female sex and larger cannula size (2-4)
- Identifying specific patients at risk for these catastrophic complications remains difficult, in part due to challenging physical examinations

AIM: The purpose of this study was to identify objective markers of impending limb ischemia following femoral artery cannulation.

Methods

Cohort:

- Retrospective review of all pediatric patients who underwent veno-arterial (VA) ECMO between 2016 and 2023 at a tertiary pediatric hospital

Outcomes:

- Demographics
- Laboratory markers starting at time of Cannulation
- Procedural/surgical interventions
- Complications

Results

Table 1. Cohort demographics and cllinical features of patients who underswent ECMO 2016 - 2023

	Case	*Control*	*Total*	*P-value*
Number cases	(N=5)	(N=31)	(N=36)	
Sex				
Male	2 (40%)	11 (35.5%)	22	1
Female	3 (60%)	20 (64.5%)	23	
Age at time of admission				
Mean (SD)	16 (6.28)	15 (4.12)	15 (4.38)	0.895
Median [Min, Max]	14 [12.0, 27.0]	16 [1.00, 24.0]	15 [1.00, 27.0]	
Diagnosis				
Cardiac	3 (60.0%)	13 (41.9%)	16 (44.4%)	0.955
Overdose	1 (20.0%)	6 (19.4%)	7 (19.4%)	
Sepsis	1 (20.0%)	4 (12.9%)	5 (13.9%)	
Pulmonary	0 (0%)	8 (25.8%)	8 (22.2%)	
Venous Cannula Size				
Mean (SD)	25 (0)	24 (4.10)	24.2 (3.81)	0.872
Median [Min, Max]	25 [25, 25]	25 [7, 32]	25 [7, 32]	
Duration of ECMO (hours)				
Mean (SD)	211.6 (273.3)	603.3 (1281.6)	533.3 (1171.6)	0.798
Median [Min, Max]	103.16 [43.8, 695]	114.6 [33, 438.3]	114.6 [33, 438.3]	
Missing	0 (0%)	8 (25.8%)	8 (22.2%)	
Time from ECMO Start to Time of Death (hours)				
Mean (SD)	NA (NA)	1580 (2283.3)	1580 (2283.3)	1
Median [Min, Max]	NA [NA, NA]	73.6 [2.3, 6350]	73.6 [2.3, 6350]	
Missing	5 (100%)	20 (64.5%)	25 (69.4%)	
Mortality Status				
Alive	5 (100%)	20 (64.5%)	25 (69.4%)	0.866
Deceased within 1 year of ECMO tx	0 (0%)	4 (12.9%)	4 (11.1%)	
Deceased within 30 days of ECMO tx	0 (0%)	7 (22.6%)	7 (19.4%)	

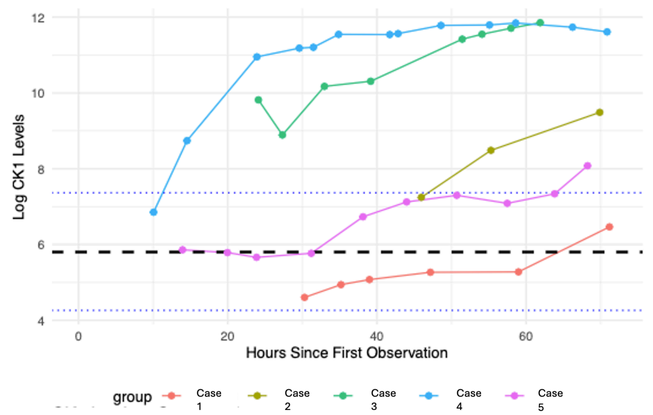

FIgure 1. Logistic regression of creatinine kinase (CK) levels over time after initial cannulization

- 36 patients were reviewed, with 5 cases of lower extremity complications
  - Complications included below knee amputations, fasciotomies, and thrombectomies
- Clinical diagnoses prior to canalization showed no differences between groups
- Venous cannula size was equivocal between patient groups
- No difference observed between cases and control groups for duration of ECMO
- The overall mortality rate was 30.6%

Table 2. Laboratory markers post ECMO cannulization.

	Case	*Control*	*P-value*
Creatine Kinase	37490.75 (13216-103397)	825 (20-18641)	< 0.001
Lactate	4.1 (2.3-5.9)	1.29 (0.36-42.25)	0.20
Hematocrit	32.8 (30.6-36.8)	35.73 (16.55-44.4)	0.34
PTT	59.72 (35.45-66.6)	62.2 (24.2-184.15)	0.66
DTT	67.3 (43-91.6)	81.3 (76.75-99.9)	0.56
aPTT	67.3 (43-91.6)	81.3 (76.75-99.9)	0.55

- No differences in lactate (p=0.208) hematocrit (0.341) or PTT (p=0.661) between the groups
- Maximum CK over 22,913 was indicative of critical limb ischemia (Youden's index= 0.9545)

Conclusion

- 36 patients were reviewed, with 5 cases of lower extremity complications
  - Complications included 2 below knee amputations (BKA), 2 fasciotomies, and 1 thrombectomy and fasciotomy
- Etiology of these complications ranged from prolonged ischemia, to reperfusion injury resulting in compartment syndrome (CS) to thrombosis
  - The overall limb ischemia rate was 13.8%
  - The overal mortality rate was 30.6%
- There were no differences in demographic variables or underlying diagnosis between patients who developed limb ischemia and those who did not
- Laboratory markers including lactate, hematocrit, and PTT showed no differences between the cohorts
- Patients who developed limb ischemia had significantly higher creatine kinase (CK) compared to those who did not

Significance: CK is a useful lab test to identify patients with an elevated risk for acute limb ischemia following femoral cannulation for VA-ECMO.

Limitations: Single center study, smaller cohort, provider dependent practices

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Acknowledgements

Special thanks to:

- Max Wohlauer, MD
- Julia S. Sanders, MD

- University of Colorado, Department of Vascular Surgery
- Colorado Children's Hospital, Department of Orthopedics