Acute kidney injury and fluid overload during pediatric extracorporeal membrane oxygenation are associated with increased mortality: a report of the multi-centre KIDMO study group.

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Background

- Extracorporeal membrane oxygenation (ECMO) is a life-saving therapy for pediatric and adult patients with severe cardiac and/or respiratory failure.
- ECMO patients are at increased risk of acute kidney injury and the development of fluid overload which are both associated with increased mortality.
- Renal replacement therapy has become an important tool in the management of severe acute kidney injury in patients undergoing ECMO.
- The pediatric ECMO literature examining these topics consists only of single center experiences with relatively small patient populations.
- A need exists for a multi-center group to evaluate acute kidney injury, fluid overload and renal replacement therapy for pediatric patients on ECMO in a comprehensive manner.

Objective

- To evaluate the incidence and outcomes of acute kidney injury in children on ECMO.
- To characterize the incidence and implications on outcome of fluid overload for children on ECMO
- To describe epidemiology of and the outcomes associated with the use of renal replacement therapy in children on ECMO.

Hypothesis

- We hypothesize that acute kidney injury and the use of renal replacement therapy will occur frequently in children treated with ECMO and will be associated with increased mortality
- We further hypothesize that children on ECMO will be subject to the development of significant fluid overload and the degree of fluid overload will be associated with increased mortality

Methods

- The Kidney Intervention During Extracorporeal Membrane Oxygenation (KIDMO) study group has been formed with 6 participating institutions:
  - University of Michigan, C.S. Mott Children's Hospital, Ann Arbor, Michigan, USA[1]
  - University of Alabama Birmingham, Birmingham, Alabama, USA [2]
  - Vanderbilt University School of Medicine, Nashville, Tennessee, USA[3]
  - Cincinnati Children's Hospital, Cincinnati, Ohio, USA[4]
  - Emory University/Children's Healthcare of Atlanta, Atlanta, Georgia, USA[5]
  - McGill University Health Centre, Montreal, Canada[6]
- We present a preliminary analysis from an ongoing retrospective review of children at 4 centers (cardiac and respiratory) from the KIDMO study group receiving ECMO from 2007-2011
- Acute kidney injury was defined based on rise in creatinine criteria or requirement for renal replacement therapy based on the KDIGO modifications of the AKIN criteria.
- Fluid overload was calculated at the initiation of ECMO and during ECMO by cumulative ins/outs.
  - $\%\text{Fluid Overload} = \frac{\sum(\text{Fluid in} - \text{Fluid out})}{\text{ICU Admission Weight}} \times 100$
- Results reported as number (N) and percent (%)
- Children with incomplete data were excluded. (N=34)
- Indications for renal replacement therapy were extracted from physician notes
- Outcomes of interest included ECMO mortality and in-hospital mortality.

Results

- 358 of 392 patients had adequate data for analysis
- Median age less than 1 month
- ECMO mortality was 24.0%
  - Acute kidney injury during the course of ECMO was associated with increased ECMO mortality (36.3 vs.12.8%, p<0.001)
- In hospital mortality was 39.7%
  - Acute kidney injury during the course of ECMO was associated increased in-hospital mortality (53.2 vs 27.3%, p<0.001).
- 112 (31.5%) patients received renal replacement therapy
  - 96.4% CRRT, 3.6% Peritoneal Dialysis

Table 1: Acute Kidney Injury

Stage	At ECMO Initiation (N=353)	During ECMO (N=358)
0	289 (82%)	187 (53%)
1	9 (3%)	19 (5%)
2	18 (5%)	23 (6%)
3	37 (10%)	129 (36%)

Table 2: Indications for Renal Replacement Therapy

	N=112
Fluid Overload	92 (82%)
Acute Kidney Injury	8 (7%)
Electrolyte Abnormalities	3 (3%)
Toxin Removal	5 (4%)
Not Indicated	4 (4%)

Table 3: ECMO Mortality

Variable	Survival		p
	Yes (N=272)	No (N=86)	
Acute Kidney Injury	109 (40%)	62 (72%)	<0.001
Acute Kidney Injury at ECMO Initiation	44 (16%)	20 (23%)	0.122
Renal Replacement Therapy	65 (24%)	47 (55%)	<0.001
Fluid Overload at ECMO Initiation (%)*	12(19)	16(19)	0.15
Peak Fluid Overload on ECMO (%)*	35(32)	58(50)	<0.001

** Mean (SD)*

Results

Table 4: In Hospital Mortality

Variable	Survival		p
	Yes (N=216)	No (N=142)	
Acute Kidney Injury	80 (37%)	91 (64%)	<0.001
Acute Kidney Injury at ECMO Initiation	32 (15%)	32 (23%)	0.062
Renal Replacement Therapy	43 (20%)	69 (49%)	<0.001
Fluid Overload at ECMO Initiation(%)*	11(17)	16(21)	0.045
Peak Fluid Overload on ECMO (%)*	31(27)	55(48)	<0.001

** Mean (SD)*

Discussion

- We report the first multi-centre report systematically evaluating acute kidney injury, fluid overload, and renal replacement therapy in children on ECMO
- This is the first multi-centre study to utilize the AKIN criteria to systematically define the prevalence of acute kidney injury at ECMO initiation and the incidence of acute kidney injury during the course of ECMO in children
- We demonstrate that acute kidney injury occurs commonly during the course of ECMO and there is a strong association between acute kidney injury and mortality
- Severe fluid overload commonly occurs during ECMO and is associated with increased mortality
- Further analysis incorporating data from 2 additional centers is planned to further delineate associations between acute kidney injury, renal replacement therapy, and fluid overload on survival and other clinical outcomes.

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