Neonatal Pediatric Heart and Renal Outcomes Network (NEPHRON); Association of Fluid Balance and Clinical Outcomes Following Neonatal Cardiac Surgery

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BACKGROUND

Fluid overload after cardiac surgery (CS) is common and is associated with poor outcomes. The Neonatal and Pediatric Heart and Renal Outcomes Network (NEPHRON) was developed to investigate acute kidney injury (AKI) and fluid balance (FB) after CS.

OBJECTIVES

- Describe characteristics of FB following CS and associations with clinical outcomes.
- Primary outcome: Mortality (in hospital or 30 day)
- Secondary outcomes: Duration of post-operative mechanical ventilation, ICU LOS and, hospital LOS

METHODS

- 22-center study of neonates (<30 days) undergoing CS utilizing the NEPHRON data module which is linked to the Pediatric Cardiac Critical Care Consortium registry data.
- Consecutive retrospective subjects from 8/20-17-1/2018.
- Excluded: those with >1 operation in the preceding 7 days, preoperative RRT or sCr >1.5, or perioperative ECMO
- Daily FB%: [(daily net FB) / pre-operative weight] x 100
- Cumulative FB%: [(sum of all preceding daily net FB)/ preoperative weight] x 100

RESULTS

N = 2223 analyzed
CPB = 1652, Non CPB = 571
CICU mortality 3.1% (n=69) (Table 1)

- Overall peak cumulative FB% was only 4.9%
- Peak cumulative FB% in survivors was 4.5% (IQR 0.4 to 10.3)
- 26% (n=581) had a peak CFB >10%
- Only 3% (n=67) had a peak CFB >21%

Figure 1: Cumulative FB% by POD and bypass status

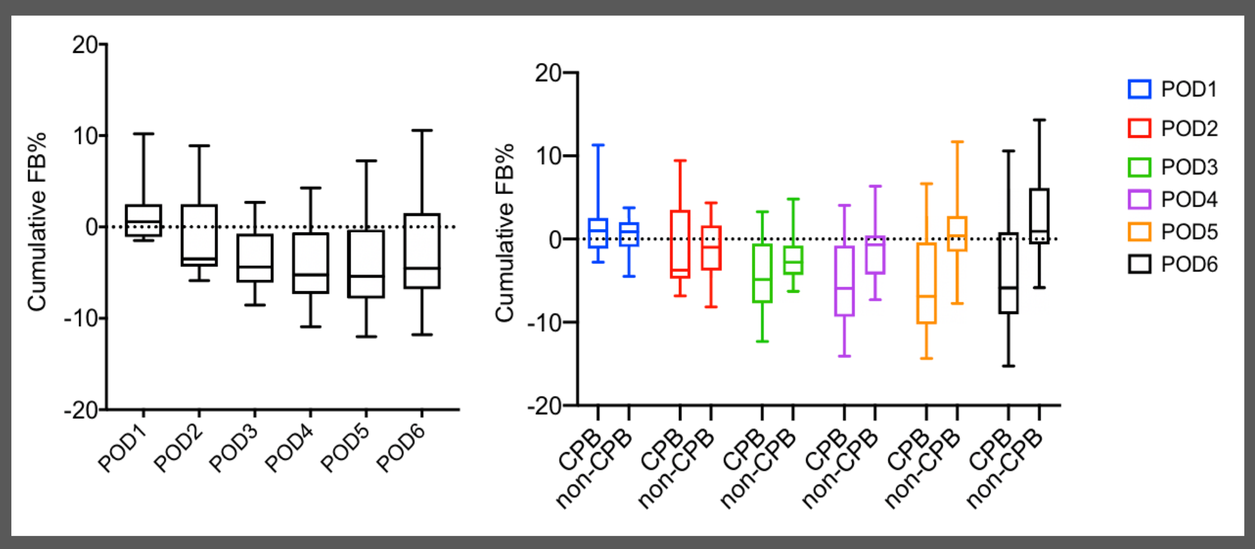
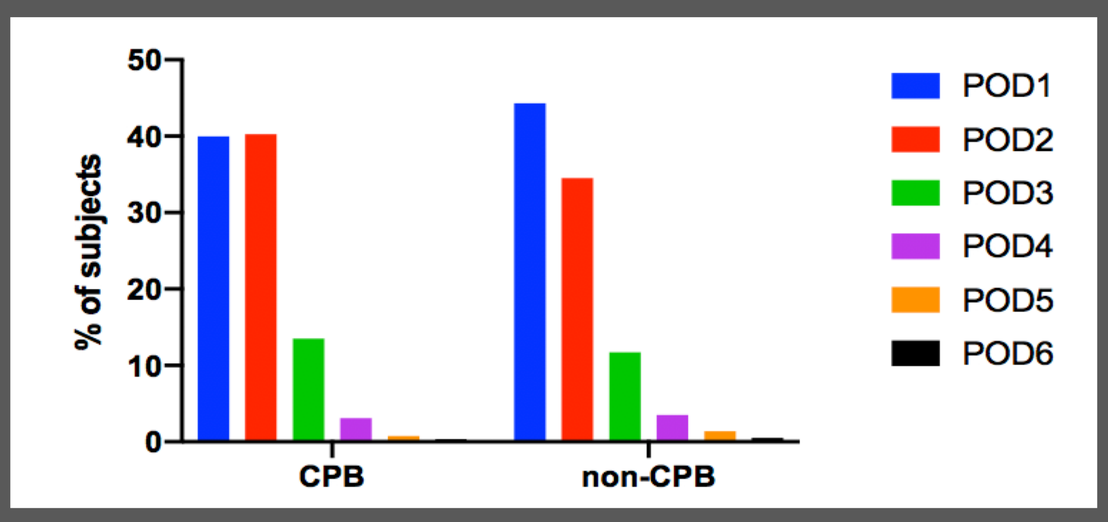


Figure 2: Time to first negative daily FB by POD and bypass status



RESULTS

Table 1: Peak cumulative FB% by patient characteristics

	Peak Cumulative FB%	
	N (%)	Median (IQR)
All	2223 (100%)	4.9 (0.41-10.47)
Preterm		
Yes	285 (13%)	7.3 (1.42-13.97)
No	1938 (87%)	4.6 (0.33-9.9)
Ventilated At Surgery		
Yes	621 (28%)	3.8 (-0.16-9.41)
No	1602 (72%)	5.1 (0.62-10.65)
Inotropes At Surgery		
Yes	325 (15%)	3.5 (0-9.07)
No	1898 (85%)	5 (0.53-10.64)
Deep Hypothermic Circulatory Arrest		
Yes	620 (28%)	3.9 (-0.87-8.65)
No	1603 (72%)	5.3 (0.93-11.11)
STAT Category		
1	82 (4%)	8.2 (2.45-14.46)
2	304 (14%)	5.4 (0.86-11.85)
3	285 (13%)	4.6 (0.09-10.24)
4	1152 (52%)	4.9 (0.55-10.47)
5	397 (18%)	3.7 (-0.79-8.19)
N/A, unclassifiable	3 (0.1%)	6.8 (5.3-8.09)
Peak KDIGO Stage		
0	1021 (46%)	4.5 (-0.13-9.77)
1	699 (31%)	4.9 (0.78-10.41)
2	301 (14%)	5.8 (1.55-11.22)
3	202 (9%)	5.2 (0.62-13.45)
MUF		
Yes	985 (44%)	4.1 (-0.47-9.34)
No	1238 (56%)	5.5 (1.02-11.2)
Lasix in CVOR		
Yes	556 (25%)	4.3 (-0.39-9.61)
No	1667 (75%)	5 (0.67-10.7)
Prophylactic PD		
Yes	308 (14%)	3.9 (0.19-8.71)
No	1915 (86%)	5 (0.47-10.7)
Mortality		
Yes	2154 (97%)	4.8 (0.43-10.3)
No	69 (3.1%)	5.3 (0.3-14.71)

Figure 2: Cumulative FB% by mortality and POD

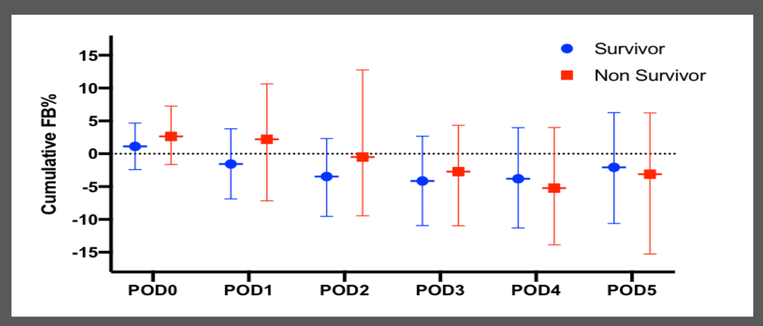


Table 2: Multivariable model of FB candidate variables with mortality, duration of ventilation, and ICU and hospital LOS.

	** Adjusted logistic regression modeling (n=2214)*			
Candidate Fluid Balance (FB) Indices	Mortality	Mechanical ventilation duration (Median = 7 days)	*CICU LOS* (Median = 16 days)	*Hospital LOS* (Median = 28 days)
Time to 1st negative daily FB	NS	**IRR = 1.14 ; p = 0.001**	**IRR = 1.10; p = 0.016**	**IRR = 1.13; p = 0.005**
Cumulative FB% POD 1	NS	NS	NS	NS
Peak Cumulative FB% continuous	NS	NS	NS	NS
Peak Cumulative FB% categorical	NS	NS	NS	NS
<10%				
10 to <20%				
20 to <30%				
>30%				
Interactions of FB% with Time to 1st negative daily FB	NS	NS	NS	NS

*Adjusted for underweight, pre-term, chromosomal abnormalities, pre-operative ventilation, pre-operative mechanic support , [1]pre-operative high risk factors, [2]'Other' preoperative risk factors, STAT score, pre-operative VIS score, CT output, any post-op complication, and any post-operative infection. ([1] 'Pre-operative high risk factors' included cardio-pulmonary resuscitation, shock at time of surgery, hepatic dysfunction, stroke, cerebrovascular accident, intracranial hemorrhage >grade 2 within 48h prior to surgery, or renal failure requiring dialysis. [2] 'Other pre-operative risk factors' were any STS risk factor for the index operation other than those included in 'high risk' and invasive ventilation to treat cardiorespiratory failure and pre- operative mechanical support.)

- No FB candidate indices were associated with mortality
- For each day the patient did not achieve the 1st negative daily FB there was independent association with an increase in:
- Mechanical ventilation by ~1day (14% above median of 7d)
- CICU LOS by ~2 days (13% above median of 16d)
- Hospital LOS by ~2.8 days (10% above median of 28d)

CONCLUSIONS

- No FB candidate indices were associated with mortality.
- Time to 1st negative daily FB is a clinically relevant target and may be a surrogate for hemodynamic recovery.
- Next step: evaluate risk factors for time to first day negative FB

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