Sodium Balance in Hyponatremic Patients Receiving Custom Dilution Continuous Renal Replacement Therapy Fluids

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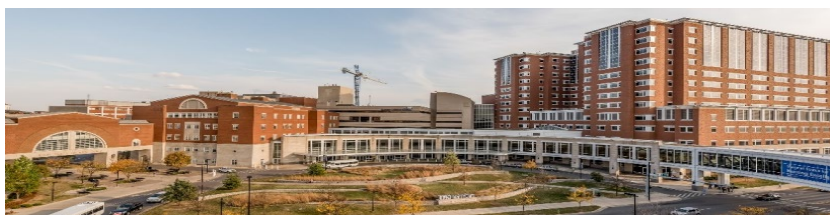
Abstract

Rapid or over correction of serum sodium in an intensive care unit patient can lead to devastating patient outcomes, such as osmotic demyelination syndrome (ODS). ODS is characterized by mental status changes, paralysis and respiratory failure. Risk factors for ODS include chronic hyponatremia, over or rapid correction of serum sodium, preexisting alcohol use, malnutrition and presence of liver disease. Hyponatremic patients requiring continuous renal replacement therapy (CRRT) are high risk of rapid sodium correction due to the standard 140mEq/L sodium chloride concentration in the fluids. Our institution instituted a collaborative protocol between nephrology and pharmacy to create custom CRRT dilution solutions for patients at risk of ODS. Patients with a serum sodium <120mEq/L are eligible for the protocol. The CRRT bags are diluted with sterile water according to the calculation of the patient's desired sodium change in 24 hours (6-8mEq/L/day). This is a retrospective cohort study evaluating the effectiveness of the hyponatremia protocol on serum sodium changes in the first 24h and 48h of CRRT therapy. Patients admitted to an ICU at the University of Kentucky from 2021 to 2023 were identified by having received the protocol orders, with a nadir serum sodium of <120mEq/L. Comparator patients were identified throughout the same timeframe with a nadir serum sodium <120mEq/L, who did not receive the custom dilution fluids for CRRT. The primary study outcome is the change in serum sodium from baseline to the 24h change, and proportion of patients achieving the goal sodium. A total of 18 patients were found eligible for this evaluation: nine patients received the protocol, and nine did not. The baseline serum sodium was not different between the two cohorts: protocol 117mEq/L (114-118) vs non-protocol 117mEq/L (114-118), p=0.94. The serum sodium at 24h was significantly lower in the protocol group: 122mEq/L (121-125) vs 130mEq/L (128-132), p= 0.046 and lower at 48h: 123mEq/L (121-131) vs 135mEq/L (129- 138), p=0.05. All nine protocol patients (100%) met the 24h sodium goal whilst using the protocol, vs (66%) met the goal without the protocol, p= 0.05. In this small cohort study, patients were more likely to have a slower sodium correction, and more likely to meet their sodium goals with custom dilution CRRT fluids, versus standard CRRT fluids. Further validation should be done with a larger cohort.

Introduction

- Rapid or over correction of serum sodium in an intensive care unit patient can lead to devastating patient outcomes, such as osmotic demyelination syndrome (ODS).
- ODS is characterized by mental status changes, paralysis and respiratory failure.
- Risk factors for ODS include chronic hyponatremia, over or rapid correction of serum sodium, preexisting alcohol use, malnutrition and presence of liver disease.
- Hyponatremic patients requiring continuous renal replacement therapy (CRRT) are high risk of rapid sodium correction due to the standard 140mEq/L sodium chloride concentration in the fluids.



Methods and Materials

- Non-randomized retrospective cohort study evaluating the feasibility and effectiveness of the hyponatremia protocol on serum sodium changes in the first 24h and 48h of CRRT therapy.

Patients admitted to an ICU at the University of Kentucky from 2021 to 2023 were identified by having received the protocol orders, with a nadir serum sodium of <120mEq/L.

Comparator patients were identified throughout the same timeframe with a nadir serum sodium <120mEq/L, who did not receive the custom dilution fluids for CRRT.

The primary study outcome is the change in serum sodium from baseline to the 24h change, and proportion of patients achieving the goal sodium.

Results

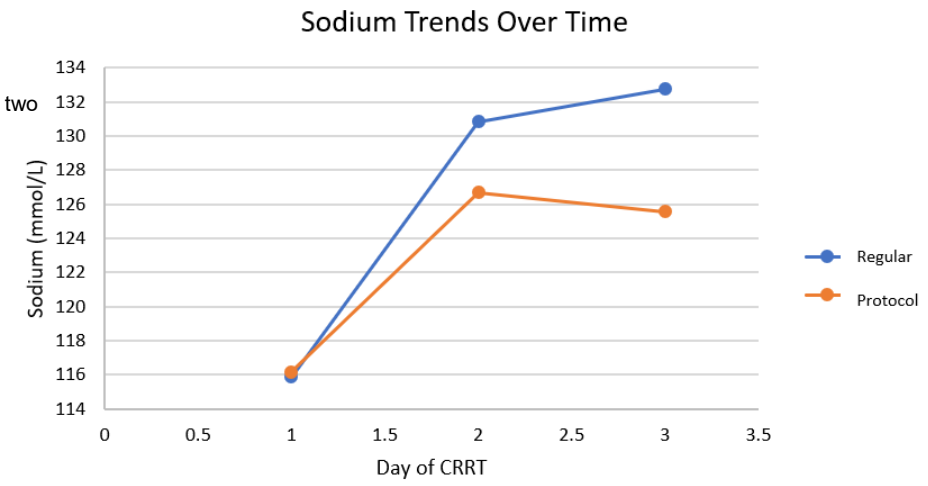
Table 1. Demographics

Variable	Hyponatremia (N=9)	Regular CRRT (N=9)	p-value
MICU n, (%)	7 ((78%)	3 (33%)	0.269
Surg/Trauma ICU n, (%)	1 (11%)	3 (33%)	
CCU n, (%)	1 (11%)	2 (22%)	
NICU n, (%)	0 (0%)	1 (11%)	
Age (median IQR)	44 (40-52)	57 (46-65)	0.331
Race (w) n, (%)	7 (78%)	9 (100%)	0.134
SOFA Score (median IQR)	9 (6.5-13)	7 (6-10)	0.553
Charlson Score (median IQR)	7 (6-9)	9 (5.5-12)	
CRRT total duration (median IQR)	3.78 (3-6.75)	2.02 (1-5)	0.269
CRRT protocol duration (median IQR)	2.66 (0.97-3.22)	-	-
ICU LOS (median IQR)	10.9 (3.3-13)	8 (4- 16)	0.757
Hospital LOS (median IQR)	16.16 (13-29.8)	16 (8 -28)	0.659
Mortality n, (%)	5 (56%)	5 (56%)	1
AMS Work-up n, (%)	1 (11%)	4 (44%)	0.114

Table 2. Study Outcomes

Variable	Hyponatremia (N=9)	Regular CRRT (N=9)	p-value
Baseline Na min (median IQR)	117 (114-118)	117 (114-118.5)	0.94
Baseline Na max (median IQR)	118 (116-120)	122 (120-125)	0.121
Baseline to 24h delta (min) (median IQR)	2 (1-2)	4 (0.33-10)	0.287
Baseline to 24h delta (max) (median IQR)	3 (2-9)	8 (5-10)	0.536
0-24h min (median IQR)	118 (117-119)	121 (118-124)	0.120
0-24 max (median IQR)	122 (121-125)	130 (128-132)	0.046
24-48h delta (min) (median IQR)	2 (2-4)	4.5 (0.33-12.5)	1.0
24-48h delta (max) (median IQR)	3 (2-3)	3.25 (-2 – 6)	0.77
24-48 min (median IQR)	121 (118-122)	132 (125.5- 135)	0.054
24-48 max (median IQR)	123 (121-131)	135.5 (129.5- 138)	0.054
Met 24h delta goal n, (%)	9 (100%)	6 (66%)	0.05

Fig 1. Sodium balance in the two study groups



Discussion

- Hyponatremia customization patients had a slower sodium correction over 24h and 48h versus standard CRRT fluids.
- Hyponatremia customization patients were more likely to meet their sodium goals with custom dilution CRRT fluids, versus standard CRRT fluids.

Conclusions

- Custom hyponatremia protocols appear feasible
- Future studies should evaluate for effectiveness, focusing on clinical outcomes

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