



Does the use of an EHR-integrated pathway for the care of patients with hyponatremia decrease the incidence of overcorrection of serum sodium compared to usual care?

Ryan Tseng, Dr. Daniel Resnick Ault



Intro

Background & Significance

- Hyponatremia (serum sodium <135 mEq/L) = most common electrolyte abnormality w/ potentially life-threatening complications (1)(2).
- Higher admission rates, ICU upgrades, and prolonged stays, severity-dependent (3).
- Present in 17% of deaths, predictive marker for poor outcomes (4) -> increased costs and resource use (5). (Think strong ion difference equation – ↓ Na -> ↓ SID = acidosis)

Pathophysiology & Diagnosis

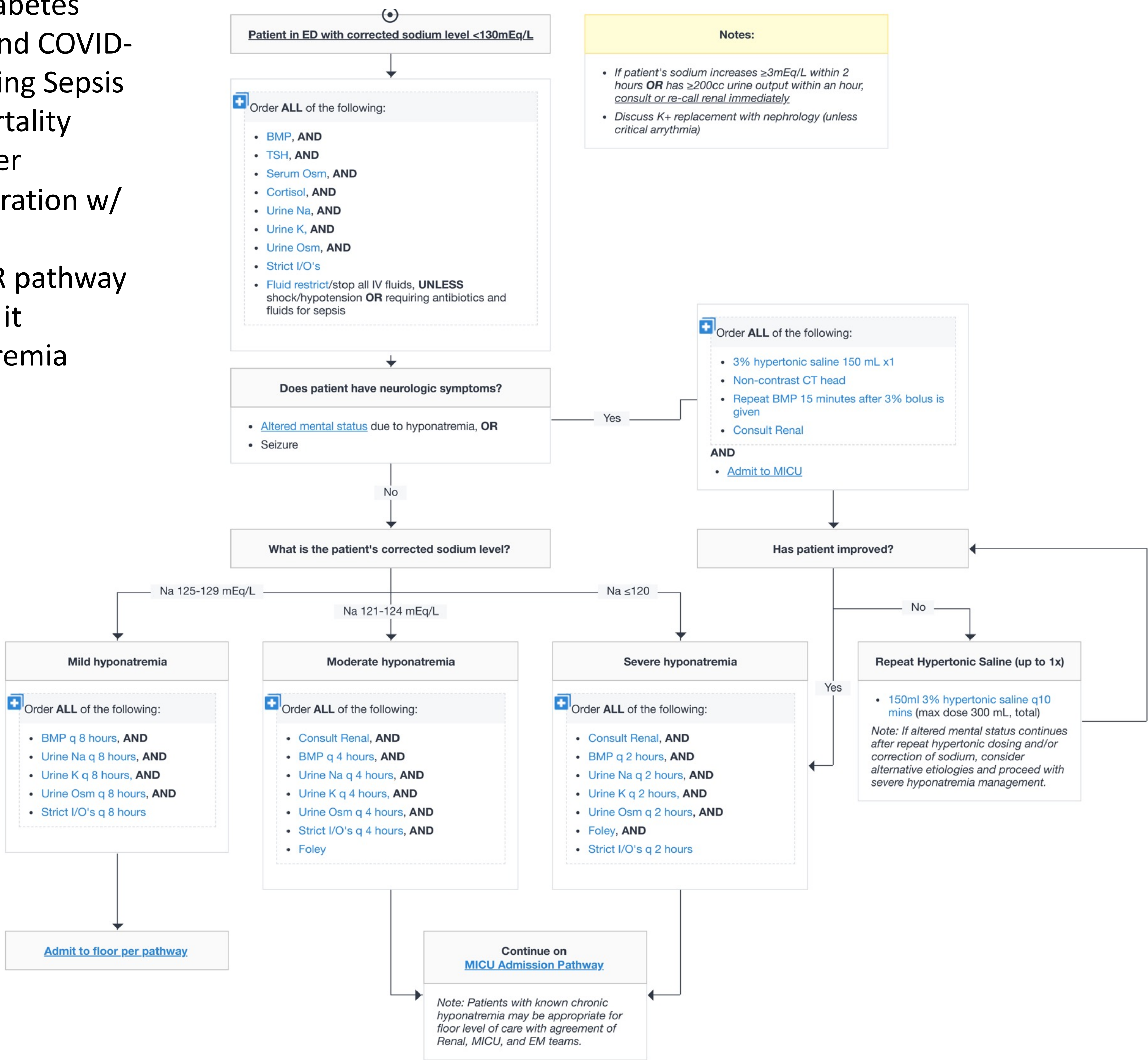
- Categorization by chronicity and fluid status: hypovolemic, hypervolemic, or euvolemic hyponatremia (6).
- Guidelines exist for classification, but no diagnostic algorithm for workup (7).

Complications

- Overcorrection -> osmotic demyelination syndrome (ODS) (1)(8) -- rapid serum sodium shifts -> CNS demyelination (hyperosmotic stress and glial cell injury) (9)(10) -> permanent sequelae
- Current sodium correction limit: ≤10 mEq/L per day (1).
- Prevention = main stay mgt of ODS (9).
- Under-correction risks: cerebral edema, seizures, respiratory arrest

EHR-Embedded Pathway

- Goal: standardize diagnosis and treatment = efficiency & accuracy -> less chance of over/under correction
- Prevents missed/delayed orders – Ex: early nephrology consults
- Success of EHR: diabetes management (9) and COVID-19 (10)(11), Surviving Sepsis Campaign (6% mortality reduction and faster antibiotic administration w/ pathway use) (12).
- Evaluating this EHR pathway could determine if it improves hyponatremia outcomes (13).



Methods

- Retrospective observational study: University of Colorado Hospital ED (Sep 2020 – Sep 2022) (≥18 years) w/ hyponatremia
- Primary Outcome: Proportion of patients with ≤8 mEq/L increase in serum sodium within 24 hours
- Secondary Outcome: reference QR code to right for complete list
 - Post-hoc t-test for average length of stay
 - Post-hoc chi-squared test for renal consults and 60-day mortality



Results

	Pathway	Non - Pathway
Age	64 ± 17	62 ± 17
Age Range	22 - 102	18 - 103
Race % non-White	69	76
Race % White	31	24
% Medicaid	44	54
Average Length of Stay	6.8 ± 10.3	6.5 ± 13.7
Renal Consults Ordered*	344	323
% Renal Consults Ordered*	51	14
Deaths within 60 days	53	225
% Deaths within 60 days	7.9	10.1
Total Patients (n)	671	2238

Table 1: Descriptive statistics w/ results of the t-test for the average length of stay with SE, the number of renal consults ordered and the number of deaths within 60 days w/ respective chi-squared test.

* = statistically significant difference, p < 0.05

Conclusion

- EHR pathway significantly increased renal consult orders
- No significant difference in hospital length of stay

Limitations

- Retrospective design limits generalizability beyond facility & time period.
- Regional patterns/trends at other institutions may not be reflected in this dataset.
- Selection bias of clinicians to use or not use the EHR pathway – patient demographics such as insurance status or race.
- Unmeasured confounders
- Future analyses: Multi-institutional data could enable a cost-benefit analysis or explore hyponatremia severity relative to the rate of correction for deeper stratification.

References

- Buffington MA, Abreo K. Hyponatremia: A Review. J Intensive Care Med. 2016 May;31(4):223-36. doi: 10.1177/0885066614566794. Epub 2015 Jan 14. PMID: 25592330.
- Olsson K, Ohlin B, Melander O. Epidemiology and characteristics of hyponatremia in the emergency department. Eur J Intern Med. 2013 Mar;24(2):110-6. doi: 10.1016/j.ejim.2012.10.014. Epub 2012 Nov 22. PMID: 23176963.
- Otterness K, Singer AJ, Thode HC Jr, Peacock WF. Hyponatremia and hypernatremia in the emergency department: severity and outcomes. Clin Exp Emerg Med. 2023 Jun;10(2):172-180. doi: 10.15441/ceem.22.380. Epub 2023 Jan 30. PMID: 36718485; PMCID: PMC10350347.
- Hoorntje EJ, Zietse R. Diagnosis and Treatment of Hyponatremia: Compilation of the Guidelines. J Am Soc Nephrol. 2017 May;28(5):1340-1349. doi:10.1681/ASN.2016101139. Epub 2017 Feb 7. PMID: 28174217; PMCID: PMC5407738.
- Zilberberg MD, Exuzides A, Spalding J, Foreman A, Jones AG, Colby C, Shorr AF. Hyponatremia and hospital outcomes among patients with pneumonia: a retrospective cohort study. BMC Pulm Med. 2008 Aug 18;8:16. doi: 10.1186/1471-2466-8-16. PMID: 18710521; PMCID: PMC2531075.
- Adrogué HJ, Tucker BM, Madias NE. Diagnosis and Management of Hyponatremia: A Review. JAMA. 2022 Jul 19;328(3):280-291. doi: 10.1001/jama.2022.11176. PMID: 35852524.
- Gerwer JE, Bacani G, Juang PS, Kulasa K. Electronic Health Record-Based Decision-Making Support in Inpatient Diabetes Management. Curr Diab Rep. 2022 Sep;22(9):433-440. doi: 10.1007/s11892-022-01481-0. Epub 2022 Aug 2. PMID: 35917098; PMCID: PMC9355925.
- Reijnders TDY, Janssen WMJT, Niamut SML, Kramer AB. Role of Risk Factors in Developing Osmotic Demyelination Syndrome During Correction of Hyponatremia: A Case Study. Cureus. 2020 Jan 2;12(1):e6547. doi: 10.7759/cureus.6547. PMID: 32042522; PMCID: PMC6996461.
- Bartlett AH, Makini S, Ruokis S, Kate Selling M, Hall L, Umscheid CA, Kao CK. Use of clinical pathways integrated into the electronic health record to address the coronavirus disease 2019 (COVID-19) pandemic. Infect Control Hosp Epidemiol. 2023 Feb;44(2):260-267. doi: 10.1017/ice.2022.64. Epub 2022 Mar 22. PMID: 35314010; PMCID: PMC9043631.
- Pham, PM.T., Pham, PAT., Pham, S.V. et al. Correction of hyponatremia and osmotic demyelinating syndrome: have we neglected to think intracellularly? Clin Exp Nephrol 19, 489–495 (2015). https://doi.org/10.1007/s10157-014-1021-y
- Wendel SK, Bookman K, Holmes M, Wiler JL. Successful Implementation of Workflow-Embedded Clinical Pathways During the COVID 19 Pandemic. Qual Manag Health Care. 2023 Jul-Sep 01;32(3):205-210. doi: 10.1097/QMH.0000000000000408. Epub 2023 Mar 6. PMID: 36913774; PMCID: PMC10289068.
- Dale CR, Schoepflin Sanders S, Chang SC, Pandhair O, Diggs WG, Woodruff W, Selander DN, Mark NM, Nurse S, Sullivan M, Mezaaruaps L, O'Mahony DS. Order Set Usage is Associated With Lower Hospital Mortality in Patients With Sepsis. Crit Care Explor. 2023 May 16;5(5):e0918. doi:10.1097/CCE.0000000000000918. PMID: 37206374; PMCID: PMC10191554.
- Perer A, Wang F, Hu J. Mining and exploring care pathways from electronic medical records with visual analytics. J Biomed Inform. 2015 Aug; 56:369-78. doi: 10.1016/j.jbi.2015.06.020. Epub 2015 Jul 2. PMID: 26146159.