

# Dose of isotonic fluid associated with lower risk of serum sodium overcorrection in pediatric patients with chronic hypovolemic hyponatremia

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## INTRODUCTION

- **Hyponatremia (serum Na <135 mEq/L)** is the **most common electrolyte disturbance** in hospitalized children, with an incidence of 17-45%.
- Hyponatremia creates an osmolar mismatch between the blood and brain, leading to **brain swelling (cerebral edema)**. When hyponatremia persists >48 hours (“chronic”), the brain attempts to prevent this swelling by shedding osmoles. This leaves the brain **vulnerable to demyelination injury** when hyponatremia is corrected too quickly.
- Experts estimate a safe speed of correction to be **8-12mEq/L/24 hours**.
- **Current management strategies** for treating hypovolemic hyponatremia, which often involve giving isotonic IV fluids, are based on theoretical calculations which are **not shown to be sufficiently accurate**.
- There have been **no pediatric studies** addressing the optimal isotonic fluid rate needed in order to prevent over-correction, or addressing risk factors for over-correction.

## RESEARCH QUESTIONS

1. A) Is there an association between **equivalent isotonic fluid rate** administered within the first 24 hours and **risk of over-correction (>10mEq/L/24h)**?  
B) What is the **highest** equivalent isotonic fluid **rate** which effectively **avoids over-correction**?
2. Is there an association between over-correction and the following **cofactors**?
  - a) Demographics: age, sex, weight
  - b) Initial labs: serum Na, K, BUN, Cr
  - c) Treatment characteristics: location of treatment initiation, initial fluid type, initial fluid strategy, bolus volume given, number of times fluid rate/composition changed
  - d) Complications: PICU involvement, seizures, diuretics given

## HYPOTHESIS

A higher equivalent isotonic fluid rate will be associated with greater risk of over-correction.

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## METHODS

### Retrospective chart review

**Inclusion criteria:** Children ages 1 month – 18 years of age presenting to the Children’s Hospital of Winnipeg between 1990 – 2020 with hypovolemic hyponatremia, defined as:

- a. Serum Na <135 **and**:
  - i. Meeting Gorelick’s simplified dehydration criteria (LR 6.1 for dehydration)
  - ii. **and/or**: overall clinical impression of hypovolemia documented by treating clinician
  - iii. **and/or**: urine Na <30mEq/L and urine osmolality >100mOsm/L
- b. Inpatients with clear laboratory evidence of hyponatremia persisting >48 hours **and** clinical dehydration as per criteria i. through iii.

### Exclusion criteria:

- a. IV fluids initiated prior to first labs being drawn
- b. Chronic renal, neurologic, or cardiac disease
- c. Evidence of SIADH or pseudohyponatremia
- d. Diuretics or sodium supplements as home medications
- e. Signs/symptoms of cerebral edema on presentation or 3% NaCl given
- f. Blood or albumin given within first 24 hours
- g. Hyponatremia not treated with crystalloid

### Statistical methods:

- Descriptive statistics (mean + SD; frequencies; median + IQR as appropriate)
- Simple *t*-tests or chi-squared tests for each variable
- Univariate logistic regression
- Multivariate models



## RESULTS

	All Patients	Appropriately Corrected	Overcorrected	P
<i>N</i>	45	17	28	
<b>Age (yrs), median (IQR)</b>	<b>2.5 (5.75)</b>	<b>5.83 (9.33)</b>	<b>1.5 (2.77)</b>	<b>0.007</b>
Sex, <i>n</i> (%)				0.3384
Female	13 (28.9)	3 (17.6)	10 (35.7)	
Male	32 (71.1)	14 (82.3)	18 (64.3)	
<b>Weight (kg), median (IQR)</b>	<b>13.5 (12.7)</b>	<b>16.5 (20.5)</b>	<b>11.81 (12.48)</b>	<b>0.05655</b>
<b>Pre-treatment serum Na (mmol/L), median (IQR)</b>	<b>125 (5)</b>	<b>127 (2)</b>	<b>123 (6)</b>	<b>0.001241</b>
Pre-treatment serum K (mmol/L), median (IQR)	4 (1)	3 (1)	4 (2)	0.04694
Mean fluid rate (ml/kg/hr), median (IQR)	2.93 (2.95)	2.23 (1.6)	3.69 (2.53)	0.002781
Bolus volume given (ml/kg), median (IQR)	18.18 (21.01)	17.24 (20.29)	19.47 (29.60)	0.2599
Times fluid rate/composition changed in 24h period, median (IQR)	1 (2)	1 (2)	1 (1)	0.5591
% of total fluid given PO, median (IQR)	0 (23.31)	0 (27.97)	0 (16.10)	0.5825
Evidence of calculation used, <i>n</i> (%)				0.8372
Yes				
No	10 (22.2)	3 (17.6)	7 (25)	
IV treatment initiated at tertiary centre, <i>n</i> (%)				0.3316
Yes		16 (94.1)	21 (75)	
No		1 (5.9)	7 (25)	
Adverse events, <i>n</i> (%)				
Seizure (Y)		1 (5.9)	4 (14.3)	
Lasix given (Y)		12 (11.8)	0 (0)	
PICU involvement (Y)		4 (23.5)	8 (28.6)	

\*P-values generated using *t*-tests for continuous variables and chi-squared tests for binary variables

## CONCLUSION

- Risk factors for over-correction of hypovolemic hyponatremia include:
  - **Faster isotonic fluid rate (>3ml/kg/hr)**
  - **Younger age**
  - **Lower serum Na at presentation**

## NEXT STEPS

- In process of completing logistic regression modelling
- Several dozen charts still to review

