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Original Research Paper

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VARIABILITY IN SERUM SODIUM LEVEL AND ITS PROGNOSTIC SIGNIFICANCE IN SEVERE TRAUMATIC BRAIN INJURY PATIENTS IN A TERTIARY CARE CENTER

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ABSTRACT

Aim: To evaluate the variability in serum sodium levels among 100 patients with severe TBI and its relationship to intracranial pressure (ICP), ICU stay, and neurological outcomes. **Materials and Methods:** A prospective observational study was conducted in 100 adult patients with severe TBI (GCS ≤8) admitted to a tertiary neurocritical care unit. Daily serum sodium levels were monitored for 14 days. Variability (ΔNa) was calculated as the difference between maximum and minimum serum sodium values during ICU stay. Dysnatremia episodes (Na^+ <135 mmol/L or >145 mmol/L) and osmotherapy use were recorded. Outcomes were assessed by the Glasgow Outcome Scale (GOS) at discharge. **Result:** Mean age: 37.8 ± 13.9 years; Male:Female = 76:24. Mean GCS on admission: 6 ± 2. Mean ΔNa: 20.2 ± 8.4 mmol/L. Hyponatremia occurred in 28% and hypernatremia in 47% of patients. ΔNa >15 mmol/L was significantly associated with higher mean ICP (p = 0.012), longer ICU stay (p = 0.018), and poor GOS (p = 0.003). Mortality was 32%, while 38% achieved favorable outcomes (GOS 4–5). **Conclusion:** Serum sodium variability (>15 mmol/L) is an independent predictor of poor neurological outcome and mortality in severe TBI. Continuous sodium monitoring and targeted correction may reduce secondary brain injury.

KEYWORDS :

INTRODUCTION

Traumatic brain injury (TBI) remains a major public health concern and is a leading cause of death and disability, especially in young adults. Secondary brain injury mechanisms such as cerebral edema, osmotic imbalance, and neuroendocrine dysfunction significantly affect prognosis. Serum sodium concentration is a key factor in maintaining cerebral osmotic balance. Dysnatremia (both hypo- and hypernatremia) has been associated with poor outcomes in neurocritical patients. However, variability in sodium levels (ΔNa) rather than a single sodium value may better reflect physiological instability and predict outcomes in severe TBI. This study investigates the variability of serum sodium and its relationship with ICP, ICU stay, and neurological outcomes.

MATERIALS AND METHODS

Study Design: Prospective observational cohort study. conducted in: Neurosurgical Intensive Care Unit, Government Mohan Kumaramangalam Medical College, Salem.
Duration: December 2023 – November 2024.
Sample Size: 100 adult patients with severe TBI (GCS ≤8).

Inclusion Criteria

- Age ≥18 years
- Severe TBI (GCS ≤8 on admission)
- Admission within 24 hours of injury

Exclusion Criteria

- Pre-existing renal, hepatic, or endocrine disorders
- Chronic electrolyte imbalance
- ICU stay <48 hours

Data Collected

- Demographics, mechanism of injury, GCS, CT findings
- Daily serum sodium levels (mmol/L) for 14 days
- ICP readings, osmotherapy, and fluid balance
- Glasgow Outcome Scale (GOS) at discharge

Statistical Analysis

Continuous variables were expressed as mean ± SD, categorical variables as percentages. Pearson's correlation and logistic regression were used to identify predictors of poor outcomes (GOS 1–3). $p < 0.05$ was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

PARAMETER	MEAN ± SD /n(%)
Age (years)	37.8 ± 13.9
Males	76 (76%)
Road Traffic accidents	68%
Falls	21%
Assaults / Others	11%
Mean GCS on admission	6 ± 2

Serum Sodium Profile

Parameter	Value
Initial Serum Na^+ (mmol/L)	138.7 ± 4.2
Lowest Na^+ (mmol/L)	128.3 ± 5.1
Highest Na^+ (mmol/L)	148.5 ± 6.0
Mean ΔNa (mmol/L)	20.2 ± 8.4
Hyponatremia Episodes	28%
Hypernatremia Episodes	47%
ΔNa >15 mmol/L	61% of patients

Clinical Correlations

Variable	ΔNa ≤15 mmol/L	ΔNa >15 mmol/L	P-value
Mean ICP (mmHg)	21.4 ± 4.2	28.1 ± 6.3	0.012
ICU Stay (days)	8.9 ± 3.6	13.4 ± 5.1	0.018
Poor Outcome (GOS 1–3)	25%	56%	0.003

Multivariate analysis showed ΔNa >15 mmol/L as an independent predictor of poor outcome (Odds Ratio 2.7; 95% CI 1.4–5.1; p = 0.009).

DISCUSSION

This study shows that serum sodium variability significantly impacts outcomes in severe TBI. Nearly half of the patients developed hypernatremia, mostly due to osmotherapy, while hyponatremia was attributed to SIADH or cerebral salt wasting. Patients with ΔNa >15 mmol/L had higher ICP, longer ICU stay, and poorer outcomes. These findings align with previous research (Li et al., 2020; Stocchetti et al., 2019), highlighting that sodium variability reflects systemic instability and may directly contribute to cerebral injury. Strict sodium monitoring, individualized osmotherapy, and gradual correction of dysnatremia are crucial for optimizing neurological recovery.

CONCLUSION

Serum sodium variability greater than 15 mmol/L is common in severe TBI and is strongly associated with poor neurological outcomes and mortality. Maintaining stable sodium levels through vigilant monitoring and targeted therapy should be prioritized in neurocritical care protocols.

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