



Original Article

PREVALENCE AND CLINICAL CHARACTERISTICS OF HYPERNATREMIA IN CRITICALLY ILL PATIENTS ADMITTED TO THE MEDICAL ICU OF A TERTIARY CARE HOSPITAL

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OPEN ACCESS

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Received: 18-09-2025

Accepted: 10-10-2025

Available online: 26-10-2025

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ABSTRACT

Background: Hyponatremia is a common electrolyte disorder in critically ill patients and is associated with increased morbidity and mortality. This study was conducted to evaluate the incidence, causes, and clinical outcomes of hyponatremia among ICU patients.

Methods: A cross-sectional observational study was carried out in the Department of Medicine, Mathuradas Mathur Hospital, Jodhpur, Rajasthan. A total of 200 ICU patients aged above 18 years were included. Serum sodium levels were measured at admission and at 48 and 72 hours of ICU stay. Patients were classified as normonatremic, ICU-acquired hyponatremic, or pre-admission hyponatremic based on their sodium values. Clinical parameters, APACHE II scores, length of stay, and mortality were analysed using SPSS software.

Results: The overall incidence of hyponatremia was high among ICU patients. ICU-acquired hyponatremia occurred in 19% of cases, while 22% had pre-admission hyponatremia. Mortality rates increased with the severity of hyponatremia—19.6% in normonatremic, 25.5% in mild, 43.5% in moderate, and 66.6% in severe cases ($p < 0.01$). Hyponatremic patients had higher APACHE II scores, longer ICU stays, and more frequent need for mechanical ventilation compared to normonatremic patients.

Conclusion: Hyponatremia is a frequent and serious electrolyte disturbance in ICU patients and is strongly associated with higher mortality and longer ICU stay. Early identification, close monitoring, and appropriate management of sodium imbalance are essential to improve outcomes in critically ill patients.

Keywords: Hyponatremia, ICU, Mortality, APACHE II score, Electrolyte imbalance.

INTRODUCTION

Sodium is the most abundant cation in the extracellular fluid (ECF) and plays a pivotal role in maintaining osmotic equilibrium, extracellular volume, and neuromuscular function. The serum sodium concentration, which normally ranges from 135 to 145 mmol/L, is crucial for the regulation of extracellular tonicity and the movement of water across cell membranes through osmotic gradients. Dysnatremias (both hyponatremia and hyponatremia) are particularly significant because they not only reflect the underlying severity of illness but also contribute directly to adverse clinical outcomes. Hyponatremia, defined as a serum sodium concentration exceeding 145 mmol/L, is one of the most frequent electrolyte abnormalities observed in hospitalized patients, especially those requiring intensive care management.¹

Hyponatremia affects approximately 6% to 42% of patients admitted to intensive care units (ICUs) and is consistently associated with a 50% to 60% increase in short-term mortality. Even mild elevations of serum sodium (<150 mmol/L) have

been shown to correlate with a greater than 20% 30-day mortality rate, underscoring the prognostic significance of even modest sodium derangements in critically ill patients.²

Hyponatremia can be classified as community-acquired (present on admission (PAH)) or ICU-acquired ((IAH) developing during hospitalization). Community-acquired hyponatremia is commonly associated with dehydration, impaired thirst mechanisms, or underlying chronic illness in elderly and debilitated patients. In contrast, ICU-acquired hyponatremia is largely iatrogenic, resulting from inadequate free water replacement, excessive sodium administration, use of diuretics, osmotic agents and renal concentrating defect.^{3,4}

Multiple studies have demonstrated that hyponatremia correlates with increased morbidity, prolonged mechanical ventilation, longer ICU stay, and higher mortality. The risk of death increases with the degree of hyponatremia, and even mild elevations above the normal range have been independently associated with poor outcomes. The mechanisms underlying this association include neuronal dehydration, altered cerebral perfusion, altered mental status, acute kidney injury, sepsis, or multi-organ dysfunction, metabolic stress, and inflammation, which can exacerbate underlying critical illness. In addition, hyponatremia increases the need for vasopressors, and delays recovery, adding significantly to healthcare costs and ICU resource utilization.^{5,6}

Despite its clinical relevance, there is limited data from Indian tertiary care settings describing the prevalence, severity, and outcome patterns of hyponatremia among critically ill patients, particularly distinguishing between pre-admission and ICU-acquired forms. Understanding these patterns is essential to guide early identification and appropriate management. Hence, the present study was undertaken to determine the prevalence of hyponatremia among critically ill patients admitted to the medical ICU of a tertiary care hospital, to analyse its clinical profile, and to assess the correlation between the degree of hyponatremia and ICU mortality.

MATERIALS AND METHODS

The present study was observational cross-sectional study conducted in the Department of Medicine, Mathuradas Mathur (MDM) Hospital associated with Dr. S. N. Medical College, Jodhpur, Rajasthan, India. The study was completed before 31st December 2022. A total of 200 patients were included in the study. The study was conducted following strict ethical standards. Approval was obtained from the Institutional Human Ethics Committee, and written informed consent was taken from all participants or their legal guardians prior to data collection. The confidentiality of all study participants was maintained throughout the study period.

In our study, patient selection on the basis of inclusion and exclusion criteria. All patients aged 18 years and above, of either gender, who were admitted to the medical ICU for more than 48 hours were included in the study. Patients who were pregnant or lactating, those receiving long-term diuretics, steroids, antimetabolite or chemotherapy drugs, as well as patients with chronic renal failure, renal transplant recipients, those on regular long-term dialysis, and patients with accidental or traumatic brain injury were excluded from the study.

Methodology

After obtaining informed consent, relevant data were collected using a structured proforma. Information regarding age, gender, severity of illness scores (APACHE II and GCS), duration of ICU stays, need for mechanical ventilation, vasopressor support, and in-hospital mortality was recorded. All patients had their serum sodium levels measured at ICU admission and subsequently at 48 hours and 72 hours after admission. Based on serial sodium measurements, patients were categorized as having ICU-acquired hyponatremia (IAH) when they had two consecutive serum sodium values ≥ 145 mmol/L during their ICU stay. For further classification, moderate hyponatremia was defined as sodium levels between 145–154 mmol/L, and severe hyponatremia was defined as sodium levels ≥ 155 mmol/L. The rate of sodium correction was also assessed and categorized as slow (<0.25 mmol/L/hr), moderate (0.25–0.50 mmol/L/hr), and fast (>0.50 mmol/L/hr), with the highest correction rate for each patient being recorded for analysis.

Statistical analysis

The data collected during the study was compiled using a Microsoft Excel spreadsheet and analysed statistically using SPSS 22.0 software package (SPSS Inc., Chicago, IL, USA). Qualitative data were expressed as frequencies and percentages, while quantitative data were represented as mean $\pm$ standard deviation (SD). The difference in proportion was analysed by using chi square test. A p value of < 0.05 was considered as statistically significant.

RESULTS

This study included a total of 200 patients on the basis of inclusion and exclusion criteria. A total of 200 ICU patients were studied, including 83 with hyponatremia and 117 with normonatremia. Among hyponatremic patients, 38 (45.8%) developed ICU-acquired hyponatremia (IAH) and 45 (54.2%) had pre-admission hyponatremia (PAH). The mean age and gender distribution were similar across groups. Altered mental status was more common in hyponatremic patients than in normonatremic ones ($p < 0.01$). Mild hyponatremia was most frequent, followed by moderate and severe types. The median onset of IAH was 4 days, lasting about 3 days. APACHE II scores were significantly higher in hyponatremic

groups compared to normonatremia ($p < 0.01$). Acute kidney injury, mechanical ventilation, and inotropic support were more frequent in hypernatremic patients. The median duration of ventilation and ICU stay was also longer in these groups ($p < 0.01$). ICU mortality was highest in hypernatremic patients—34.2% in IAH and 35.5% in PAH—compared to 19.6% in normonatremic patients, showing a significant association between hypernatremia and poor outcomes. **(TABLE 1)**

Overall ICU mortality was 26% (52 deaths). Mortality increased with the severity of hypernatremia. Among normonatremic patients, 23 (19.6%) died, whereas mortality 25.5% in mild, 43.5% in moderate, and 66.6% in severe hypernatremia. The odds of ICU mortality were significantly higher with increasing sodium levels. Compared to normonatremia, the odds ratio (OR) for mortality was 1.56 in mild, 3.57 in moderate, and 5.25 in severe hypernatremia, showing a strong dose-dependent relationship ($p < 0.01$). **(TABLE 2)**

These findings indicate that as the degree of hypernatremia worsens, the risk of ICU mortality increases significantly, highlighting hypernatremia as an independent predictor of poor outcome in critically ill patients.

Table 1: Comparison of demographic and clinical characteristics between study groups

Parameters	ICU-acquired Hypernatremia (n = 38)	Pre-admission Hypernatremia (n = 45)	Normonatremia (n = 117)	P-value
Mean age	61.26	56.54	55.42	0.18
Sex				
Male	20	24	53	0.45
Female	18	21	64	
Altered mental status	19 (50.0%)	28 (62.2%)	32 (27.4%)	<0.01
Hypernatremia severity				
Mild (Na 146-149 mmol/L) (n, %)	26 (68.4%)	25 (55.6%)	NA	<0.05
Moderate (Na 150-154 mmol/L) (n, %)	9 (23.7%)	14 (31.1%)	NA	<0.05
Severe (Na ≥ 155 mmol/L) (n, %)	3 (7.9%)	6 (13.3%)	NA	<0.05
Time to hypernatremia onset (days), median (IQR)	4 (2–5)	NA	NA	—
Hypernatremia duration (days), median (IQR)	3 (2–4)	4 (3–5)	NA	0.36
APACHE II score, median (IQR)	17 (11–22)	18 (13–25)	12 (8–18)	<0.01
Acute kidney injury (n, %)	16 (42.1%)	22 (48.9%)	46 (39.3%)	0.04
Haemodialysis required (n, %)	8 (21.1%)	11 (24.4%)	25 (21.4%)	0.39
Mechanical ventilation required (n, %)	34 (89.5%)	36 (80.0%)	59 (50.4%)	<0.01
Duration of mechanical ventilation (days), median (IQR)	5 (3–7)	3 (2–5)	1 (0–3)	<0.01
Inotropic/vasopressor support required (n, %)	18 (47.4%)	19 (42.2%)	34 (29.1%)	<0.01
Length of ICU stay (days), median (IQR)	6 (4–9)	5 (3–8)	3 (1–5)	<0.01
ICU mortality (n, %)	13 (34.2%)	16 (35.5%)	23 (19.65%)	<0.01

Table 2: Correlation of ICU Mortality with Degree of Hypernatremia (N = 200)

Degree of Dysnatremias	Serum Sodium (mmol/L)	No. of Patients (200)	ICU Mortality 52(26%)	Survival & ICU Discharge (148)	OR (95% CI)	p-value
Normonatremia	135–145	117	23 (19.65%)	94 (80.3%)	1.00 (Ref)	—
Mild hypernatremia	146–149	51	13 (25.5%)	38 (74.5%)	1.56 (0.97–2.52)	0.06
Moderate hypernatremia	150–154	23	10 (43.5%)	13 (56.5%)	3.57 (1.82–7.01)	<0.01
Severe hypernatremia	≥ 155	9	6 (66.66%)	3 (33.33%)	5.25 (2.07–13.31)	<0.001

DISCUSSION

The present study demonstrates a clear and graded association between the degree of hypernatremia and ICU mortality in a cohort of 200 critically ill patients. In the present study, we observed that the overall prevalence of hypernatremia among ICU patients was high, and the severity of hypernatremia was directly related to increased ICU mortality. Among the 200 critically ill patients studied, 117 (58.5%) were normonatremic and 83 (41.5%) had hypernatremia. Mortality increased progressively with the rise in serum sodium levels — 19.6% in normonatremia, 25.5% in mild, 43.5% in moderate, and 66.6% in severe hypernatremia. This clearly indicates that hypernatremia is an important prognostic marker for poor outcomes in ICU patients.

These findings are consistent with several previous studies. Lindner et al. (2007) conducted a prospective study on 981 critically ill patients and found that hypernatremia was present in 9% of cases and was independently associated with a two-fold increase in mortality compared with normonatremic patients (39% vs. 24%).⁷ Similarly, other study Waite et al. (2013) analysed ICU admissions and reported that ICU-acquired hypernatremia occurred in 4.3% of cases and was strongly associated with higher hospital mortality and prolonged ICU stay.⁸

In our study, most hypernatremic patients had higher APACHE II scores, indicating greater illness severity. They also required mechanical ventilation and vasopressor support more frequently than normonatremic patients. These findings are in agreement with studies by Stelfox et al. (2008) and Funk et al. (2010), who reported that ICU-acquired hypernatremia was associated with longer ventilation duration, higher vasopressor requirement, and increased risk of death.^{9,10} In this study also observed, both pre-admission hypernatremia (PAH) and ICU-acquired hypernatremia (IAH). PAH was more frequent in elderly and dehydrated patients, while IAH developed during ICU stay, often within the first 4–5 days of admission. Similar findings were reported by Nasser et al (2024).¹¹

In current study, mortality with the degree of hypernatremia emphasizes the dose-response relationship between serum sodium and survival. The odds ratio for mortality increased from 1.56 in mild hypernatremia to 3.57 in moderate and 5.25 in severe cases, compared with normonatremic patients. These results are similar to the findings of Bagshaw et al. (2009), who observed that even mild hypernatremia (Na 146–149 mmol/L) was linked to higher hospital mortality, while severe hypernatremia (Na $\geq$ 155 mmol/L) showed nearly a five-fold increased risk.¹²

The present study found significant differences between hypernatremia and normonatremia in terms of development of AKI, requirement of HD, MV requirement. Hypernatremia group have higher tendency for development of AKI, have higher requirements of MV and have higher mortality in comparison to normonatremia patients. These findings were aligned with other study Limbani Mapata et al (2022).¹³

Our study highlights the strong relationship between hypernatremia and ICU mortality. But it has some limitations. It was a single-centre observational study, so results may not represent all ICU populations. Despite these limitations, our study reinforces the importance of early detection and prevention of hypernatremia. Frequent monitoring of serum sodium, judicious use of saline infusions, early correction of water deficits, and careful management of diuretics can reduce the risk of ICU-acquired hypernatremia. Preventive strategies are especially important since several studies have shown that correcting hypernatremia slowly and appropriately can improve neurological recovery and reduce complications.^{14,15}

CONCLUSION

Hypernatremia is a common electrolyte disturbance among critically ill patients and is strongly associated with increased morbidity and mortality in the ICU. In our study, the prevalence of hypernatremia was high, and mortality increased progressively with the severity of serum sodium elevation. Patients with moderate and severe hypernatremia had significantly higher APACHE II scores, longer ICU stays, and greater need for mechanical ventilation and vasopressor support compared to normonatremic patients. Both ICU-acquired and pre-admission hypernatremia independently contributed to poor outcomes, emphasizing that hypernatremia reflects not only disease severity but also potentially preventable iatrogenic factors such as inadequate fluid replacement and excessive sodium administration.

Early recognition, close monitoring of serum sodium levels, and timely correction of hypernatremia are essential to improve patient outcomes. Preventive strategies—such as avoiding unnecessary sodium load, ensuring adequate hydration, and individualized fluid management—can help reduce the incidence and impact of hypernatremia in critically ill patients.

Funding: No funding sources

Conflict of interest: None declared

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