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Etiology, Clinical Profile, and Outcomes of Hyponatremia in Adults: A Prospective Observational Study

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ABSTRACT

Introduction: Hyponatremia is the most common electrolyte disorder encountered in hospitalized patients and is associated with significant morbidity, prolonged hospital stay, and increased mortality. The etiology of hyponatremia is heterogeneous, and early identification of the underlying cause is essential for appropriate management and improved clinical outcomes. This study evaluated the etiological profile and clinical outcomes of hyponatremia in adult patients admitted to a tertiary care hospital.

Materials and Methods: A prospective observational study was conducted in the Department of General Medicine of a tertiary care teaching hospital from May 2024 to May 2025. A total of 120 adult patients (≥18 years) with serum sodium <135 mEq/L were enrolled. Demographic characteristics, clinical presentation, laboratory parameters, etiological factors, treatment modalities, and hospital outcomes were recorded. Hyponatremia was classified as mild, moderate, or severe based on serum sodium concentration. Data were analyzed using SPSS version 26.0, with a p-value <0.05 considered statistically significant.

Results: The mean age of the patients was 59.8 ± 16.2 years, and 56.7% were males. Generalized weakness (74.2%) was the most common presenting symptom. Moderate hyponatremia was observed in 38.3% of patients, while SIADH (25.8%) was the leading etiology, followed by diuretic-induced hyponatremia (17.5%) and congestive heart failure (15.0%). Fluid restriction (60.0%) was the most frequently used treatment. Severe hyponatremia was significantly associated with increased ICU admission, mechanical ventilation, longer hospital stay, and higher in-hospital mortality (all p<0.01). Older age, lower serum sodium levels, chronic kidney disease, and congestive heart failure were significantly associated with mortality.

Conclusion: SIADH was the predominant cause of hyponatremia in this study. Increasing severity of hyponatremia was associated with poorer clinical outcomes and higher mortality. Early etiological diagnosis and timely, individualized management are essential to reduce complications and improve outcomes in adults with hyponatremia.

Keywords*: Hyponatremia; Syndrome of inappropriate antidiuretic hormone secretion; Electrolyte disorders; Etiology; Clinical outcomes.*

INTRODUCTION

Hyponatremia, defined as a serum sodium concentration of less than 135 mEq/L, is the most common electrolyte disorder encountered in clinical practice and affects patients across a wide spectrum of medical and surgical conditions [1,2]. It is particularly prevalent among hospitalized and elderly patients, with reported incidence ranging from 15% to 30% depending on the study population [3,4]. Hyponatremia results from an imbalance in water homeostasis rather than

sodium deficiency alone and may arise from various conditions such as syndrome of inappropriate antidiuretic hormone secretion (SIADH), heart failure, liver cirrhosis, chronic kidney disease, endocrine disorders, gastrointestinal losses, and the use of medications including diuretics [5]. The clinical manifestations vary from mild nonspecific symptoms such as fatigue, nausea, and headache to severe neurological complications including seizures, coma, and death, depending on the severity and rapidity of onset [6].

The underlying etiology of hyponatremia is often multifactorial, making accurate diagnosis and appropriate management challenging [7]. A systematic clinical assessment combined with laboratory evaluation, including serum and urine osmolality, urine sodium concentration, and assessment of volume status, is essential to identify the underlying cause and guide treatment [8]. Early recognition is particularly important because inappropriate correction or delayed treatment may lead to serious complications such as osmotic demyelination syndrome or persistent neurological dysfunction [9]. Therefore, determining the etiology of hyponatremia is a critical step in improving patient outcomes.

Several studies have demonstrated that hyponatremia is independently associated with increased morbidity, prolonged hospital stay, greater need for intensive care, higher healthcare costs, and increased mortality [10]. Severe hyponatremia has been linked to adverse outcomes including respiratory failure, cognitive impairment, falls, fractures, and poor prognosis in patients with cardiovascular, renal, hepatic, and neurological diseases [11,12]. However, the spectrum of etiological factors and their relationship with clinical outcomes varies across different populations due to differences in demographics, comorbidities, prescribing practices, and healthcare settings [12]. Consequently, institution-specific data are valuable for understanding local disease patterns and optimizing management strategies.

The present study aimed to evaluate the etiological profile of hyponatremia in adult patients and to assess the clinical outcomes associated with different causes and severities of hyponatremia in a tertiary care hospital.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Medicine of a tertiary care teaching hospital over a period of one year, from May 2024 to May 2025. A total of 120 consecutive adult patients (≥18 years) diagnosed with hyponatremia (serum sodium <135 mEq/L) at admission or during hospitalization were enrolled after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants or their legally authorized representatives prior to inclusion in the study.

Adult patients with documented hyponatremia who consented to participate were included in the study. Patients with pseudohyponatremia due to severe hyperlipidemia or paraproteinemia, those with hypertonic hyponatremia secondary to marked hyperglycemia or osmotic agents, patients with incomplete clinical or laboratory records, and those unwilling to participate were excluded. Demographic details, presenting complaints, medical history, drug history (particularly diuretic use), comorbid illnesses, physical examination findings, and volume status assessment were recorded using a predesigned case record form.

All patients underwent detailed laboratory evaluation including serum sodium, potassium, chloride, blood urea, serum creatinine, blood glucose, serum osmolality, urine sodium, and urine osmolality whenever clinically indicated. Additional investigations such as thyroid function tests, serum cortisol, liver function tests, chest radiography, electrocardiography, ultrasonography, echocardiography, and computed tomography or magnetic resonance imaging were performed when required to identify the underlying etiology. Hyponatremia was classified as mild (130–134 mEq/L), moderate (125–129 mEq/L), or severe (<125 mEq/L). The etiology was established based on clinical findings, laboratory investigations, and standard diagnostic criteria, including syndrome of inappropriate antidiuretic hormone secretion (SIADH), diuretic-induced hyponatremia, congestive heart failure, chronic kidney disease, chronic liver disease, gastrointestinal losses, endocrine disorders, and other identifiable causes.

Patients received treatment according to the underlying cause and severity of hyponatremia, including fluid restriction, isotonic saline, hypertonic saline, oral salt supplementation, vasopressin receptor antagonists, and correction of the precipitating condition. Clinical outcomes including requirement for intensive care unit admission, mechanical ventilation, duration of hospital stay, correction of serum sodium, and in-hospital mortality were recorded. Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the independent Student's *t*-test or one-way ANOVA for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 120 adult patients with hyponatremia were included in the study. The mean age of the participants was 59.8 ± 16.2 years, with nearly half (47.5%) aged above 60 years. Males constituted 56.7% of the study population. Generalized

weakness was the most common presenting symptom (74.2%), followed by nausea/vomiting (43.3%), altered sensorium (34.2%), confusion (30.8%), and dizziness (27.5%). Seizures were observed in 15.0% of patients. (Table 1).

Table 1. Baseline Characteristics and Clinical Presentation of Patients with Hyponatremia (N=120)

Variable	Category	Value
Age group (years)	18–40	24 (20.0)
	41–60	39 (32.5)
	>60	57 (47.5)
	Mean ± SD	59.8 ± 16.2
Gender	Male	68 (56.7)
	Female	52 (43.3)
Presenting symptoms	Generalized weakness	89 (74.2)
	Nausea/Vomiting	52 (43.3)
	Altered sensorium	41 (34.2)
	Confusion	37 (30.8)
	Dizziness	33 (27.5)
	Dyspnea	31 (25.8)
	Headache	26 (21.7)
	Pedal edema	22 (18.3)
	Seizures	18 (15.0)

Moderate hyponatremia was the most frequent severity category (38.3%), followed by mild (35.0%) and severe hyponatremia (26.7%). SIADH was the leading etiology, accounting for 25.8% of cases, followed by diuretic-induced hyponatremia (17.5%) and congestive heart failure (15.0%). Hypertension (49.2%) and diabetes mellitus (38.3%) were the most common associated comorbidities, while chronic kidney disease and heart failure were present in approximately 15% of patients each. (Table 2).

Table 2. Severity, Etiology and Associated Comorbidities (N=120)

Variable	Category	Number (%)
Severity of hyponatremia	Mild (130–134 mEq/L)	42 (35.0)
	Moderate (125–129 mEq/L)	46 (38.3)
	Severe (<125 mEq/L)	32 (26.7)
Etiology	SIADH	31 (25.8)
	Diuretic induced	21 (17.5)
	Congestive heart failure	18 (15.0)
	Chronic kidney disease	13 (10.8)
	Chronic liver disease	10 (8.3)
	Gastrointestinal losses	9 (7.5)
	Adrenal insufficiency	5 (4.2)
	Hyperglycemia	5 (4.2)
	Hypothyroidism	4 (3.3)
	Others	4 (3.3)
Comorbidities	Hypertension	59 (49.2)
	Diabetes mellitus	46 (38.3)
	Heart failure	19 (15.8)
	Chronic kidney disease	18 (15.0)
	Chronic liver disease	12 (10.0)
	COPD	11 (9.2)
	Malignancy	8 (6.7)

The mean serum sodium concentration at presentation was 124.8 ± 5.6 mEq/L. The mean serum potassium level was 4.12 ± 0.74 mEq/L, while the mean blood urea and serum creatinine levels were 43.8 ± 20.7 mg/dL and 1.43 ± 0.81 mg/dL, respectively. The mean serum osmolality was 267.4 ± 14.8 mOsm/kg, and the average urine sodium concentration was 49.7 ± 26.5 mEq/L. (Table 3).

Table 3. Laboratory Characteristics of the Study Population (N=120)

Parameter	Mean ± SD
Serum sodium (mEq/L)	124.8 ± 5.6
Serum potassium (mEq/L)	4.12 ± 0.74
Blood urea (mg/dL)	43.8 ± 20.7
Serum creatinine (mg/dL)	1.43 ± 0.81
Serum osmolality (mOsm/kg)	267.4 ± 14.8
Urine sodium (mEq/L)	49.7 ± 26.5

Fluid restriction was the most commonly employed treatment modality (60.0%), followed by oral salt supplementation (45.0%) and normal saline infusion (40.0%). Hypertonic saline was administered to 30.0% of patients, whereas loop diuretics and tolvaptan were used in 18.3% and 14.2% of patients, respectively. Several patients received more than one therapeutic intervention according to the underlying etiology and severity of hyponatremia. (Table 4).

Table 4. Treatment Modalities Administered (N=120)

Treatment	Number (%)
Fluid restriction	72 (60.0)
Normal saline infusion	48 (40.0)
Hypertonic saline	36 (30.0)
Oral salt supplementation	54 (45.0)
Loop diuretics	22 (18.3)
Tolvaptan	17 (14.2)

Clinical outcomes varied significantly according to the severity of hyponatremia. Patients with severe hyponatremia had the highest rates of ICU admission (53.1%), mechanical ventilation (37.5%), prolonged hospital stay (9.4 ± 3.8 days), and in-hospital mortality (25.0%). These outcomes were significantly worse compared with patients with mild and moderate hyponatremia (all $p < 0.01$). (Table 5).

Table 5. Clinical Outcomes According to Severity of Hyponatremia

Outcome	Mild (n=42)	Moderate (n=46)	Severe (n=32)	p value
ICU admission	3 (7.1)	9 (19.6)	17 (53.1)	<0.001
Mechanical ventilation	1 (2.4)	5 (10.9)	12 (37.5)	<0.001
Hospital stay (days), mean ± SD	4.8 ± 1.6	6.7 ± 2.3	9.4 ± 3.8	<0.001
Mortality	1 (2.4)	4 (8.7)	8 (25.0)	0.006

Patients who did not survive were significantly older than survivors (71.3 ± 12.4 vs. 58.2 ± 15.8 years; $p = 0.004$) and had lower mean serum sodium levels at presentation (119.6 ± 4.2 vs. 125.4 ± 5.3 mEq/L; $p < 0.001$). Severe hyponatremia, chronic kidney disease, and congestive heart failure were significantly more common among non-survivors, indicating their association with increased in-hospital mortality. (Table 6).

Table 6. Factors Associated with In-Hospital Mortality

Variable	Survivors (n=107)	Non-survivors (n=13)	p value
Age (years), mean ± SD	58.2 ± 15.8	71.3 ± 12.4	0.004
Serum sodium (mEq/L), mean ± SD	125.4 ± 5.3	119.6 ± 4.2	<0.001
Severe hyponatremia	24 (22.4)	8 (61.5)	0.003
Chronic kidney disease	13 (12.1)	5 (38.5)	0.011
Congestive heart failure	14 (13.1)	5 (38.5)	0.020

DISCUSSION

Hyponatremia is a common electrolyte abnormality among hospitalized adults and is particularly frequent in the elderly because of multiple comorbidities, polypharmacy, and impaired renal water handling. In the present study, the mean age was 59.8 ± 16.2 years, with nearly half of the patients being older than 60 years, and males constituted 56.7% of the study population. Generalized weakness was the predominant presenting symptom, followed by nausea/vomiting and altered sensorium. These findings are comparable with those reported by Singh et al., who also observed a higher prevalence of hyponatremia among older adults with neurological manifestations being the most frequent clinical presentation [13]. Similarly, epidemiological studies by Upadhyay et al. have shown that hyponatremia occurs predominantly in elderly hospitalized patients and is associated with substantial clinical burden [14].

In the present study, moderate hyponatremia was the most common severity category, while SIADH (25.8%) emerged as the leading etiology, followed by diuretic-induced hyponatremia and congestive heart failure. Hypertension and diabetes

mellitus were the most frequent associated comorbidities. These observations are consistent with the review by Burst, which identified SIADH, diuretic therapy, heart failure, renal disease, and liver disease as the principal causes of hyponatremia in hospitalized adults [15]. In contrast, Singh et al. reported diuretic-induced hyponatremia as the most common etiology, followed by SIADH, highlighting the influence of differences in patient demographics, prescribing practices, and underlying disease patterns across institutions [13].

An important finding of the present study was the significant association between severe hyponatremia and adverse clinical outcomes. Patients with severe hyponatremia had significantly higher rates of ICU admission, mechanical ventilation, prolonged hospitalization, and in-hospital mortality compared with patients having mild or moderate hyponatremia. Furthermore, non-survivors were significantly older, had lower serum sodium concentrations, and more frequently had chronic kidney disease and congestive heart failure. These findings are in agreement with the large cohort study by Waikar et al., which demonstrated progressively increasing mortality with worsening hyponatremia among hospitalized patients [16]. Hoorn and Zietse also emphasized that hyponatremia is not only a marker of severe underlying illness but also an independent predictor of poor clinical outcomes and mortality, particularly in patients with cardiovascular, renal, and hepatic diseases [17].

Appropriate identification of the underlying etiology and timely institution of targeted therapy remain essential for improving outcomes in patients with hyponatremia. In the present study, fluid restriction was the most commonly employed treatment, followed by oral salt supplementation and isotonic saline, reflecting individualized management based on volume status and etiology. Current literature similarly recommends etiology-based treatment strategies, with fluid restriction being the cornerstone for SIADH and isotonic or hypertonic saline reserved for hypovolemic or symptomatic severe hyponatremia [15,18]. Overall, the findings of the present study reinforce existing evidence that early recognition of the underlying cause, careful correction of serum sodium, and prompt management of associated comorbidities are crucial in reducing morbidity and improving the prognosis of hospitalized adults with hyponatremia.

CONCLUSION

Hyponatremia is a common electrolyte disorder among hospitalized adults and is associated with diverse etiologies, with SIADH, diuretic use, and congestive heart failure being the most frequent causes in the present study. Increasing severity of hyponatremia was significantly associated with adverse clinical outcomes, including higher rates of intensive care unit admission, mechanical ventilation, prolonged hospital stay, and in-hospital mortality. Elderly patients and those with chronic kidney disease or heart failure were at particularly high risk of poor outcomes. Early identification of the underlying etiology, careful evaluation of contributing comorbidities, and prompt, etiology-specific management are essential to improve patient outcomes and reduce the morbidity and mortality associated with hyponatremia.

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