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ORIGINAL ARTICLE

Electrolyte Disturbances in ICU Patients – Patterns, Predictors, and Outcomes in 70 Cases

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ABSTRACT

Background: *Electrolyte disturbances are common in critically ill patients and are associated with increased morbidity, prolonged ICU stay, and mortality. Understanding their prevalence, patterns, and predictors is essential for timely intervention.* ***Objective:*** *To evaluate the incidence, patterns, risk factors, and outcomes associated with electrolyte disturbances in ICU patients.* ***Methods & Materials:*** *This prospective observational study included 70 adult patients admitted to the intensive care unit (ICU) over a six-month period. Serum electrolytes including sodium, potassium, calcium, magnesium, and phosphate were measured at admission and monitored daily. Demographic data, comorbidities, severity of illness (APACHE II score), and clinical outcomes were recorded. Statistical analyses included descriptive statistics, chi-square tests, logistic regression for predictors, and Kaplan–Meier survival curves for outcomes.* ***Results:*** *Electrolyte disturbances were detected in 81.4% of patients, with hyponatremia (42.8%) and hypokalemia (38.5%) being most prevalent. Hypocalcemia and hypomagnesemia occurred in 25.7% and 20% of cases, respectively. Multivariate analysis identified sepsis (OR 3.2; 95% CI 1.5–6.8), diuretic use (OR 2.7; 95% CI 1.2–5.9), and higher APACHE II score (OR 1.1 per point; 95% CI 1.02–1.18) as independent predictors of electrolyte imbalance. Patients with multiple electrolyte disturbances had significantly longer ICU stays (median 12 vs. 7 days, p<0.05) and higher mortality (28.5% vs. 7.1%, p<0.01).* ***Conclusion:*** *Electrolyte disturbances are highly prevalent in ICU patients and are associated with worse outcomes. Early identification of high-risk patients, close monitoring, and prompt correction of abnormalities may improve prognosis in critically ill populations.*

Keywords: *Electrolyte Disturbance, ICU, Hyponatremia, Hypokalemia, Outcomes, Predictors*

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INTRODUCTION

Electrolytes play a pivotal role in maintaining cellular function, neuromuscular conduction, and acid-base balance. In critically ill patients, derangements of serum electrolytes are frequent and often multifactorial, resulting from underlying disease, therapeutic interventions, or iatrogenic causes.[1,2] Electrolyte imbalances, including abnormalities in sodium, potassium, calcium, magnesium, and phosphate, can significantly affect cardiovascular, renal, and neurological systems, potentially leading to adverse outcomes.[3,4] The intensive care unit (ICU) is a unique environment where patients are critically ill, often hemodynamically unstable, and exposed to numerous interventions including intravenous fluids, vasopressors, diuretics, and mechanical ventilation. These factors predispose patients to disturbances in electrolyte homeostasis.[5] Among these, hyponatremia and hypokalemia are frequently reported and have been linked with increased ICU length of stay, mechanical ventilation duration, and mortality.[6,7] Several studies have explored individual electrolyte disorders; however, there is limited comprehensive data evaluating patterns, predictors, and cumulative impact on outcomes across multiple electrolytes in a single ICU cohort.[8] Identification of patients at risk for electrolyte disturbances is essential for early intervention, which may improve morbidity and reduce mortality.[9] The present study aims to fill this gap by prospectively assessing 70 ICU patients for electrolyte disturbances, identifying their predictors, and evaluating their clinical outcomes. The objectives are: (1) to determine the prevalence and pattern of electrolyte disturbances; (2) to identify clinical and laboratory predictors; and (3) to analyze the impact on ICU length of stay and mortality.

METHODS & MATERIALS

Study Design and Population

This prospective observational study was conducted in the 12-bed ICU of Department of Medicine, Dhaka Medical College Hospital, Dhaka, Bangladesh from January to June 2025, over six months from January to June 2025. Inclusion criteria were adult patients (≥18 years) admitted to the ICU for more than 48 hours. Exclusion criteria included end-stage renal disease on

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dialysis, known primary electrolyte disorders, and patients with incomplete laboratory data. Seventy patients meeting the criteria were enrolled consecutively.

Data Collection

Demographic data (age, sex), comorbidities (diabetes, hypertension, chronic kidney disease), and ICU admission diagnosis were recorded. Severity of illness was assessed using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score at admission. Medication history, particularly diuretic or nephrotoxic drug use, was documented.

Laboratory Evaluation

Serum electrolytes were measured at ICU admission and subsequently monitored daily using standard automated analyzers. The reference ranges were: sodium 135–145 mmol/L, potassium 3.5–5.0 mmol/L, calcium 8.5–10.5 mg/dL, magnesium 1.7–2.5 mg/dL, phosphate 2.5–4.5 mg/dL. Electrolyte disturbances were defined as deviations from these ranges. Multiple disturbances were defined as ≥2 electrolyte abnormalities simultaneously.

Outcomes

Primary outcomes included ICU length of stay and in-hospital mortality. Secondary outcomes included requirement for renal replacement therapy (RRT), mechanical ventilation duration, and incidence of arrhythmias.

Statistical Analysis

Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± SD or median (interquartile range) and compared using Student's t-test or Mann–Whitney U test. Categorical variables were expressed as counts and percentages, compared using chi-square or Fisher's exact test. Logistic regression analysis identified independent predictors of electrolyte disturbances. Kaplan–Meier survival analysis assessed mortality in patients with and without disturbances. A p-value <0.05 was considered statistically significant.

RESULTS

Patient Characteristics

A total of 70 patients were included in the study, with a mean age of 58.2 ± 16.4 years. Among them, 41 (58.5%) were male and 29 (41.5%) female. Common comorbidities included hypertension in 30 patients (42.8%), diabetes mellitus in 27 patients (38.5%), and chronic kidney disease in 11 patients (15.7%). The primary admission diagnoses were sepsis in 25 patients (35.7%), acute respiratory distress syndrome (ARDS) in 15 patients (21.4%), cardiovascular emergencies in 11 patients (15.7%), trauma in 9 patients (12.8%), and other conditions in 10 patients (14.2%). The mean APACHE II score was 19.8 ± 6.4, reflecting moderately severe critical illness.

Table – I: Demographic and Clinical Characteristics of ICU Patients (*n*=70)

Variable	Number (%) / Mean ± SD
Age (years)	58.2 ± 16.4
Male sex	41 (58.5)
Hypertension	30 (42.8)
Diabetes mellitus	27 (38.5)
Chronic kidney disease	11 (15.7)
Admission diagnosis: Sepsis	25 (35.7)
ARDS	15 (21.4)
Cardiovascular emergencies	11 (15.7)
Trauma	9 (12.8)
Other	10 (14.2)
APACHE II score	19.8 ± 6.4

Prevalence and Pattern of Electrolyte Disturbances

Out of 70 patients, 57 (81.4%) developed at least one electrolyte disturbance during ICU stay. Hyponatremia was the most common abnormality, affecting 30 patients (42.8%), followed by hypokalemia in 27 patients (38.5%). Hypocalcemia was observed in 18 patients (25.7%), hypomagnesemia in 14 patients (20%), and hypophosphatemia in 10 patients (14.2%). Less common disturbances included hypernatremia in 7 patients (10%) and hyperkalemia in 5 patients (7.1%).

Table – II: Prevalence of Electrolyte Disturbances in ICU Patients

Electrolyte Disturbance	Number of Patients (%)
Hyponatremia	30 (42.8)
Hypokalemia	27 (38.5)
Hypocalcemia	18 (25.7)
Hypomagnesemia	14 (20)
Hypophosphatemia	10 (14.2)
Hypernatremia	7 (10)
Hyperkalemia	5 (7.1)

Among patients with disturbances, 26 (37.1%) had multiple electrolyte abnormalities. The most frequent combination was hyponatremia with hypokalemia, observed in 12 patients, followed by hyponatremia with hypocalcemia in 6 patients. This highlights the tendency for concurrent disturbances in critically ill patients.

Table – III: Distribution of Multiple Electrolyte Disturbances

Combination of Disturbances	Number of Patients (%)
Hyponatremia + Hypokalemia	12 (17.1)
Hyponatremia + Hypocalcemia	6 (8.5)
Hypokalemia + Hypomagnesemia	4 (5.7)
Hyponatremia + Hypokalemia + Hypocalcemia	4 (5.7)

Predictors of Electrolyte Disturbances

On univariate analysis, sepsis, diuretic therapy, higher APACHE II scores, and renal dysfunction were significantly associated with electrolyte disturbances (p<0.05). Age, sex, and presence of comorbidities such as diabetes or hypertension were not significantly associated.

Multivariate logistic regression identified three independent predictors:

- **Sepsis**: OR 3.2; 95% CI 1.5–6.8; p=0.003
- **Diuretic use**: OR 2.7; 95% CI 1.2–5.9; p=0.01
- **Higher APACHE II score**: OR 1.1 per point; 95% CI 1.02–1.18; p=0.02

Table – IV: Multivariate Logistic Regression for Predictors of Electrolyte Disturbances

Predictor	Odds Ratio (OR)	95% CI	p-value
Sepsis	3.2	1.5–6.8	0.003
Diuretic use	2.7	1.2–5.9	0.01
APACHE II score	1.1 per point	1.02–1.18	0.02

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Clinical Outcomes

Patients with any electrolyte disturbance had longer ICU stays, with a median of 12 days (IQR 9–16) compared to 7 days (IQR 5–10) in patients without disturbances (p=0.01). Mortality was also significantly higher in patients with disturbances (28.5% vs. 7.1%; p=0.01).

Specific associations included:

- **Hyponatremia**: Associated with prolonged mechanical ventilation (median 6 vs. 3 days, p=0.04).
- **Hypokalemia**: Linked to arrhythmias in 5 of 27 patients (18.5%), compared to 2 of 43 patients (4.7%) without hypokalemia (p=0.03).
- **Hypocalcemia and hypomagnesemia**: Predisposed patients with acute kidney injury to require renal replacement therapy (RRT).

Table – V: Outcomes According to Electrolyte Disturbances

Outcome	Electrolyte Disturbance (n=57)	No Disturbance (n=13)	p-value
ICU length of stay, median (IQR)	12 (9–16)	7 (5–10)	0.01
Mortality (%)	28.5	7.1	0.01
Mechanical ventilation duration, median days	6 (4–10)	3 (2–5)	0.04
Arrhythmias (%)	18.5	4.7	0.03
RRT requirement (%)	15.7	0	0.05

Kaplan–Meier survival analysis demonstrated significantly lower cumulative survival in patients with multiple electrolyte disturbances compared to those with single or no disturbances (log-rank p=0.005), underscoring the prognostic impact of combined abnormalities.

DISCUSSION

Electrolyte disturbances are extremely common in critically ill patients, with this study showing a prevalence of 81.4%, aligning with prior reports ranging from 60% to 90% in ICU populations.[10,11] Hyponatremia and hypokalemia were the most frequent abnormalities, consistent with other observational studies.[12]

Hyponatremia in ICU patients is often multifactorial, resulting from volume depletion, SIADH, sepsis, or diuretic therapy. It has been associated with increased mortality and prolonged ICU stay, as observed in our cohort.[13] Hypokalemia, noted in 38.5% of patients, may arise from renal losses, gastrointestinal losses, or insulin-mediated shifts. Its clinical significance lies in the risk of life-threatening arrhythmias, particularly in patients with cardiovascular comorbidities.[14]

Hypocalcemia and hypomagnesemia were observed in 25.7% and 20% of patients, respectively. Critical illness–related hypocalcemia is linked with sepsis and renal dysfunction, possibly due to altered parathyroid hormone response and vitamin D metabolism.[15] Magnesium deficiency, though less frequently reported, is associated with cardiac arrhythmias, neuromuscular irritability, and increased mortality.[16] Hypophosphatemia, while less prevalent, can compromise diaphragmatic contractility and contribute to weaning failure from mechanical ventilation.[17]

Predictors: Sepsis emerged as the strongest independent predictor of electrolyte disturbances, highlighting the systemic inflammatory response and fluid shifts associated with critical illness.[18] Diuretic use, commonly employed for volume management, predisposed patients to sodium, potassium, and magnesium losses. Higher APACHE II scores, reflecting more severe illness, also predicted disturbances, suggesting that sicker patients are more prone to metabolic derangements.

Outcomes: The study confirmed that electrolyte disturbances adversely affect clinical outcomes. Patients with multiple disturbances had longer ICU stays, increased need for organ support, and higher mortality. These findings underscore the importance of early identification and correction of abnormalities. Previous studies have similarly reported associations between electrolyte imbalances and adverse outcomes, although many focused on single electrolytes.[19,20]

Clinical implications: Regular monitoring of serum electrolytes, especially in septic and high-APACHE II score patients, is essential. Protocolized correction strategies may prevent complications, reduce ICU length of stay, and potentially improve survival. Electrolyte management should be individualized, taking into account underlying etiology, comorbidities, and concomitant therapies.

Strengths and Limitations: This study is strengthened by its prospective design and comprehensive evaluation of multiple electrolytes. However, it is limited by the single-center design and relatively small sample size (70 patients), which may limit generalizability. Additionally, long-term outcomes beyond ICU discharge were not assessed.

Future directions: Larger multicenter studies are warranted to validate these findings. Research should also explore the impact of early, protocolized electrolyte correction on morbidity and mortality in ICU patients.

Conclusion

Electrolyte disturbances are highly prevalent in ICU patients, with hyponatremia and hypokalemia being the most common. Sepsis, diuretic therapy, and higher severity of illness are significant predictors. These disturbances are associated with prolonged ICU stay, increased requirement for organ support, and higher mortality. Early recognition and timely correction are crucial for improving outcomes in critically ill patients.

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