Section: Internal Medicine

Original Research Article

THE IMPACT OF ON ADMISSION SERUM ELECTROLYTES ON PATIENTS ADMITTED TO MEDICAL ICU ON THE BASIS OF LENGTH OF ICU STAY, NEED FOR MECHANICAL VENTILATION AND MORTALITY

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Abstract

Background: Electrolyte imbalances are common among critically ill patients and can significantly impact clinical outcomes. This study aims to investigate the relationship between on-admission serum electrolyte levels and ICU outcomes, including length of stay, the need for mechanical ventilation, and mortality. **Materials and Methods:** This prospective observational study included 76 patients admitted to the medical ICU of Shri Mahant Indiresh Hospital. Serum levels of sodium, potassium, calcium, and phosphorus were measured on admission. Data were analyzed to assess correlations between electrolyte abnormalities and ICU outcomes, with particular attention to differences across age, sex, and electrolyte levels. **Result:** The mean age of patients was 54 years, with 47 females and 29 males included in the study. Hypernatremia was associated with a significantly longer ICU stay and a higher requirement for mechanical ventilation ($p < 0.01$). Both hypo- and hyperkalemia were linked to elevated mortality rates, particularly in patients requiring ventilatory support. Hypocalcemia and hyperphosphatemia were also significantly associated with increased mortality and a higher incidence of renal complications requiring replacement therapy. **Conclusion:** Abnormal serum electrolyte levels at ICU admission are significant predictors of adverse outcomes. These findings underscore the importance of routine electrolyte monitoring and timely correction to improve patient prognosis in the ICU. Future studies should further explore the mechanisms linking electrolyte imbalances to ICU mortality and other critical outcomes, particularly in diverse and resource-limited settings.

INTRODUCTION

Electrolytes imbalance is among the most common clinical complications met in the setting of intensive care and is associated with the poor prognosis with respect to morbidity and mortality.[1] Depletion of these electrolytes can induce a wide range of clinical disorders, including neuromuscular dysfunction and severe arrhythmias. The risk for these disorders increases significantly when more than one electrolyte is deficient.[2]

Disturbances in plasma sodium concentrations are a common clinical problem in patients admitted to the intensive care unit. Many cases of dysnatremia are acquired after a patient is admitted to the ICU, and the presence of dysnatremia is associated with poor prognosis.

Critically ill patients are at risk for alterations in their serum K+ level. Reduced kidney function, the presence of metabolic acidosis, use of mechanical ventilation, and increases in cell turnover promote K+ accumulation. Certain medications such as insulin, sympathomimetic agents, and diuretics decrease serum K+, while spironolactone, angiotensin-converting enzyme inhibitors, and angiotensin receptor antagonists increase serum K+. Hypokalemia and hyperkalemia can both induce cardiac arrhythmias.[3-5]

Hypocalcemia has been described to reach a prevalence of 18% in hospitalized patients and up to 85% in the intensive care units.[6] The mechanism by which low serum calcium concentration leads to poor

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outcome in critically ill patients can be described as follows: Firstly, as hypocalcemia causes decline in myocardial contractility, it is associated with congestive heart failure in hypocalcemic patients. Secondly, hypocalcemia can be associated with increased risk of rapid renal dysfunction, which may result in renal replacement therapy. Thirdly, considering the important role of calcium in the body, its serum levels are precisely regulated and is in close relationship with levels of phosphorus, magnesium, and vitamin D. All these issues can contribute to worse outcome of critically ill patients.

Hypophosphatemia has been associated with critical conditions like gram negative sepsis.[7]

The importance of hyperphosphatemia has been largely and consistently emphasized in patients with chronic kidney disease (CKD) and chronic cardiovascular disease.[8,9]

MATERIALS AND METHODS

Source of Data: The study included subjects admitted to medical ICUs of Shri Mahant Indiresh Hospital, an associated hospital of SGRR Institute of medical and health sciences, Patel Nagar, Dehradun. Data was collected from the hospital's database and patient's records

Study type: Prospective Observation Study

Sample size: 76 subjects admitted to medical ICUs of SMIH would be included if they satisfy inclusion and exclusion criteria.

Inclusion criteria

All patients Age >18 years admitted to the medical ICU.

Exclusion criteria

Patients who have been admitted to the ICU in the past 30 days.

Investigation and intervention: The subjects so included were evaluated with thorough history and clinical examination. Serum Electrolytes- sodium, potassium, calcium and phosphorus were noted at the time of study.

Normal values taken as:

Element	Values
Sodium	135-145 mmol/L
Potassium	3.5-5.0 mmol/L
Calcium	8.5-10.5 mg/dl
Phosphorus	2.5-4.5 mg/dl

RESULTS

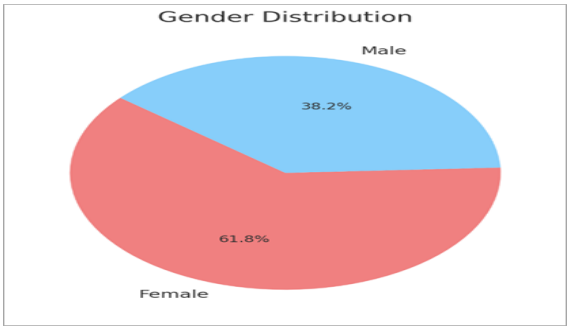

Figure 1: A pie chart illustrating the proportion of male and female patients admitted to the ICU. This figure provides a visual overview of the gender composition in the study population.

This study included a total of 76 patients admitted to medical ICU. They were followed up for 7 days and the demographic and clinical characteristics, along with electrolyte levels, were analyzed to determine their impact on ICU outcomes, including length of stay, need for mechanical ventilation, and mortality.

Demographic and Clinical Characteristics

Age and Gender Distribution

- **Age:** Patients ranged from 18 to 89 years, with an average of 54 years.
- **Gender Distribution:** The cohort included 47 females and 29 males.

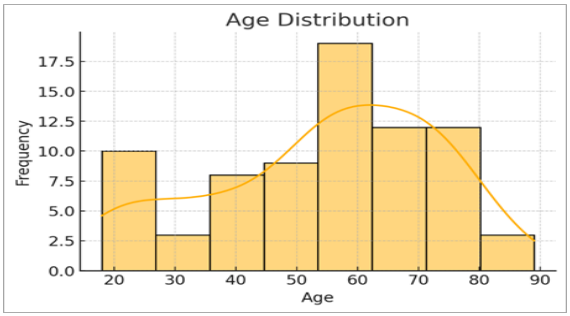

Figure 2: A histogram or bar chart showing the distribution of age ranges among ICU patients, categorized into age groups (e.g., 18–30, 31–50, etc.), offering insight into the age demographics of the cohort.

Analysis Of Electrolyte Abnormalities and Clinical Outcomes

Sodium Abnormalities

- ICU Stay: Patients with hypernatremia had significantly longer ICU stays compared to those with normal sodium levels ($p = 0.0067$).
- Ventilation Requirement: A higher percentage of patients with hypernatremia required mechanical ventilation.
- Mortality Rate: The mortality rate was elevated in hypernatremia cases.

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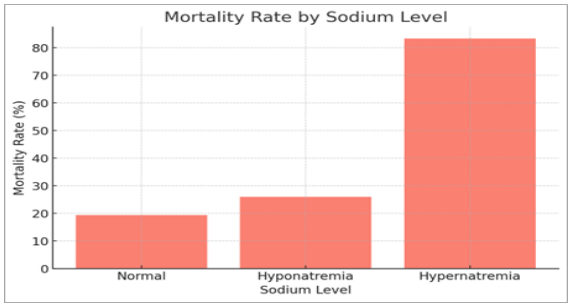
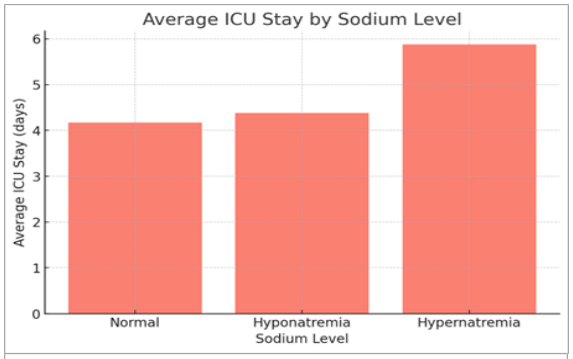




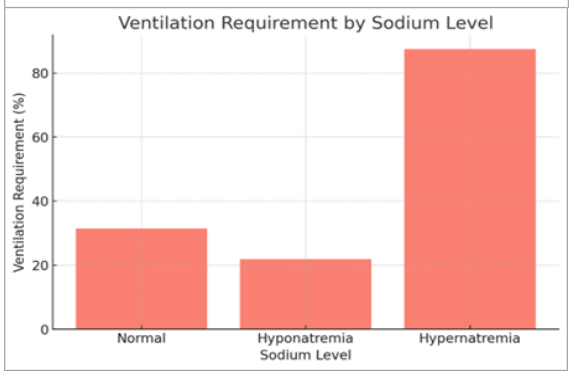
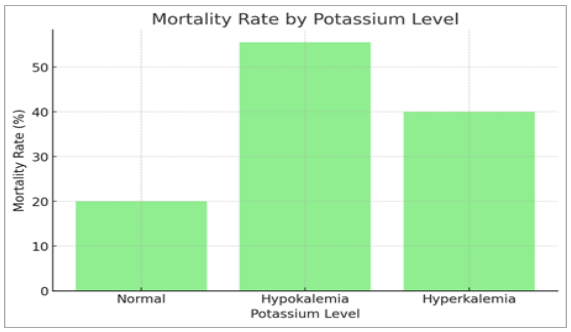
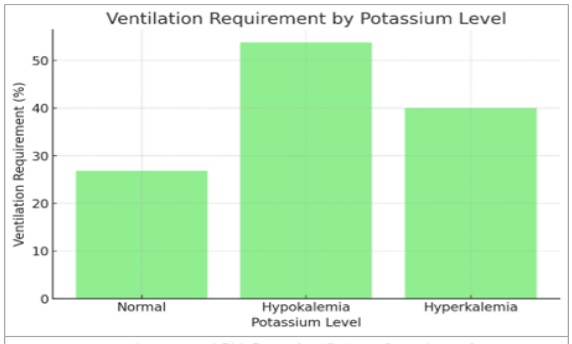


Figure 3: Bar charts illustrating average icu stay, need for mechanical ventilation and mortality by sodium category (normal, hyponatremia, and hypernatremia) to clearly show differences.

Potassium Abnormalities

- **ICU Stay:** Hypokalemic patients had significantly longer ICU stays than those with normal potassium levels (p = 0.0345) significant.
- **Ventilation Requirement:** Ventilation requirement was higher in hypokalemia cases.
- **Mortality Rate:** Mortality was slightly higher in hypokalemic patients.





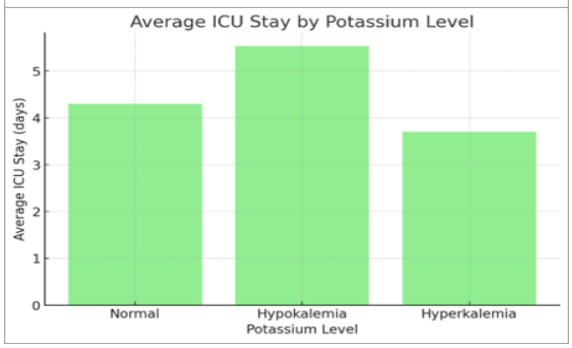
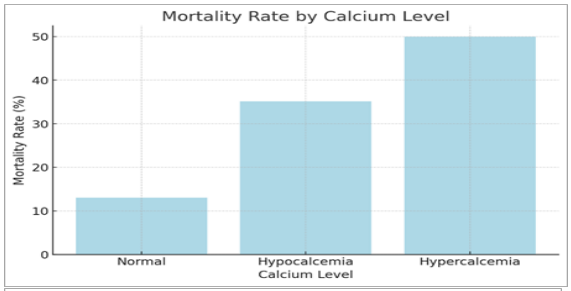
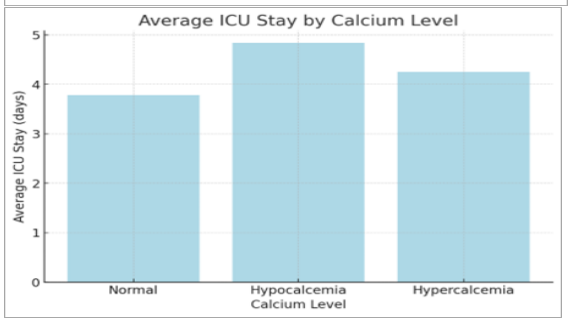


Figure 4: Bar charts illustrating average icu stay, need for mechanical ventilation and mortality by potassium category (normal, hypokalemia, and hyperkalemia) to clearly show differences.

Calcium Abnormalities

- **ICU Stay:** Hypocalcemic patients had a significantly longer ICU stay (p = 0.0258) significant.
- **Ventilation Requirement:** Higher ventilation requirement in hypocalcemic cases.
- **Mortality Rate:** Slightly elevated mortality rate in hypocalcemia cases.





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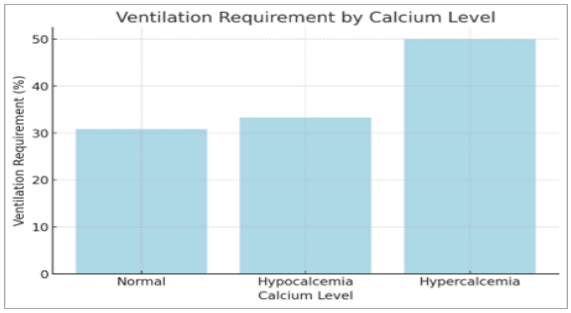
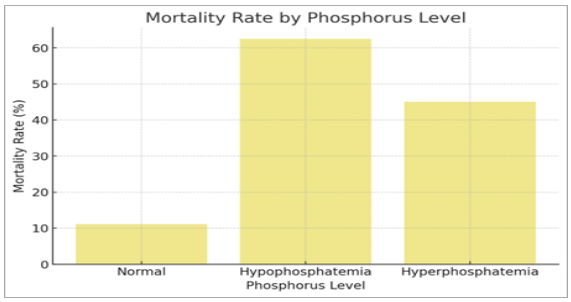


Figure 5: Bar charts illustrating average icu stay, need for mechanical ventilation and mortality by calcium category (normal, hypocalcemia, and hypercalcemia) to clearly show differences.

Phosphorus Abnormalities

- **ICU Stay:** No significant differences in ICU stay were observed for phosphorus levels.
- **Ventilation Requirement:** Slightly higher ventilation requirement in hypophosphatemia cases.
- **Mortality Rate:** No substantial differences in mortality based on phosphorus levels.



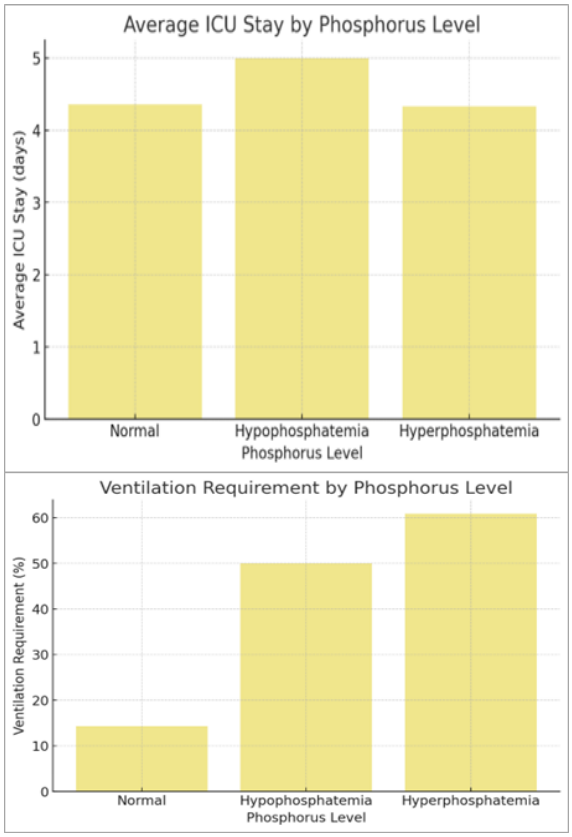


Figure 6: Bar charts illustrating average icu stay, need for mechanical ventilation and mortality by phosphorus category (normal, hypophosphatemia, and hyperphosphatemia) to clearly show differences.

Electrolyte Summary

Table 1: This table presents the mean, median, mode, and normal reference range for each electrolyte (sodium, potassium, calcium, phosphorus) in the cohort at the time of ICU admission. This summary provides a quick overview of electrolyte distributions.

Electrolyte	Mean (units)	Median (units)	Mode (units)	Normal Range
Sodium	136.33 mmol/L	136.00 mmol/L	136.0 mmol/L	135-145 mmol/L
Potassium	4.18 mmol/L	4.05 mmol/L	4.0 mmol/L	3.5-5.0 mmol/L
Calcium	8.27 mg/dL	8.15 mg/dL	7.9 mg/dL	8.5-10.5 mg/dL
Phosphorus	4.39 mg/dL	3.90 mg/dL	3.9 mg/dL	2.5-4.5 mg/dL

Comparative Summary of Electrolyte Levels and Outcomes

Table 2: Provides a comparative summary for each electrolyte, detailing the average ICU stay, ventilation requirement, and mortality rate across different electrolyte levels.

Electrolyte	Level	Avg ICU Stay (days)	Ventilation Requirement (%)	Mortality Rate (%)
Sodium	High	5.88	87.5	83.33
	Low	4.38	21.9	25.93
	Normal	4.17	31.4	19.35
Potassium	High	3.70	40.0	40.0
	Low	5.54	53.8	55.56
	Normal	4.30	26.9	20.0
Calcium	High	4.25	50.0	50.0
	Low	4.84	33.3	35.14
	Normal	3.78	30.8	13.04
Phosphorus	High	4.33	60.9	45.0
	Low	5.00	50.0	62.5
	Normal	4.36	14.3	11.11

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DISCUSSION

Electrolyte imbalances are prevalent among critically ill patients and are often indicative of worse clinical outcomes, including increased ICU length of stay, need for mechanical ventilation, and elevated mortality rates. This study reinforces the significance of serum electrolyte levels as prognostic markers for patients admitted to the ICU, in alignment with prior research findings on dysnatremia, hyperkalemia, hypocalcemia, and hyperphosphatemia.

In our cohort, hyponatremia and hypernatremia were significantly associated with poorer outcomes. This aligns with findings from Mousavi et al,[2] who observed that critically ill patients with sodium imbalances were more likely to experience adverse outcomes, especially mortality. Sodium disturbances affect neurological function due to cellular osmosis disruptions, which can lead to life-threatening symptoms like seizures and cerebral edema (in hyponatremia) or dehydration and vascular damage (in hypernatremia). Effective sodium level management remains crucial in mitigating these risks.

Similarly, potassium imbalances demonstrated a significant correlation with adverse outcomes in our study, particularly mortality and increased mechanical ventilation needs. Our findings echo Gunturi et al,[10] prospective observations, which underscored hyperkalemia's role in heightening mortality risks among ICU patients due to cardiac arrhythmias and neuromuscular dysfunction. The role of hypokalemia and hyperkalemia in ICU mortality has been widely recognized due to their potential for cardiac instability, warranting careful monitoring and timely correction of potassium levels upon ICU admission.

The impact of hypocalcemia on ICU outcomes observed in our study was substantial, with low calcium levels associated with higher rates of renal replacement therapy and ICU mortality. This is consistent with research that highlights the critical role of calcium in cardiac and renal function, where low calcium can precipitate heart failure and rapid renal decline, worsening patient outcomes.[6,11] Given that hypocalcemia can escalate in critically ill settings, especially with conditions like sepsis and major infections, proactive calcium monitoring is essential.

Hyperphosphatemia was another significant predictor of ICU mortality in our cohort, aligning with Sin et al. Where both hypo and hyperphosphatemia were associated with longer ICU stay and increased risk of mortality.[12] Hyperphosphatemia's association with organ dysfunction, particularly renal, underscores the need for vigilant management in critically ill patients to mitigate these risks. Elevated phosphate levels could reflect underlying metabolic stress, renal impairment, or cellular breakdown, which are markers of disease severity in ICU populations.

CONCLUSION

In conclusion, our study highlights the predictive value of serum electrolyte disturbances in ICU outcomes. Close monitoring and early correction of dysnatremia, potassium abnormalities, hypocalcemia, and hyperphosphatemia could be critical interventions to improve survival rates and reduce the need for prolonged ICU interventions. Further studies are needed to validate these findings across diverse populations and to develop standardized protocols for electrolyte management in critically ill patients, particularly in resource-limited settings where ICU resources are often constrained.

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