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Serum Magnesium as a Prognostic Indicator in Critical Illness: Experience from a Tertiary Care ICU.

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Abstract

Background: ***Aim:*** To evaluate the association between serum magnesium levels and disease severity as well as prognosis in critically ill patients admitted to the Intensive Care Unit (ICU). ***Objectives:*** 1To determine the prevalence of hypomagnesemia in critically ill patients. 2To assess the relationship between serum magnesium levels and disease severity using APACHE II score. 3To evaluate the association between serum magnesium levels and clinical outcomes, including duration of mechanical ventilation. ***Material and Methods :*** This observational study was conducted in the ICU of a tertiary care hospital over a period of 18 months (April 2024 to September 2025). A total of 205 critically ill patients aged between 18 and 65 years were included. Serum magnesium levels were measured within 24 hours of ICU admission. Disease severity was assessed using the APACHE II scoring system. Statistical analysis was performed using correlation analysis, chi-square test, and comparison of means. ***Results:*** Hypomagnesemia was observed in 49.3% of patients. A significant negative correlation was found between serum magnesium levels and APACHE II score ($r = -0.332$, $p = 0.001$), indicating that lower magnesium levels were associated with higher disease severity. Hypomagnesemia was most prevalent in severe cases (89.5%), followed by moderate (43.5%) and mild cases (0%), with a statistically significant association ($p = 0.001$). A significant negative correlation was also observed between serum magnesium levels and duration of mechanical ventilation ($r = -0.442$, $p = 0.001$). ***Conclusion:*** Hypomagnesemia is highly prevalent among critically ill patients and is significantly associated with increased disease severity and poorer clinical outcomes. Serum magnesium may serve as a useful prognostic biomarker in ICU settings.

Keywords: Hypomagnesemia, Serum Magnesium, Critical Illness, ICU, APACHE II Score, Prognostic Marker, Mechanical Ventilation.

INTRODUCTION

Critical illness is a complex clinical state characterized by multi-organ dysfunction requiring intensive monitoring and therapeutic support in the intensive care unit (ICU). Electrolyte imbalances are frequently encountered in such patients and play a crucial role in determining disease severity and outcomes. Among these, magnesium is an essential intracellular cation involved in numerous physiological processes including energy metabolism, protein synthesis, neuromuscular conduction, and cardiovascular stability (1,2).

Magnesium acts as a cofactor for over 300 enzymatic reactions and is vital for maintaining cellular homeostasis. It plays an important role in regulating ion channels, particularly calcium and potassium, thereby influencing cardiac rhythm and vascular tone (3). Despite its significance, magnesium is often overlooked in routine ICU evaluation compared to other electrolytes such as sodium and potassium.

Hypomagnesemia is commonly observed in critically ill patients, with reported prevalence ranging from 20% to 60% (4). The etiology is multifactorial, including inadequate intake, gastrointestinal losses, renal wasting, medications (such as diuretics and aminoglycosides), and redistribution during stress conditions like sepsis (5,6).

Clinically, hypomagnesemia has been associated with arrhythmias, increased vasopressor requirement, neuromuscular irritability, and impaired respiratory muscle function (7). Several studies have demonstrated a correlation between low magnesium levels and increased disease severity scores such as APACHE II and SOFA, as well as higher mortality rates (8,9).

However, data from Indian ICU settings remain limited. Therefore, this study was undertaken to evaluate the association between serum magnesium levels, disease severity, and prognosis in critically ill patients.

MATERIALS AND METHODS

This hospital-based observational study was conducted in the ICU of Mahatma Gandhi Medical College & Hospital, Jaipur, over 18 months (April 2024–September 2025).

A total of 205 critically ill patients aged 18–65 years were included after obtaining informed consent. Patients with known conditions affecting magnesium balance (chronic diarrhea, renal failure requiring dialysis, recent magnesium therapy, or drugs affecting magnesium levels) were excluded.

Serum magnesium levels were measured within 24 hours of ICU admission. Disease severity was assessed using the APACHE II scoring system. Patients were followed until discharge, death, or leaving against medical advice.
Statistical analysis was performed using SPSS version 23. Pearson correlation, chi-square test, and independent t-test were applied. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic, Clinical, and Serum Magnesium Profile of Critically Ill Patients (n = 205)

Variable	Category	n (%)	Mean ± SD (Range)
Age (years)	≤50 years	66 (32.1)	48.2 ± 11.20 (21–67)
	>50 years	139 (67.9)	
Gender	Male	113 (55.2)	
	Female	92 (44.8)	
Locality	Urban	134 (65.4)	
	Rural	71 (34.6)	
APACHE II Score	Overall	205 (100)	16.07 ± 4.79 (4–20)
Disease Severity	Mild (0–9)	33 (16.1)	
	Moderate (10–19)	115 (56.1)	
	Severe (20–29)	57 (27.8)	
Serum Magnesium	Hypomagnesemia	101 (49.3)	1.73 ± 0.23 (1.3–2.0)
	Normomagnesemia	104 (50.7)	
Cause of ICU Admission	Sepsis	56 (27.3)	
	Acute Kidney Injury	54 (26.3)	
	Chronic Liver Disease	41 (20.0)	
	COPD	38 (18.5)	
	Meningitis	16 (7.8)	

Table1 : The study population was predominantly above 50 years with a slight male predominance and majority urban residence. Most patients had moderate disease severity based on APACHE II score. Hypomagnesemia was present in nearly half of the patients (49.3%). Sepsis and acute kidney injury were the most common causes of ICU admission.

Table 2: Association of Serum Magnesium with Disease Severity, Clinical Parameters, and Outcomes (n = 205)

Variable	Category	n (%)	Mean ± SD (Range)
Correlation with APACHE II Score	All patients	205 (100)	r = –0.332, p = 0.001
Correlation with ICU Stay	All patients	205 (100)	r = –0.027, p = 0.701
Correlation with Oxygen Requirement	All patients	205 (100)	r = –0.010, p = 0.891
Correlation with CPAP Duration	All patients	205 (100)	r = 0.016, p = 0.820
Correlation with Ventilation Duration	All patients	205 (100)	r = –0.442, p = 0.001
Disease Severity	Mild	0 (0%)	
	Moderate	50 (43.5%)	
	Severe	51 (89.5%)	p = 0.001
Cause of Admission	COPD	18 (~47%)	
	Acute Kidney Injury	26 (~48%)	
	Chronic Liver Disease	21 (~51%)	
	Meningitis	9 (~56%)	
	Sepsis	27 (~48%)	p ≈ 0.669
Outcome	Death	61 (29.8)	1.61 ± 0.20
	Discharge	83 (40.5)	1.82 ± 0.18
	LAMA	61 (29.8)	1.70 ± 0.22
Hypomagnesemia in Death Cases	Present	44 (72%)	
	Absent	17 (28%)	
Severity among Death Cases	Mild	0 (0%)	
	Moderate	6 (10%)	
	Severe	55 (90%)	
Cause of Death	Acute Kidney Injury	18 (29.5%)	
	Sepsis	13 (21.3%)	
	Meningitis	13 (21.3%)	
	Chronic Liver Disease	12 (19.7%)	
	COPD	4 (6.6%)	

Table2: Serum magnesium levels showed a significant inverse correlation with disease severity (APACHE II score). Hypomagnesemia increased with worsening severity and was highest in severe cases. Lower magnesium levels were also associated with prolonged mechanical ventilation, while no significant association was found with ICU stay or oxygen requirement. Hypomagnesemia was more common among patients with poor outcomes.

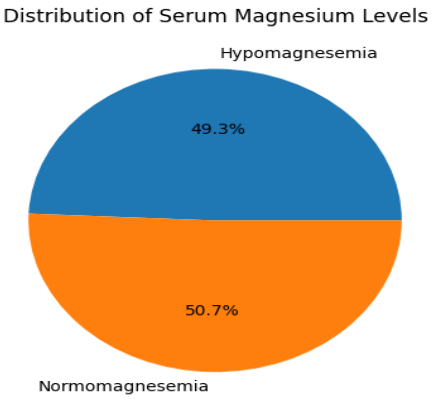

Figure1: This pie chart shows the distribution of serum magnesium levels among critically ill patients. Hypomagnesemia was observed in 49.3% of patients, while 50.7% had normal magnesium levels, indicating a nearly equal distribution with a high prevalence of magnesium imbalance in the ICU population.

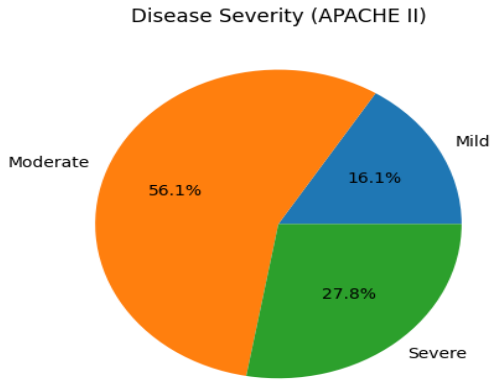

Figure 2: This pie chart represents disease severity among the study population. The majority of patients had moderate disease (56.1%), followed by severe (27.8%) and mild (16.1%) categories.

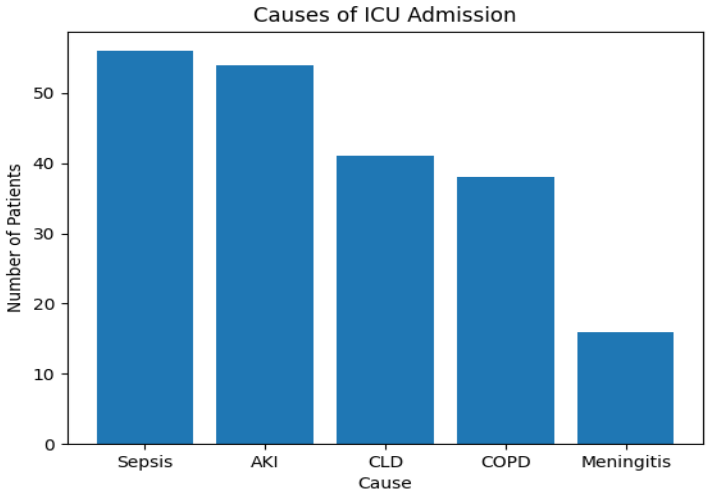

Figure 3: This bar diagram shows the distribution of causes of ICU admission. Sepsis was the most common cause (56 cases), followed closely by acute kidney injury (54 cases). Chronic liver disease and COPD were also significant contributors, while meningitis was the least common.

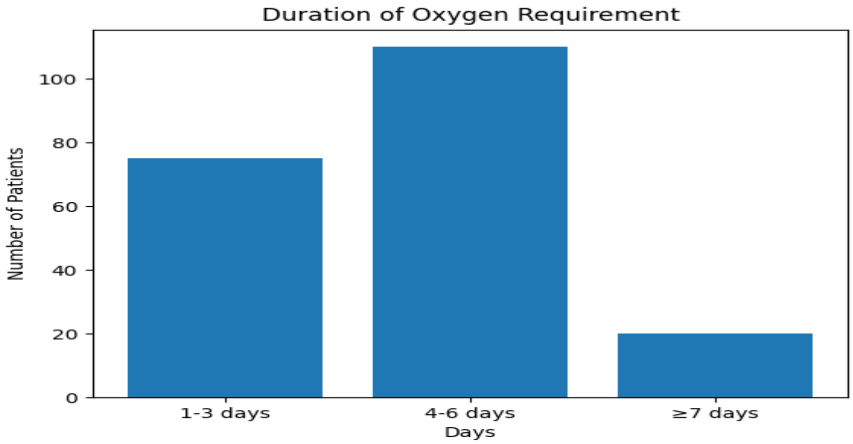

Figure 4: This bar diagram illustrates the duration of oxygen therapy among ICU patients. Most patients required oxygen for 4–6 days, followed by 1–3 days, while only a small proportion required prolonged oxygen support (≥7 days).

DISCUSSION

The present study demonstrated a high prevalence of hypomagnesemia (49.3%) among critically ill patients, which is consistent with previous studies reporting magnesium deficiency in ICU populations (4,6). This high prevalence reflects the complex interplay of factors such as systemic inflammation, renal dysfunction, poor nutritional status, and medication effects in critically ill patients.

A significant inverse correlation was observed between serum magnesium levels and disease severity as assessed by APACHE II score. Patients with lower magnesium levels had higher severity scores, indicating more severe illness. Similar findings have been reported in earlier studies, where hypomagnesemia was associated with increased physiological derangement and higher severity indices (8,10). The underlying mechanism may involve increased inflammatory cytokines, impaired cellular energy metabolism, and dysregulation of ion transport systems.

In this study, hypomagnesemia increased progressively with worsening disease severity, being absent in mild cases and highly prevalent in severe cases. This suggests that magnesium may serve as an important marker of disease progression. Comparable trends have been observed in studies evaluating electrolyte disturbances in critically ill patients, reinforcing the role of magnesium as a severity indicator (9,11).

The study also found a significant association between low magnesium levels and prolonged duration of mechanical ventilation. Magnesium deficiency can impair respiratory muscle function and reduce diaphragmatic contractility, leading to difficulty in weaning from ventilatory support (7,12). This finding highlights the importance of magnesium in respiratory physiology and its potential impact on ICU management.

However, no significant association was found between serum magnesium levels and duration of ICU stay, oxygen requirement, or CPAP duration. This suggests that magnesium levels may reflect acute disease severity rather than the overall duration of hospitalization, a finding consistent with previous literature (10).
Although hypomagnesemia was observed across different causes of ICU admission, no statistically significant association was found with specific etiologies. This indicates that magnesium imbalance is a generalized phenomenon in critical illness rather than disease-specific.

Furthermore, magnesium levels were lower among patients with poor outcomes, and hypomagnesemia was more prevalent among death cases. This supports previous evidence suggesting that magnesium deficiency is associated with increased mortality in critically ill patients (9,13). The mechanisms may include cardiovascular instability, arrhythmogenesis, and impaired immune response.

Overall, the findings of this study reinforce the importance of serum magnesium as a marker of disease severity and prognosis in critically ill patients.

CONCLUSION

Hypomagnesemia is a common electrolyte abnormality in critically ill patients and is significantly associated with increased disease severity and adverse clinical outcomes. Lower serum magnesium levels correlate with higher APACHE II scores and prolonged mechanical ventilation, indicating greater physiological derangement.

Serum magnesium measurement is simple, cost-effective, and readily available, making it a valuable prognostic biomarker in ICU settings. Early identification and appropriate management of magnesium imbalance may contribute to improved patient outcomes.

Further large-scale studies are recommended to establish the role of magnesium correction in reducing morbidity and mortality in critically ill patients.

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