SERUM HYPOMAGNESEMIA IN CRITICALLY ILL PATIENTS IN MEDICAL ICU WITH AND WITHOUT DIABETES MELLITUS

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Abstract

Background: Hypomagnesemia is a common electrolyte disturbance in critically ill patients, often associated with poor outcomes. The impact of hypomagnesemia on mortality and its relationship with diabetes mellitus in ICU patients remains an area of clinical interest.

Objective: To evaluate the prevalence of hypomagnesemia in critically ill patients and assess its impact on patient outcomes, particularly in those with diabetes mellitus.

Methods: A prospective observational study was conducted in the Medical ICU at Sree Balaji Medical College & Hospital, Chennai, including 60 critically ill patients. Serum magnesium levels were measured on admission, and patients were classified into hypomagnesemia and normomagnesemia groups. The relationship between magnesium levels, diabetic status, and patient outcomes was analyzed using statistical methods.

Results: Among the 60 patients, 31.7% had hypomagnesemia, with a higher prevalence in diabetic patients (45.9%) compared to non-diabetics (8.7%). The mean serum magnesium level was 1.79 mg/dL. Hypomagnesemia was significantly associated with increased mortality (78.9%) compared to normomagnesemic patients (41.4%, $p<0.05$). A longer duration of diabetes was linked to lower magnesium levels.

Conclusion: Hypomagnesemia is a significant predictor of poor outcomes in critically ill patients, particularly those with diabetes mellitus. Regular monitoring and timely correction of magnesium levels may improve ICU patient prognosis.

Introduction

Critically ill patients often experience significant metabolic and electrolyte disturbances that impact their clinical outcomes. Among these disturbances, hypomagnesemia (low serum magnesium levels) is a frequently overlooked yet crucial factor that influences morbidity and mortality in intensive care unit (ICU) patients. Magnesium is an essential intracellular cation involved in numerous physiological

processes, including enzymatic reactions, neuromuscular function, and cardiovascular stability. Deficiency of this vital electrolyte has been associated with increased inflammation, insulin resistance, cardiovascular instability, and poor immune response, all of which are critical determinants of survival in the ICU (1,2).

Despite advances in ICU care, mortality rates remain high among critically ill patients, necessitating the identification of additional modifiable risk factors (3,4). Current clinical management in the ICU focuses primarily on sodium, potassium, and calcium imbalances, often neglecting magnesium levels. Emerging evidence suggests that low magnesium may contribute to worsening organ dysfunction, arrhythmias, and prolonged ICU stays, yet its role is not well established in clinical practice (5,6).

One patient may recover well from a critical illness, while another with similar demographics and treatment may deteriorate rapidly. This disparity raises an important question: Are we missing key biochemical markers that influence outcomes? Previous studies have reported contradictory findings regarding the role of hypomagnesemia in ICU mortality and its link to underlying conditions such as diabetes mellitus (DM) (7,8). While some research has identified low serum magnesium as a risk factor for diabetes progression and complications, others have failed to establish a clear association between magnesium levels and ICU survival (9,10). This inconsistency underscores the need for further investigation.

The impact of hypomagnesemia on critically ill patients with and without diabetes mellitus is not well understood. While it is known that diabetic patients frequently experience magnesium depletion due to increased urinary excretion (11,12), its clinical significance in critically ill settings remains unclear. This study aims to determine whether low serum magnesium levels correlate with increased mortality, particularly in diabetic patients, and whether magnesium status should be considered in ICU treatment protocols (13). We hypothesize that critically ill patients with hypomagnesemia have higher mortality rates compared to those with normal magnesium levels, and this effect is more pronounced in patients with diabetes mellitus.

Objectives

1. To assess the prevalence of hypomagnesemia in critically ill patients in a Medical ICU.
2. To evaluate the relationship between serum magnesium levels and mortality in critically ill patients.
3. To determine whether diabetic patients are more prone to hypomagnesemia and if this affects their prognosis.
4. To identify if magnesium levels can serve as a potential biomarker for ICU patient outcomes.

Methods

Study Design: This study was a prospective observational study conducted in the Medical Intensive Care Unit (MICU) of Sree Balaji Medical College & Hospital, Chennai. The study aimed to assess the prevalence of hypomagnesemia in critically ill patients and its impact on mortality and outcomes, particularly in diabetic patients.

Ethical Considerations: The study was approved by the Institutional Ethical Committee. Written informed consent was obtained from all patients or their legally authorized representatives before inclusion in the study.

Patient Selection

Inclusion Criteria

Patients admitted to the MICU with **critical illness**, including:

- Severe infections (complicated malaria, leptospirosis, urinary tract infections, cellulitis, tuberculosis)
- Hepatic failure (acute viral hepatitis, cirrhosis)
- Renal failure (acute kidney injury due to hypovolemia, chronic kidney disease)
- Respiratory failure (COPD, interstitial lung disease, ARDS)
- Cardiovascular conditions (ischemic heart disease, valvular heart disease, congestive heart failure)
- Cerebrovascular accidents (ischemic/hemorrhagic stroke)
- Metabolic disorders (diabetic ketoacidosis, hyperosmolar hyperglycemic state)
- Poisonings (organophosphate toxicity, snake bites)

Exclusion Criteria

Patients were excluded if they:

- Had received magnesium supplementation before ICU admission.
- Were on loop or thiazide diuretics, digoxin, or cisplatin therapy, as these drugs influence magnesium metabolism.
- Were pregnant or pediatric patients (age <18 years).
- Had pre-existing hypomagnesemia or conditions affecting magnesium homeostasis, such as chronic malabsorption syndromes.

Serum Magnesium Estimation

Serum magnesium levels were estimated using an atomic absorption spectrophotometer, a gold-standard technique for accurate quantification of serum magnesium concentration. Blood samples (3-5 mL) were collected via venipuncture into plain vacutainers. Samples were centrifuged at 3,000 rpm for 10 minutes to separate serum. Analysis was performed immediately to avoid sample degradation. Magnesium concentration was expressed in mg/dL.

Reference Ranges for Serum Magnesium

- Normal range: 1.7 – 2.2 mg/dL
- Hypomagnesemia: <1.7 mg/dL
- Severe hypomagnesemia: <1.5 mg/dL

Patients were categorized based on their serum magnesium levels into:

1. Normomagnesemia group (≥1.7 mg/dL)
2. Hypomagnesemia group (<1.7 mg/dL)

Data Collection

Comprehensive demographic and clinical data were collected, including:

- Age, gender, comorbidities (diabetes mellitus, hypertension, CKD, etc.)
- Primary reason for ICU admission
- Severity of illness (APACHE II, SOFA scores, if applicable)

- Length of ICU stay
- Laboratory investigations (serum magnesium, glucose, creatinine, electrolytes, arterial blood gases)
- Treatment modalities used (ventilator support, vasopressors, dialysis, insulin therapy)
- Patient outcomes (survival vs. non-survival)

Statistical Analysis

All statistical analyses were conducted using SPSS software (version 25.0). Continuous variables (e.g., age, serum magnesium levels) were expressed as mean ± standard deviation (SD). Categorical variables (e.g., gender, survival status) were expressed as percentages. Independent t-tests were used to compare means between the hypomagnesemia and normomagnesemia groups. Chi-square (χ^2) test was used for categorical comparisons. Pearson's correlation coefficient was applied to assess the relationship between serum magnesium levels and mortality rates. Logistic regression analysis was performed to determine predictors of mortality, adjusting for potential confounders such as age, diabetes status, and severity of illness. A p-value <0.05 was considered statistically significant. Confidence intervals were set at 95% to ensure robust data interpretation.

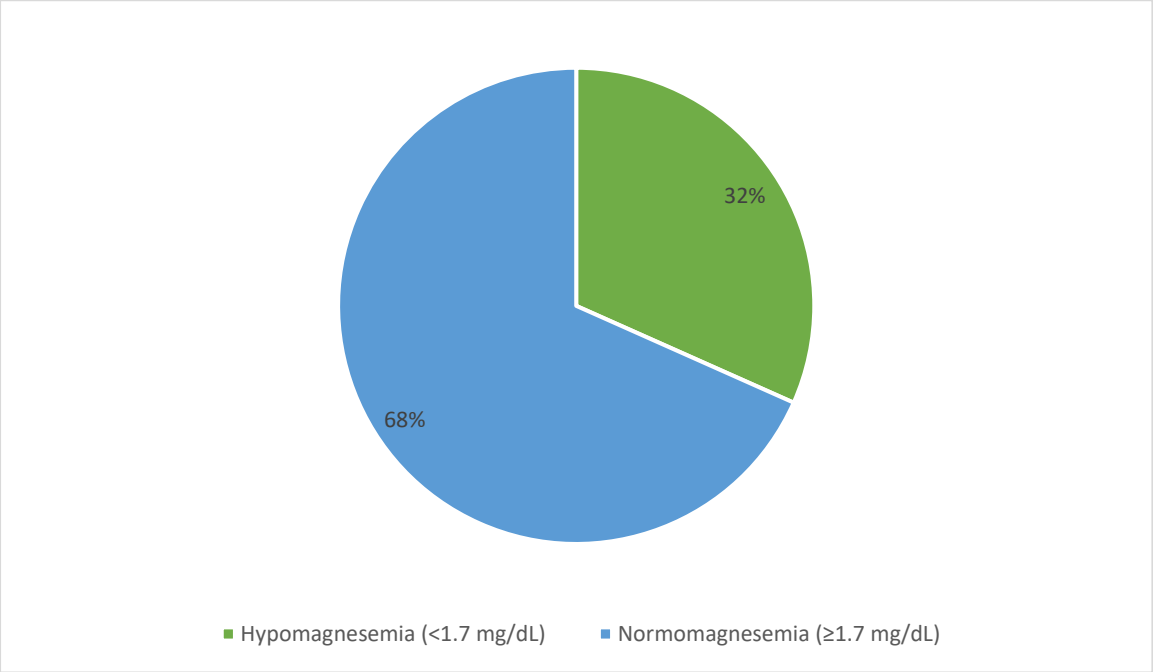
Results

Patient Distribution and Magnesium Levels

A total of 60 critically ill patients were included in the study. Among them: 31.7% (n=19) had hypomagnesemia (<1.7 mg/dL). 68.3% (n=41) had normal serum magnesium levels (≥1.7 mg/dL).

Table 1: Patient Distribution and Magnesium Levels

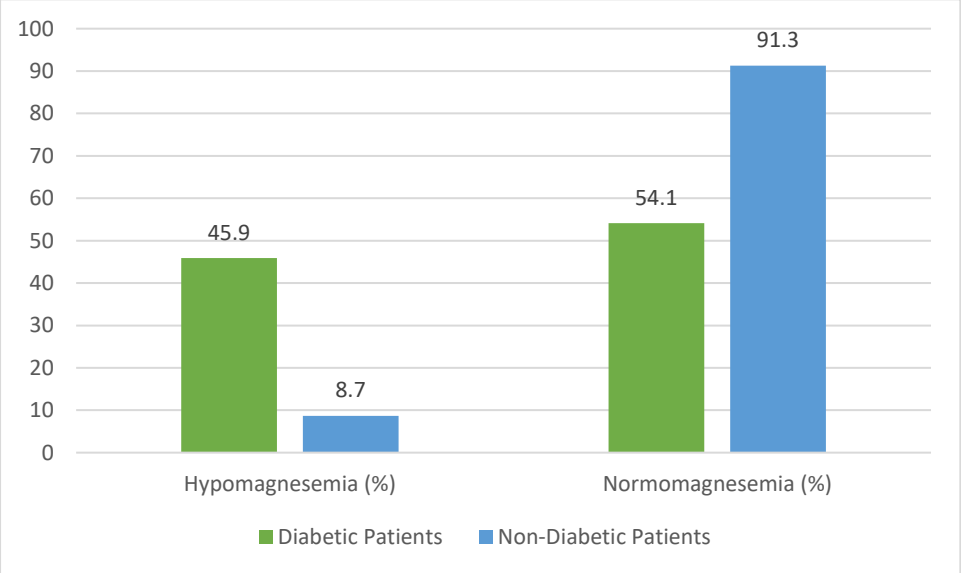
Category	Number of Patients	Percentage (%)
Total Patients	60	100
Hypomagnesemia (<1.7 mg/dL)	19	31.7
Normomagnesemia (≥1.7 mg/dL)	41	68.3



Diabetes and Hypomagnesemia: Among 37 diabetic patients, 45.9% (n=17) had hypomagnesemia. Among 23 non-diabetic patients, only 8.7% (n=2) had hypomagnesemia. A statistically significant association was found between diabetes and hypomagnesemia (p = 0.0031).

Table 2: Diabetes and Hypomagnesemia

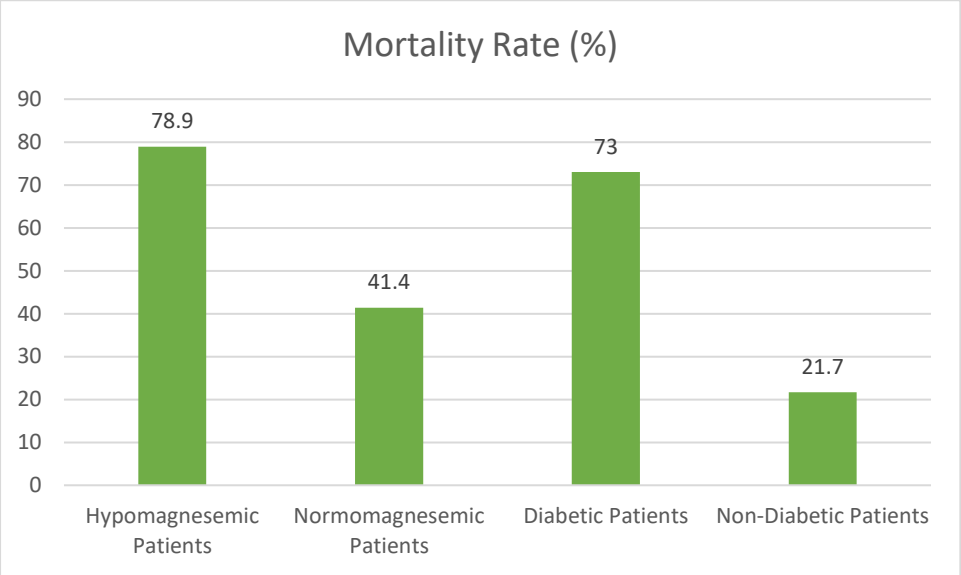
Diabetes Status	Total Patients	Hypomagnesemia (%)	Normomagnesemia (%)	p-value
Diabetic Patients	37	45.9	54.1	**0.0031**
Non-Diabetic Patients	23	8.7	91.3	



Mortality Analysis: The overall mortality rate was 53.3% (n=32). Patients with hypomagnesemia had a significantly higher mortality rate (78.9%) compared to normomagnesemic patients (41.4%) (p = 0.0011). Diabetic patients had a mortality rate of 73.0%, compared to 21.7% in non-diabetics (p = 0.0001).

Table 3: Mortality Analysis

Category	Mortality Rate (%)	p-value
All Patients	53.3	-
Hypomagnesemic Patients	78.9	**0.0011**
Normomagnesemic Patients	41.4	
Diabetic Patients	73.0	**0.0001**
Non-Diabetic Patients	21.7	



Age and Magnesium Levels: The mean age of hypomagnesemic patients was 66.3 ± 9.7 years, significantly higher than that of normomagnesemic patients (56.8 ± 11.3 years, p = 0.0027). Older patients were more likely to develop hypomagnesemia, suggesting age as a potential risk factor.

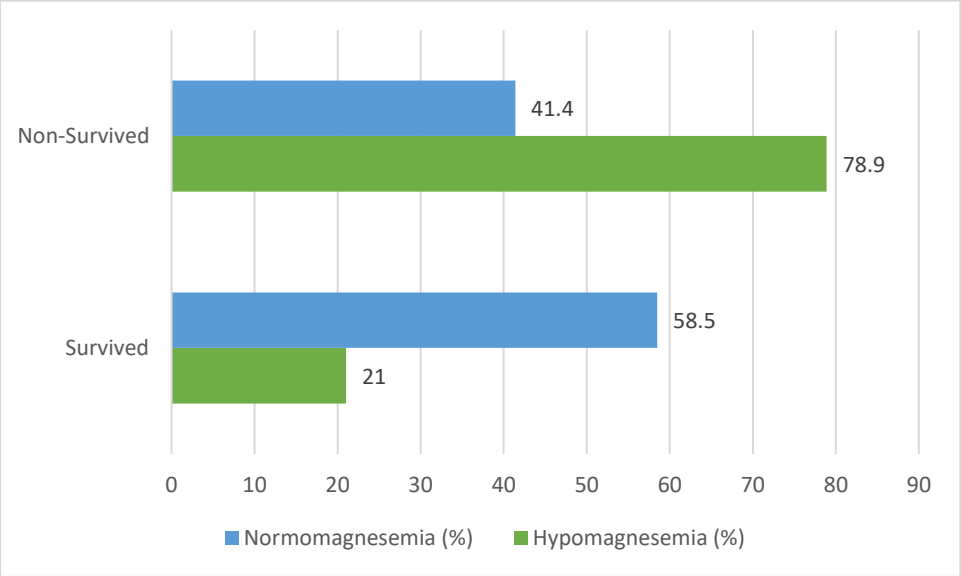
Table 4: Age and Magnesium Levels

Magnesium Status	Mean Age (years)	Standard Deviation	p-value
Hypomagnesemic Patients	66.3	9.7	**0.0027**
Normomagnesemic Patients	56.8	11.3	

Survival Outcomes: Among 19 patients with hypomagnesemia, only 4 survived (21.0%), while 15 (78.9%) did not survive. Among 41 normomagnesemic patients, 24 survived (58.5%), and 17 did not survive (41.4%).

Table 5: Survival Outcomes

Survival Status	Hypomagnesemia (%)	Normomagnesemia (%)
Survived	21.0	58.5
Non-Survived	78.9	41.4



Discussion

The findings of this study confirm the significant association between hypomagnesemia and increased mortality in critically ill patients, particularly those with diabetes mellitus. Similar trends have been observed in previous studies, emphasizing the clinical relevance of magnesium deficiency in ICU patients.

Our study found that 31.7% of critically ill patients had hypomagnesemia, consistent with previous reports indicating a prevalence of 20-65% in ICU settings (1,2). Chernow et al. (3) observed that hypomagnesemia was present in nearly 60% of ICU patients, suggesting that its frequency varies based on patient selection, underlying conditions, and hospital practices. Soliman et al. (4) demonstrated that patients with ionized hypomagnesemia had significantly worse outcomes, reinforcing our findings that magnesium depletion is an underappreciated risk factor in critically ill patients.

A key observation in our study was the higher prevalence of hypomagnesemia among diabetic patients (45.9%) compared to non-diabetic patients (8.7%) ($p = 0.0031$). This aligns with earlier studies that identified diabetes as a risk factor for hypomagnesemia due to increased renal magnesium losses and insulin resistance (5). Barbagallo et al. (6) reported that chronic hyperglycemia leads to renal magnesium wasting, worsening the electrolyte imbalance in diabetic patients. Similar findings were documented by Lopez-Ridaura et al. (12), who found that magnesium deficiency correlates with poor glycemic control and diabetic complications.

The overall mortality rate in our study was 53.3%, with hypomagnesemic patients showing a significantly higher mortality rate (78.9%) compared to normomagnesemic patients (41.4%) ($p = 0.0011$). These results are in agreement with Soliman et al. (4), who found that low serum magnesium was associated with increased mortality risk in ICU patients. Whang et al. (1) also demonstrated that patients with severe magnesium deficiency had a 40% higher risk of ICU mortality, further supporting our conclusion that magnesium levels should be closely monitored to improve survival outcomes.

Older patients were found to be more susceptible to hypomagnesemia, with a mean age of 66.3 ± 9.7 years in hypomagnesemic patients compared to 56.8 ± 11.3 years in normomagnesemic patients (p = 0.0027). This is consistent with prior research indicating a higher prevalence of hypomagnesemia among elderly ICU patients due to age-related renal dysfunction and altered magnesium homeostasis (10,11).

Given the high prevalence of hypomagnesemia in critically ill patients and its association with increased mortality, regular serum magnesium assessment should be standard practice in ICU settings. Early detection of hypomagnesemia could help prevent complications such as cardiac arrhythmias, neuromuscular dysfunction, and prolonged ICU stays. Patients with diabetes, sepsis, or renal impairment should be prioritized for magnesium level screening. Evidence from previous studies suggests that magnesium supplementation may improve ICU patient survival (12). Magnesium replacement therapy has been shown to reduce ICU mortality, improve cardiovascular stability, and decrease hospital stay duration (13). However, our study did not evaluate the effect of magnesium supplementation on clinical outcomes. Future randomized controlled trials are needed to assess whether routine magnesium replacement improves survival in critically ill patients. Our study reinforces the strong link between diabetes and hypomagnesemia. Clinical implications include: Routine magnesium screening in diabetic patients, particularly those with poor glycemic control or long-standing diabetes. Correcting magnesium deficiency may improve insulin sensitivity and reduce diabetic complications (13). Future research should explore whether magnesium supplementation can enhance glucose metabolism in ICU patients with diabetes.

While our study provides valuable insights into hypomagnesemia and ICU outcomes, there are some limitations that need to be acknowledged: The study was conducted with 60 patients, which may limit the generalizability of the findings. A larger multicenter study is needed to validate these results in a broader ICU population. This study was conducted in a single tertiary care hospital, which may introduce institutional bias. ICU practices, treatment protocols, and patient demographics may differ across different hospitals and regions. The study did not assess whether correcting hypomagnesemia had any impact on patient survival. Future research should focus on whether magnesium supplementation improves outcomes in ICU patients with hypomagnesemia. Although we adjusted for age, diabetes, and illness severity, other potential confounders like nutritional status, use of diuretics, and inflammatory markers were not included. A more comprehensive analysis incorporating these variables could strengthen the findings. Future studies should involve larger patient populations across multiple centers to confirm our findings. Prospective trials evaluating the impact of magnesium therapy on ICU survival are warranted. Further research should explore the underlying pathophysiology of magnesium depletion in critically ill patients, including its role in inflammation, oxidative stress, and cardiac dysfunction. Identifying which subgroup of ICU patients benefit most from magnesium supplementation could help optimize clinical interventions. Studies should assess the optimal timing, dosage, and formulation of magnesium therapy.

Our study highlights the high prevalence of hypomagnesemia in critically ill patients and its strong association with increased mortality, particularly in diabetic patients. These findings are consistent with previous research, emphasizing the need for routine magnesium monitoring in ICU settings.

Conclusion

This study demonstrates a high prevalence of hypomagnesemia in critically ill patients and its significant association with increased mortality, particularly in diabetic patients. Among the 60 ICU patients studied, 31.7% had hypomagnesemia, and these patients exhibited a mortality rate of 78.9%, nearly double that of normomagnesemic patients (41.4%). The findings indicate that diabetic patients are at a higher risk of developing hypomagnesemia, with a strong correlation between longer diabetes duration and lower magnesium levels. Additionally, older critically ill patients were more likely to have hypomagnesemia, highlighting age as an independent risk factor. Given these observations, routine magnesium monitoring in ICU patients should be implemented as part of standard critical care practice, particularly for diabetic and elderly patients. While magnesium supplementation may improve ICU

outcomes, further randomized controlled trials are necessary to establish its clinical benefits. Future research should focus on large-scale, multicenter studies to validate these findings and determine whether magnesium correction strategies can improve survival in critically ill patients. By incorporating magnesium assessment into ICU protocols, clinicians may enhance patient management, reduce complications, and improve overall survival outcomes.

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