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ORIGINAL ARTICLE

Frequency and outcome of hypomagnesamia in children admitted in PICU of National Institute of Child Health, Karachi, Pakistan.

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ABSTRACT… Objective: To determine the frequency of hypomagnesamia (HM) in children admitted to pediatric intensive care unit (PICU), and its association with outcomes. **Study Design:** Cross-sectional study. **Setting:** The PICU of National Institute of Child Health (NICH), Karachi, Pakistan. **Period:** October 2024 to March 2025. **Methods:** A total of 194 children between 1 month and 12 years admitted to the PICU were analyzed. Serum magnesium levels < 1.5 mg/dL were labeled as HM. Outcomes were recorded in the form of children requiring mechanical ventilation, duration of PICU stay, and discharged or mortality. Data analysis was performed using IBM-SPSS Statistics, Version 26.0. Chi-square test, or independent sample test (as appropriate) were applied to see the impact of effect modifiers on HM. For all statistical tests, $p<0.05$ as significant. **Results:** In a total of 194 children, 160 (54.6%) were female, and the mean age was 5.83±3.45 years. HM was identified in 91 (46.9%) children. HM was having significant association with sepsis (44.0% vs. 17.5%, $p=0.032$), severe acute malnutrition (40.7% vs. 29.1%, $p<0.001$), and hypocalcemia (33.0% vs. 16.5%, $p=0.008$). The mean duration of mechanical ventilation ($p=0.025$), and PICU stay ($p=0.019$) were significantly higher in children with HM. HM was significantly associated with mortality (14.3% vs. 2.9%, $p=0.004$). **Conclusion:** HM is a frequent electrolyte disturbance in PICU, linked with sepsis, and malnutrition. HM is associated with greater need for mechanical ventilation, prolonged PICU stay, and increased mortality.

Key words: Hypomagnesemia, Magnesium, Mechanical Ventilation, Mortality, PICU.

INTRODUCTION

Magnesium (Mg) is recognized as the 2nd most prevalent cation within cells, and ranks 4th most abundant cation in the human body.[1] Mg serves as a cofactor for approximately 300 enzymatic reactions and plays a vital role in various metabolic processes involving carbohydrates, lipids, nucleic acids, and proteins. Mg is essential for maintaining cellular membrane integrity, modulating neuromuscular activity, and controlling cell permeability.[2] Deficiency of Mg is a common occurrence across multiple clinical conditions such as protein-energy malnutrition, disorders of absorption, hypoalbuminemia, and sepsis.[3] Disturbances in Mg levels may arise after interventions like extended gastrointestinal suction, administration of blood products, exposure to excessive catecholamines, or the use of diuretics and aminoglycosides, which are commonly employed in critical care settings. As a result, Mg deficiency is anticipated to be prevalent among critically ill individuals.[3]

Research has demonstrated significant variability in the prevalence of hypomagnesemia (HM) within intensive care units, with rates ranging from 20% to 70%.[4] Evidence indicates that HM is strongly linked to an increased likelihood of requiring mechanical ventilation (MV), prolonged duration of ICU admission, and higher mortality rates.[5,6]

HM is a frequently under-recognized electrolyte disturbance in critically ill children, with significant clinical implications. Mg deficiency can contribute to life-threatening complications, and resistance to correction of other electrolyte imbalances.

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Critically ill pediatric patients are at higher risk due to underlying illnesses, as well as the effects of intensive therapies. Despite its potential impact, local data on HM in Pakistani pediatric ICUs (PICUs) is lacking. This study addresses this gap and seeks to inform evidence-based practices to improve outcomes in this vulnerable population. This study was done to determine the frequency of HM in children admitted to PICU and its association with outcomes.

METHODS

This cross-sectional study was conducted at the PICU of National Institute of Child Health (NICH), Karachi, Pakistan during October 2024 to March 2025. Approval from Institutional Ethical Review Board was obtained prior to the commencement of this research (IERB-24/2024). Written and informed consent were taken from parents/ caregivers. A sample size of 194 was calculated using online OpenEpi sample size calculator taking the proportion of HM as 44%[4], with 95% confidence level and 7% margin of error. Non–probability consecutive sampling technique was adopted. Inclusion criteria were children between 1 month and 12 years admitted to the PICU (regardless of the indication). Children with known congenital renal Mg wasting, received supplemental Mg in the last 24 hours, or trauma or conditions requiring surgery were excluded. Parents or caregivers of children who did not allow participation in this study were also excluded.

Children fulfilling the eligibility criteria were included. Demographic details of each child such as gender, age, and height were noted. Detailed medical history was obtained and clinical examination was performed. Five ml venous blood was collected in a serum vacutainer was sent for assessment of serum Mg, calcium and potassium levels. All children were treated according to the standard institutional PICU protocols. Serum Mg < 1.5 mg/dL were labeled as HM.[7] Hypocalcemia was labeled as serum calcium < 8.5 mg/dl.[8] Hypokalemia was named when serum potassium < 3.5 mEq/L.[9] Sever acute malnutrition (SAM) was identified as per WHO protocols.[10] Outcomes were recorded in the form of children requiring MV, duration of PICU stay, and discharged or mortality.

Data analysis was performed using "IBM-SPSS Statistics, Version 26.0". Mean and standard deviation were calculated for quantitative variables. Frequency and percentages were shown for qualitative variables. Effect modifiers were controlled through stratification and post-stratification, chi-square test, or independent sample test (as appropriate) to see their effect on HM. Correlational analysis was performed applying Pearson's correlation (r). Diagnostic utility of serum Mg levels was assessed for predicting mortality by performing receive-operating characteristic curve (ROC) analysis, and estimating "area under curve (AUC)" with 95% confidence level. For all statistical tests, $p<0.05$ as significant.

RESULTS

In a total of 194 children, 160 (54.6%) were female, and 88 (45.4%) male. The mean age was 5.83±3.45 years, ranging between 1 month to 12 years. The mean weight, and height were 16.90±7.90 kg, and 88.74±23.48 cm, respectively. Sepsis was found in 70 (36.1%) children, while severe acute malnutrition was diagnosed in 55 (28.4%) children. The most common disease categories were respiratory, neurological, and cardiovascular disorders, documented in 44 (22.7%), 43 (22.2%), and 39 (20.1%) children, respectively. The mean magenesium level was 1.55±0.41 mg/dl, while HM was identified in 91 (46.9%) children. Hypocalcemia, and hypokalemia were present in 37 (19.1%), and 47 (24.2%) children, respectively. HM was found to have significant association with sepsis (44.0% vs. 17.5%, $p=0.032$), SAM (40.7% vs. 29.1%, $p<0.001$), and hypocalcemia (33.0% vs. 16.5%, $p=0.008$). Table-I is showing details about the association of HM with baseline characteristics of children admitted to PICU.

The MV was required by 127 (65.5%) children, while the mean duration of MV was significantly more among children having HM ($p=0.025$). The mean duration of PICU stay was 6.49±3.85 days, and it was significantly prolonged among children with HM ($p=0.019$). Mortality was noted among 16 (8.2%) children. HM was significantly associated

with mortality (14.3% vs. 2.9%, p=0.004). Details about the association of HM with outcomes are shown in Table-II.

Correlational analysis revealed relatively weak but significantly inverse relationship between serum Mg levels and duration of PICU stay among children (r=-0.189, p=0.008) as shown in scatter-dot plot in Figure-1.

Correlational analysis revealed relatively weak but significantly inverse relationship between serum Mg levels and duration of MV among children (r=-0.180, p=0.012) as shown in scatter-dot plot in Figure-2.

ROC curve analysis showed AUC as 0.744 (0.632-0.856) with p=0.001, exhibiting strong diagnostic utility of serum Mg levels predicting mortality among children admitted to PICU (Figure-3).

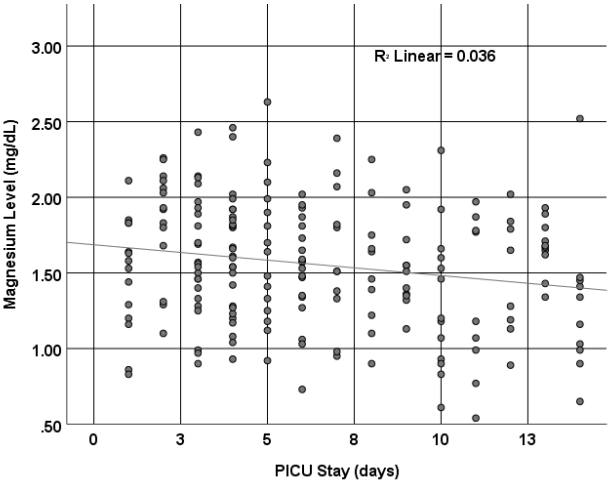

Figure-1. Correlation of duration of PICU with serum magnesium levels

Baseline Characteristics		Hypomagnesemia		P-Value
		Yes (n=91)	No (n=103)	
Gender	Male	35 (38.5%)	53 (51.5%)	0.070
	Female	56 (61.5%)	50 (48.5%)	
Age (years), Mean±SD		5.79±3.55	5.87±3.38	0.884
Weight (kg), Mean±SD		16.84±8.1	16.95±7.73	0.920
Height (cm), Mean±SD		88.31±24.32	89.11±22.83	0.816
Sepsis		40 (44.0%)	30 (29.1%)	0.032
Disease category	Respiratory	21 (23.1%)	23 (22.3%)	0.966
	Neurological	19 (20.9%)	24 (23.3%)	
	Cardiovascular	17 (18.7%)	22 (21.4%)	
	Gastrointestinal	18 (19.8%)	18 (17.5%)	
	Others	16 (17.6%)	16 (15.5%)	
Severe acute malnutrition		37 (40.7%)	18 (17.5%)	<0.001
Hypocalcemia		20 (22.0%)	17 (16.5%)	0.333
Hypokalemia		30 (33.0%)	17 (16.5%)	0.008

Table-I. Association of hypomagnesemia with baseline characteristics

Outcome Variables		Hypomagnesemia		P-Value
		Yes (n=91)	No (n=103)	
Need for mechanical ventilation		67 (73.6%)	60 (58.3%)	0.025
Mechanical ventilation duration (days), Mean±SD		3.80±3.00	2.76±2.95	0.016
Duration of PICU (days), Mean±SD		7.18±3.99	5.88±3.63	0.019
Final outcome	Discharged	78 (86.7%)	100 (97.1%)	0.004
	Mortality	13 (14.3%)	3 (2.9%)	

Table-II. Association of hypomagnesemia with outcomes

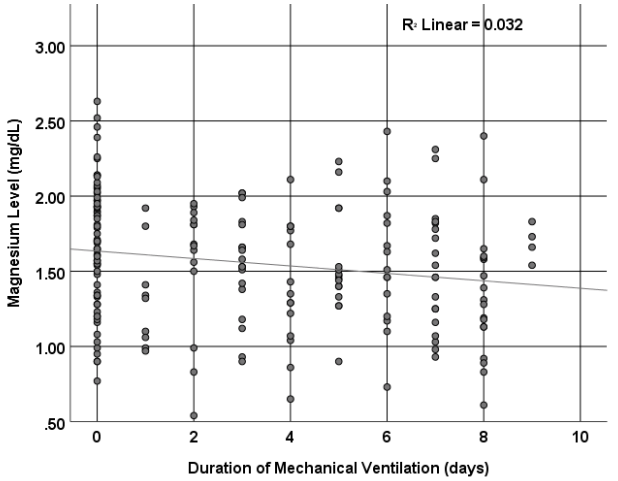

Figure-2. Correlation of duration of mechanical ventilation with serum magnesium levels

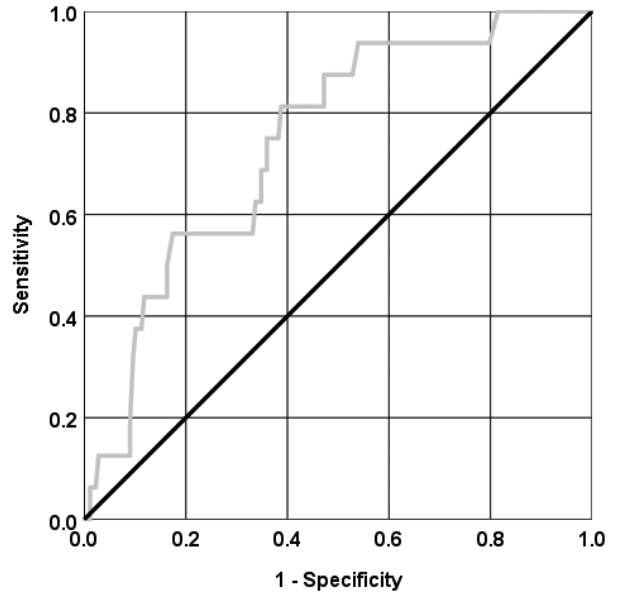

Figure-3. Diagnostic value of serum magnesium levels in predicting mortality in PICU

DISCUSSION

Among critically ill children, the frequency of HM was 46.9% in this study. This prevalence is consistent with Bojd et al., who reported a frequency of 44.7%.[11] Stephanos and George reported 40.0% children admitted to PICU to have HM.[12] The observed prevalence in the present study is higher than that reported in Verive et al.[13], multicenter study from the United States, which found a prevalence of only 11%. The disparity may be attributed to differences in nutritional status, healthcare access, illness severity, and routine practices related to electrolyte monitoring across healthcare systems. In the present study, HM was significantly associated with sepsis (44.0% vs. 29.1%, p=0.032), severe acute malnutrition (40.7% vs. 17.5%, p<0.001), and hypokalemia (33.0% vs. 16.5%, p=0.008). Deekshitha et al., identified similar associations with sepsis and malnutrition, with HM.[14] Hypokalemia, and hypocalcemia have long been recognized as electrolyte disturbances commonly accompanying HM due to Mg role in maintaining intracellular potassium and calcium homeostasis.[15] The present study aligns with these pathophysiological correlations.

The current study did not observe statistically significant associations between HM and gender (p=0.070), age (mean 5.79±3.55 vs. 5.87±3.38 years, p=0.884), or weight and height. These findings mirror those of Deekshitha et al.[14], who also did not find significant age or gender differences. In contrast, Erdogan and Menevse[16] found higher mean age in HM children (p=0.04), suggesting that regional factors and population heterogeneity may influence age-related trends.

A key contribution of this study lies in demonstrating the clinical implications of HM. Children with HM had significantly higher rates of MV (73.6% vs. 58.3%, p=0.025), and prolonged ventilation duration (3.80±3.00 vs. 2.76±2.95 days, p=0.016). The mean PICU stay was significantly longer in the HM group (7.18±3.99 vs. 5.88±3.63 days, p=0.019). These results are consistent with the findings by Farrukh et al.[17], as well as Haque and Saleem[4] who also observed prolonged hospitalization in patients with low serum Mg. Erdogan and Menevse[16] similarly reported significantly extended ICU stays, and ventilator support among HM children. Overall mortality in the study was 8.2%, and HM was significantly associated with higher mortality (14.3% vs. 2.9%, p=0.004). The prognostic value of Mg indicated good discriminatory ability for mortality prediction, and comparable findings were noted by Krishna et al.[18], and Bojd et al.[11], where mortality was higher among patients with HM.

Correlational analyses revealed weak but

statistically significant inverse associations between serum Mg, and both duration of PICU stay (r=-0.189, p=0.008) and duration of MV (r=-0.180, p=0.012). These findings align with those of Erdogan and Menevse[16], who also demonstrated negative correlations between Mg and ventilation parameters. Although the strength of correlation is modest, the clinical significance lies in the cumulative impact of prolonged critical care, increased healthcare costs, and higher complication risks associated with longer ICU admissions. Routine assessment of serum Mg levels at PICU admission may help identify children at risk of prolonged MV, and adverse outcomes.[19,20] Early correction of HM, in conjunction with monitoring of related electrolyte disturbances such as hypocalcemia and hypokalemia, could improve outcomes.[21,22] These results also underscore the importance of integrating Mg into standard electrolyte panels in resource-constrained settings, especially for high-risk subgroups such as septic and malnourished children.

Early identification and timely correction of hypomagnesemia may help mitigate the risk of complications such as neuromuscular instability, refractory electrolyte disturbances, and hemodynamic instability. Incorporating magnesium assessment into standard critical care protocols could facilitate prompt intervention, potentially reducing morbidity and mortality among vulnerable pediatric patients. Recognizing the link between hypomagnesemia and underlying conditions such as sepsis and malnutrition emphasizes the importance of a comprehensive approach to the management of these high-risk groups. This study supports the need for increased clinical vigilance and proactive management of magnesium disturbances in the pediatric intensive care setting.

The cross-sectional nature of the study precludes causal inferences. Serial measurements of Mg levels during PICU stay were not performed, which could have provided insights into dynamic changes and their temporal relationship with outcomes. Medication use, particularly diuretics and aminoglycosides, known to influence Mg homeostasis, was not evaluated.

CONCLUSION

Hypomagnesemia is a common electrolyte disturbance among children admitted to PICU, affecting nearly half of the studied population. Hypomagenesemia is significantly associated with sepsis, severe acute malnutrition, and other electrolyte imbalances. Hypomagnesemia correlates with increased need for MV, longer PICU stays, and higher mortality. These findings reinforce the role of Mg as a critical biomarker in pediatric critical care and highlight the need for routine screening and early management strategies to mitigate adverse outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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1	**Sadia Qadir:** Data collection, drafting, responsible for data's, integrity, proof reading, approval for publication.
2	**Murtaza Ali Gowa:** Study concept, design, critical revisions.
3	**Hira Nawaz:** Data collection, study concept, revisions.
4	**Ghazala Jamal:** Proof reading, design.
5	**Bakhtawar Chandio:** Analysis, proof reading.