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Serum Magnesium Level in Critically Ill Children

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Abstract

Introduction: Magnesium acts as a cofactor of more than 300 enzymes, particularly enzymes responsible for phosphate transfer, and regulates calcium ion movement in smooth muscle cells, which has an important role in maintaining cardiac contractility and peripheral vascular tone. Abnormalities in serum magnesium levels are known to cause life-threatening problems in critically ill children.

Aim of the study: It aimed to investigate the serum magnesium level in critically ill children, identify precipitating factors that could affect the magnesium level, and conduct a prospective evaluation of the outcome.

Subjects and Methods: 100 children were admitted to the ICU at Fayoum Teaching Hospital from March 1st, 2019 to November 30th, 2019. They were prospectively analyzed with the exclusion of children who received magnesium products within the last 24 hours and children with known congenital renal magnesium wasting (e.g., Bartter's syndrome and Gitelaman's syndrome).

Results: The median magnesium level on admission was 2.5 (range 0.6-4.6) mg/dl. The percentage of hypomagnesaemia was 3% (3 cases), 57% (57 cases) had normal magnesium, and hyper-magnesaemia was present in 40% (40 cases) at admission. Serum magnesium levels were lower in non-survived children with a median of 2.3 (2.3-2.6) than in those who survived with a median of 2.5 (2.3-2.7), but there was no statistically significant association with mortality with a p value of 0.274.

Conclusion: We can't consider serum magnesium predictive of mortality. The incorporation of other electrolytes may be more predictive of mortality than magnesium.

Keywords: Magnesium; Mortality; Pediatric Intensive Care Units.

1. Introduction

Magnesium, an abundant mineral in the body, is found naturally in many foods, is chemically added to other meals, is accessible as a dietary supplement, and is found in many drugs (such as laxatives and antacids). Magnesium is a cofactor in over 300 enzyme systems that control many biochemical activities in our bodies, such as muscle and neuron function, protein synthesis, blood glucose regulation, and blood pressure control [1].

Magnesium is required for the creation of energy, glycolysis, and oxidative phosphorylation. Magnesium is also involved in the active movement of potassium and calcium ions across cell membranes, which aids nerve conduction, muscular contraction, and heart rhythm [2].

Although hypomagnesemia is normally asymptomatic, it can cause neurological issues such as tremors, tetany, nystagmus, hemiparesis, and convulsions. Torsades de pointes, hypertension, coronary vasospasm, and bronchial airway constriction are all possible [3].

The etiology of hypomagnesemia in critical illnesses is multifaceted, with causes including insufficient oral intake, renal and gastrointestinal losses, and changes in cellular distribution [4]. Because of the inability to mobilize magnesium stores, initial losses in conditions of negative magnesium balance arise from the extracellular space; equilibrium with bone stores does not occur for several weeks [5].

Hypomagnesemia is a common condition seen in hospitalized individuals. In patients in intensive care, when diet, hypoalbuminemia, and drugs such as diuretics may play key roles, the prevalence jumps to 60 to 66% [6].

The current study aimed to look into the prevalence of hypomagnesemia and how it affects critically ill children.

2. Subjects and methods

2.1. Subjects

The current prospective cohort study was conducted at a single center among patients admitted to the Pediatric Intensive Care Unit of Fayoum University Hospital, Fayoum, Egypt, for more than two days. It included 100 patients between the ages of 1 month and 14 years.

Inclusion criteria

Both sexes of children with an age range between 1 month and 14 years were recruited.

Exclusion criteria

That included patients who received magnesium products within the last 24 hours and those with known congenital renal magnesium wasting (e.g., Bartter's syndrome and Gitelman's syndrome).

2.2. *Methods*

All patients were subjected to the following:

Full history taking

That focused on data on the patient's age, sex, admission diagnosis, whether mechanical ventilation support was needed, time of mechanical ventilation, whether the patient received diuretics or aminoglycosides on admission or not, and length of stay in the PICU and hospital.

Full medical assessment

That included vital signs, anthropometric measurements, a systematic examination, and a measurement of the Glasgow coma scale.

Laboratory investigations

By estimation of the levels of magnesium (Mg), lactate, sodium, potassium, albumin, and CRP.

Blood samples were obtained immediately after admission. Serum lactate samples were collected in a fluoride tube and centrifuged at 2000–3000 RPM for approximately 20 minutes, stored at -200C, and analyzed at the same time. Serum magnesium samples were collected in chemistry tubes, stored at -200 °C, and centrifuged at 2000–3000 RPM for approximately 20 minutes.

The Pediatric Risk of Mortality (PRISM)-III score was calculated for each patient at the time of admission. The PRISM-III score is an internationally validated score that assesses the risk of mortality and the prognosis of the case. The score consists of 17 physiological and laboratory parameters, including systolic blood pressure, heart rate, temperature, pupillary reaction, mental status, acidosis, pH, arterial partial pressure of carbon dioxide (PaCO2), arterial partial pressure of oxygen (PaO2), total carbon dioxide, prothrombin time (PT), partial thromboplastin time (PTT), blood glucose, serum concentrations of potassium, blood urea nitrogen (BUN), creatinine, total white blood cells, and platelet count.

2.3. Statistical Methods

All collected data were analyzed by the Statistical Package for Social Science (SPSS) software version 22.

3. Results

This prospective study comprised 100 patients admitted to Fayoum University Hospital's PICU. Fifty-eight (58%) of the patients included were males, while 42% were females. The median age was 18 months (interquartile range = 5.5-43.8 months), the median weight was 10 kg (interquartile range = 5.4-15 kg), and the median height was 78 cm (interquartile range = 64-93.5 cm) (Table 1).

Table 1: Basic characteristics of studied children (N=100).

Variables		Median	IQR
Age (months)		18	5.5-43.8
Weight (Kg)		10	5.4-15
Height (cm)		78	64-93.5
Sex	**Male**	58 (58%)	
	Female	42 (42%) _	

The median PICU stay in the current study was 7 days (4-9), and the median hospital stay was 8 days (5-13). The most common reason for admission in the current study was respiratory disease in 32 instances (32%), accounting for roughly one-third of the patients, followed by CNS disorders in 19 cases (19%) and trauma in 11 cases (11%) Figure 1).

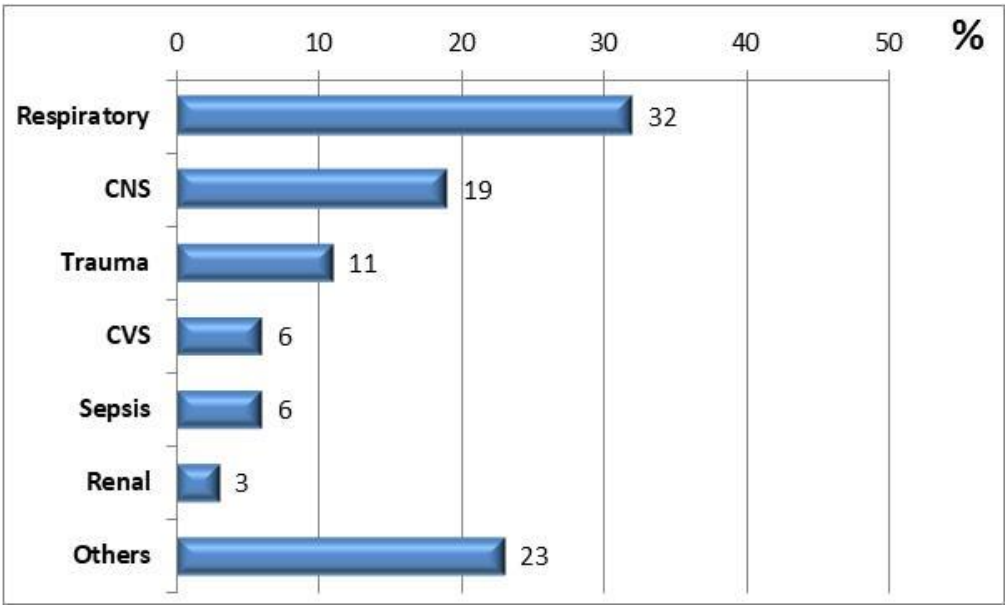

Figure 1: Diagnoses of the studied patients in descending order (N=100).

In terms of laboratory evaluation, the median blood glucose level was 121 (IQR = 103-152). The median blood urea level was 13 (IQR = 7.5-20.5), the median creatinine level was 0.5 (0.4-0.7), the median PT level was 16.6 (IQR = 15-19.1), the median serum lactate level was 33.8 (24.6-46.9), and the median serum albumin level was 3.8 (3.3-4.1). The median WBC count was 12.4 (9.6-17.7) and the median platelet count was 340 (216-440) on the CBC.

The mortality rate among the children studied was 12 (12%). Furthermore, it was significantly associated with age, weight, and height because the deceased group was statistically younger (IQR = 2-8.5 months) than the survived group (IQR = 7.5-48 months), $p = 0.001$, and the deceased group's weight and height were statistically lower ($p = 0.001$ and 0.028, respectively). Although the female death rate was higher than the male death rate, the difference was not statistically significant. Magnesium levels in 100 patients were normal in 57 cases (57%), hypermagnesemia in 40 children (40%), and hypomagnesemia in only three children (3%). In our investigation, hypomagnesemia was found in three (9.4%) of the patients with respiratory disorders, whereas hypermagnesemia was found in sixteen (40.6%) of the patients with respiratory difficulties (Table 2). The current findings revealed that there was no statistically significant variation in magnesium levels based on age, weight, height, gender, or reason for PICU admission. In terms of the link with the PRISM III score, there was no significant difference between different Mg levels in this study ($p = 0.204$).

Table 2: Comparisons of side effects of the MS injection in different study groups.

Variable	Hypomagnesaemia (N=3)	Normal (N=57)	Hypermagnesemia (N=40)	*P-value*
CVS	0 (0.0)	5 (83.3)	1 (16.7)	0.399
Sepsis	0 (0.0)	3 (50.0)	3 (50.0)	
Renal	0 (0.0)	2 (66.7)	1 (33.3)	
CNS	0 (0.0)	13 (68.4)	6 (31.6)	
Respiratory	3 (9.4)	16 (50.0)	13 (40.6)	
Trauma	0 (0.0)	5 (45.5)	6 (54.5)	
Others	0 (0.0)	13 (56.5)	10 (43.5)	

Serum magnesium was lower in non-surviving children, with a median of 2.3 (2.3–2.6), than in those who survived, with a median of 2.5 (2.3–2.7), but the serum magnesium level had no statistically significant association with mortality (p = 0.274 (Table 3).

Table 3: Correlation between serum magnesium and mortality.

Variable	Non-survived (N=12)	Survived (N=88)	*P-value*
Mg	**2.3 (2.3-2.6)**	**2.5 (2.3-2.7)**	0.274
Hypomagnesaemia	**0 (0.0)**	**3 (100.0)**	**0.377**
Normal	**9 (15.8)**	**48 (84.2)**	
Hypermagnesemia	**3 (7.5)**	**37 (92.5)**	

4. Discussion

Magnesium is required for life and is involved in several biochemical and physiological processes in the human body [7]. Although hypomagnesemia is typically asymptomatic, it can cause significant neurological, pulmonary, and cardiac problems [3].

In the current study, the most common reason for hospitalization was a respiratory disease (32%, or nearly one-third of the patients). In Erdoan and Menevşe's (2018) study, individuals with respiratory problems (31 cases) were the most common, followed by neurological diseases (30 cases) and cardiac diseases (28 cases) [8]. According to another study, 35.5% of patients had pneumonia, 25.6% had sepsis, and 11% had encephalitis [9].

Only 3% of those studied had hypomagnesemia, whereas 57% had normal Mg levels and 40% had hypermagnesemia. In contrast to our findings, Haque and Saleem (2009) discovered hypomagnesemia in 44% of their PICU patients [10]. El Beleidy et al. (2017) found hypomagnesemia in 31% of subjects [9]. According to Zafar et al. (2014), 50 (71.43%) of 70 critically ill patients were

normomagnesemic, 17 (24.29%) were hypomagnesemic, and three were hypermagnesemic [11].

In the current investigation, the mortality rate was equivalent to or less than 12%, compared to prior studies that indicated 17%, 25%, and 40% [7, 12, 13]. It was, however, greater than several studies from industrialized nations, which found death rates of 6.2% and 2.7%, respectively [14, 15].

The link between hypomagnesemia and death rates differs between studies. Hypomagnesemia patients had a higher death rate than normomagnesemic patients [11, 16]. According to Haque and Saleem (2009), patients with normomagnesemia had a greater death rate (32/100, or 32%) than those with hypomagnesemia (22/79, or 27.8%) [9].

Despite the fact that magnesium levels were lower in dead children than in those who survived, the difference was not statistically significant in this investigation. A few investigations, however, have shown no link between hypomagnesemia and increased mortality in severely sick or wounded individuals [17, 18].

Finally, despite the aforementioned findings, there were numerous limitations to this study that must be highlighted, such as the fact that it was a single-center study and may not represent the findings at other centers. Furthermore, the study included a limited number of patients, and 40% of them had hypermagnesemia for no apparent cause, necessitating further examination.

Conclusions

In severely ill children, hypermagnesemia is more prevalent than hypomagnesemia. Serum magnesium levels do not predict mortality. Based on the current data, we propose that all children in the PICU have their electrolyte levels measured upon arrival in order to identify their influence on mortality, prioritize their treatment programs, and make timely therapeutic decisions. More multi-center studies with a large number of patients are needed to corroborate our findings on the utility of adding magnesium and serum electrolyte levels to the PRISM-III score to predict death.

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Conflicts of Interest: All authors declare no conflict of interest.

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