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Serum Magnesium Level of Patients Admitted to the Pediatric Intensive Care Unit: A Prospective Analytical Study

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Abstract

Background: The mean prevalence of hypomagnesemia in pediatric intensive care units is 18-44% in different studies. In patients with hypomagnesemia compared to patients with normal magnesium levels, there is a significant difference in terms of mortality, duration of hospitalization and ICU stay, the need for mechanical ventilation and its duration. The aim of this study was assessing the prevalence of hypomagnesemia in PICU and the impact of it on patients' prognosis.

Methods: The current study was a prospective analytical study. Ninety patients between 1 month and 12 years old were included. A detailed medical history, clinical examination and on admission magnesium level were performed on all patients. The prognoses of the patients were evaluated by the length of PICU and hospital stay, the duration of mechanical ventilation and mortality.

Results: The mean concentration of magnesium level was 1.9±0.2 mg/dl; and 91.1% of patients were normomagnesemia and 5.6% were hypomagnesemia. The average duration of PICU stay in this study was about 8.1±3.8 days and the average duration of need for ventilator was 2.0±6.9 days. Only 18.9% of patients needed mechanical ventilation. Magnesium level was not correlated with PICU stay, need for mechanical ventilation, mortality and other electrolyte concentrations except for serum phosphorus.

Conclusion: The prevalence of hypomagnesaemia in pediatric patients admitted to the PICU is variable in different centers, so it is recommended that magnesium concentration levels be checked routinely and corrected if necessary.

Key Words: Hypomagnesemia, Magnesium, Pediatric Intensive Care Unit, Prognosis.

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1- INTRODUCTION

Electrolyte disorders are common in patients hospitalized in the Intensive Care Unit (ICU) and are associated with many complications and mortality (1, 2). Meanwhile, magnesium deficiency is a common clinical problem, which is seen especially in critically ill patients and those who have undergone surgery (3-6). Hypomagnesemia is reported in more than 10-20% of internal ward patients and 65%-81% of ICU patients, and it is the most common undiagnosed electrolyte disorder in internal medicine (7-9). The mean prevalence of hypomagnesemia in Pediatric ICU (PICU) is 18-44% in different studies. Different criteria have been considered for malnutrition, and serum magnesium level is one of them (10).

Insufficient oral intake of magnesium, kidney and digestive disorders, changes in intracellular and extracellular distribution, malabsorption, hypoalbuminemia, sepsis, blood transfusion or drugs such as diuretics, proton pump inhibitor and aminoglycosides; and genetic diseases could be cause of hypomagnesemia in PICU (11-13).

It has been found that in patients with hypomagnesemia compared to patients with normal magnesium level, there is a significant difference in terms of mortality, duration of hospitalization and ICU stay, along with the need for mechanical ventilation and its duration. Hypocalcemia, hypokalemia, and hyponatremia are more common in the group with hypomagnesemia; they have higher scores in disease severity indexes (APACHE and SOFA score), and higher concentration of serum lactate (14-18). Assessing the prognosis of patients admitted to ICU is difficult, but very important. Based on previous studies, the greater the total body magnesium deficiency, the worse the individual's prognosis in ICU (19).

Since there is lack of data on PICU, the aim of this study was assessing the prevalence of hypomagnesemia in PICU and the impact of it on patients' prognoses in 17 Shahrivar Children's Hospital in Rasht, Iran

2- MATERIALS AND METHODS

The current study was a prospective analytical study. Ninety patients between 1 month and 12 years old, admitted to the PICU of 17 Shahrivar Children's Hospital in Rasht, Iran, between June 2022 and June 2023, were included.

Patients with known magnesium excretion disorders, patients who received magnesium supplementation within 24 hours before hospital admission, those having a surgery within one month before, and head injury patients were excluded.

$$n = \frac{\left(z_{1-\frac{\alpha}{2}} + z_{1-\beta}\right)^2 .\sigma^2}{d^2} = \frac{(1.96+0.84)^2\, 0.16^2}{(0.048)^2} = 87.11 \cong 88$$

After approval of the code of ethics by the ethical committee of Guilan University of Medical Sciences (Code: IR.GUMS.REC.1401.326), 90 children under 12 years of age hospitalized in the PICU were included. Written informed consent letter was obtained from parents/ guardians before enrollment.

A detailed medical history and clinical examination were performed on all patients. Upon entering the PICU, a venous blood sample was taken to measure the level of magnesium. In addition, kidney function, sodium, potassium, phosphorus, albumin, and calcium levels were evaluated. All patients were treated according to PICU treatment protocols. All patients were followed up by the researcher until they were discharged from the hospital. The prognosis of the patients was evaluated by the length of PICU and hospital stay, as well as the duration of mechanical ventilation and mortality. Serum Magnesium level was reported as

mg/dl; and the patients were divided into three categories based on magnesium level as follows: Normal: 1.5-2.3 mg/dl, Hypomagnesemia: <1/5 mg/dl, Hypermagnesemia: >2.3 mg/dl (20).

3- RESULTS

In this study, 90 patients including 46 girls (51.1%) and 44 boys (48.9%) admitted to the PICU were included. The average age of the patients was 5.9 ± 5.4 years and the average weight was 22.3 ± 18.5 kg. The mean concentration of magnesium level was 1.9±0.2 mg/dl.

Most of the patients were admitted due to neurological diseases (26.7%), respiratory diseases (17.8%) and poisoning (10%), respectively. The most consumed drugs were antibiotics (23.9%), neurologic drugs (17.7%), supplements (12.8%), and gastrointestinal drugs (11.2%), respectively.

The average duration of PICU stay was about 8.1±3.8 days and the average duration of need for a ventilator was 2.0±6.9 days. Only 17 (18.9%) patients needed mechanical ventilation.

Table-1: Lab tests results and correlations of magnesium with laboratory parameters

Variable	Baseline (Mean±SD) (mg/dl)	Spearman's rank correlation coefficient	P-Value
Magnesium	1.9±0.2	-	-
Sodium	137.6±5.6	0.012	0.908
Potassium	3.8±0.7	0.135	0.206
Calcium	7.6±2.6	-0.092	0.387
Phosphorous	3.7±2.1	0.232	0.028
Albumin	2.2±1.9	-0.028	0.796
Creatinine	0.7±1.1	0.138	0.193

Table 1 shows the baseline lab test results and correlations of serum magnesium level with laboratory parameters. Magnesium level is not correlated with any of these parameters except for serum phosphorus (P = 0.028).

Table-2: Correlations between Magnesium Status and mortality rate, PICU stay and Mechanical ventilation

Variable	Hypomagnesemia	Normal Magnesemia	Hypermagnesemia	P-Value
Patient (Percent)	5(5.6%)	91.1%	3.3%	-
Mortality rate Patient (Percent)	2(9.5%)	19(90.5%)	0(0%)	0.429
PICU stay (day) (Mean±SD)	8.6±6.4	7.4±6.6	3.3±2.8	0.703
Mechanical ventilation (day) (Mean±SD)	1.0±2.2	2.1±7.2	0.0±0.0	0.454

As shown in Table 2, 21 patients (23.3%) died at the time of discharge, and there was no significant relation between mortality rate and magnesium status at baseline (P=0.429). Either, there was no significant difference in PICU stay and

mechanical ventilation days with the magnesium level in patients (P>0.05).

Table 3 shows that even in the case of dividing the patients based on serum magnesium into higher and lower than 2 mg/dl, there was no significant difference in the levels of other electrolytes, mortality rate and PICU stay (P>0.05).

Table-3: Correlations between Magnesium Level and mortality rate, PICU stay and Mechanical ventilation

Median (IQR)	Magnesium > 2 mg/dl	Magnesium < 2 mg/dl	P-Value
Sodium	137.00(135.00-140.00)	137.00 (134.00-140.00)	0.778
Potassium	3.80(3.10-4.30)	4.00 (3.40-4.30)	0.098
Calcium	8.50(8.00-9.10)	8.40(8.00-8.80)	0.511
Phosphorous	4.20(3.40-5.30)	3.80(2.60-4.50)	0.027
Creatinine	0.5(0.4-0.6)	0.5(0.4-0.7)	0.191
PICU stay	6.00(2.00-12.00)	5.00(2.00-9.00)	0.321
Mortality	8	13	0.58
Mechanical ventilation	8.00(5.00-16.00)	8.00(5.00-11.00)	0.318

4- DISCUSSION

In the present study we aimed to assess the prevalence of hypomagnesaemia and its related factors in pediatric patients admitted to the PICU. In this study, 90 patients during a one-year period were included, including 51.1% girls and 48.9% boys, with the average age of 5.9 ± 5.4 years and average weight of 22.3 ± 18.5 kg.

In concordance with our result, in studies by Farrukht et al. (21), and Erdogan and Menevse (22), most of the patients were admitted due to neurological and respiratory diseases, respectively.

The mean concentration of magnesium level was 1.9±0.2 mg/dl; and 91.1% of the patients were normal magnesemia, 5.6% hypomagnesemia, and 3.3% hypermagnesemia. The prevalence of hypomagnesemia has been different in published studies, Soliman et al. (23) reported 18%, Farrukh et al. reported 25.5%, Dandinavar et al. reported 28%, Valizadeh et al. (24) reported 31.94%, Assarian et al. reported 36%, Haque and Saleem reported 44.1%, Sadeghi-bojd et al. reported 44.7%, Honarmand and safavi (25) reported 51%, and Limaye et al. (26) reported 52%. We reported the least prevalence of hypomagnesemia between these studies. This difference could be due to the difference in past medical, drug, and surgical history or nutritional status of the PICU patients.

The average duration of PICU stay in this study was about 8.1±3.8 days and the average duration of need for ventilator was 2.0±6.9 days. Only 18.9% of the patients needed mechanical ventilation.

Magnesium level was not correlated with PICU stay, need for mechanical ventilation, mortality and other electrolyte concentrations except for serum phosphorus.

It is assumed that hypomagnesemia causes muscle weakness and respiratory failure and difficulty in weaning the patient from the ventilator as well. So, it could be related to higher ventilation days.

In studies by Asssarian et al., Honarmand et al., patients with hypomagnesemia had higher serum lactate levels, APACHE II, SOFA score and also higher mortality and ventilation duration. Dandinavar et al., found that PICU stay and mortality were higher in patients with hypomagnesemia. They also found that hypocalcemia and

hypokalemia are higher in these patients. Sadeghi-bojd et al., conducted that patients with hypomagnesemia had higher mortality rates. Karnik et al. (27) showed that hypokalemia, hypocalcemia, hypophosphatemia, and hypoalbuminemia were significantly higher in hypomagnesemia patients. Safavi and Honarmand reported that hypocalcemia, hypokalemia, and hyponatremia were more common among hypomagnesemia patients, especially in those who were older than 16 years of age. They also found that hypomagnesemia patients had more hypocalcemia, hypokalemia, and hyponatremia.

We assumed that the difference between the results of our study with those of the others may be due to the low prevalence of hypomagnesemia in our PICU, probably due to good nutritional status and past medical, surgical and drug history. Also, serum ionized magnesium concentration may be a non-reliable indicator of the body magnesium status; and total magnesium measurement and urine magnesium exertion can be possibly more reliable.

4-1. Limitations of the study

This study was conducted in a single center and this was its first limitation. Besides, it was not possible to assess all the variables. Furthermore, we just checked the magnesium levels at the beginning of PICU admission.

5- CONCLUSION

Based on the results of this study, the prevalence of hypomagnesaemia in pediatric patients admitted to the PICU is variable in different centers, so it is recommended that magnesium concentration levels be checked routinely and corrected if necessary.

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7- REFERENCES

1. Lee JW. Fluid and electrolyte disturbances in critically ill patients. Electrolytes & Blood Pressure: E & BP. 2010 Dec;8(2):72.

2. Kraft MD, Btaiche IF, Sacks GS, Kudsk KA. Treatment of electrolyte disorders in adult patients in the intensive care unit. American Journal of Health-System Pharmacy. 2005 Aug 15;62(16):1663-82.

3. Buckley MS, LeBlanc JM, Cawley MJ. Electrolyte disturbances associated with commonly prescribed medications in the intensive care unit. Critical care medicine. 2010 Jun 1;38:S253-64.

4. Sadeghi-Bojd S, Noori NM, Damani E, Teimouri A. Electrolyte disturbances in PICU: a cross sectional study. Nephro-Urology Monthly. 2019 May 31;11(2).

5. Tong GM, Rude RK. Magnesium deficiency in critical illness. Journal of intensive care medicine. 2005 Jan;20(1):3-17.

6. Escuela MP, Guerra M, Añón JM, Martínez-Vizcaíno V, Zapatero MD, García-Jalón A, Celaya S. Total and ionized serum magnesium in critically ill patients. Intensive care medicine. 2005 Jan;31:151-6.

7. Safavi M, Honarmand A. Admission hypomagnesemia--impact on mortality or morbidity in critically ill patients. Middle East journal of anaesthesiology. 2007 Oct 1;19(3):645-60.

8. Vormann J. Magnesium: nutrition and metabolism. Molecular aspects of medicine. 2003 Feb 6;24(1-3):27-37.

9. Chandrashekhar C, Pillai R, Vasudev PH, Babu T, Panachiyil GM. A Prospective Observational Study of Hypomagnesemia in Critically Ill Paediatric Patients. Journal of Nepal Paediatric Society. 2020 Sep 11;40(2):67-71.

10. Saleem AF, Haque A. On admission

hypomagnesemia in critically ill children: Risk factors and outcome. The Indian Journal of Pediatrics. 2009 Dec;76:1227-30.

11. Martin KJ, González EA, Slatopolsky E. Clinical consequences and management of hypomagnesemia. Journal of the American Society of Nephrology. 2009 Nov 1;20(11):2291-5.

12. Singhi SC, Singh J, Prasad R. Hypo-and Hypermagnesemia in an Indian Pediatric Intensive Care Unit. Journal of tropical pediatrics. 2003 Apr 1;49(2):99-103.

13. Viering DH, de Baaij JH, Walsh SB, Kleta R, Bockenhauer D. Genetic causes of hypomagnesemia, a clinical overview. Pediatric nephrology. 2017 Jul;32:1123-35.

14. Broman M, Hansson F, Klarin B. Analysis of hypo-and hypermagnesemia in an intensive care unit cohort. Acta anaesthesiologica Scandinavica. 2018 May;62(5):648-57.

15. Hulst JM, Joosten KF, Tibboel D, van Goudoever JB. Causes and consequences of inadequate substrate supply to pediatric ICU patients. Current Opinion in Clinical Nutrition & Metabolic Care. 2006 May 1;9(3):297-303.

16. Dandinavar SF, Ratageri VH, Wari PK. Prevalence of hypomagnesemia in children admitted to pediatric intensive care unit and its correlation with patient outcome. International Journal of Contemporary Pediatrics. 2019. 6(2):462-467.

17. Assarian A, Noormandi A, Khalili H, Mohammadi M, Abdollahi A. Correlation between Serum Magnesium and Lactate Levels at the Time of ICU Admission and Early Phase of Sepsis. Archives of Anesthesiology and Critical Care. 2019 Jul 2;5(3):86-90.

18. Sadeghi-Bojd S, Noori N, Zarifi E, Teimouri A. Prevalence of hypomagnesaemia in children admitted to the pediatric Intensive Care Unit and its related factors in Zahedan, Iran. International Journal of Pediatrics. 2021 May 1;9(5):13539-49.

19. Peivandi Yazdi A, Hashemi E, Salehi M, Masoumzadeh M, Razavi M. Evaluation of the Prevalence of Hypomagnesemia in the First 24th Hour after Selective Operations in Intensive Care Unit Patients.

20. Gragossian A, Bashir K, Bhutta BS, Friede R. Hypomagnesemia.

21. Farrukh RI, Masood SH, Shakoor I, Naseer AM, Sultana SA, Nasir F. Outcome and Incidence of Hypomagnesemia in Children Admitted in Pediatric Intensive Care Unit of a Tertiary Care Hospital. Pakistan Journal of Medical and Health Sciences. 2021;15(5):1169-73.

22. Erdogan I, Gursu HA, Varan B, Ozkan M, Sezgin A. Hypomagnesemia in pediatric heart transplant patients treated with tacrolimus. Exp. Clin. Transplant. 2016;10.

23. Soliman HM, Mercan D, Lobo SS, Mélot C, Vincent JL. Development of ionized hypomagnesemia is associated with higher mortality rates. Critical care medicine. 2003 Apr 1;31(4):1082-7.

24. Valizadeh Hassanlouei MA, Hassani E, Rahimi Rad MH, Adeli SH, Karimi Sakhvidi N, Boudag H. Evaluation of serum magnesium and the effect on prognosis in patients admitted to intensive care unit. Studies in Medical Sciences. 2013 Apr 10;24(1):30-7.

25. Honarmand AZ, Safavi MR. Association between admission hypomagnesemia mortality or mortality of critically ill patients in intensive care unit. Hormozgan Med J. 2008 Jan 1;12(3):151-60.

26. Limaye CS, Londhey VA, Nadkart

MY, Borges NE. Hypomagnesemia in critically ill medical patients. The Journal of the Association of Physicians of India. 2011 Jan 1;59:19-22.

27. Karnik ND, Gupta AV. Hypomagnesemia in ICU. The Journal of the Association of Physicians of India. 2016 Nov;64(11):11-3.