



Hypophosphatemia in critically ill children

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Abstract

Introduction: Hypophosphatemia is a common disorder in critically ill patients, and is associated with myasthenia, especially in respiratory muscles, and respiratory infections. This study was conducted to describe the prevalence of hypophosphatemia in children hospitalized in the pediatric intensive care unit (PICU) of Children's Hospital in Tabriz, Iran, in 2014-2015.

Methods: In this descriptive study, medical records of all children admitted to the PICU of the children's university hospital affiliated to Tabriz University of Medical Sciences were collected from archives of the hospital from 2014-2015 upon adopting permission. The medical records were examined in terms of demographic information, clinical diagnosis of the disease, serum phosphate level, nutritional status, therapeutic interventions, and other underlying specifications. The data were analyzed using SPSS software and descriptive tests.

Results: Of the 83 eligible medical records, 45 records belonged to boys, and 38 records belonged to girls. The most prevalent and the least prevalent diseases in these children were acute pulmonary disease (57.8%) and septic shock (1.2%) respectively. Regarding the nutritional status, 38.6% of the children suffered malnutrition. Phosphorus deficiency was prevalent in the first day in 10.8% of the children, and abnormal levels of phosphorus were observed from the fourth to the sixth day in 26.5% of the children, which increased to 34.9% from the seventh to the tenth day.

Conclusion: This study showed no statistically significant correlation between sex and prevalence of hypophosphatemia. Type of disease was not significantly associated with the level of phosphorus. Moreover, the patients' nutritional status was not significantly associated with the prevalence of hypophosphatemia.

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Introduction

Hypophosphatemia refers to the level of serum phosphate lower than 2.5 mg/dl

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(0.8 mmol/l).¹ Adults and children are recommended to consume 1000 and 800 mg of phosphate per day respectively.² Low levels of phosphate cause problems in patients admitted to intensive care units (ICUs).³ Despite the continuous monitoring of the level of sodium, potassium, and calcium ions in critically ill patients admitted to ICUs, phosphorus is not routinely monitored in these patients,⁴ because patients with mild hypophosphatemia do not show specific clinical signs and symptoms.⁵ Phosphorus-containing compounds play important role in cellular structure (cell membrane and nucleic acids), cell metabolism, ATP production, and homeostasis.⁶

Studies have shown that hypophosphatemia is associated with reduced cardiac output, respiratory muscle weakness, respiratory failure,⁷ delayed discontinuation of the ventilator, and increased hospital stay,⁶ as hemolytic anemia occurs in low concentrations of serum phosphorus.⁸ Hypophosphatemia is an known cause of myopathy and rhabdomyolysis,⁹ and is a life-threatening factor causing death in children with kwashiorkor.¹⁰ However, the level of complications varies with levels of serum phosphorus, and the first step toward managing hypophosphatemic patients is to determine whether the low serum phosphorus level is the result of the reduced total body phosphorus or is a reflection of an intracellular shift.¹¹ The plasma phosphorus does not always indicate the total phosphorus of the body because only 1% of the body phosphate is extracellular. Therefore, a child may suffer phosphorus deficiency despite his normal serum phosphorus.¹² The important role of phosphorus mandates the diagnosis of hypophosphatemia in critically ill patients. Notably, few studies have been performed in this regard, especially in children, and there are only case reports from Iran despite the critical role of phosphorus in biological processes. In this respect, this study was conducted to determine the risk factors of hypophosphatemia in children hospitalized

in the pediatric intensive care unit (PICU) of Children's Hospital in Tabriz, Iran, in 2014-2015.

Methods

This cross-sectional study was performed in Children's Teaching Hospital, the only specialized center for children in Tabriz. To begin the study, medical records of all critically ill children admitted to the PICU were collected from archives of the hospital upon adopting permission and were examined in terms of relevant variables from 20 February 2014 to 20 February 2015. The data extracted from medical records included demographic information, clinical diagnosis of the disease (acute respiratory disease, infectious disease, sepsis, shock, and heart disease), serum phosphate level (serum phosphorus level on the first day, fourth to sixth and seventh to tenth day of hospitalization), nutritional status, duration of fasting, and therapeutic interventions [use of vasoactive medications, steroids or diuretics, and performing total parenteral nutrition (TPN)]. A sample of 83 patients was selected through convenience sampling. In this study, hypophosphatemia referred to the serum phosphorus lower than 3.8 mg/dl in children under 2 years old and under 3.5 mg/dl in children over 2 years old. The weight-to-age curve and BMI were used to classify nutritional status of children < 2 years old and those > 2 years old respectively. The inclusion criterion of this study was children hospitalized in PICU. The data were analyzed using SPSS software (version 16, SPSS Inc., Chicago, IL, USA) and $P < 0.05$ was considered significant.

Results

Of the studied 83 patients who received a vasoactive medication during the study, 45 patients were male (54.2%), and 38 patients were female (45.8%), with a mean age of 25.97 months. The most prevalent and the least prevalent disease in these children were acute pulmonary disease (57.8%) and septic shock (1.2%), respectively. Regarding

the nutritional status, 38.6% of the children suffered malnutrition. The use of steroid was the children on the first day, 26.5% of the children from the 4th to the 6th day, and 34.9% of the children from the 7th to the 10th day. The total prevalence of hypophosphatemia in this study was 24%.

Table 1 shows the association among variables. It was noted that the prevalence of

positive in 82.0% of the patients. The level of serum phosphorus was abnormal in 10.8% of hypophosphatemia were not significantly associated with sex, age, and nutritional status on the mentioned days. The medications were also not significantly associated with the level of phosphorus on the studied days.

Table 1. Distribution of underlying specifications and their correlation

| Level of phosphorus in the studied days | Results of test | | |
|---|--------------------------------------|--|---|
| | 1 st day (4.49 ± 0.98) | 4 th -6 th days (4.18 ± 1.01) | 7 th -10 th days (3.98 ± 0.97) |
| Underlying specifications | P | P | P |
| Age | 0.24 | 0.31 | 0.90 |
| Sex | 0.49 | 0.62 | 0.89 |
| Type of disease | 0.58 | 0.11 | 0.82 |
| Nutritional status | 0.72 | 0.21 | 0.48 |
| Steroid | 0.65 | 0.73 | 0.72 |
| Diuretic | 0.42 | 0.35 | 0.61 |
| TPN | 0.72 | 0.78 | 0.70 |

Discussion

This study was performed to determine the risk factors of hypophosphatemia in children hospitalized in the PICU of Children's Hospital in Tabriz, in 2014-2015. The total prevalence of hypophosphatemia was 24% during the first 10 days of hospitalization. The prevalence of hypophosphatemia has been reported 2-3% in patients hospitalized in the United States, which increased to 30% in patients admitted to ICUs.¹³ Furthermore, these patients are at a higher risk of decrease in serum phosphorus due to their special conditions and diseases, such as cardiopulmonary failure, sepsis, diabetic ketoacidosis, and surgeries. Therefore, clinicians should regularly monitor the level of phosphorus in these patients.¹⁴

A review of literature about the incidence, symptoms, and treatment of hypophosphatemia in critically ill patients by Geerse et al. showed that the prevalence of hypophosphatemia in patients admitted to ICUs is higher than other patients, and the critical condition of ICU patients exposes them to a higher risk of hypophosphatemia.

The cardiopulmonary failure has been reported as an important symptom in this regard. Only patients with severe or symptomatic disease are treated.¹⁴ Pulmonary problems were the most frequent diseases in the present study, too.

In a prospective survey by Santana e Meneses et al. to study the prevalence of hypophosphatemia and its risk factors in critically ill children, 82 children admitted to PICU were examined for serum phosphorus level during the first 10 days of hospitalization.¹⁵ They obtained data on age, sex, diagnosis and nutritional status in terms of the phosphate content of diet, severity of disease, sepsis, use of dopamine, use of diuretic or steroid, and duration of fasting. Their results showed that 61.0% of patients in PICU became hypophosphatemic within the first 10 days of hospitalization, and 39.1% of patients suffered malnutrition. In this respect, the level of phosphorus in susceptible patients admitted to ICUs should be monitored on the first 10 days of hospitalization.

In the present study, age and sex were not significantly associated with the prevalence of hypophosphatemia. Hosseinpanah et al.¹⁶ studied serum level of calcium, phosphorus, and albumin in primary school children in

23 provinces of Iran, in 1996, and reported the mean calcium, phosphorus, and albumin in the children were 8.6 ± 0.7 mg/dl, 4.9 ± 0.9 mg/dl, and 4.6 ± 0.6 mg/dl, respectively. The females and males did not significantly differ in terms of the level of serum calcium and albumin. However, serum phosphorus was significantly higher in boys than girls. In this study, nutritional status was not significantly associated with the prevalence of hypophosphatemia. In a study by Martinez et al., the prevalence of hypophosphatemia after a surgery in patients receiving TPN increased such that they found it was necessary to constantly monitor and support these patients by a nutrition team and finally concluded that nutritional interventions were associated with hypophosphatemia.¹⁷

Conclusion

According to the results of this study, the level of hypophosphatemia decreased in the studied days, and thus, children admitted to ICUs should be monitored during the first 10 days of hospitalization. This is true especially in patients with acute pulmonary disease and malnutrition and patients receiving special medications. Considering the small sample size of only one hospital in the present study, it is recommended to conduct more comprehensive

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Authors' Contribution

All authors have read and approved the manuscript. KSH, ZM, FA and LM performed the data collection, as well as writing, critical revision, and drafting of the manuscript. AG and AHJR undertook major parts of the study design and performed the statistical analysis, data analysis, and data interpretation.

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Conflict of Interest

Authors have no conflict of interest.

Ethic approval

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