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Original Research Article

A study of serum magnesium level in critically ill patients**Prasad G Ugaragol^{*1}, L S Patil² and Deepak Chinagi³**¹Post graduate/Junior Resident, Shri B M Patil Medical College and Research Center, Vijayapur, India²Professor, Department of Medicine, Shri B M Patil Medical College and Research Center, Vijayapur, India³Junior Resident, Shri B M Patil Medical College and Research Center, Vijayapur, India

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***Correspondence Info:**Dr. Prasad G Ugaragol,
Post graduate/Junior Resident
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Vijayapur, India***Article History:****Received:** 26/10/2017**Revised:** 15/12/2017**Accepted:** 19/12/2017**DOI:** <https://doi.org/10.7439/ijbar.v8i12.4439>**Abstract****Background:** It is considered that Hypomagnesemia is one of the underdiagnosed electrolyte abnormalities in patients who are critically ill. Many studies have been done to find the hypomagnesemia prevalence and its effects on patients regarding mortality and morbidity. So we have undertaken this study to know the effects of Hypomagnesemia in critically ill patients admitted in medical critical ward. And it is an observational study.**Aims and Objectives:** To study the level of serum magnesium in critically ill patients and to correlate its effects with patient outcome in terms of length of stay in ICU, need for ventilator support, duration of ventilator support, APACHE II score. To detect any electrolyte abnormalities associated with hypomagnesemia.**Results:** In our study, on admission in ICU, 55.3% patients had hypomagnesemia, and patients with hypomagnesemia have mean duration of stay in ICU was 8.2 days, longer duration on mechanical ventilator i.e. 6.3 day and APACHE II Score of 15.7 and more frequently patients were in sepsis (25.9%), 15.3 % had cardiovascular abnormality. Patients with hypomagnesemia were more frequently associated with Diabetes Mellitus (34%) and they were having higher mortality rate (48.9%).**Conclusion:** In the critically ill patients Hypomagnesemia was prevalent in higher rate. And it was associated with a higher mortality rate in them. And the requirement of ventilator support and duration on ventilator was significantly higher in hypomagnesemic patients. Hypomagnesemia was more commonly associated with sepsis, diabetes mellitus. And also it was associated with higher mortality rates and APACHE II Score.**Keywords:** Hypomagnesemia; Hypokalemia; APACHE II Score.**1. Introduction**

In the human body Magnesium is known to be the fourth abundant cation and next to potassium which is known to be second most abundant cation intracellularly[1]. And it helps in completing reaction as cofactor nearly for 300 enzymes more commonly involving transferring of phosphate group; it is the major intracellular divalent cation. And it also helps in the formation of ATP. And maintain neuromuscular excitability and maintenance of cardiac function is also its major action. With ATP, Intracellular magnesium will form key complex and acts as an important cofactor for transporters, enzymes, and nucleic acids needed for normal cellular function, energy

metabolism and replication. The normal concentration of serum magnesium is between the ranges of 1.8 to 2.5 mg/dl [2], In that 30% will be bound to the protein and 15% is loosely bound to the many other anions and phosphate. According to studies during the ICU stay 20 to 65% of critically ill patients develop hypomagnesemia [3]. It is very important to consider Hypomagnesemia, as it is very common in patients with critical illness. Hypomagnesemia is usually coexisting with hypokalemia. Patients with hypomagnesemia on admission have been found to have an important impact on mortality and morbidity according to many important studies. Such patients have a higher

APACHE II Score, which has a poor prognosis. Hypomagnesemia is an important factor causing prolonged stay in critically ill patients admitted in ICU. It causes an increased need for ventilator support, and increased number of days on ventilator. Hypomagnesemia will cause neuromuscular weakness and respiratory failure and hence it has been an important factor leading to weaning difficulty for the patient off the ventilator. Electrolyte abnormalities are associated with Hypomagnesemia, like hypokaleaemia. These electrolyte disturbances further aggravate the morbidity and mortality. Hypomagnesemia is common in patients with Diabetes mellitus and Alcoholism. Various studies have supported it and is an overall factor which increases the mortality and morbidity of the patients. Our present study aims to look at the above said factors and to determine the impact of hypomagnesemia in critically ill medical patients in a centre for tertiary care.

2. Materials and Methods

It is the hospital based cross sectional observational study including 85 patients admitted in CCU , ICU and Emergency ward of BLDEU'S Shri B. M. Patil Medical College, hospital and research centre, Vijayapur done over a period of one and half year with approval of institutional ethical clearance committee and obtained the informed written consent from patient and attenders about study.

For each patient detailed history and thorough physical examination, APACHE II Score calculation , relevant blood and urine investigation were performed, followed up till discharge or death and parameters like length of stay in ICU, need of ventilatory support, duration of ventilator support associated electrolyte abnormalities like hypokalemia were observed into.

Blood was collected in a clean dry test tube and transported to the biochemistry laboratory at Shri B. M. Patil Medical College, Vijayapur and the quantitative determination of serum magnesium test was done by calmagite method with Reference range of 1.8 - 2.5mg/dl. And patients included were with severe infections, including sepsis ,respiratory failure, cardiogenic shock ,acute renal failure, liver failure, cerebrovascular accidents with coma, poisonings with respiratoty failure, Diabetic Ketoacidosis, Snake Bites with organ failure, Shock with Septicaemia, Cerebral malaria, Encephalopathy, patients with less than 18 years of age were excluded.

2.1 Statistical analysis

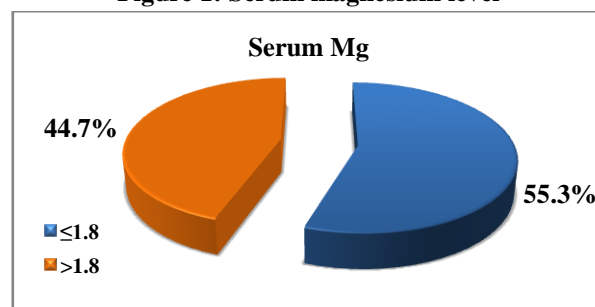
All Characteristics were summarized descriptively. For continuous variable, the summary statistics of N, arithmetic mean (referred to as mean), standard deviation (SD) was used. For categorical data, the number and percentage was used in data summaries.

A chi –square(X^2) test was employed to determine the significance of differences between groups for categorical data. For continous data, the difference of analysis variables was tested with t-test regression analysis p-value <0.05 was considered to be statistically significant. Microsoft word and Excel were used for the generation of tables, graphs etc.

3. Results

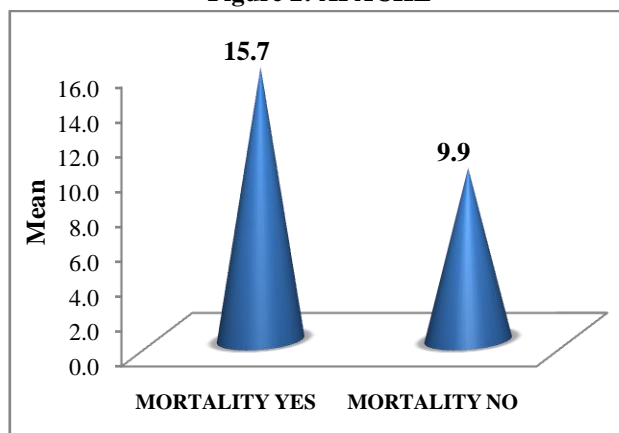
Out of the total 85 patients, a total of 50 patients were males and 35 were females and 38 patients (44.7%) had normal magnesium level, 47 patients (55.3%) of total cases had hypomagnesemia (Figure 1). The mean serum magnesium level was 1.5 mg/dL and the mean APACHE II score was 15.7 ± 6.2 in those who attained mortality and in those who survived was 9.9 ± 6.0 and which was statistically significant (p value=0.017).

Figure 1: Serum magnesium level



Hence hypomagnesemia was associated with increased mortality and a higher APACHE II score (Figure 2).

Figure 2: APACHE



The mean of duration of stay in ICU was 8.2 days in those who died and 5.1 days in those who survived and it is statistically significant with p value of 0.036. Out of 47 hypomagnesemic patients are 74.5% i.e. 35 patients needed ventilator support and 52.6% i.e. 20 out of 38 normomagnesemic patients needed ventilatory support (significant $P < 0.036$). There was no significant association between hypomagnesemia and other electrolytes (both potassium and sodium). There was an

association between sepsis and hypomagnesemia. In our study 25.9% patients were suffering from sepsis, 15.3% patients with cardiovascular involvement, 11.8% were OP poisoning patients and 10.6% with central nervous involvement. There was an significant association between hypomagnesemia in critically ill patients and diabetes and/or hypertension. The present study does not show any relation of hypomagnesemia with inotropic use, increased creatinine values, presence of metabolic acidosis or anemia. There was an increasing trend of alcoholics having hypomagnesemia, even though in our study it was not statistically significant ($P = 0.987$). There was no association of hypomagnesemia with arrhythmia or neurological complications. There was no association of hypomagnesemia with either diet or smoking. And hypomagnesemic patients had higher mortality than normomagnesemic (48.9% vs 26.3%) which is statistically significant with p value of 0.033.

4. Discussion

Magnesium is the second most common intracellular cation. It plays an important role in homeostasis. Magnesium is the cofactor for most of the adenosine triphosphate (ATP) reactions because it is the ATP–magnesium complex that is bound to and hydrolyzed by the enzymes.[1]

Many factors contribute to hypomagnesemia and magnesium deficiency in critically ill patients; like impaired GI absorption, nasogastric suction, poor content of

magnesium in feeding formulae or TPN solutions, administration of drugs like diuretics, aminoglycosides, Amphotericin-B which cause renal wasting of magnesium[4,5]. In our observational study, A total of 85 patients who were critically ill, were admitted in ICU and observed that those with hypomagnesemia had a poor prognosis and increased mortality. Various studies have been done in the past, which assessed the prevalence of hypomagnesemia in critically ill patients. The range of hypomagnesemia varies between 14 % and 70 %. In our study the prevalence of hypomagnesemia was found to be 55.3%. Various studies with prevalence of hypomagnesemia is shown in table 1.

Table 1: Comparative Studies of Prevalence of Hypomagnesemia

Various studies	Low Magnesium
Safavi <i>et al</i> [6]	51%
Ryzen <i>et al</i> [3]	51%
Chernow <i>et al</i> [4]	61%
Guerin <i>et al</i> [7]	66%
Present study	55.3%

Most of the studies have measured the total serum magnesium, some have measured RBC magnesium. However, in few studies ionized magnesium were measured. In those studies, it has been found that the prevalence of hypomagnesemia was very low.[6] Studies which measured ionized magnesium had shown lower prevalence than studies which measured serum magnesium levels. Prevalence of Hypomagnesemia based on Different Methods is shown in table 2

Table 2: Prevalence of Hypomagnesemia based on Different Methods

Study	No of patients	Type of Mg	Prevalence	Study year
Chernow <i>et al</i> [4]	193	Total	61%	1989
Ryzen <i>et al</i> [3]	92	Total	51%	1985
Rubeiz <i>et al</i> [8]	197	Total	20%	1993
Guerin <i>et al</i> [7]	179	Total and RBC	44% and 66%	1996
Soliman <i>et al</i> [9]	422	Ionized	18%	2003
Huijigen <i>et al</i> [10]	155	Ionized	14%	2000
Safavi <i>et al</i> [6]	100	Total	51%	2007

Various studies like Chernow *et al*[4] and Safavi *et al*[6] shown a higher mortality rate of 41% and 55% respectively and 46% according to Rubeiz *et al*[8] in patients with hypomagnesemia than in normo-magnesemic patients and in our present study it is 48.9%.

The mortality in patients with hypomagnesemia was attributed to be secondary to more common causes like electrolyte imbalance, cardiac arrhythmias, sepsis and septicaemia which are more common in ICU. Hypomagnesemia is known to cause muscle weakness and respiratory failure. It is one of the factors causing difficulty in weaning the patient from the ventilator. In the current study it is seen that patients with hypomagnesemia needed ventilator support more frequently and for a longer duration

of 6 days. In a study performed by Fiaccordori *et al*[11] it was found that patients with low muscle magnesium were on ventilatory support for more number of days. Safavi *et al*[6] had found that in patients with hypomagnesemia the duration of mechanical ventilation was longer i.e. 7 days. And our study it is 6.3 days. In our study we found that patients admitted with hypomagnesemia their length of stay in ICU was prolonged with a mean of 8.2 days. In the study carried out by Soliman *et al*[9] there was no difference in the length of ICU stay, in our study it is 5.5 days. However the patients who developed hypomagnesemia during their ICU stay had longer duration of stay in the ICU. APACHE II Score is one of the various ICU scoring systems available to prognosticate the patient's condition. Soliman *et al*[9],

found that those patients who develop ionized hypomagnesemia during their ICU stay had higher APACHE II Score on admission (22.9). In this study, APACHE II score was calculated for each patient at the time of admission. It was found that the patients with hypomagnesemia had higher APACHE II Score at admission and hence, higher morbidity and mortality. The mean APACHE II Score in our study group was 15.7. Hypomagnesemia has been known to be associated with diabetes mellitus. It is due to increased renal losses of magnesium that accompany glycosuria. There is a strong relationship between hypomagnesemia and insulin resistance [12]. In a study conducted by Limaye *et al*[13], it was found that, hypomagnesemia was more common among the diabetic patients, 27%, and it was statistically significant. Hypomagnesemia has been known to be associated with Diabetes Mellitus (DM). In the present study hypomagnesemia was more common in diabetic patients (34%) which were significant.

Most of the studies have shown significance of Alcohol with hypomagnesemia but in our study we found that there was no significance with 34% of prevalence. Soliman *et al*[9] had noted hypomagnesemia in one-third of patients, 33% with chronic liver disease and alcoholism. In a study by Limaye *et al*[13] hypomagnesemia was observed in one-half of alcoholic patients (50%). Chronic alcoholism is one of the predisposing factors for magnesium deficiency. Magnesium depletion in alcoholic individuals is due to a number of factors including poor nutrition, alcohol-induced renal tubular dysfunction leading to renal magnesium wasting, pancreatitis, and intracellular shift in alcohol withdrawal syndrome.

In our study, patients admitted in ICU with critical illness with history of Hypertension were associated with Hypomagnesemia 38.3% and was statistically significant. In this study hypokalemia was not significantly associated with hypomagnesemia. Various studies have shown association of hypokalemia with hypomagnesemia. In a study by Limaye *et al*[13], half of the patients (48%) with hypokalemia had low serum magnesium levels. In another study by Soliman *et al*[9] about 58.8% had hypokalemia with low serum Magnesium levels.

4. Conclusion

Hypomagnesemia is a common electrolyte imbalance in the critically ill patients. It is associated with higher mortality and morbidity rate in critically ill patients and is also associated with more frequent and more prolonged ventilatory support. It was seen in this study that hypomagnesemia is frequently associated with sepsis, diabetes mellitus and cardiovascular diseases. The assessment of serum magnesium concentration is

inexpensive and easy to employ and provides important information about magnesium status in patients. Hypomagnesemia, when detected, may require correction for the management of those with critical illness for better outcomes and hence, benefit of magnesium supplementation to prevent or correct hypomagnesemia in critically ill patients needs further study.

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