Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublisher.com/sjams/

OPEN ACCESS

Biochemistry

Serum Magnesium Levels in Critically Ill Geriatric Patients

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| **Received:** 25.01.2019 | **Accepted:** 04.02.2019 | **Published:** 19.02.2019
DOI: 10.21276/sjams.2019.7.2.22

Abstract **Original Research Article**

Magnesium is the fourth most abundant mineral and the second most abundant intracellular divalent cation, yet its deficiency in critically ill‑patients is frequently overlooked. Present study was to assess the impact of serum magnesium levels on outcomes in critically ill elderly patients in whom aging itself is a comorbidity. It was a prospective observational study, which involved 130 patients aged 60 years and older from both the medical and surgical ICUs. The subjects studied were monitored for serum magnesium levels on Day 1 of intensive care unit (ICU) admission. Patients were divided into 3 groups i.e normomagnesemic, hypomagnesemic and hypermagnesemic depending on the serum magnesium levels and compared for various parameters.Results of our study showed 47cases (36.15%) had normal magnesium levels (Group1), 80 (61.5%) cases had low magnesium levels (Group2), 3 (2.30%) patients had high magnesium levels(Group3). Mean ICU stay in our study was 5.10 ± 2.05 and 5.7 ± 1.95 days for Group1 and Group 2 respectively ($P > 0.05$). Other associated findings were the electrolyte abnormalities such as hypokalemia, hyponatremia, hypocalcemia and hypophosphatemia. Group 2 patients were associated with higher mortality rate as compared to Group 1&3.We conclude that critically ill elderly patients have a high prevalence of hypomagnesemia and these patients were associated with higher mortality rate and had no impact on the duration of medical intensive care unit stay in our study. Physicians should be alert to the high incidence of hypomagnesemia in these patients and should monitor it regularly, as it may help in reducing the adverse clinical outcomes of hypomagnesemia.

Keywords: Hypomagnesemia, Normomagnesemia, elderly, critically ill, mortality, outcome.

INTRODUCTION

Magnesium is the fourth most abundant mineral and the second most abundant intracellular divalent cation and is a cofactor for over 300 metabolic reactions in the body, yet its deficiency in critically ill‑patients is frequently overlooked [1,2]. Various geriatric diseases like osteoporosis, cataract, hypertension etc commonly show alteration in magnesium distribution because of their low magnesium intake, diminished intestinal absorption, and increased urinary output (due to frequent use of diuretics and digitalis)[3,4].Disorders of magnesium metabolism are among the most common electrolyte disturbances in hospitalized patients, especially in the critically ill elderly , the incidence of hypomagnesemia is reported to be 2% in the general population, 10-20% in hospitalized patients, 50-60% in intensive care unit (ICU) patients, 30-80% in persons with alcoholism, and 25% in outpatients with diabetes[4]. Critically ill‑geriatric patients are more prone to both symptomatic or asymptomatic magnesium deficiency that can lead to some important clinical consequences such as hypokalemia, cardiac arrhythmias, hypocalcemia, neurotoxicity and psychiatric problems, so monitoring of serum magnesium may have prognostic and therapeutic implications ultimately reducing the adverse clinical outcomes of hypomagnesemia[5].Present study was to assess the impact of serum magnesium levels on outcomes in critically ill elderly patients in whom aging itself is a comorbidity.

MATERIALS AND METHODS

After obtaining approval of the Institutional Ethics Committee, 130 elderly patients from both the medical and surgical ICUs ,aged > 60 years, of either sex were taken up for this prospective observational study undertaken in a tertiary care hospital of pune, over a period of 1 year. Patients were enrolled at random and the selection bias was avoided by

registering those patients who fulfilled the criteria for critical illness on the basis of a severity scoring system (Acute Physiology and Chronic Health Evaluation-II). Patients were enrolled for the study after informed consent was given by first‐degree relatives of critically ill‐patients. The approval was on the agreement that good laboratory practice, quality control ensured, and that every finding would be treated with utmost confidentiality and for the purpose of this research only. All work was performed according to the International Guidelines for Human Experimentation in Biomedical Research [6]. Demographic data (age and sex), medical history, medications administrated and length of ICU stay were recorded for each patient. Exclusion criteria included patients of age <60years, stable patients not fulfilling the criteria for ICU admission, patients who had received magnesium prior to ICU admission, documented hypomagnesemia.

Sample Collection

Fasting venous blood samples were collected from the ante-cubital vein after informed consent on day 1of ICU admission. The blood was allowed to clot for 30 minutes and was centrifuged at 3000 RPM for 10 minutes and serum was separated and estimation of serum magnesium was done by the Calmagite dye method [7]. The reference serum magnesium level by this method is 1.6-2.5 mg/dl. Other investigations such as arterial blood gases, complete blood count, kidney function tests, liver function tests, serum electrolytes, electrocardiography, chest X‐ray and ultrasonography were also done.Serum magnesium level of < 1.60 mg/dl was regarded as hypomagnesemia and ≥ 2.56 mg/dl as hypermagnesemia. Subjects were divided into three groups i.e Normomagnesemic (Group1), Hypomagnesemic (Group2) and Hypermagnesemic (Group3).

Data Analysis

During data collection completed questionnaires were checked regularly to rectify any discrepancy, logical errors or missing information. The data entry was carried using Microsoft Office Excel worksheet and then exported to statistical software and analyzed using appropriate statistical tests by using Statistical Package for Social Services (SPSS version 21 for MAC IBM, Inc.).Means were calculated and t-test was applied to find out significance level.

RESULTS

Among 130 geriatric patients admitted in ICU, 47cases (36.15%) had normal magnesium levels (Group 1), 80 (61.5%) cases had low magnesium levels (Group 2), 3 (2.30%) patients had high magnesium levels (group 3). Mean Age of group1, group2 and group3 were 67.66, 68.76, 66.33 respectively. The details are given in table 1.

Table-1: Demographic data of Study Population

	Normal Magnesium Group 1	Hypo Magnesium Group 2	Hyper Magnesium Group3
Mean Age	66.71 ± 5.74	68.76 ± 5.94	66.33 ± 4.1
Sex (Males) (Females)	27 2	52 28	2 1
Total : 130	47 (36.15 %)	80 (61.5%)	3 (2.30%)

Mean ± SD of serum magnesium of normomagnesemic patients was 2.01 ± 0.29 mg/dl while as mean ± SD of serum magnesium of hypomagnesemic and hypermagnesemic patients were 1.41 ± 0.14 and 2.66 ± 0.06 mg/dl respectively. The major groups of patients admitted to the ICU were grouped as patients with hepatic failure, chronic kidney disease (CKD), chronic obstructive pulmonary disease, ischemic heart disease, sepsis, stroke, and others. Hypomagnesemic patients mostly comprised of multiorgan dysfunction (31.2%), septicemia (25%) and IHD while as normomagnesemic patients had mostly septicemia (23.4%), IHD (10.6%) (Table 3). Mean APACHE‐II score of hypomagnesemic patients was 22.87 ± 6.10 while that of normomagnesemic patients was 2.13 ± 4.37 (P = 0.10). In addition, mean ICU stay in our study was 5.7 ± 1.95 and 5.10 ± 2.05 days for hypomagnesemic and normomagnesemic groups respectively (p > 0.05). Our study revealed the mortality rate in the hypomagnesemic group to be 40% (32), which was higher than the rate of 27.6 % (13) in the normomagnesemic group (p = 0.15).Other associated findings were the electrolyte abnormalities such as hypokalemia, hyponatremia, hypocalcemia and hypophosphatemia.

Table-2: Comparison of Mean ICU stay and APACHE –II score in Group 1 and Group2.

	Normomagnesemic Group 1	Hypomagnesemic Group 2	P value
ICU Stay (Days) (Mean ± SD)	5.10 ± 2.05	5.7 ± 1.95	0.10
APACHE‐II score (Mean ± SD)	21.13 ± 4.37	22.82 ± 5.90	0.10
Expired (%)	13 (27.6%)	32 (40%)	0.15

APACHE I I- Acute Physiology and Chronic Health Evaluation-II

Table-3: Distribution of Mg levels in critically ill geriatric patients

Diagnosis	Normal Magnesium	Hypo Magnesium	Hyper Magnesium
IHD	5(10.6%)	9 (11.25%)	
Hepatic failure	4 (8.5%)	8 (10%)	
CKD	3 (6.3%)	6 (7.5%)	2
COPD	1 (2.1%)	2 (2.5%)	
Sepsis	11 (23.4%)	20 (25%)	
Stroke	3 (6.3%)	2 (2.5%)	
Multiorgan dysfunction	2 (4.2%)	25 (31.2%)	
Malignancy	4 (8.5%)	1 (1.2%)	
Others	14 (29.7%)	5 (6.2%)	1

DISCUSSION

Our study revealed definite lowering of serum magnesium levels in critically ill geriatric patients. These observations correlate well with previous studies [8,5]. There are multiple reasons for magnesium deficiency in critical care settings e.g, decreased absorption caused by impaired gastrointestinal activity, malnutrition, renal wasting of various drugs (e.g., digoxin, gentamicin, etc.), diabetes mellitus, hypokalemia and hypocalcemia [9]. Urinary magnesium excretion increases by 25-400% following digitalis and diuretic therapy, older patients because of their proclivity for cardiovascular disorders, are more likely to take digitalis and diuretic preparations. Stress, diabetes, gastrointestinal disorders commonly seen in geriatric population, have a role in magnesium depletion. Medications to treat infections (aminoglycosides) and constipation (purgatives) can also lead to hypomagnesemia [10].We observed Hypermagnesemia in 3 patients; the maximum level was 2.75 mg/dl, In our study, the mean duration of stay in the ICU was 5.1 ± 2.05 days for patients with a normal magnesium level and 5.7 ± 1.95 days for patients with hypomagnesemia. These findings are in accordance with the study by Soliman *et al*. Limaye *et al*. who also found no difference in the length of ICU stay between hypomagnesemic and normomagnesemic patients [11,12], however in a study by Kumar et al, there was a significant difference in the length of ICU stay between hypomagnesemic and normomagnesemic groups of patients (5.46 ± 5.75 days vs. 3.93 ± 3.88 days, p = 0.0002)[13].

Magnesium deficiency in critical illness correlates with higher morbidity and mortality. Various studies have shown a varying relationship between hypomagnesemia and mortality/morbidity rates. On average, a higher mortality rate was detected in hypomagnesemic patients irrespective of their age when compared with normomagnesemic patients, as reported by Kumar *et al*. (38.56% vs. 14.73%), Limaye *et al*. (57% vs. 31%), Safavi and Honarmand (55% vs. 35%), and Rubeiz *et al*. (46% vs. 25%), Chernow *et al*. (41% vs. 13%). [14-16] This study in critical ill elderly patients revealed the mortality rate in the hypomagnesemic group to be 40% , which was higher than the rate of 27.6% in the normomagnesemic group (p = 0.15) and is in accordance with above studies, however Guérin *et al*. had found no difference in ICU mortality between hypomagnesemic and normomagnesemic groups (18% vs. 17%); but noted a higher mortality rate among hypermagnesemic patients. [17] Limitation and possible biases of our study were of confounding factors, For example, electrolyte abnormalities such as hypokalemia are frequently associated with magnesium deficiency due to impairment of Na-K-ATPase activity [18], hypoalbuminemic states as in cirrhosis may lead to low magnesium values as 30% of magnesium is bound to albumin, Sepsis alone is a risk factors for developing hypomagnesemia [12,13].

CONCLUSION

We conclude that critically ill elderly patients have a high prevalence of hypomagnesemia and these patients were associated with higher mortality rate and had no impact on the duration of medical intensive care unit stay in our study. Physicians should be alert to the high incidence of hypomagnesemia in these patients and should monitor it regularly, as it may help in reducing the adverse clinical outcomes of hypomagnesemia.

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