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Frequency of Hypomagnesemia in Patients with Hypokalemia Admitted in A Tertiary Care Hospital

Md Sazzad Hosen Romel and Rezowana Afrin

ABSTRACT

Deficiencies of electrolytes (hypokalemia and hypomagnesemia) are of clinical importance in hospitalized patients. Hypomagnesemia is often associated with hypokalemia and concomitant hypomagnesemia potentiates hypokalemia and makes it difficult to treat with potassium replacement alone. Therefore, the aim of this study was to evaluate the frequency of hypomagnesemia in hypokalemic patients admitted in a tertiary care hospital. Total 75 patients with admission hypokalemia (serum potassium <3.5 mmol/l) were approached for inclusion in the study. Overall frequency of hypomagnesemia (serum Mg^{2+} level <0.66 mmol/L) were present in 58.7% (n=44) patients. A positive correlation was observed between serum level of potassium and magnesium in our study population. (Pearson's correlation co-efficient, r=0.801, P <0.001). However, before any final comment further multicenter study is recommended.

Keywords: Hypokalemia, Hypomagnesemia, Frequency, Risk factors.

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I. Introduction

Despite the relentless efforts of the body's homeostatic pathways coupled with insulin and beta-adrenergic tone playing a critical role to maintain the internal distribution of potassium and a normal serum potassium level (3.5–5.0 mEq/L) under normal conditions, disorders of altered potassium homeostasis are common. Hypokalemia is such a disorder characterized by serum potassium level below 3.5 mEq/l. Though potassium rich diet can treat asymptomatic and mild hypokalemic patients, oral or intravenous potassium is required to manage symptomatic or severe hypokalemic patients [1]-[2]. However treatment of the underlying disease or removal of the causative factor should be the goal of hypokalemia management. It is found that over 50% hypokalemic patients have associated hypomagnesemia [3]-[7]. A study showed that 42% of patients who are hypokalemic on admission to hospital also have concomitant magnesium deficiency [5]. Serum magnesium concentration is tightly controlled with a normal serum value of 0.66–0.96 mmol/L. Hypomagnesemia enhances renal loss of potassium and subsequently worsens hypokalemia [8]. Hypomagnesemia also renders hypokalemia refractory to potassium replacement therapy which is why replacement of both potassium and magnesium is required for the correction of hypokalemia associated with hypomagnesemia [9]. Clinically, combination of hypokalemia and hypomagnesemia is often observed in patients receiving diuretic therapy (Loop or thiazide) [10]. Other responsible factors include gastrointestinal loss(vomiting, diarrhea), alcoholism; Bartter and Gitelman syndromes; and nephrotoxic drugs which include aminoglycosides, amphotericin B, cisplatin based chemotherapies etc. [11]. Hypomagnesemia is present in about 40% of diuretic treated hypokalemic patients. Frequency of hypomagnesemia is 63.3% in diabetic hypokalemic patients [12]. In spite of all the supportive evidences for supplementation of magnesium in hypokalemic patients, some studies could not establish association between hypomagnesemia and hypokalemia to be significant [7],[13]. There were differences among the findings of different studies which is likely due to the heterogenicity of the study population, which founded the basis to look for the frequency of hypomagnesemia in hypokalemic patients in Bangladeshi population.

II. Materials And Methods

This was a cross-sectional study which was carried out over a sample of 75 patients who were above 18 years of age, admitted at Combined Military Hospital Dhaka and on admission had serum potassium below 3.5 mmol/l. The study was done over a six-month period, beginning 1st June 2019 to 30th November 2019, without interruption. All patients were evaluated with detailed history taking and physical examination. Blood samples were collected from the patients maintaining all aseptic precautions. From the collected samples serum potassium and magnesium levels were measured. Reference range of Serum magnesium is determined at 0.66-0.96 mmol/l. Reference range of Serum potassium is determined at 3.5-5.2 mmol/l. 'Statistical Packages for Social Sciences' (SPSS) version 23.0 program was used to analyze the collected data. Written informed consent was taken from all patients.

III. Results

Total 75 patients with hypokalemia were enrolled in the study with mean age of 48.87±15.37 year and ranged between 20 to 83 years. Majority patients (25.3%) were found in 51-60 years age group. It was found that, male was predominant in present study (53.3%). Male female ratio was 1.14:1. Majority respondents hailed from urban area (78.7%) and others from rural area (21.3%). It is mentioned that in this study, socioeconomic status of the participants were divided into the three groups based on monthly income where Poor income group was defined as income range between 7501 to 10000 Bangladeshi taka (BDT)per month, Middle income group: 10001 to 15000 BDT per month and Rich income group: Above 15000 BDT per month.[14] Majority respondents belonged to average socio-economic condition (58.7%, n=44) and followed by in decreasing order above average (22.7%, n=17) and below average (18.6%, n=14). Mean values of systolic and diastolic BP of study population was recorded 121.07±20.70 mmHg and 72.27±12.69 mmHg. Majority patients were in normal BMI range (37.3%) followed by 33.3% overweight patients and 26.7% obese patients. Mean BMI value was 24.60±4.44. Among 75 hypokalemic patients of our study, disease induced hypokalemia was seen in 65.4% cases. In majority cases, the causes were diarrhea (33.3%) and severe vomiting (24.0%) which causes severe electrolyte abnormality if not supplemented properly. Drug induced hypokalemia was seen in 34.7% cases. Responsible drugs mostly include Diuretics (Loop diuretics and Thiazides) and Laxatives. Mean serum K^+ and Mg^{2+} values with their range (min and max) were tabulated below. The potassium level ranged between 2.12 and 3.38 mmol/L. That means all the patients had hypokalemia while the range of serum Mg^{2+} was 0.35 to 1.02 mmol/L. Grades of hypokalemia in our admitted patients were tabulated below with frequency. Majority (45.3%) were found moderate hypokalemia (K^+ 2.5-3 mmol/L) among them. Magnesium status of study population showed that, hypomagnesemia (serum Mg^{2+} level <0.66 mmol/L) were present in 44 patients (58.7%). Of all, 88.2% severe hypokalemic patients and 79.4% moderate hypokalemic patients showed hypomagnesemia in our study. While 91.7% mild hypokalemic patients had normal magnesium value. Both the studies were significant statistically. Among 44 hypomagnesemic patients 75.0% were found to have grade-1 hypomagnesemia (Mg^{2+} <0.66-0.5 mmol/L). Mean Mg^{2+} was 0.533±0.094 mmol/L. A positive correlation was observed between serum potassium and serum magnesium level in our study population (Pearson's correlation co-efficient, r= 0.801, P <0.001).

TABLE I: Clinical Characteristics of Study Population (n=75)

Variables	Frequency	Percentages (%)
Mean Systolic BP (mmHg)		121.07±20.70
Mean Diastolic BP (mmHg)		72.27±12.69
BMI category		
Underweight (<18.5 Kg/m^2)	2	2.7%
Normal (18.5-22.9 Kg/m^2)	28	37.3%
Overweight (23-24.9 Kg/m^2)	25	33.3%
Obese ≥ 25 Kg/m^2)	20	26.7%
Mean BMI (Kg/m^2)		24.60±4.44

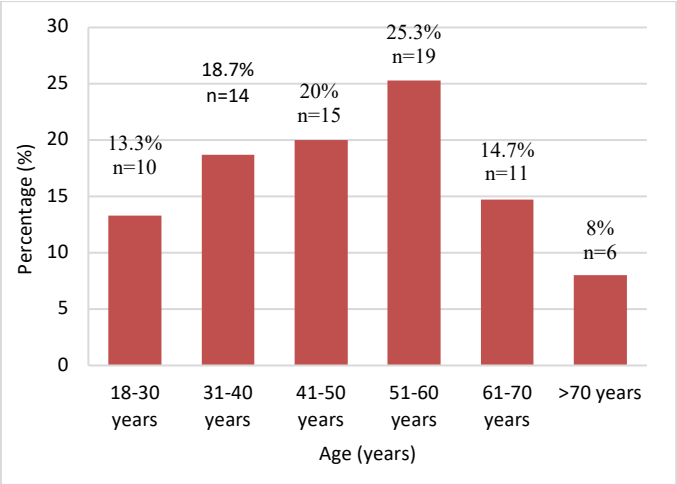

Fig. 1. Age distribution of study population (n=75).

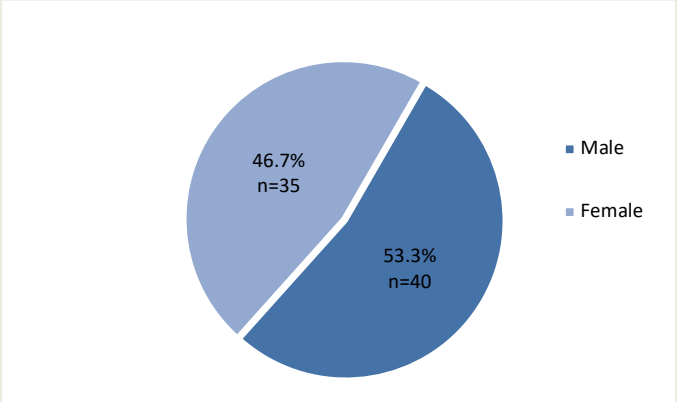

Fig. 2. Distribution of study population according to their sex (n=75).

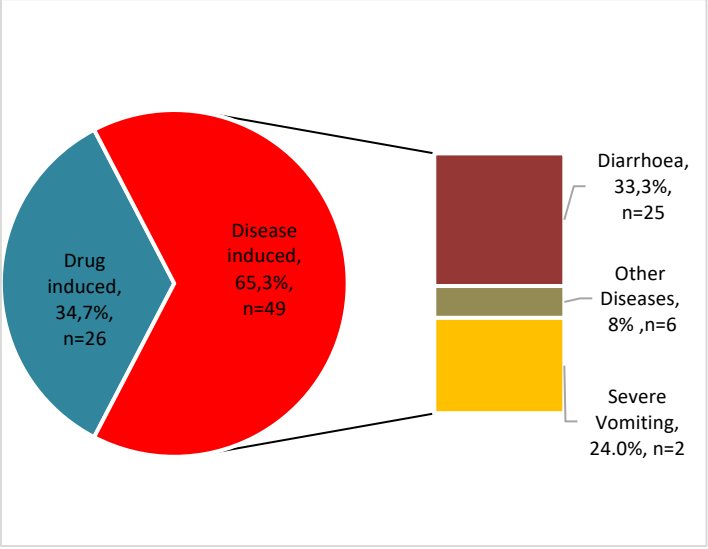

Fig. 3. Causes of hypokalaemia in study population (n=75).

TABLE II: Serum Potassium (K^+) and Serum Magnesium (Mg^{2+}) Value of Study Population (n=75)

Serum electrolytes	Mean	Std. Deviation	Minimum	Maximum
Serum potassium (mmol/L)	2.76	0.35	2.12	3.38
Serum magnesium (mmol/L)	0.68	0.19	0.35	1.02

TABLE III: GRADE OF HYPOKALEMIA OF STUDY POPULATION (N=75)

Hypokalemia grade	Frequency	Percentage (%)
Mild (3-3.5 mmol/L)	24	32
Moderate (2.5-3 mmol/L)	34	45.3
Severe (<2.5 mmol/L)	17	22.7
Total	75	100

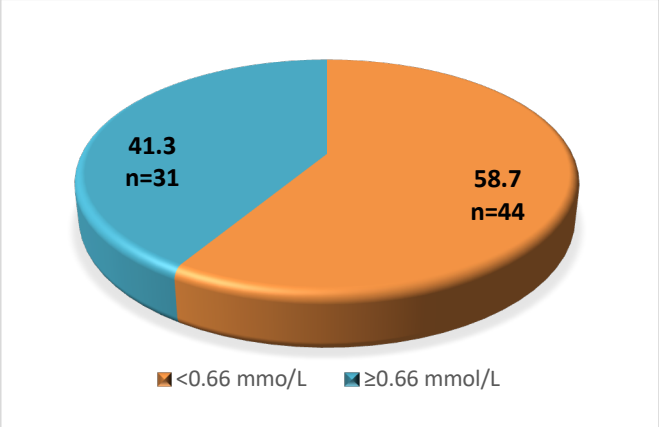

Fig. 4. Magnesium status of study population (n=75).

TABLE IV: MAGNESIUM STATUS IN DIFFERENT GRADES OF HYPOKALEMIA IN OUR STUDY POPULATION (N=75)

Variables	Mild hypokalemia	Moderate hypokalemia	Severe hypokalemia	P-value*
Hypomagnesemia	2 (8.3%)	27 (79.4%)	15 (88.2%)	<0.001
Normal Mg^{2+}	22 (91.7%)	7 (20.6%)	2 (11.8%)	<0.001
Total	24 (100%)	34 (100%)	17 (100%)	

*p-value determined by Chi-square test.

TABLE V: SERUM MAGNESIUM STATUS IN HYPOMAGNESEMIA PATIENTS WITH GRADE OF HYPOMAGNESEMIA [15] (N=44)

	Frequency (n=44)	Percentage (%)
Hypomagnesemia Grades		
Grade 1 (<0.66-0.5 mmol/L)	33	75.0
Grade 2 (<0.5-0.4 mmol/L)	5	11.4
Grade 3 (<0.4-0.3mmol/L)	6	13.6
Mean Mg^{2+}	0.553 ± 0.094 mmol/L	
Minimum Mg^{2+}	0.35 mmol/L	
Maximum Mg^{2+}	0.65 mmol/L	

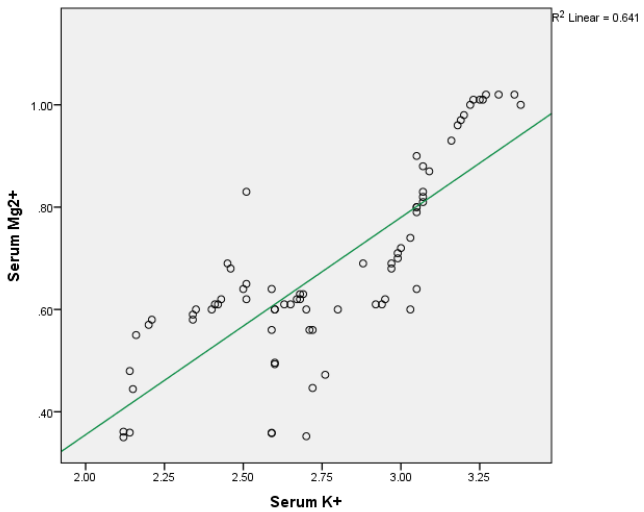

Fig. 5. Correlation between serum magnesium & serum potassium.

IV. DISCUSSION

Potassium and magnesium are the two most abundant intra-cellular cations in the body.[16] They play vital roles in the functioning of excitable tissues such as nerves, skeletal muscle and cardiac muscle [17]. They also play pivotal roles in various cellular metabolic reactions and replication [18]-[19]. Whereas intracellular potassium serves as a catalyst in a few enzymatic reactions, magnesium serves as a co-factor in more than 300 enzymatic reactions [16]-[17]. There are some reports documenting a relationship between serum magnesium and potassium which imply an association of hypomagnesemia with hypokalemia.[5],[20] This study aimed at determining the frequency of hypomagnesemia in hypokalemic patients admitted in a hospital and to promote the routine measurement of serum magnesium level of hypokalemic patients in our setting.

Total 75 patients were studied among which 25.3% were from 51-60 years age group with mean age 48.87±15.37 years. Several studies show that the risk of various cardiovascular diseases including hypertension, ischemic heart diseases and renal diseases (Acute kidney injury and chronic kidney disease) are proportionately higher in this age group [21]-[22]. Mayee *et al.* [23], in their prospective observational study about hypokalemia patients, found majority in similar age group. Most of our study population were found to be of normal weight (37.3%) followed by overweight (33.3%) and obese (26.7%). Mean BMI was recorded 24.60±4.44 kg/m^2. Mayee *et al.* recorded majority patients as overweight [23].

Drug induced (mainly diuretics and laxatives) hypokalemia was observed in 34.7% people and disease induced hypokalemia in 65.3% cases. Major disease condition was gastro-intestinal loss of potassium either by diarrhea (33.3%) or severe vomiting (24.0%). Other diseases like Cushing's Syndrome, Conn's syndrome, Renal Tubular Acidosis etc. were present in 8% cases. Eliacik et al. reported 91.8% causes of hypokalemia occurred due to GI potassium loss [24]. Other studies also stated that gastrointestinal loss of potassium is the major cause of hypokalemia [25]-[26]. Diuretics and laxatives were the common drugs for hypokalemia in study subjects. Use of diuretics causes excessive loss of potassium in the urine. Diuretics were also found to be responsible for hypokalemia among the geriatric population too [27].

32% of all patients were found to be mild hypokalemic, 45.3% moderate and 22.7% were severe hypokalemic. Mean potassium value was 2.76±0.35 mmol/L with range of 2.12-3.38 mmol/L. Hypomagnesemia was observed in 58.7% patients with hypomagnesemia with mean Mg^{2+} value of 0.68±0.19 mmol/L. Previous studies also show similar association between hypokalemia and hypomagnesemia [3]-[5]. Magnesium status in patients with different grades of hypokalemia showed that, 88.2% with severe hypokalemia, 79.4% with moderate hypokalemia and 8.3% with mild hypokalemia had hypomagnesemia. The study was statistically significant. However, Deheinzelin et al. and Watson and O'Kell could not find a significant association between the serum level of potassium and magnesium [7], [13].

Mean value of serum Mg^{2+} in 44 hypomagnesemic patients of our study was 0.553 ± 0.094 mmol/L with 75% patients having grade-1 hypomagnesemia. Serum potassium level was however, found to have a significant predictive value for hypomagnesaemia in our study population (Pearson's

correlation co-efficient, r= 0.801, P <0.001). According to Roberts, the correlation between these constituents is 0.28. He mentioned that the serum levels of both potassium and magnesium were significantly correlated with the subject's age. He also reported that the correlation between potassium and magnesium remained significant even after correction for the effect of age [20]. Reports from several studies show, imbalance of serum potassium concentration is an important factor responsible for the genesis of cardiac arrhythmias [28]-[29]. Though the mechanisms of cardiac arrythmia due to hypokalemia, particularly in mild degrees, have not been clearly defined, there are evidences that hypomagnesemia may also be an important factor in the genesis of cardiac arrhythmias associated with hypokalemia [13], [30]-[31]. As both of the electrolyte imbalances share initiation by the same mechanisms including diuretic therapy, primary hyperaldosteronism, renal tubular acidosis etc., co-occurrence of hypokalemia and hypomagnesemia is getting attention in recent years.

V. Conclusion

More than half of the hypokalemic patients had co-existing hypomagnesemia. And the hypomagnesemia is linked with severity grading of hypokalemia. As the study was conducted in a single center, therefore, before any final comment further multicenter study is recommended.

Conflict of Interest

We declare that we do not have any conflict of interest.

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