STUDY OF HYPOMAGNESAEMIA IN CRITICALLY-ILL PATIENTS IN MEDICAL INTENSIVE CARE UNIT AT TERTIARY CARE HOSPITAL

Sumit Kamble[1], Hetal Patel[2], Smita Trivedi[3]

[1]Senior Resident, Department of Medicine, GMERS, Gotri, Vadodara.
[2]Assistant Professor, Department of Medicine, GMERS, Gotri, Vadodara.
[3]Professor and HOD, Department of Medicine, Baroda Medical College, Vadodara.

ABSTRACT

BACKGROUND

Magnesium is the second most abundant intracellular cation and the fourth most common cation in the body. The effect of magnesium on important biological processes such as glycolysis, oxidative phosphorylation, nucleotide metabolism, protein biosynthesis signifies the importance of magnesium in cellular metabolism. Magnesium plays a role in numerous enzymatic processes in the body and has direct role in activation of enzymes such as phosphofructokinase, creatine kinase, acetylate cyclase and sodium potassium ATPase.

The aim of the study is to-

1. Study serum magnesium level in critically-ill patient.
2. Correlate serum magnesium level with patient outcomes.
3. Identify primary medical conditions and the factors predisposing or contributing to abnormalities of serum magnesium.

MATERIALS AND METHODS

Study of 100 cases admitted over a period of 2 years, i.e. between 2010 to 2012 in MICU at SSG Hospital, Vadodara. The patient admitted for critical illness in ICU was included in study. The patients who received magnesium before admission to MICU were excluded from study. A blood sample was collected for estimation of serum total magnesium level on admission to MICU. History and clinical finding were noted for each patient, other haematological, biochemical and radiological investigations were performed as indicated in every patient.

RESULTS

66% were male and 34% were female patients. Hypomagnesaemia was found in 52%, normal level in 41% and hypomagnesaemia in 7%. Present study shows mortality and sepsis were statistically significant findings in study population, i.e. in patients with hypomagnesaemia ($p<0.05$). Statistically significant correlation was found with hypocalcaemia and hypoalbuminaemia in study populations ($p<0.05$). However, hypomagnesaemia doesn't show significant association with duration of MICU stay, need of ventilator.

CONCLUSION

Hypomagnesaemia is a one of electrolyte imbalance in the critically-ill patients. Hypomagnesaemia is associated with higher mortality rate in critically-ill patients as Mg plays important role in homeostasis. Morbidity and mortality in critically-ill patient has relation with low Mg level. However, potential benefits of Mg supplementation to prevent or correct hypomagnesaemia in critically-ill patients require further study.

KEYWORDS

MICU, Hypomagnesaemia.

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BACKGROUND

Magnesium is the second most abundant intracellular cation and the fourth most common cation in the body. The effect of magnesium on important biological processes such as glycolysis, oxidative phosphorylation, nucleotide metabolism, protein biosynthesis signifies the importance of magnesium in cellular metabolism. Magnesium plays a role in numerous enzymatic processes in the body and has direct role in activation of enzymes such as phosphofructokinase, creatine kinase, acetylate cyclase and sodium potassium ATPase.[1,2,3]

Many factors contribute to hypomagnesaemia in critically-ill patients like impaired gastrointestinal absorption, nasogastric suction and poor content of magnesium in feeding formulae or TPN solutions, administration of drugs

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Corresponding Author:
Dr. Hetal Patel,
No. B15, Maruti Society,
Karodia Road, Gorwa, Vadodara-390016.
E-mail: hetal.patel5210@gmail.com
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like diuretics, aminoglycosides, amphotericin B, which cause renal wasting of magnesium.[4,5]

Estimates of Mg deficiency range from 20% to 61%.[6,7,8] Study found that reductions in total serum Mg on admission are associated with increased mortality.[9]

Objectives

1. To study serum magnesium level in critically-ill patients.
2. To correlate serum magnesium level with patient outcomes.
3. To identify primary medical conditions associated with abnormalities of serum magnesium.
4. To identify the factors predisposing or contributing to hypomagnesaemia in critically-ill medical patients admitted in a medical ICU.
5. To detect other electrolyte abnormalities associated with hypomagnesaemia.

MATERIALS AND METHODS

Study of 100 cases admitted over a period of 2 years, i.e. between 2010 to 2012 in MICU at SSG Hospital, Vadodara.

Inclusion Criteria

The patient admitted for critical illness in ICU were included in study.

Exclusion Criteria

The patients who received magnesium before admission to MICU were excluded from study.

- A blood sample was collected for estimation of serum total magnesium level on admission to MICU. History and clinical findings were noted for each patient, other haematological, biochemical and radiological investigations were performed as indicated in every patient.
- Method of serum Mg estimation- Xylidyl blue reagent.
- Specimen- Non-haemolysed serum or lithium heparin plasma maybe analysed since the magnesium concentration inside erythrocytes is 10 times greater than that in ECF. Haemolysis should be avoided and serum should be separated from the cell as soon as possible.

Reference range for serum magnesium.

Serum Magnesium Level	mg/dL
Hypomagnesaemia	<1.6
Normal level	1.6-2.6
Hypermagnesaemia	>2.6
Normal Values	

RESULTS

66% were male patients and 34% were female patients.

Aetiology of Disease	No. of Patients	No. of Patients with Hypomagnesaemia
OP poisoning	28	21/28
Snake bite	16	5/16
Malaria	21	7/21
Ischaemic heart disease	10	7/10
Other infection	4	¼
Diabetic ketoacidosis	6	2/6
Hepatic encephalopathy	8	5/8
Acute respiratory distress syndrome	5	3/5
Guillain-Barre syndrome	2	½
Table 1. Aetiologic Distribution of Patients and Prevalence of Hypomagnesaemia in Study Population		

Organophosphorus poisoning, snakebite, malaria, diabetic ketoacidosis, hepatic encephalopathy, ischaemic heart diseases and acute respiratory distress syndrome were aetiologic findings in MICU patients.

Serum Magnesium Level	Patients (%)
Hypomagnesaemia	52%
Normal level	41%
Hypermagnesaemia	7%
Table 2. Distribution of Serum Magnesium Level in Patients (%)	

Hypomagnesaemia was present in 52% of patients.

Serum Magnesium Level	Mean Duration of Stays (Days)
Hypomagnesaemia	8 ± 7.92
Normal level	6 ± 3.84
Hypermagnesaemia	5.28
Table 3. Distribution of Mean Duration of Stay in MICU	

The difference was not statically significant (P>0.05).

Serum Magnesium Level	Need of Ventilator Support (%)
Hypomagnesaemia	86% (45/52)
Normomagnesaemia	78% (32/41)
Table 4. Distribution of Need of Ventilator Support in Study Population	

The difference was not statically significant (P>0.05).

Serum Magnesium Level	Duration of Ventilator Support (Days)
Hypomagnesaemia	4.27 ± 5.01
Normomagnesaemia	2.15 ± 3.36
Table 5. Distribution of Duration of Ventilator Support in Study Population	

The difference was statically significant (P<0.05).

Serum Magnesium Level	Mortality (%)
Hypomagnesaemia	57.7% (30/52)
Normomagnesaemia	31.7% (13/41)
Table 6. Distribution of Mortality in Study Population	

The difference was statically significant (P<0.05).

Serum Magnesium Level	Patients (%)
Hypomagnesaemia	38% (20/52)
Normal level	19% (8/41)
Hypermagnesaemia	14% (1/7)
Table 7. Distribution of Sepsis in Study Population	

The difference was statically significant (P<0.05).

Serum Magnesium Level	Hypocalcaemia (%)
Hypomagnesaemia	70% (36/52)
Normo/hypermagnesaemia	50% (24/48)

Table 8. Distribution of Hypocalcaemia in Study Population

The difference was statically significant (P<0.05).

Serum Magnesium Level	Hypokalaemia (%)
Hypomagnesaemia	40% (22/52)
Normo/hypermagnesaemia	34% (16/48)

Table 9. Distribution of Hypokalaemia in Study Population

The difference was not statically significant (P>0.05).

Serum Magnesium Level	
Hypomagnesaemia	80% (42/52)
Normo/hypermagnesaemia	70% (34/48)

Table 10. Distribution of Hypoalbuminaemia in Study Population

The difference was statically significant (P<0.05).

Serum Magnesium Level	Patients (%)
Hypomagnesaemia	14/52 (27%)
Normo/hypermagnesaemia	6/41 (14%)

Table 11. Distribution of Diabetes in Study Population

The difference was statically significant (P<0.05).

Serum Magnesium Level	Patients (%)
Hypomagnesaemia	11/52 (21%)
Normo/hypomagnesaemia	6/41 (14%)

Table 12. History of Chronic Alcoholism in Study Population

The difference was statically significant (P<0.05).

DISCUSSION

Table gives the prevalence of hypomagnesaemia and hypomagnesaemia in various studies carried out previously in critically-ill patients all over the world and results of this study. The prevalence of hypomagnesaemia was in range of 44% to 61%. In the present study, 52% patients from MICU were found to have serum magnesium level less than normal.

Hypermagnesaemia is less commonly found than hypomagnesaemia. It is reported in range of 4-14% in literature and this study of hypomagnesaemia was seen in 7% of patients.

International Study	Year	No. of Patients	Hypomagnesaemia	Hypermagnesaemia	Normomagnesaemia
Safavi et al	2007	100	51%	-	49%
Deheinzelin et al	2000	226	45.6%	-	54.4%
Chernow et al	1989	193	61%	5%	34%
Ryzen et al	1985	94	51%	-	-
Guerin et al	1996	179	44%	6%	50%
Our study	2012	100	52%	7%	41%

Table 13. Prevalence of Hypomagnesaemia Study

	Hypomagnesaemia	Normomagnesaemia	Significance
Prevalence	52/100 (52%)	41/100 (41%)	-
Mortality rate	30/52 (57.7%)	13/41 (31.7)	Yes
Need of ventilator	45/52 (86%)	32/41 (78%)	No
Duration of ventilator (hrs.)	4.27±5.01	2.15±3.36	Yes
MICU stay(days)	8.00±7.92	6.17±3.84	No
Hypocalcaemia	36/52 (69%)	24/48 (50%)	Yes
Hypokalaemia	22/52 (40%)	16/48 (34%)	No
Hypoalbuminaemia	42/52 (80.76%)	34/48 (70.8%)	Yes
Sepsis	20/52 (38%)	8/41 (19%)	Yes
DM	14/52 (27%)	6/41 (14%)	Yes
Alcoholism	11/52 (21%)	6/41 (14%)	Yes

Table 14. Hypomagnesaemia in Various Studies

Yes (p<0.05), No (p>0.05).

The relationship between hypomagnesaemia or hypomagnesaemia and mortality rate varies from study to study. A higher mortality rate was detected in hypomagnesaemic patients as compared to normomagnesaemic patients by Soliman et al, Chernow et al (41% vs. 13%),[10] Rubiez et al[9] (46% vs. 25%)[9] and Safavi et al (55% vs. 35%).[11] In the current study, the mortality rate in hypomagnesaemic group was 57%, which is significantly higher as compared to 31% in the normomagnesaemic group and 43% in the normomagnesaemic group (p<0.05). The higher mortality

rates in the hypomagnesaemic patients can be explained by greater incidence of electrolyte abnormalities especially hypokalaemia and cardiac arrhythmias and a strong association of hypomagnesaemia with sepsis and septic shock, which is common cause of death in ICU patients.

Hypomagnesaemia is known to cause muscle weakness and respiratory failure. It is one of the factors causing difficulty in weaning the patients from the ventilator. In the current study, it has been found that patients with hypomagnesaemia did not need ventilator support more frequently, but for longer duration. In a study by Fiaccordori et al,[12] it was found that patients with low magnesium were on ventilatory support for more numbers of days. In study by Safavi et al,[11] it was associated with loner ventilator duration (7.2 vs. 4.7 days, $p < 0.01$).

In present study, there was no difference in ICU stay in different study population. Same finding were found in study by Soliman et al.[13]

Magnesium plays an important role in sepsis. Hypomagnesaemia is associated with increased release of endothelin and proinflammatory cytokines. Sepsis is independent factor for developing hypomagnesaemia during ICU stay as found by Soliman et al. In the present study, the incidence of sepsis was twice as common in hypomagnesaemic patients as compared to normomagnesaemic patients ($p<0.05$).

Hypomagnesaemia 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 hypomagnesaemia and insulin resistance. Magnesium supplementation is associated with decreased insulin requirements.[14,15] In the present study, hypomagnesaemia was more common in diabetic patients ($p<0.05$).

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, intracellular shift in alcohol withdrawal syndrome. Soliman et al had noted hypomagnesaemia in one third of patients with chronic liver disease and alcoholism. In present study, the prevalence of hypomagnesaemia was observed in 11 out of 21 alcoholic patients.

Hypomagnesaemia was commonly associated with other electrolyte abnormalities. Whang et al[16] had found hypomagnesaemia in 42% patients with hypokalaemia, 29% patients with hypophosphataemia, 27% patients with hyponatraemia and 22% patients with hypocalcaemia. Hypokalaemia, hypocalcaemia and hypophosphataemia are said to be the predictors of hypomagnesaemia. Hypokalaemia seen in hypomagnesaemic patients is relatively refractory to potassium supplementation until magnesium deficiency is corrected. In this study, half of the patients (58%) with hypokalaemia also had low serum magnesium level. Hypocalcaemia is also commonly associated with hypomagnesaemia. The mechanism involves defects in synthesis and release of parathyroid hormone as well as end-organ resistance to parathyroid hormone. As with hypokalaemia, the hypocalcaemia of magnesium depletion is difficult to correct unless magnesium deficits are corrected. The present study also found increased incidence of hypocalcaemia in hypomagnesaemic patients than normomagnesaemic patients.

CONCLUSION

Hypomagnesaemia is a one of electrolyte imbalance in the critically-ill patients. Hypomagnesaemia is associated with higher mortality rate in critically-ill patients as Mg plays important role in homeostasis. Morbidity and mortality in critically-ill patient has relation with low Mg level. However, potential benefits of Mg supplementation to prevent or correct hypomagnesaemia in critically-ill patients require further study.

REFERENCES

[1] Elin RJ. Magnesium: the fifth but forgotten electrolyte. Am J Clin Pathol 1994;102(5):616-622.
[2] Whang R. Magnesium deficiency: pathogenesis, prevalence, and clinical implications. Am J Med 1987;82(3A):24-29.
[3] Huijgen HJ, Soesan M, Sanders R, et al. Magnesium levels in critically ill patients. What should we measure? Am J Clin Pathol 2000;114(5):688-695.
[4] Whang R, Whang DD, Ryder KW, et al. Routine serum magnesium determination: a contemporary clinical imperative. Magnes Res 1990;3(4):267-270.
[5] Toffaletti J. Physiology and regulation. Ionized calcium, magnesium and lactate measurements in critical care settings. Am J Clin Pathol 1995;104(4 Suppl 1):S88-94.
[6] Reinhart RA, Desbiens NA. Hypomagnesemia in patients entering the ICU. Crit Care Med 1985;13(6):506-507.
[7] Ryzen E, Wagers PW, Singer FR, et al. Magnesium deficiency in a medical ICU population. Crit Care Med 1985;13(1):19-21.
[8] Salem M, Munoz R, Chernow B. Hypomagnesemia in critical illness. A common and clinically important problem. Crit Care Clin 1991;7(1):225-252.
[9] Rubeiz GJ, Thill-Baharozian M, Hardie D, et al. Association of hypomagnesemia and mortality in acutely ill medical patients. Crit Care Med 1993;21(2):203-209.
[10] Chernow B, Bamberger S, Stoiko M, et al. Hypomagnesemia in patients in postoperative intensive care. Chest 1989;95(2):391-397.
[11] Safavi M, Honarmand A. Admission hypomagnesemia--impact on mortality or morbidity in critically ill patients. Middle East J Anesthesiol 2007;19(3):645-660.
[12] Fiaccadori E, Del Canale S, Vitali P, et al. Skeletal muscle energetics, acid-base equilibrium and lactate metabolism in patients with severe hypercapnia and hypoxemia. Chest 1987;92(5):883-887.

[13] Soliman HM, Mercan D, Lobo SSM, et al. Development of ionized hypomagnesemia is associated with higher mortality rates. Crit Care Med 2003;31(4):1082-1087.
[14] Rodriguez-Moran M, Guerrero-Romero F. Oral
[15] Tosiello L. Hypomagnesemia and diabetes mellitus. A review of clinical implications. Arch Intern Med 1996;156(11):1143-1148.
magnesium supplementation improves insulin sensitivity and metabolic control in type 2 diabetic subjects: a randomized double-blind controlled trial. Diabetes Care 2003;26(4):1147-1152.
[16] Whang R, Oei TO, Aikawa JK, et al. Predictors of clinical hypomagnesemia. Hypokalemia, hypophosphatemia, hyponatremia and hypocalcemia. Arch Intern Med 1984;144(9):1794-1796.