Original Article

# Effects of magnesium on clinical outcome of critical care traumatic patients

**Seyed Muhammad Nasir-al-din Tabatabaei[1], Alireza Jahangirifard[2], Mehrnegar Safarzaei[1], Majid Golestani Eraghi[3], Maziar Mahjoubifard[1]**

## Abstract

**Background:** Magnesium (Mg) is a necessary element in a vast number of enzymatic paths throughout the body, so, its cellular mechanisms affect clinical outcome; it is also the main second intracellular cation playing a crucial role in ATP/ADP energy conversion. Lack of Mg is usually reported in 10% of hospitalized patients worldwide. Chronic hypomagnesaemia is also in correlation with many chronic pathologic conditions. The present study was designed to assess the correlation of the serum level of Mg in ICU admitted patients with their prognosis.

**Materials and Methods:** Through a retrospective cross-sectional design, 180 ICU admitted patients over 18 years, between 2012 and 2014 were enrolled in the study; 90 had normomagnesemia and 90 hypomagnesaemia. APACHE II score was calculated for patients after 24 hours of admission in ICU before measuring serum Mg level of each patient. Then, patients' outcomes were assessed. Mortality, hospital stay, requirement for mechanical ventilation and duration of mechanical ventilation were recorded.

**Results:** Out of total patients with normal serum Mg 22 (22.4%) died while 36 (40%) died with hypomagnesaemia. There was no significant difference between the groups for the length of hospital stay. 48.9% of total patients with normal Mg who were admitted in ICU needed ventilator, but 78.9% of hypomagnesaemia cases were to use ventilator who were significantly higher than the other group. In terms of the time of ventilator use, a significant difference was seen between the patients with normal or low serum Mg. Individuals with normal Mg needed more days of ventilation, interestingly (26.5 vs. 17.5 days).

**Conclusion:** Low serum magnesium could be a key factor for assessing prognosis among ICU admitted patients, especially in critically ill ones.

**Keywords:** Magnesium, critical care, clinical outcome

**Please cite this article as:** Tabatabaei SMN, Jahangirifard A, Safarzaei M, Golestani Eraghi M, Mahjoubifard M. Effects of magnesium on clinical outcome of critical traumatic patients. J Cell Mol Anesth. 2017;2(1):9-14.

1. Zahedan University of Medical Sciences, Zahedan, Iran
2. Tracheal Diseases Research Center, National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, Iran
3. Lung Transplantation Research Center, National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, Iran

**Corresponding Author:** Maziar Mahjoubifard, MD, Assistant Professor of Anesthesiology, Fellowship of Cardiac Anesthesia, Zahedan University of Medical Sciences, Zahedan, Iran; e mail: m_mahgoobifard@yahoo.com

## Introduction

Magnesium is a necessary element in a vast number of enzymatic systems inside the body as well as being the main second intracellular cation playing a crucial role in ATP/ADP energy conversion (Figure

1). The total body magnesium is supposed to be around 2000 meq/lit; a half of it available in bones while less than 1% in the intracellular solution; providing 1.3-2.2 meq/lit plasma concentration and 20% of it is bind to proteins (1-4). All the body organs such as heart, muscles, and kidneys need Mg for their good functions. Mg also is crucial for managing absorption, metabolism and action of several cations like potassium, calcium, cooper and zinc. Human needs 300 mg/day of Mg on average, which would be raised in pregnancy, breast feeding or disease convalescence period (2, 3,5-7). Lack of Mg is usually reported in 10% of hospitalized people worldwide. Chronic hypomagnesaemia is also in correlation with many other chronic medical conditions like diabetes mellitus, cardiac disorders, osteoporosis, hypertension, and even with higher risk of death in the intensive care unit (ICU) admitted patients (3, 4). There are many factors, including medical conditions like vomiting, diarrhea, and other GI problems could disrupt Mg balance in body which is, in turn, resulted from viral infections. Also, some chronic diseases like irritable bowel syndrome, pancreatitis, hyperthyroidism, renal problems, and bowel lesions cause chronic hypomagnesaemia besides using tea, salt or alcohol, hyperhidrosis, and even stress. Hypomagnesaemia represents with irritability, anger, sleep problems, nausea and vomiting, vertigo, muscular spasms, malaise, tachypnea, cardiac arrhythmia and finally seizure. Mg is well known as a supplementary treatment in diabetes, asthma, fibromyalgia, arrhythmias, hypertension, migraine, cardiac diseases, pre-eclampsia, in addition to restless leg syndrome; it is considered as a factor to decrease pain (2, 8-10).

Hypermagnesemia is also a concern which is usually caused by increased renal reabsorption or incomplete excretion as well as its much oral intake, resulting often in hypotension in individuals (5, 11, 12).

The present study was designed to assess the correlation of the Mg serum level in ICU admitted patients with their prognosis to accept or deny this kind of relationship as a prognostic tool.

# Methods

Through a retrospective cross-sectional design, 180 ICU admitted patients enrolled the study considering inclusion and exclusion criteria. The patients were admitted in two university hospitals in Southeastern Iran and the center of Sistan and Baluchistan province. The records were evaluated from 2012 to 2014 which belonged to traumatic cases that admitted in ICU and were at least 18 years old. Patients who experienced CPR in recent 24 hours in addition to cases of burn, recent Mg supplement intake, and hospitalization more than 24 hours were excluded. The sample size was calculated based on a study which defined 55% mortality rate in hypomagnesaemia (13) to achieve 80% study power regarding following equation:

$$n = \frac{(p_1(1-p_1)+p_2(1-p_2))\times(Z_\alpha + Z_\beta)^2}{(p_1-p_2)^2}$$

P1 = 55%, P2 = 35%, $Z^{\alpha}$ = 1.96, $Z^{\beta}$ = 0.75
N= 87

So, 90 records were defined for each group of normomagnesemia and hypomagnesaemia. Normal serum Mg was ranged 1.3-2.1 meq/l while hypomagnesaemia was defined as Mg<1.3meq/l in serum.

Census sampling was considered through our study focusing on the early Mg serum level at the point of ICU admission. APACHE II score was calculated for patients after 24 hours of admission in ICU before recording the Mg serum level of each patient in relevant designed questionnaire. There are some standard scoring systems to assess the severity of the diseases or the risk of death, especially in ICU admitted patients among which APACHE II is the most popular one (14, 15). The higher the APACHE II score, the more the risk of death in patients (15). However, patients' outcomes were checked to find any correlation in this regard. In addition to mortality; hospital stay, requirement to mechanical ventilation and its duration were recorded.

**Statistics**

Using SPSS 20 for windows, all the data were analyzed by t-test, Chi-square test and Fisher's exact test in order to compare serum Mg levels and their means in addition to Pearson's correlation coefficient to assess the correlation between serum Mg level and the APACHE II score. The confidence interval was 95% with a 0.05 type1 error and the significance of 0.05.

**Ethics**

The study design was approved by IRB of ethics, coded 617, dated 2012, Research deputy, School of Medicine. As a retrospective cross-sectional study, no intervention was done throughout the work; also, all the information was kept as totally private and anonymous.

# Results

Total 180 traumatic patients were admitted in ICU of study hospitals in Southeast of Iran with the mean age of 42.4±19.6 years, including 102 males

**Table 1:** The mean age and sex distribution among the two studied groups.

| | Normo-Mg | Hypo-Mg | Total | Significance |
|---|---|---|---|---|
| | 35.4 ± 18.9 | 49.2 ± 17.8 | - | 0.001 |
| | 58 (64.4%) | 24 (26.7%) | 102 (56.7%) | 0.001 |
| | 32 (35.6%) | 66 (73.3%) | 78 (43.3%) | |
| | 90 (50%) | 90 (50%) | 180 (100%) | |

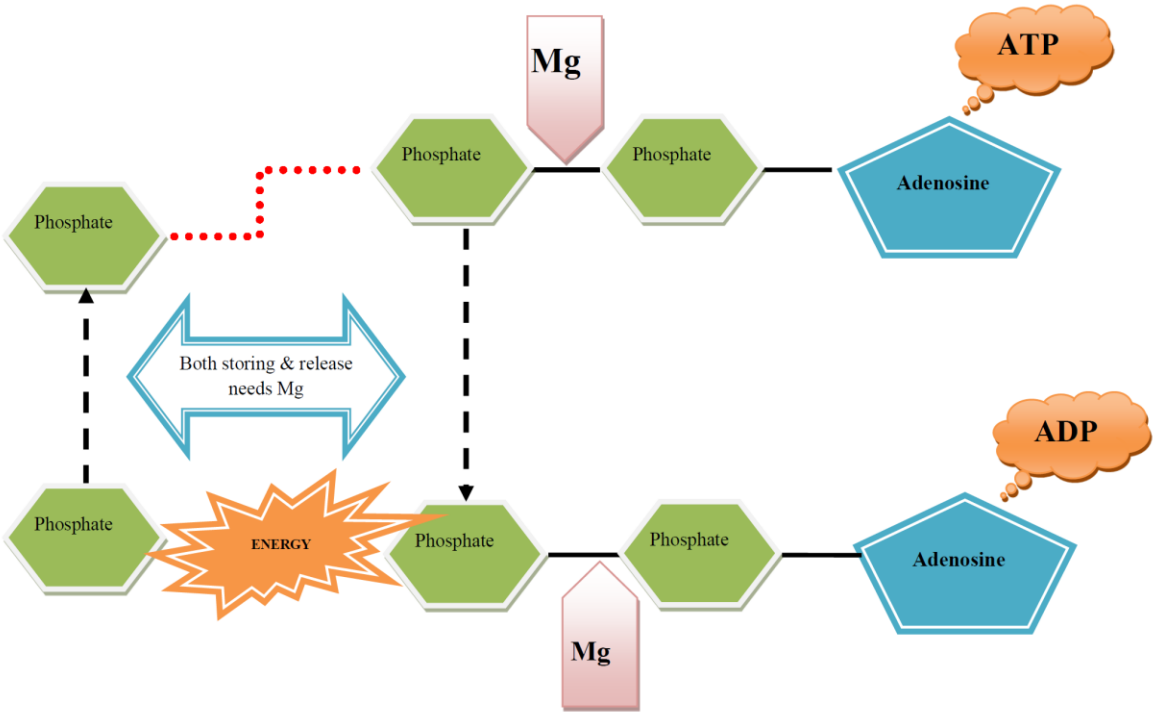


**Figure 1.** Magnesium as a key regulator of cellular energetic.

**Table 2:** The factors to assess the patients' prognosis in ICU.

| | Normal Mg | Low Mg | Total | Significance |
|---|---|---|---|---|
| | 24.9 ± 27.4 | 23.2 ± 18.4 | - | 0.633 |
| Yes | 44 (48.9%) | 71 (78.9%) | 115 (63.9%) | 0.001 |
| No | 46 (51.1%) | 19 (21.1%) | 65 (36.1%) | |
| | 26.5 ± 26.9 | 17.5 ± 15.5 | - | 0.024 |
| Alive | 68 (75.6%) | 54 (60%) | 122 (67.8%) | 0.035 |
| Death | 22 (24.4%) | 36 (40%) | 58 (32.2%) | |
| | 90 (50%) | 90 (50%) | 180 (100%) | |

(56.7%) and 78 (43.3%) females. Two genders significantly differed in terms of mean age (P value =0.001). The mean age and sex distribution in two groups of normomagnesemia and hypomagnesaemia were also significantly different as table 1represents.

**Early serum Mg Level and mortality in ICU**

Out of total patients with normal serum Mg 22 (22.4%) died while 36 (40%) died with hypomagnesaemia (p value =0.035).

**Early serum Mg level and hospital stay**

There was no significant difference between the groups in length of hospitalization (p value =0.633). The mean lengths of hospitalization were 24.9 and 23.2 days in normal and high Mg groups, respectively.

**Early serum Mg level and ventilator need**

As can be seen in table 2, 48.9% of total patients with normal Mg who were admitted in ICU needed ventilator, but 78.9% of hypomagnesaemia cases were to use ventilator who were significantly higher than the other group (p value = 0.001). In terms of the time of ventilator use, a significant difference was seen between the patients with normal or low serum Mg (p value = 0.024). Individuals with normal Mg needed more days of ventilation, interestingly (26.5 vs. 17.5 days). Table 2 summarizes the findings in this matter.

# Discussion

The findings of the present study show that the admitted patients in ICU during our performance who experienced low serum Mg levels, not only had significantly higher rates of mortality, but also needed more ventilator use beside having longer hospital stay. There have been a vast number of attempts to answer the concerns about the relationship between serum levels of Mg and some factors in ICU admitted patients such as mortality, hospital stay, ventilator needs. For instance, Zafar et al. in 2014 in India realized 74.47% mortality in hypomagnesaemia while we found 40% mortality rate in similar cases compared with normomagnesemia ones (16). Through another retrospective performance in 2007, Safavi and colleagues showed a much more mortality, hospital stay and ICU stay in hypomagnesaemia patients in addition to higher rates of electrolyte imbalance like total hypocalcemia, hypokalemia, and hyponatremia (13). They also found that cases of low serum Mg needed more and longer mechanical ventilation comparing with other patients. So, monitoring of serum Mg may play a prognostic role in ICU which is also useful in making early decisions for treatment. We found no significantly different hospital stay between two groups of normal and low Mg through our research work. Mechanical ventilation was required in 79% of our patients with hypomagnesaemia whilst just less than 50% among normomagnesemia cases.

Limaye in India concluded that diabetes mellitus could be a cause of hypomagnesaemia (17). Many of attempts showed more needs to ventilation in terms of times and duration although we found longer ventilation need in normomagnesemia when compared with hypomagnesaemia patients. On the other hand, Soliman et al. express no correlation between Mg serum level and mortality and hospital stay (18). They named long ICU stay, diuretics and sepsis as the main triggers of hypomagnesaemia. Guerin and colleagues not only found no correlation between studied factors and serum Mg levels, but also blamed hypomagnesaemia as the main cause of low prognosis and mortality (10). Either way, low serum magnesium sounds to be a key factor to assess the prognosis among ICU admitted patients, especially in critically ill patients.

Imperfect record system and laboratory errors in serum Mg levels were the most challengeable items through the present study.

## Conclusion

Although there was no significant difference between low and normal level Mg groups in term of ICU stay, but hypomagnesemia patients had longer mechanical ventilation time and mortality rate. So low serum magnesium sounds to be a key factor to assess the prognosis among ICU admitted patients, especially in critically ill patients.

## Acknowledgment

The authors would like to acknowledge the kind help of all our research colleagues and our clinical colleagues, including physicians and nurses, in Zahedan University of Medical Sciences, Zahedan, Tracheal Diseases Research Center, National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, and Lung Transplantation Research Center, National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, Iran for their kind assistance in performing the research.

## Conflicts of Interest

The authors declare that they have no conflict of interest.

## References

1. Bansal P, Baduni N, Bhalla J, Mahawar B. A comparative evaluation of magnesium sulphate and nitroglycerine as potential adjuncts to lidocaine in intravenous regional anaesthesia. International journal of critical illness and injury science. 2015;5(1):27-31.

2. De Oliveira GS J, Castro-Alves LJ, Khan JH, McCarthy RJ. Perioperative systemic magnesium to minimize postoperative pain: a meta-analysis of randomized controlled trials. Anesthesiology. 2013;119(1):178-90.

3. Gruenbaum SE, Bilotta F. Postoperative ICU management of patients after subarachnoid hemorrhage. Curr Opin Anaesthesiol. 2014;27(5):489-93.

4. Velissaris D, Karamouzos V, Pierrakos C, Aretha D, Karanikolas M. Hypomagnesemia in Critically Ill Sepsis Patients. Journal of clinical medicine research. 2015;7(12):911-8.

5. Dabbagh A, Bastanifar E, Foroughi M, Rajaei S, Keramatinia AA. The effect of intravenous magnesium sulfate on serum levels of N-terminal pro-brain natriuretic peptide (NT pro-BNP) in elective CABG with cardiopulmonary bypass. J Anesth. 2013;27(5):693-8.

6. Dabbagh A, Elyasi H, Razavi SS, Fathi M, Rajaei S. Intravenous magnesium sulfate for post-operative pain in patients undergoing lower limb orthopedic surgery. Acta Anaesthesiol Scand. 2009;53(8):1088-91.

7. Ferasatkish R, Dabbagh A, Alavi M, Mollasadeghi G, Hydarpur E, Moghadam AA, et al. Effect of magnesium sulfate on extubation time and acute pain in coronary artery bypass surgery. Acta Anaesthesiol Scand. 2008;52(10):1348-52.

8. Bilotta F, Gelb AW, Stazi E, Titi L, Paoloni FP, Rosa G. Pharmacological perioperative brain neuroprotection: a qualitative review of randomized clinical trials. Br J Anaesth. 2013;110 Suppl 1:i113-20.

9. Murphy JD, Paskaradevan J, Eisler LL, Ouanes JP, Tomas VA, Freck EA, et al. Analgesic efficacy of continuous intravenous magnesium infusion as an adjuvant to morphine for postoperative analgesia: a systematic review and meta-analysis. Middle East journal of anaesthesiology. 2013;22(1):11-20.

10. Pascual-Ramirez J, Gil-Trujillo S, Alcantarilla C. Intrathecal magnesium as analgesic adjuvant for spinal anesthesia: a meta-analysis of randomized trials. Minerva anestesiologica. 2013;79(6):667-78.

11. Dabbagh A, Rajaei S, Shamsolahrar MH. The effect of intravenous magnesium sulfate on acute postoperative bleeding in elective coronary artery bypass surgery. J Perianesth Nurs. 2010;25(5):290-5.

12. Mirkheshti A, Aryani MR, Shojaei P, Dabbagh A. The Effect of Adding Magnesium Sulfate to Lidocaine Compared with Paracetamol in Prevention of Acute Pain in Hand Surgery Patients Under Intravenous Regional Anesthesia (IVRA). Int J Prev Med. 2012;3(9):616-21.

13. Safavi M, Honarmand A. Admission hypomagnesemia--impact on mortality or morbidity in critically ill patients. Middle East journal of anaesthesiology. 2007;19(3):645-60.
14. Das K, Ozdogan M, Karateke F, Uzun AS, Sozen S, Ozdas S. Comparison of APACHE II, P-POSSUM and SAPS II scoring systems in patients underwent planned laparotomies due to secondary peritonitis. Annali italiani di chirurgia. 2014;85(1):16-21.
15. Thorsen K, Soreide JA, Soreide K. Scoring systems for outcome prediction in patients with perforated peptic ulcer. Scandinavian journal of trauma, resuscitation and emergency medicine. 2013;21:25.
16. Zafar MS, Wani JI, Karim R, Mir MM, Koul PA. Significance of serum magnesium levels in critically ill-patients. International journal of applied & basic medical research. 2014;4(1):34-7.
17. Limaye CS, Londhey VA, Nadkart MY, Borges NE. Hypomagnesemia in critically ill medical patients. The Journal of the Association of Physicians of India. 2011;59:19-22.
18. Soliman HM, Mercan D, Lobo SS, Melot C, Vincent JL. Development of ionized hypomagnesemia is associated with higher mortality rates. Critical care medicine. 2003;31(4):1082-7.