

COMPARISON OF SERUM MAGNESIUM LEVEL (1-5 DAY) IN PATIENTS WITH AND WITHOUT ARRHYTHMIAS IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

Md. Abdul Baset¹, Md. Zahirul Haque², Md. Azizul Hoque³, Malay Kumar Saha⁴, Lakshman Chandra Barai⁵,
Md. Zanzibul Tareq⁶, Abu Jafar Md. Tareq Morshed⁷

¹Junior Consultant (Medicine), Upazila Health Complex, Paba, Rajshahi, Bangladesh.

²Associate Professor, Department of Medicine, Rajshahi Medical College Hospital, Rajshahi, Bangladesh.

³Associate Professor and Head (Ex.), Department of Medicine, Rajshahi Medical College Hospital, Rajshahi, Bangladesh.

⁴Associate Professor, Unit Chief, Department Of Orthopaedic Surgery, MBBS, D-Ortho, MS-Ortho, Mymensingh Medical College, Mymensingh, Bangladesh.

⁵Assistant Professor, Cardiology, MBBS, D.CARD, MCPS, National Institute of Cardiovascular Diseases and Hospital, Dhaka, Bangladesh.

⁶Assistant Registrar, Cardiac Surgery, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.

⁷Assistant Registrar, Cardiac Surgery, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.

***Corresponding Author: Md. Abdul Baset**

Junior Consultant (Medicine), Upazila Health Complex, Paba, Rajshahi, Bangladesh.

Article Received on 12/07/2020

Article Revised on 02/08/2020

Article Accepted on 22/08/2020

ABSTRACT

Introduction: Magnesium deficiency leads to the progression of atheromatous plaques which occurs as a result of hyperlipidemia. Myocardial infarction is one of the most common causes of mortality where its prognosis depends upon various factors. This study is performed to know the effect of magnesium levels in the serum of acute MI patients to the occurrence of arrhythmias. **Objective:** To find out the "Comparison of Serum Magnesium level (1-5 Day) in patients with and without Arrhythmias in Patients with Acute Myocardial Infarction: A Study in Rajshahi Medical College Hospital, Rajshahi, Bangladesh. **Study design:** Descriptive cross sectional study. **Study place & period:** Department of Cardiology, Rajshahi Medical College Hospital, Rajshahi from July, 2013 to November, 2013. **Subjects:** 50 patients with acute myocardial infarction admitted to the Department of Cardiology, Rajshahi Medical College Hospital. **Methods:** Data was collected from patients of any age and both sexes with acute myocardial infarction as determined by clinical features, ECG evidence and biochemical report. Blood sample for estimation of serum magnesium level was collected as early as possible within 24 hours of admission and 5th day of admission. After admission to CCU every patient was under continuous cardiac monitoring to see and record any arrhythmia within 5 days onset of symptoms. **Results:** A total of 50 patients of acute myocardial infarction were included during the study period. The male to female ratio in the study group was 3.17:1 and the maximum incidence of acute myocardial infarction was seen in 5th and 6th decade. In the study group mean serum magnesium level in 50 patients on day-1 is 1.86 ± 0.39 and on Day-5 is 2.26 ± 0.5 . Mean serum magnesium level in 26 patients with arrhythmia was 1.65 ± 0.26 on day-1 and 1.98 ± 0.25 on day-5. In the study group, mean serum magnesium level in 24 patients without arrhythmia was 2.05 ± 0.41 on day-1 and 2.48 ± 0.52 on day-5. The difference between the magnesium level in patients with arrhythmia and without arrhythmia is statically significant on both day- 1 and day-5 ($p < 0.001$). PVC was the most common type (42.5%) of arrhythmia. **Conclusion:** serum magnesium levels are significantly low in patients who develop arrhythmia in acute myocardial infarction.

KEYWORDS: Coronary artery disease, acute myocardial infarction, serum magnesium level, arrhythmia.

I. INTRODUCTION

Magnesium deficiency leads to the progression of atheromatous plaques which occurs as a result of hyperlipidemia. Myocardial infarction is one of the most common causes of mortality where its prognosis depends upon various factors. This study is performed to know the effect of magnesium levels in the serum of acute MI patients to the occurrence of arrhythmias. Coronary artery disease (CAD) is the highest killer in developed

countries and is now an emerging epidemic in developing countries including Bangladesh. During recent years, more than six million people worldwide died of Ischaemic heart disease, which was predicted to be the leading cause deaths all over the world.^[1] A study showed that acute myocardial infarction (AMI) is the leading cause of death in Bangladesh in the 4th decade of life.^[2] So, in our population myocardial infarction emerged as a major killer and in the long run a major

cause of morbidity also are becoming a significant burden on health care services in Bangladesh. In Bangladesh, the prevalence of CAD was estimated as 13/1000 in 2004.^[3] The role of magnesium in cardiovascular disease has received widespread attention. The relationship between hypomagnesemia and arrhythmias has been well documented. Several investigators have also noted the association between magnesium deficiency and coronary artery disease.^[4,5] Magnesium (Mg) is the second most common intracellular cation after potassium (K).^[6] Mg is a cofactor in more than 300 enzyme systems in human cells and it has a predominant role in normal myocardial physiology. Magnesium improves myocardial metabolism, inhibits calcium accumulation and myocardial cell death. It improves vascular tone, peripheral vascular resistance, after load and cardiac output, reduces cardiac arrhythmias and improves lipid metabolism. Magnesium also reduces vulnerability to oxygen derived free radicals, improves endothelial function and inhibits platelet function including platelet aggregation and adhesion.^[7] Myocardial magnesium concentration in patients with sudden death due to ischemic heart disease was found to be very low.^[8] These findings directly correlated with the resultant complications of myocardial infarction, such as arrhythmias. The reduction of infarct size with magnesium has profound research and clinical implications.^[9] Hypomagnesemia is an important risk factor for post AMI complication. It has been reported in various international studies that the serum Mg level is not only low at admission in cases of AMI but also continues to fall even for days after the onset of AMI.^[10,11,12] It is unknown however, if the low cardiac content precedes the myocardial infarction or is result of it. Hypomagnesemia is present in acute myocardial infarction (AMI) as shift of magnesium from extra cellular to intracellular compartments occur.^[13] A number of clinical studies have shown a fall in the serum magnesium concentration within first 24 to 48 hours after myocardial infarction.^[14] A study from Rajasthan tried to determine the prognostic significance of serum magnesium levels in acute MI. Serum magnesium was found to be significantly lowered on the first day and it gradually rose to normal value by the twenty first day.^[15] One study of Dhaka showed that there is a significant lower serum Mg and K level in AMI than chronic IHD and fall of serum Mg immediately after AMI may be due to the catecholamine induced high FFA which causes bindings and precipitation of Mg into the cells, resulting in a sudden decrease in total plasma Mg level.^[16] As reported recently, intracellular magnesium levels are reduced in patients with AMI. This deficiency is not adequately reflected in serum measurements, since magnesium is predominantly an intracellular ion and less than 1% of total body magnesium is found in the intravascular compartment.^[17] Some studies also found no significant change of serum magnesium. In the last decade several reviews have been concerned with the relevance of Mg in cardiac disease. Nevertheless, the

role of Mg qualitatively and quantitatively is not fully appreciated by most physicians. Serum Mg measurements are not routinely performed. The consequence is that essential data are often lacking. To the best of my knowledge, very few studies have been made on serum magnesium level in acute myocardial infarction in Bangladesh.

II. OBJECTIVE OF THE STUDY

To find out the "Comparison of Serum Magnesium level (1-5 Day) in patients with and without Arrhythmias in Patients with Acute Myocardial Infarction: A Study in Rajshahi Medical College Hospital, Rajshahi, Bangladesh.

III. MATERIALS AND METHODS

Study design: Descriptive cross sectional study

Place of study: Department of Cardiology, Rajshahi Medical College Hospital, Rajshahi.

Study period: July 2013 to November 2013.

Sample size: 50

Study population: All cases of acute myocardial infarction admitted in cardiology ward of Rajshahi Medical college hospital from 5 months of the date of acceptance of protocol.

Sampling method: Purposive sampling method. Every consecutive clinical case of acute myocardial infarction admitted in RMCH fulfilling the inclusion criteria were included for the study.

Selection criteria: Those patients presenting to the hospital within 12 hours of onset of symptoms were taken.

Inclusion criteria

Patients were considered to have acute myocardial infarction, only if they had two of the following criteria:

- i. History of chest discomfort
- ii. ECG changes of acute myocardial infarction
- iii. Rise of cardiac enzymes.

Exclusion criteria

- i. Patients presenting 12 hours after the onset of chest pain
- ii. Patients with hypokalemia
- iii. Those who are taking diuretics.

Procedure of data collection: Data were collected from patients of any age and both sexes with acute myocardial infarction as determined by clinical features, ECG evidence and biochemical report. Blood sample for estimation of serum magnesium level was collected as early as possible within 24 hours of admission and 5th day of admission. After admission to CCU every patient was under continuous cardiac monitoring to see and record any arrhythmia within 5 days onset of symptoms. Detailed history and thorough clinical examination was performed in a prefixed questionnaire form or data collection sheet after taking informed consent of the patients. They were then subjected to a battery of investigations necessary for the patients with acute myocardial infarction and arrhythmia.

Data analysis: Socio-demographic and clinical variables: Data for socio- demographic and clinical variables were obtained from all participants by the use of a pre- designed and easily understandable questionnaire. After collection of all the data it was entered in the SPSS 16.0 statistical software.

IV. RESULTS

A total of 50 patients of acute myocardial infarction were included during the study period. The male to female

ratio in the study group was 3.17:1 and the maximum incidence of acute myocardial infarction was seen in 5th and 6th decade.[Figure-1] showed the age distribution of the study respondent. Out of 50 cases the maximum incidence of acute myocardial infarction was seen in the 5th and 6th decades 14(28.0%) and 24(48.0%), followed by 7th and 8th decades 5(10%) and 3(6%). 4(8%) patients were in the age group of 4th decade.

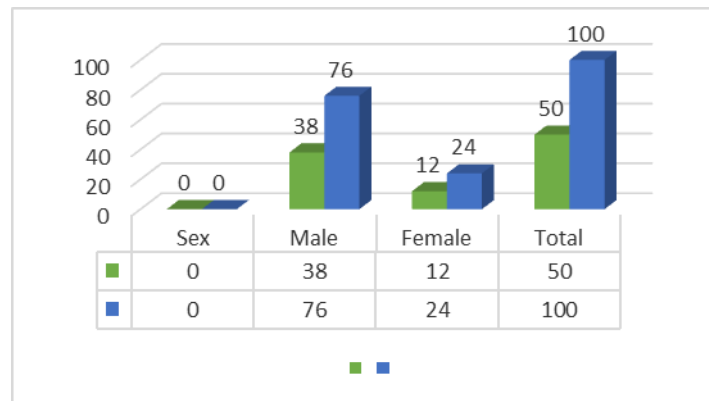


Figure-1: Sex distribution of the study patients (n=50).

Table-1: Distribution of the study respondent according to risk factors (n=50)

Risk factors	No. of cases	Percentage
Smoking	35	70.00
Family history of premature coronary artery disease	10	20.00
Obesity	12	24.00
Hypertension	15	30.00
Diabetes mellitus	18	36.00
Dyslipidemia	6	12.00

In the study, smoking is the most common 70% risk factor found in the patients with acute myocardial infarction. In the present study, out of 50 patients, 12 (24%) were found to be obese based on criteria of National Cholesterol Education Programme. Waist circumference was measured in all patients, men whose waist circumference is more than 102 cm and females whose waist circumference is more than 88cms were

considered to be obese. In the present study, of 50 patients 15 (30%) patients were found to be hypertensive. Patients whose blood pressure is $\geq 140/90$ are considered to be hypertensive. In the present study, of the 50 patients, 18(36%) patients were found to be diabetics and 12 (24%) patients were found to be dyslipidemic. Family history of coronary artery disease found in 10(20.0%) patients [Table-1].

Table-2: Serum magnesium levels in patients with arrhythmias (n=26).

Serum magnesium levels (mg/dL)	Day-1 (n=26)	Percent	Day-5 (n=21)	Percent
<1.6	9	34.6	2	9.5
1.6 to 2.40	17	65.4	17	81.0
>2.4	-	-	2	9.5

Among 26 patients with arrhythmia 9(34.6%) had serum magnesium level <1.6 mg/dl and 17(65.4%) had serum magnesium level in between 1.6-2.40 mg/dl on day-1. Out of 21 patients who developed arrhythmia 2(9.5%)

had serum magnesium level < 1.6 mg/dl, 17(81.0%) had level in between 1.6-2.40 mg/dl and 2(9.5%) had serum magnesium level > 2.40mg/dl on day-5 [Table-2].

Table-3: Serum magnesium levels in patients without arrhythmias (n=24).

Serum magnesium levels (mg/dL)	Day-1 (n=24)	Percent	Day-5 (n=23)	Percent
<1.6	3	12.5	-	-
1.6 to 2.40	19	79.2	14	60.9
>2.4	2	8.3	9	39.1

Among 24 patients without arrhythmia 3(12.5%) had serum magnesium level <1.6 mg/dl, 19(79.2%) had serum magnesium level in between 1.6-2.40 mg/dl and 2(8.3%) had level > 2.4 mg/dl on day-1. Out of 23

patients without arrhythmia 14(60.9%) had serum magnesium level in between 1.6-2.40 mg/dl and 9(39.1%) had level > 2.40 mg/dl on day-5 [Table-3].

Table-4: Mean serum magnesium level in Day 1 and Day 5 (n=50)

	Day-1	Day-5
Mean serum magnesium in 50 cases	1.86±0.39	2.26±0.50
Mean serum magnesium level in patients with arrhythmia	1.65±0.26	1.98±0.25

In this cross sectional study of 50 patients, the mean serum magnesium level on day-1 in all 50 patients was 1.86±0.39 and the mean serum magnesium level on day-5 was 2.26±0.5. In the present study, out of 50 patients 26 patients had significant ventricular premature

contractions/ ventricular tachycardia/ ventricular fibrillation during their 5-days course in the hospital. The mean serum magnesium level in this group on day-1 was 1.65±0.26 and day-5 was 1.98±0.25 [Table-4].

Table-5: Comparison of Serum Magnesium level in patients with Arrhythmias and without Arrhythmias (Day-1) (n=50).

	No. of cases	Serum magnesium Day-1	t- value	p-value
Mean serum magnesium level in patients with arrhythmia	26	1.65±0.26	4.28	<0.001*
Mean serum magnesium level in patients without arrhythmia	24	2.08±0.41		

Data were analyzed by using independent student t-test, * = Significant

The above [Table-5] shows that out of 50 patients, 26 patients had arrhythmias. The mean value of serum magnesium on day-1 those with arrhythmias is 1.65±0.26

those without arrhythmias is 2.08±0.41 (p<0.001). There is a significant difference in the magnesium level in patient with arrhythmias and without arrhythmias.

Table-6: Comparison of Serum Magnesium level in patients with Arrhythmias and without Arrhythmias (Day-5) (n=44).

	No. of cases	Serum magnesium Day-5	t- value	p-value
Mean serum magnesium level in patients with arrhythmia	21	1.98±0.25	4.14	<0.001
Mean serum magnesium level in patients without arrhythmia	23	2.48±0.52		

Data were analyzed by using independent student t-test, * = Significant

The above [Table-6] shows that serum magnesium in patient with arrhythmia on Day-5 is 1.98±0.25 those without arrhythmia is 2.48±0.5. There is a significant difference between these two (p<0.001). Mortality: In the

above study out of 50 patients, 6 patients died during their 5 days hospital course. 4 patients died of ventricular tachycardia and ventricular fibrillation, 2 patients died of cardiac arrest. Mortality percentage was 12%.

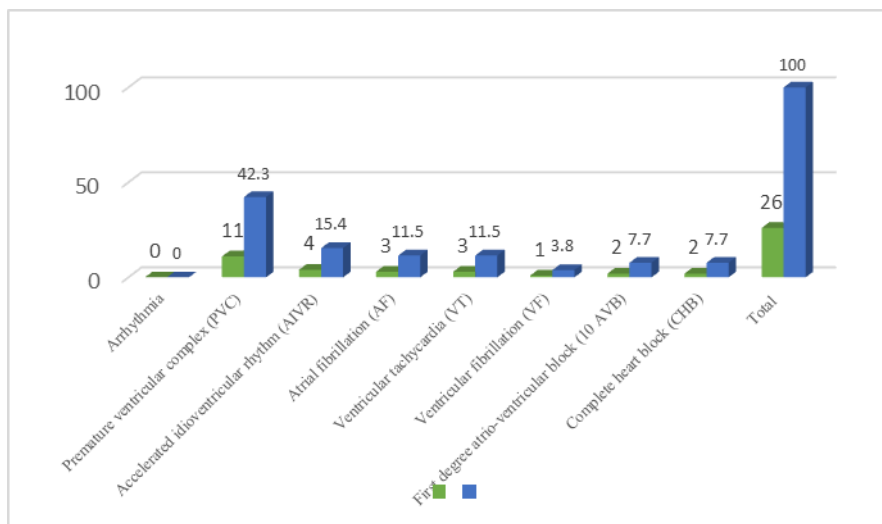


Figure-2: Distribution of pattern of arrhythmia in patients with acute myocardial infarction (n=26).

Study showed PVC occurred in 11 patients which was the most common (42.3%) arrhythmia among 26 acute MI patients who developed various arrhythmias during their 5 day course in hospital [Figure 2].

V. DISCUSSION

Heart disease is the lethal cause of death and is more common in adult male. In the present study maximum number of cases of acute myocardial infarction were in the age group 50 to 59 (48%) and the cases were predominately male (76%) suggesting that it is predominately a disease of men. Yadav P *et al*²¹ showed that Acute MI is more common in 51-60 (32%) age group & in male (72%) which is similar to this study. The effect of risk factors is multiplicative rather than additive. People with a combination of risk factors are at greatest risk and so assessment should take account of all identifiable risk factors. The present study showed that commonest risk factors in Acute MI were smoking (70%), DM (36%), hypertension (30%), Obesity (24%), hyperlipidemia (12%). In Steg PG²¹ study they found that commonest risk factors in Acute MI were smoking (62%), hypertension (50%), DM (21%), Prior infarction(19%), hyperlipidemia (35%) which is very close to the current study. Kelly A.M. *et al*²² showed that family history contributes 25% risk of ACS. Whereas present study showed 20% reflecting the similar risk. There are many modifiable and non-modifiable risk factors of coronary heart disease. In the study group mean serum magnesium level in 50 patients on day- 1 is 1.86 ± 0.39 and on Day-5 is 2.26 ± 0.5 . Mean serum magnesium level in 26 patients with arrhythmia was 1.65 ± 0.26 on day-1 and 1.98 ± 0.25 on day-5. In the study group, mean serum magnesium level in 24 patients without arrhythmia was 2.05 ± 0.41 on day-1 and 2.48 ± 0.52 on day-5. The difference between the magnesium level in patients with arrhythmia and without arrhythmia is statically significant on both day- 1 and day-5($p<0.001$). PVC was the most common type (42.5%) of arrhythmia. The role and relative importance of many risk factors for the development of coronary, peripheral and cerebrovascular disease have been defined in experimental animal studies, epidemiological studies and clinical interventional trials. The effect of risk factors is multiplicative rather than additive. Present study showed of 57.7% of the total anterior wall MI patients developed arrhythmia in their 5 days stay in hospital. Arrhythmia developed in 23.1% of inferior wall MI patients, 11.5% and 7.7% of anteroseptal and anterolateral MI patients respectively. In the present study of 50 patients, the mean serum magnesium level on day-1 in all 50 patients was 1.86 ± 0.39 and the mean serum magnesium level on day-5 was 2.26 ± 0.5 . Abraham *et al*²² reviewed magnesium level of 65 consecutive patients with an admission diagnosis of acute myocardial infarction. Serum magnesium concentration were low in patient who had AMI (mean 1.70 mg/dl, $p<0.001$) or acute coronary insufficiency (mean 1.61 mg/dl, $p<0.01$), but not in the control group or patients with non-cardiac chest pain (mean 1.91

mg/dl). Sachadeva *et al*²⁴ (1978) in 30 patients of myocardial infarction determine the magnesium levels within 24 hours, 5th and 8th day and reported as 1.83 ± 0.087 mgm%, 1.91 ± 0.149 and 1.97 ± 0.089 as against control of 2.44 ± 0.162 mgm%. The values were statistically lower on all the three days showing a progressive rise which is similar to the present study. In the present study, the serum magnesium level on day-1 was significantly lower (mean 1.65 ± 0.26) in patients with arrhythmias than those without arrhythmia (mean 2.08 ± 0.41) ($p<0.001$). There was an increase in serum magnesium from Day-1 to Day-5 in both those with arrhythmias (mean 1.98 ± 0.25) and those without arrhythmias (mean 2.48 ± 0.52) and the difference in both group is significant ($p<0.001$). Misiriya R.K.J *et al*²³ found that in STEMI commonest arrhythmia encountered was premature ventricular complex (PVC) 40.04%. Other arrhythmias observed were accelerated idioventricular rhythm (AIVR) 18%, ventricular tachycardia (VT) 13.98%. Misiriya R.K.J *et al*²³ found that in acute MI commonest arrhythmia encountered was atrial fibrillation (AF) 8.05% and ventricular fibrillation (VF) 5.36% patients. The present study showed commonest arrhythmia were PVC 42.3%, AF and VT 11.5%, AIVR 15.4% and CHB 7.7%. Dyckner T *et al*²⁵ during their 1½ years, 905 admission, 342 with acute myocardial infarction, 563 other diagnoses were treated in the CCU on admission both acute myocardial infarction and non AMI group had significantly lower serum magnesium level than as reference group. The incidence of serious ventricular premature beats, ventricular tachycardia and ventricular fibrillation on admission was significantly higher in the hypomagnesemic patients with acute myocardial infarction which is similar to the present study.

VI. CONCLUSION

In the present study, patients with acute myocardial infarction with low magnesium levels are more prone to develop ventricular arrhythmias compared to those who are having normal magnesium levels. Magnesium replacement therapy in patients with acute myocardial infarction who are having low serum magnesium level may reduce the incidence of arrhythmias. In the study group mean serum magnesium level in 50 patients on day- 1 is 1.86 ± 0.39 and on Day-5 is 2.26 ± 0.5 . Mean serum magnesium level in 26 patients with arrhythmia was 1.65 ± 0.26 on day-1 and 1.98 ± 0.25 on day-5. In the study group, mean serum magnesium level in 24 patients without arrhythmia was 2.05 ± 0.41 on day-1 and 2.48 ± 0.52 on day-5. This study shows that there is a relationship between Mg serum levels and postoperative arrhythmias. The administration of supplemental doses of Mg sulfate seems to play a protective role against occurrence of arrhythmias by maintaining Mg serum levels within normal limits and preventing hypomagnesemia. These administered amounts, however, do not cause complications due to the rise in Mg serum levels.

REFERENCES

1. Lopez AD, Murray CC. The global burden of ischaemic heart disease 1990-2020. *Nat Med*, 1998; 4: 1241-1249.
2. Khondokar RK, Hossain D, Hossain M. Retrospective analysis of acute myocardial infarction. *Bang Heart J*, 1987; 1: 14.
3. Islam MN, Ali MA & Ali M. 'Spectrum of cardiovascular disease: the current scenario in Bangladesh', *Bangladesh Heart J*, 2004; 19: 1-7.
4. Richard W Bunton. Value of serum magnesium estimation in diagnosing myocardial infarction and predicting dysrhythmias after coronary artery bypass grafting *Thorax*, 1983; 38: 946-950.
5. Jeremias A, Bertschat FL, Jeremias E, Ising H. Possible Correlation between Decrease of Ionized Magnesium. and Calcium in Blood to Patient Outcome after Acute Myocardial Infarction *J Clin Basic Cardiol*, 2000; 3: 124.
6. Wecker Wec, Parisi AF. Magnesium metabolism. *N Engl J Med.*, 1968; 278: 658-663.
7. Ebel H, Günther T. Role of Magnesium in Cardiac Disease *J. Clin. Chem. Clin. Biochem*, 1983; 21: 249-265.
8. Whang R, Chrysant S, Dillard B. Hypomagnesemia and hypokalaemia in 1000 treated ambulatory hypertensive patients. *J Am Coll Nutr.*, 1982; 1: 317.
9. Elliott M. Antman Magnesium in Acute MI *Circulation*, 1995; 92(9): 2367-2372.
10. Woods KI, Florcurs R, Haider Y. Intravenous magnesium sulphate injections in suspected acute myocardial infarction patients effects of the second Leicester intravenous magnesium international trial (LIMIT- II) *Lancet*, 1992; 339: 1553-1558.
11. Ahmed A, Junjua BA, Rizvi SFUH, Tanveer ZH, Ahmed I. Prevalence of hypomagnesaemia in patients with acute Myocardial infarction compared with normal subjects. *Sheikh Zayed Medical College J*, 2010; 4: 6-8.
12. Ahmad A, Tanvir ZH, Hussain Z. Acute myocardial infarction; Serum magnesium and electrolyte levels at presentation in emergency department. *Professional Med J*, 2010; 17(2): 246-251.
13. Autman EM, Magnesium in acute myocardial infarction: Overview of the available evidence. *Am heart J.*, 1996; 132: 487-494.
14. Abraham A, Shaoul R, Shimonovitz S. Serum magnesium levels in Acute Medical and Surgical Conditions. *Biochemical Medicine*, 1980; 24: 21.
15. Babel S, Bhatnagar HNS, Bhatnagar BK. Serum magnesium levels in cases of acute myocardial infarction and its prognostic significance. *JAPI*, 1983; 31: 755-7.
16. Choudhury MBK, Rahman MS, Hassan MM, Begum R, Hoque N, Akhtaruzzaman M, Chowdhury AN. Comparison of Serum Magnesium and Potassium in Acute Myocardial Infarction and Chronic Ischemic Heart Disease *J. Dhaka National Med. Coll. Hos*, 2011; 17 (01): 33-36.
17. Haigney MCP, Silver B, Tanglao E, Silverman HS, Hill D, Shapiro E, Gerstenblith G, Schulman SP. Intracellular magnesium levels in acute myocardial infarction. *Circulation*, 1995; 92.
18. Gupta R, Joshi P, V Mohan V, et al. Epidemiology and causation of coronary heart disease and stroke in India. *Heart*, 2008; 94: 16-26.
19. French JK, White HD. Clinical implications of the new definition of myocardial infarction. *Heart*, 2004; 90: 99-106.
20. Dyckner T. Serum magnesium in acute myocardial infarction: Relation to Arrhythmias. *Acta med scan*, 1980; 207: 59-66.
21. Steg PG, Goldberg RJ, Gore JM, Fox KAA et al. Baseline Characteristics, Management Practices, and In-Hospital Outcomes of Patients Hospitalized With Acute Coronary Syndromes in the Global Registry of Acute Coronary Events (GRACE). *The American Journal of cardiology*, 2002; 90: 358-363.
22. Misiriya KJR, Sudhayakumar N, Khadar SA, George R, Jayaprakash VL, Pappachan JM. The Clinical Spectrum of Acute Coronary Syndromes: Experience from a Major Center in Kerala: Association of Physicians of India, 2009.
23. Abraham A, Shaoul R, Shimonovitz S et al. Serum magnesium levels in Acute Medical and Surgical Conditions. *Biochemical Medicine*, 1980; 24: 21.
24. Sachadeva et al. Serum magnesium and platelet adhesiveness in acute myocardial infarction. *JIMA*, 1978; 71: 165.
25. Dyckner T. Serum magnesium in acute myocardial infarction: Relation to Arrhythmias. *Acta med scan*, 1980; 207: 59-66.