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# Serum Magnesium as a prognostic marker in acute coronary syndromes and its correlation with coronary prognostic index

**Akhilesh Annadatha**[1], **Anuj Varma**[2], **Sourya Acharya**[3], **Sunil Kumar**[2], **Dhruv Talwar**[5], **Vidya Hulkoti**[1], **Shivam Khanna**[1], **Ruchita Kabra**[1*], **Apurva Dubey**[1], **Anamika Giri**[1]

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**Authors' Affiliation:**
[1]Resident, Department of Medicine, JNMC, Wardha, India
[2]Professor, Department of Medicine, JNMC, Wardha, India
[3]Professor and Head, Department of Medicine, JNMC, Wardha, India

[*]**Corresponding Author**
Resident, Department of Medicine, JNMC, Wardha, India
Email: ruchitapkabra@gmail.com

**Contact List**

| | |
|---|---|
| Akhilesh Annadatha | achyutakhilesh@gmail.com |
| Anuj Varma | anujvarma1985@gmail.com |
| Sourya Acharya | souryaacharya74@gmail.com |
| Sunil Kumar | sunilkumarmed@gmail.com |
| Dhruv Talwar | dhruv.talwar2395@gmail.com |
| Vidya Hulkoti | drvidyahulkoti@gmail.com |
| Shivam Khanna | drshivamkhanna@gmail.com |
| Ruchita Kabra | ruchitapkabra@gmail.com |
| Apurva Dubey | apurvadubey18@gmail.com |
| Anamika Giri | anamika95giri@gmail.com |

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## ABSTRACT

*Aim:* The aim is to evaluate Serum Magnesium as a prognostic marker in Acute Coronary Syndromes (ACS) and to compare with Coronary Prognostic Index (CPI). *Methods:* This case control study conducted in the intensive care unit (ICU) of AVBRH, Sawangi, Wardha taking 150 cases of ACS and 150 healthy age and sex matched controls. CPI was calculated in the cases of ACS and Serum Magnesium was calculated on admission for cases and controls and was compared between them. P value of <0.05 was taken as significant. *Results:* 6% of the cases gave history of myocardial infarction and 22% gave history of Angina and 34.6% gave history of smoking. Mean levels of serum Magnesium on admission (mg/dL) in cases was 1.82 ± 0.29 and among controls was 1.86 ± 0.23 with no significant difference between them. The prevalence of Hypomagnesemia was seen in 30% of cases and 19.33% of controls. Significant negative correlation was seen between serum Magnesium levels on admission with CPI with correlation coefficient of ($r=-0.293$, $p<0.01$). Mean ± SD of CPI in patients with hypomagnesemia was 10.42 ± 5.36 which was significantly higher as compared to patients without hypomagnesemia (7.3± 3.34). *Conclusion:* This study concluded that MI was more prevalent among the male population than the female population. Hypertension, smoking, alcohol and diabetes are the common independent risk factors for ACS. Serum Magnesium levels can be predictive of severity of outcome in cases of ACS and is correlated negatively with CPI.

**Keywords:** Myocardial Infarction, Coronary Prognostic Index, Hypomagnesemia, Hypertension, Angina

## 1. INTRODUCTION

A reduction in the flow of blood in coronary arteries causes a group of conditions better known as "Acute coronary syndrome (ACS)" or coronary heart disease (CHD). Conditions that form ACS include Non-ST Elevated Myocardial Infarction (NSTEMI/25%), ST-Elevated Myocardial Infarction (STEMI/30%) and Unstable Angina (UA/38%) (Battula et al., 2019). ACS global fatality has been estimated to be 17.5 million/year with 31% mortality, among which 75% are observed in low to middle-income countries. In India, the prevalence rates of ACS range from 3-10%, with 3%–4% in rural areas and 8%–10% in urban areas (Singh et al., 2017).

Electrocardiogram findings (particularly, ST-segment elevation presence or absence) determine immediate management for the patient with ACS. ST-segment elevation needs to be correlated clinically. ST-Elevation greater than one mm in at least 2 adjacent limb leads, ST-elevation greater than two mm in at least two adjoining precordial leads may need emergency reperfusion therapy (Mhaskar et al., 2013; Chandran et al., 2020).

It is tough to predict the outcome in cases of ACS especially acute myocardial infection (AMI). A Coronary Prognostic Index (CPI) was developed to assess the outcome in the cases of ACS (Peel et al., 1962). There are always chances of a sudden unexpected death, even in patients who are having a positive recovery and thus the prognostication needs a close watch over such patients (Mhaskar et al., 2013; Chandran et al., 2020). CPI is an easily usable index where bedside clinical findings are used. This index helps in finding out patients who are seriously ill. Once the patients are identified, they are kept under observation in intensive care units till the time their life is under threat. Health care workers are always on the quest to find out the prognostic features for acute MI, as the outcomes of acute MI are very unpredictable (Chu et al., 2017)

Electrolytes have been thought to play a major role in ACS prognosis. Particularly Magnesium is an important factor in pathogenesis and prognosis following AMI. Further, disturbance in electrolyte levels in the blood causes post AMI complications like arrhythmia (Sadiq et al., 2017; Chrysant and Chrysant, 2019). Magnesium is an essential mineral in the body (after calcium, sodium and potassium) that acts as a helper molecule for the proper functioning of more than 300 cell enzyme systems. Magnesium is crucial for the synthesis of ATP, RNA and DNA. Also, it maintains the homeostasis of the cardiovascular system. Therefore, it is imperative to regulate the blood Magnesium levels (Ismail, 2016; Gröber et al., 2015; Choi and Bae, 2015).

In studies previously done by Wulansari et al., (2019), Wulansari et al., (2019), Mohanani et al., (2019), Mohanani et al., (2019), Quader et al., (2019), Quader et al., (2019), Mhaskar et al., (2013) and Mhaskar et al., (2013) observed the prevalence of lower serum Magnesium levels in cases of Acute Myocardial infarction and have correlated the levels of Serum Magnesium to mortality.

**Aim**

The aim of the study is to assess the prognostic value of Serum Magnesium in Acute Coronary Syndromes

**Objectives**

The objectives of the study is to estimate the prevalence of abnormal Serum Magnesium levels in Acute Coronary Syndromes, to compare the levels of Serum Magnesium among patients of Acute Coronary Syndromes vis a vis normal age and sex matched controls, to find estimate the association of abnormal Serum Magnesium levels with Ventricular Tachyarrhythmia's, heart failure in Acute Coronary Syndrome patients and to correlate the levels of Serum Magnesium with Coronary Prognostic Index and mortality in cases of Acute Coronary Syndromes.

## 2. METHODS

This case control study was conducted in Acharya Vinoba Bhave Rural Hospital, a 1700 bedded rural hospital in Central India in Wardha, Maharashtra. The population of study was the cases of Acute Coronary Syndromes which were presented to the hospital within 12 hours of onset of Chest pain. The control group was healthy age and sex matched controls.

**Sample size**

Considering the prevalence of 10.9% and by using the value of $Z_{1-\alpha/2}$ as 1.96 at 5% type I error, the sample size was calculated using the following formula:

$$\frac{Z_{1-\alpha/2}{}^2 \mathrm{p}(1-\mathrm{p})}{d^2}$$

p= 10.9% = 0.109

1-p = 1- 0.109

d = desired margin of error = 5% = 0.05

$$N = \frac{1.96^2 \times 0.109\ (1 - 0.109)}{0.05} = 150$$

The sample size of this study was 300, out of which 150 were cases of ACS and 150 are age and sex matched healthy controls. The inclusion criteria is the patients who presented with symptoms of chest pain or other angina equivalents who presented to our hospital within 12 hours of onset of symptoms, with ECG changes and raise or absence of raise of cardiac enzymes for diagnosing the patient to either ST elevation Myocardial Infarction (STEMI) or Non ST elevation Myocardial Infarction (NSTEMI) or Unstable Angina (UA). The exclusion criteria included the patients of End Stage Renal Disease (ESRD) on dialysis, patients on long term diuretic or Proton Pump Inhibitor use and patients of mal absorption syndromes. Serum Magnesium levels were measured for both the cases and controls within 24 hours of admission to the hospital. Coronary Prognostic Index is calculated for all the cases. Clinical examination was done and signs of heart failure are noted and patients are also segregated on the basis of Killip Classification. The patients were observed for the presence of ventricular tachyarrythmias like Ventricular fibrillation and Ventricular tachycardia. Mortality during the hospital stay was also noted for the cases. Statistical analysis was done to find the correlation and the significance of Serum Magnesium levels with mortality and its correlation with Coronary Prognostic Index.

## 3. RESULTS

Mean ± SD of age (years) in cases was 58.38 ± 12.03 and control was 57.58 ± 10.53 with no significant difference between them (p value=0.54). Distribution of gender was comparable between cases and controls. (Female: 30.67% vs. 28.67% respectively, Male: 69.33% vs. 71.33% respectively) (P value=0.705).

**Table 1** Baseline characteristics of the cases and controls

| Demographic characteristics | Cases (n=150) | Control (n=150) | Total | P value |
|---|---|---|---|---|
| Age (years) | | | | |
| Mean ± SD | 58.38 ± 12.03 | 57.58 ± 10.53 | 57.98 ± 11.29 | 0.54* |
| Median (25th-75th percentile) | 58.5 (51.25-67) | 58 (49.25-65) | 58 (50-65) | |
| Range | 30-85 | 35-88 | 30-88 | |
| Gender | | | | |
| Female | 46 (30.67%) | 43 (28.67%) | 89 (29.67%) | 0.705† |
| Male | 104 (69.33%) | 107 (71.33%) | 211 (70.33%) | |

**Table 2** Distribution of past history of hypertension and diabetes mellitus among the cases and controls

| Past history | Cases (n=150) | Control (n=150) | Total | P value |
|---|---|---|---|---|
| Past history of hypertension | | | | |
| No | 76 (50.67%) | 86 (57.33%) | 162 (54%) | 0.247† |
| Yes | 74 (49.33%) | 64 (42.67%) | 138 (46%) | |
| Past history of diabetes mellitus | | | | |
| No | 99 (66%) | 102 (68%) | 201 (67%) | 0.713† |
| Yes | 51 (34%) | 48 (32%) | 99 (33%) | |

Distribution of past history of hypertension and diabetes mellitus was comparable between cases and controls (Hypertension: 49.33% vs. 42.67% respectively (p value=0.247), Diabetes mellitus: 34% vs. 32% respectively (p value=0.713)).

**Table 3** Distribution of past history among cases of ACS

| Past history | Frequency | Percentage |
|---|---|---|
| Past history of hypertension | 74 | 49.33% |
| Past history of myocardial infarction | 9 | 6.00% |
| Past history of Angina | 22 | 14.67% |
| Past history of diabetes mellitus | 51 | 34.00% |

**Table 4** Presenting complaints of the cases of ACS

| Presenting complaints | Frequency | Percentage |
|---|---|---|
| Chest pain | 143 | 95.33% |
| Sweating | 41 | 27.33% |
| Palpitations | 100 | 66.67% |
| Vomiting | 26 | 17.33% |
| Breathlessness | 58 | 38.67% |
| Swelling over feet | 41 | 27.33% |
| Upper abdomen discomfort | 26 | 17.33% |
| Congestive cardiac failure | 45 | 30.00% |

In present study, majority (95.33%) of ACS patients had chest pain followed by palpitations (66.67%), breathlessness (38.67%), congestive cardiac failure (30.00%), sweating (27.33%) and swelling over feet (27.33%). Vomiting and upper abdomen discomfort was seen in only 26 out of 150 patients (17.33%) each.

**Table 5** Sub-division of acute coronary syndromes among cases

| Diagnosis | Frequency | Percentage |
|---|---|---|
| NSTEMI | 19 | 12.67% |
| STEMI | 95 | 63.33% |
| UA | 36 | 24.00% |
| Total | 150 | 100.00% |

In present study, diagnosis of majority (63.33%) of patients was STEMI followed by UA (24.00%). Diagnosis was NSTEMI in only 19 out of 150 patients (12.67%).

**Table 6** Serum Magnesium levels of cases of ACS and controls

| Serum Magnesium Levels on admission (mg/dL) | Patients of ACS (n=150) | Control (n=150) | Total | P value |
|---|---|---|---|---|
| Mean ± SD | 1.82 ± 0.29 | 1.86 ± 0.23 | 1.84 ± 0.26 | 0.174* |
| Median (25th-75th percentile) | 1.8 (1.6-2) | 1.8 (1.7-2) | 1.8 (1.7-2) | |
| Range | 1.2-2.7 | 1.4-2.5 | 1.2-2.7 | |

Mean ± SD of serum Magnesium levels on admission (mg/dL) in cases was 1.82 ± 0.29 and control was 1.86 ± 0.23 with no significant difference between them (p value=0.174)

**Table 7** Prevalence of hypomagnesemia, normo-magnesemia and hypermagnesemia between the cases of STEMI, NSTEMI and UA

| Diagnosis | Hypomagnesemia (<1.7 mg/dL) (n=45) | Normomagnesemia (1.7 to 2.4mg/dL) (n=101) | Hypermagnesemia (>2.4 mg/dL) (n=4) | Total | P value |
|---|---|---|---|---|---|
| STEMI | 34 (75.56%) | 60 (59.41%) | 1 (25%) | 95 (63.33%) | 0.044‡ |
| NSTEMI | 5 (11.11%) | 12 (11.88%) | 2 (50%) | 19 (12.67%) | |
| UA | 6 (13.33%) | 29 (28.71%) | 1 (25%) | 36 (24%) | |
| Total | 45 (100%) | 101 (100%) | 4 (100%) | 150 (100%) | |

STEMI was significantly higher in hypomagnesemia (<1.7 mg/dL) as compared to normomagnesemia (1.7 to 2.4 mg/dL) and hypermagnesemia (>2.4 mg/dL) (STEMI: 75.56% vs. 59.41%, 25% respectively). UA was significantly higher in normomagnesemia (1.7 to 2.4 mg/dL) and hypermagnesemia (>2.4 mg/dL) as compared to hypomagnesemia (<1.7 mg/dL) (UA: 28.71%, 25% vs. 13.33% respectively).

**Table 8** Ventricular tachyarrythmias during hospital stay among ACS cases

| Ventricular Tachyarrythmias during hospital stay | Frequency | Percentage |
|---|---|---|
| No | 145 | 96.67% |
| Yes | 5 | 3.33% |
| Total | 150 | 100.00% |

Ventricular Tachyarrythmias (Ventricular Tachycardia/Ventricular fibrillation) during hospital stay was seen in only 5 out of 150 patients (3.33%).

**Table 9** Association of mortality with the diagnosis of ACS

| Diagnosis | Mortality (n) | Percentage |
|---|---|---|
| STEMI | 11 | 100% |
| NSTEMI | 0 | 0% |
| UA | 0 | 0% |

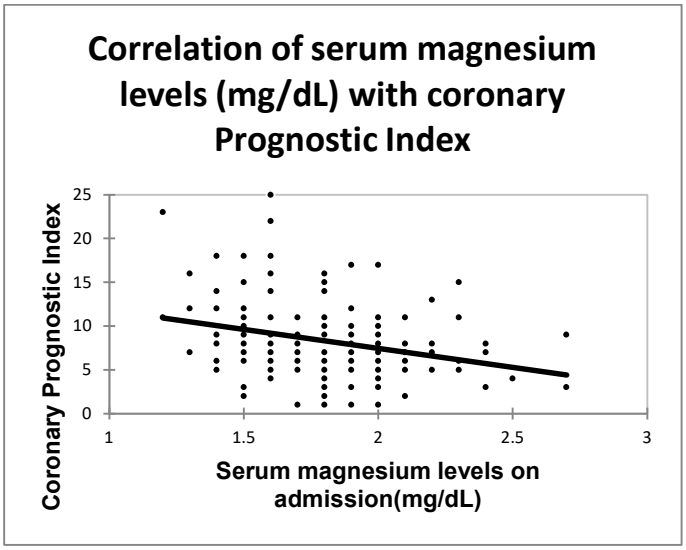
**Table 10** Mean coronary prognostic index in cases of ACS

| Variable | Mean ± SD | Median (25th-75th percentile) | Range |
|---|---|---|---|
| Coronary Prognostic Index | 8.24 ± 4.28 | 7 (5-10) | 1-25 |

Mean value of coronary prognostic index of ACS patients was 8.24 ± 4.28 with median (25th-75th percentile) of 7(5-10). Significant negative correlation was seen between serum Magnesium levels (mg/dL) with coronary prognostic index with correlation coefficient of -0.293 (p value = 0.0003)

**Table 11** Correlation of coronary prognostic index with Serum Magnesium levels

| Variables | Coronary Prognostic Index |
|---|---|
| Serum Magnesium levels on admission(mg/dL) | |
| Correlation coefficient | -0.293 |
| P value | 0.0003 |




**Graph 1** Showing correlation of Serum Magnesium levels with Coronary Prognostic Index

**Table 12** Average Serum Magnesium levels among the cases of ACS with adverse outcomes

| Serum Magnesium levels on admission(mg/dL) | Alive(n=139) | Died(n=11) | Total | P value |
|---|---|---|---|---|
| Mean ± SD | 1.84 ± 0.28 | 1.59 ± 0.33 | 1.82 ± 0.29 | 0.006* |
| Median (25th-75th percentile) | 1.8 (1.6-2) | 1.5 (1.4-1.7) | 1.8 (1.6-2) | |
| Range | 1.3-2.7 | 1.2-2.3 | 1.2-2.7 | |

Mean ± SD of serum Magnesium levels (mg/dL) in alive was 1.84 ± 0.28 which was significantly higher as compared to the patients with adverse outcomes (1.59 ± 0.33) (p value=0.006). Mortality was significantly higher in patients with hypomagnesemia (17.78%) as compared to patients without hypomagnesemia (2.86%) (P value=0.003).

**Table 13** Prevalence of hypomagnesemia among the cases with adverse outcomes

| Hypomagnesemia | Alive (n=139) | Died (n=11) | Total | P value |
|---|---|---|---|---|
| No | 102 (97.14%) | 3 (2.86%) | 105 (100%) | 0.003‡ |
| Yes | 37 (82.22%) | 8 (17.78%) | 45 (100%) | |
| Total | 139 (92.67%) | 11 (7.33%) | 150 (100%) | |

**Table 14** Average coronary prognostic index score among the cases with adverse outcomes

| Coronary Prognostic Index | Alive (n=139) | Died (n=11) | Total | P value |
|---|---|---|---|---|
| Mean ± SD | 7.71 ± 3.74 | 14.91 ± 5.17 | 8.24 ± 4.28 | <.0001* |
| Median (25th-75th percentile) | 7 (5-9) | 12 (11-17.5) | 7 (5-10) | |
| Range | 1-22 | 11-25 | 1-25 | |

Mean ± SD of Coronary Prognostic Index in patients of adverse outcomes was 14.91 ± 5.17 which was significantly higher as compared to alive (7.71 ± 3.74) (p value <.0001).

**Table 15** Comparison of coronary prognostic index with diagnosis and Killip's classification

| Coronary prognostic index | Diagnosis | I | II | III | IV | Total | P value |
|---|---|---|---|---|---|---|---|
| 1-16 | STEMI | 43 (49.43%) | 29 (33.33%) | 9 (10.34%) | 6 (6.90%) | 87 (100%) | 0.895‡ |
| | NSTEMI | 9 (47.37%) | 5 (26.32%) | 4 (21.05%) | 1 (5.26%) | 19 (100%) | |
| | UA | 18 (50%) | 13 (36.11%) | 3 (8.33%) | 2 (5.56%) | 36 (100%) | |
| | Total | 70 (49.30%) | 47 (33.10%) | 16 (11.27%) | 9 (6.34%) | 142 (100%) | |
| >=17 | STEMI | 0 (0%) | 2 (25.00%) | 2 (25.00%) | 4 50.00%) | 8 (100.00%) | - |
| | NSTEMI | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | |
| | UA | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | |
| | Total | 0 (0%) | 2 (25.00%) | 2 (25.00%) | 4 (50.00%) | 8 (100.00%) | |

Distribution of Killip's class was comparable with diagnosis (Coronary prognostic index 1-16). (Killip's Class I: (STEMI (49.43%) vs. NSTEMI (47.37%) vs UA (50%)), Killip's Class II: (STEMI (33.33%) vs. NSTEMI (26.32%) vs. UA (36.11%)), Killip's Class III: (STEMI (10.34%) vs. NSTEMI (21.05%) vs. UA (8.33%)), Killip's Class IV: (STEMI (6.90%) vs. NSTEMI (5.26%) vs. UA (5.56%)) (p value=0.895). In patients with coronary prognostic index >=17, all patient's diagnosis was STEMI with 50% patients in Killip's class IV, 25% patients in Killip's class II and III each.

Distribution of mortality was comparable with diagnosis (Coronary prognostic index 1-16) (Alive: (STEMI (91.95%) vs. NSTEMI (100%) vs. UA (100%)), Died: (STEMI (8.05%) vs. NSTEMI (0%) vs. UA (0%)) (p value=0.14). In patients with coronary prognostic index >=17, all patient's diagnosis was STEMI with 50% mortality.

**Table 16** Comparison of coronary prognostic index with diagnosis and adverse outcomes

| Coronary prognostic index | Diagnosis | Alive | Died | Total | P value |
|---|---|---|---|---|---|
| 1-16 | STEMI | 80 (91.95%) | 7 (8.05%) | 87 (100%) | 0.14‡ |
| | NSTEMI | 19 (100%) | 0 (0%) | 19 (100%) | |
| | UA | 36 (100%) | 0 (0%) | 36 (100%) | |
| | Total | 135 (95.07%) | 7 (4.93%) | 142 (100%) | |
| >=17 | STEMI | 4 (50.00%) | 4 (50.00%) | 8 (100.00%) | - |
| | NSTEMI | 0 (0%) | 0 (0%) | 0 (0%) | |
| | UA | 0 (0%) | 0 (0%) | 0 (0%) | |
| | Total | 4 (50.00%) | 4 (50.00%) | 8 (100.00%) | |

**Table 17** Comparison of hypomagnesemia, normomagnesemia and hypermagnesemia among cases of ACS with Killip's class, coronary prognostic index and adverse outcomes

| Parameters | Hypomagnesemia (<1.7 mg/dL) (n=45) | Normal levels (1.7 to 2.4 mg/dL) (n=101) | Hypermagnesemia (>2.4 mg/dL) (n=4) | Total | P value |
|---|---|---|---|---|---|
| Killip's class | | | | | |
| I | 13 (28.89%) | 54 (53.47%) | 3 (75%) | 70 (46.67%) | <.0001‡ |
| II | 12 (26.67%) | 37 (36.63%) | 0 (0%) | 49 (32.67%) | |
| III | 10 (22.22%) | 7 (6.93%) | 1 (25%) | 18 (12%) | |
| IV | 10 (22.22%) | 3 (2.97%) | 0 (0%) | 13 (8.67%) | |
| Outcome | | | | | |
| Alive | 37 (82.22%) | 98 (97.03%) | 4 (100%) | 139 (92.67%) | 0.01‡ |
| Died | 8 (17.78%) | 3 (2.97%) | 0 (0%) | 11 (7.33%) | |
| Coronary Prognostic Index | | | | | |
| Mean ± SD | 10.42 ± 5.36 | 7.4 ± 3.34 | 5 ± 2.71 | 8.24 ± 4.28 | <.0001§ |
| Median (25th-75th percentile) | 9 (7-14) | 7 (5-9) | 4 (3.75-5.25) | 7 (5-10) | |
| Range | 2-25 | 1-17 | 3-9 | 1-25 | |

Proportion of died patients was significantly higher in hypomagnesemia (<1.7 mg/dL) as compared to normal levels (1.7 to 2.4 mg/dL) and hypermagnesemia (>2.4 mg/dL) (17.78% vs. 2.97%, 0% respectively) (p value=0.01). Mean ± SD of coronary Prognostic Index in hypomagnesemia (<1.7 mg/dL) was 10.42 ± 5.36 which was significantly higher as compared to normomagnesemia (1.7 to 2.4 mg/dL) (7.4 ± 3.34) and hypermagnesemia (>2.4 mg/dL) (5 ± 2.71) (p value <0.0001).

## 4. DISCUSSION

Our study is a case control study done over a period of two years which has included 150 cases of Acute Coronary Syndromes which included 95 cases of STEMI, 19 cases of NSTEMI, 36 cases of UA and 150 healthy age and sex matched controls. Serum Magnesium levels were obtained for all the 300 patients and Coronary Prognostic Index was calculated for all the cases. The patient was segregated into Killip class based on their examination findings and the patients were observed during their hospital stay for the occurrence of ventricular tachyarrythmias and the serum Magnesium levels were correlated with coronary prognostic index and mortality for any association between them.

**Age and gender**

The average age of the cases was observed to be 58.38 ± 12.03 with 104 (69.33%) patients being male and 46 (30.67%) being female. In the study conducted by Mohanani et al., (2019) on 200 patients of acute myocardial infarction it was observed that MI was more prevalent in the male patients (63.3%) and age group of 41-50 years (26.6%). Quader et al., (2019) conducted a case control study on

100 participants to investigate the serum level of Magnesium in AMI patients. The results depicted that the 50 cases were distributed in the ratio of 2.4:1 while the mean age of case who presented with acute myocardial ischemia was 53.30±6.44 years.

**Risk factors**

Among the cases, 49.33% of gave a past history of hypertension which was greater than that of controls as 42.6% of them reported a similar history. However, this difference was statistically insignificant. Among the cases, 34% gave a past history of diabetes mellitus which was greater than that of controls as 32% of them reported of a similar history.

However, this difference was statistically insignificant. Among 150 cases, 6% gave past history of myocardial infarction and 22% gave history of Angina and 34.6% gave history of smoking. Cigarette smoking is known to accelerate the atherosclerosis of coronary arteries in both males and females and at all ages and it also increases the thrombotic risk, instability of the formed plaque and myocardial infarction. In the study conducted by Kumari and Prasad, (2020) 20% of the cases who presented with MI gave a history of smoking. It also reported that out of 50 cases, 36% were found to be hypertensive, 24% were diabetic all of which was similar to the present study.

**Presenting complaints**

In the present study, majority (95.33%) of the cases presented which chest pain and the mean duration of chest pain in hours was 6.18 ± 2.85. Other than chest pain, cases also presented with palpitations (66.67%), breathlessness (38.67%), sweating (27.33%) and swelling over feet (27.33%) and vomiting with upper abdomen discomfort in 17.33%. In the study conducted by Kumari and Prasad, (2020) chest pain was the commonest symptom (90%) followed by chest pain (46%), breathlessness in (22%) and palpitation (2%). Rahman et al., (2021) among the 50 patients suffering an acute MI, chest pain (100%) was the most common presenting symptom followed by breathlessness in 64%, seating in 60% and palpitations in 50% of the patients.

**Magnesium levels on admission**

The mean serum Magnesium levels among cases were 1.82 ± 0.29 which did not statistically differ from the controls (1.86 ± 0.23). Taking the normal range of serum Magnesium as 1.7- 2.4, 30% of the cases had hypomagnesemia while in comparison to 19.33% of the controls who had serum Magnesium level less than 1.7. A significant difference was observed between cases and controls in terms of serum Magnesium levels. Kumari and Prasad, (2020) reported the mean Magnesium levels of the serum on day-1 in all 50 patients to be 1.82±0.43. Wulansari et al., (2019) observed that the out of 38 patients of ACS, 63.2% had hypomagnesemia with mean Serum Magnesium levels of 1.9±0.2 which is in concordance with the study. Rahman et al., (2021) observed that the mean serum Magnesium level of 50 patients who developed acute MI was 1.86±0.39 which is also in concordance in the study.

**Killip's class**

Out of all the 150 cases of acute myocardial infarction, 46.5% belonged to Class I Killip's classification stating that there was no evidence of heart failure, in 32.67% findings were consistent with mild to moderate heart failure, 12% presented with overt pulmonary edema while 8.6% were in a state of cardiogenic shock. Subramanyam and Vakrani, (2015) conducted a case control study to evaluate serum Magnesium levels in patients of acute MI within 24 hours of hospital admission and to evaluate validity of serum Magnesium as prognostic indicator in acute MI. Out of 50 cases who were observed in the study, 39 (78%) were in Killip class 1 while 7 (14%) in class 2, 1 (2%) in class 3 and 3 (6%) in class 4 at presentation.

**Ventricular tachyarrhythmia's during stay**

During the stay of cases in hospital, ventricular tachyarrhythmia was not recorded in 96.67% of the cases. Kumari and Prasad, (2020) reported that 56% out of 50 patients had arrhythmias out of which 8% of 50 patients (4 patients) had Ventricular tachyarrythmias. Mohnani et al., (2019) detected arrhythmias in 130 out of 200 patients in the cross-sectional study with no sub division of the type of arrythmias observed during the study period. Rahman et al., (2021) depicted that out of 50 patients of acute myocardial infarction, 26 (52%) developed arrhythmias out of which 4 (8%) of the patients developed ventricular tachyarrythmias.

**Relation between magnesium levels and adverse outcome**

In the present study adverse outcome was faced by 7.3% of the total 150 cases who presented with acute myocardial infarction and the mean Coronary Prognostic Index among 150 cases of acute myocardial infarction was 8.24 ± 4.28. Out of 100 patients in the study conducted by Ambali and Bomman, (2018) 8% succumbed to death during hospital stay. In the study of 50 cases of acute MI by Subramanyam and Vakrani, (2015) 3 (6%) patients died within 48 hours of admission.

The present study depicts a significantly negative correlation between Coronary Prognostic Index and serum Magnesium levels on admission ($r=-0.293$, $p<0.1$). It was observed on the present study that lower the levels of serum Magnesium greater was the Coronary Prognostic Index indicating greater was the risk of heart failure. The mean Coronary Prognostic Index in cases of hypomagnesemia ($10.42 \pm 5.36$) was significantly greater when compared with the cases with no hypomagnesemia ($7.3 \pm 3.34$). A significant association was observed between Coronary Prognostic Index and status of cases in terms of Magnesium levels.

The results from this study and all the literature are evidence of the fact that low serum Magnesium levels were observed in cases of acute coronary syndromes which propagated to either death or adverse outcome. As a high Coronary Prognostic Index is indicative of congestive cardiac failure or an end stage outcome, it can be thus concluded that high Coronary Prognostic Index corresponds to a low serum Magnesium level which in turn can be attributed to higher risk of mortality.

**Limitations**

Study with larger sample will be helpful to evaluate the definite role of serum Magnesium in acute coronary syndromes. The study was performed in a hospital setting thus the results cannot be generalized for the whole population. Population recruited for control group was selected from the hospital itself which can lead to selection bias. Majority of the cases group belonged to the STEMI and there was a fewer study population of NSTEMI and UA subgroups.

## 5. CONCLUSION

There have been enough studies that have proven the adverse effects of Low Serum Magnesium levels on Cardio vascular system, especially Acute Coronary Syndromes. It also emphasizes on the fact that Serum Magnesium levels done on admission and treatment with the same can help a great deal in reduction of ACS related mortality. It also emphasizes on calculation of a simple bedside score calculation like coronary prognostic index for prediction of severe and adverse outcomes in cases of ACS. Hence in cases of ACS, it is of utmost importance for clinical investigations to look out for signs and symptoms of Congestive Cardiac Failure, Hypomagnesemia can be a key to identifying the cases at risk of adverse outcomes and thus in preventing the same.

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**Ethical approval**

This study was approved by the Institutional ethical committee of DMIMS (DU) ((Ethical approval number: DMIMS(DU)/IEC/Aug-2019/8225).

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**Conflict of interest**

The authors declare that there is no conflict of interests.

**Data and materials availability**

All data sets collected during this study are available upon reasonable request from the corresponding author.

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