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Original Research Article.

Study of Acid Base and Electrolyte Disturbances in Patients of Acute Myocardial Infarction

Deepa Katara[1], O. P. Meena[2*], Baldev Meena[3], Ramesh[1], Lokesh[1], Atul[1]

[1]Resident, [2*]Professor and Unit Head, [3]Assistant Professor,
Department of Medicine, R.N.T. Medical College, Udaipur, Rajasthan, India.

ABSTRACT

Introduction: Myocardial infarction is the main cause of death in Western countries, with in hospital mortality of 6-13%. Acid-base and electrolyte status in AMI patients at the time of admission that can be help in risk stratification and it can help for further planning of management strategy for management of patient with AMI.

Aim of Study: To Study of Acid base and electrolyte disturbances in patients of acute myocardial infarction and relation of Hypokalemia and hypomagnesemia with ventricular Arrhythmias in AMI.

Materials and Methods: This Observational study was conducted in the department of Medicine at R.N.T. Medical College and Govt. MB Hospital, Udaipur. Study subjects were 50 patients of acute ST segment elevated Myocardial Infarction presenting within 24 hrs of onset of chest pain. We estimated their acid base status, serum sodium, serum potassium, serum magnesium.

Results: The definite correlation was found between metabolic acidosis and mortality (p=0.03). There was also increased mortality in patients with hyponatremia, but p value was not statistically significant (p=0.15). In our study definite correlation found between hypokalemia and ventricular arrhythmias and also between hypomagnesemia and ventricular arrhythmias there was increased tendency towards developing ventricular arrhythmias in patients with hypokalemia and hypomagnesemias. There was no correlation found between hypernatremia and mortality and between increased potassium level and ventricular Arrhythmias in our study.

Key words: Acute Myocardial Infarction, Ventricular Arrhythmias, Hypokalemia, Hypomagnesemia.

***Correspondence to:**

Dr. O. P. Meena,
Professor and Unit Head,
Department of Medicine,
R.N.T. Medical College, Udaipur, Rajasthan, India.

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INTRODUCTION

Acute myocardial infarction is one of the leading causes of death in the developed world. The prevalence of the disease approaches three million people worldwide with more than one million deaths in the United States, annually. Acute myocardial infarction can be divided into two categories, non-ST-segment elevation MI (NSTEMI) and ST-segment elevation MI (STEMI). Unstable angina is similar to NSTEMI. However, cardiac markers are not elevated.[1-3] The term acute coronary syndrome (ACS) refers to any group of clinical symptoms compatible with acute myocardial ischemia and covers the spectrum of clinical conditions ranging from unstable angina (UA) to non-ST-segment elevation myocardial infarction (NSTEMI) to ST-segment elevation myocardial infarction (STEMI). Unstable angina and NSTEMI are closely related conditions: their pathophysiologic origins and clinical presentations are similar, but they differ in severity. A diagnosis of NSTEMI can be made when the ischemia is sufficiently severe to cause myocardial damage that results in the release of a biomarker of myocardial necrosis into the circulation (cardiac-specific troponins T or I, or muscle and brain fraction of creatine kinase [CK-MB]).[4]

In AMI, the combination of a fall in cardiac output and arterial hypoxemia leads to tissue hypoxia; metabolic acidosis is compensated by hyperventilation. Those who are not able to compensate the metabolic disturbances by respiration are at risk of higher mortality. Elevation in carbon dioxide not only increases the acidosis but also reduces the arterial oxygen tension that is particularly a dangerous combination.

Sedatives and ataractic drugs promote such property of morphine and can lead to grave consequences. Corrections of metabolic acidosis and respiratory compensation have showed different effect on prognosis of patient in different studies. Various rhythm disturbances which are even refractory to electrical cardio version are found to be spontaneously responding to correction of metabolic acidosis.

The cardiac myocyte is injured in AMI with disturbance in the electrolyte milieu due to disruption of cell membrane. Further, reduced cardiac output and compromised tissue perfusion leads to a variety of acid-base abnormalities. These could lead to occurrence of complication like arrhythmias, negative ionotropism, and leakage of fluids particularly across the pulmonary capillaries etc. We decided to conduct a study that can be helpful for assessment of the acid-base status in AMI patients at the time of admission that can be help in risk stratification and it can help for further planning of management strategy for management of patient with AMI.

AIM OF STUDY

To Study of Acid base (pH and Bicarbonate level) and electrolyte (serum sodium, serum potassium, serum magnesium) disturbances in patients of acute myocardial infarction and relation of hypokalemia and hypomagnesemia with ventricular Arrhythmias in AMI.

MATERIALS AND METHODS

Study Type: Observational

Study Design: Random prospective

Study Site: R.N.T. Medical College, Udaipur.

Subjects: Fifty patients of acute myocardial infarction were examined and investigated during their admission in R.N.T. Medical College and Govt. MB Hospital, Udaipur.

Inclusion Criteria: Fifty patients of STEMI as diagnosed clinically, by ECG and biomarkers. All patients of AMI were medicated with angiotensin converting enzyme inhibitors or angiotensin receptor blockers over and above the standard thrombolytic, antischaemic and antiplatelet therapy.

Exclusion Criteria: Anemia, significant hepatic, renal and pulmonary disease, diabetes mellitus, infection, hypo and hyperthyroidism.

Informed consent was taken from the patient before enrolment in the study. After obtaining detailed history and clinical examination of the patient blood sample were taken for laboratory investigations including ABG, Serum Electrolytes. Serum electrolytes done were s. sodium, s. potassium, s. magnesium.

The valuation of the po2, pco2, pH, Hco3- was done by comparison of the value with the individual control for the each of the above parameter.

Collected samples were sent to the standard laboratory and the tests were conducted under my supervision. The results of the test were entered to the proforma and computer for analysis.

Statistical Methods: All the patients of the STEMI were grouped according to

- pH level <7.35, 7.35-7.45, >7.45
- Bicarbonate level <Meq/l, 22-26Meq/l, >26Meq/l
- S. Sodium (mmol/l) <136mmol/l, 136-145mmol/l, >145mmol/l
- S. Potassium (mmol/l) <3.5mmol/l, 3.5-4.5mmol/l, >4.5mmol/l
- S. Magnesium (mmol/l) <1.7mg/dl, 1.7-2.4mg/dl, >2.4mg/dl

Observed outcome was survival status on the 7 the day of admission and development of ventricular Arrhythmias. The observed clinical outcome was analysed by Chi square test. P value of less than 0.05 was taken as statistically significant.

Table 1: Age and sex distribution of study subjects.

Age Group	Total (Male + Female)	Patient	
		Male	Female
21-30	1	1	0
31-40	3	1	2
41-50	11	9	2
51-60	13	9	4
61-70	16	9	7
71-80	5	2	3
81-90	1	1	0
Total	50	32	18

Table 2: Age and sex distribution of subjects with survival status.

Age group (years)	Patients			Alive patients			Dead patients		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
21-30	1	1	0	1	1	0	0	0	0
31-40	3	2	1	3	2	1	0	0	0
41-50	11	9	2	9	8	1	2	1	1
51-60	13	9	4	10	7	3	3	2	1
61-70	16	9	7	10	5	5	6	4	2
71-80	5	2	3	5	2	3	0	0	0
81-90	1	1	0	1	1	0	0	0	0
Total	50	32	18	39	14	14	11	11	4

Table 3: Subjects and Mortality according to pH level (Male and Female)

pH	Total Patients	Mortality	Total Male	Male Mortality	Total Female	Female Mortality
< 7.35	5	3	3	2	2	1
7.35-7.45	36	6	23	4	13	2
>7.45	9	2	6	1	3	1

Table 4: Subjects and Mortality according to bicarbonate level.

Bicarbonate level (Meq/l)	Total Patients	Mortality	Total Male	Male Mortality	Total Female	Female Mortality
<22	10	4	7	2	3	2
22-26	35	6	25	4	13	2
>26	5	1	3	1	2	0

Table 5: Study subjects and Mortality according to serum sodium level.

S. Sodium Level (mmol/L)	Total Patients	Mortality	Total Male	Male Mortality	Total Female	Female Mortality
< 136	7	3	5	2	2	1
136-145	38	7	25	5	13	2
>145	5	1	2	0	3	1

Table 6: Ventricular Arrhythmias in study subjects according to serum potassium level

S. Potassium Level (mmol/L)	Total Patients	Ventricular arrhythmias	Total Male	Ventricular arrhythmias in Male	Total Female	Ventricular arrhythmias in Female
<3.5	6	4	4	3	2	1
3.5-3.5	40	7	25	4	15	3
>5.5	4	1	3	1	1	0

Table 7: Ventricular Arrhythmias in study subjects according to serum magnesium level.

S. Magnesium Level (mg/dl)	Total Patients	Ventricular Arrhythmias	Total Male	Ventricular arrhythmias in Male	Total Female	Ventricular arrhythmias in Female
< 1.7	8	5	5	3	5	2
1.7-2.4	39	7	25	4	14	1
2.4	3	0	2	0	1	0

RESULTS & DISCUSSION

This study entitled "Study of Acid base and electrolyte disturbances in 50 patients of acute myocardial infarction" was conducted in the department of Medicine at R.N.T. Medical College and Govt. MB Hospital, Udaipur. Study subjects were 50 patients of acute ST segment elevated Myocardial Infarction presenting within 24 hrs of onset of chest pain. Blood samples were collected for acid base and electrolytes before initiation of any form of treatment.

In our study fifty subjects suffering from acute STEMI were between 28 to 81 years with mean age of 59.56% of our subjects (28) were below 60 years. 30% (15) were below 50 years of age. 8% (3) were below 40 years. 32% (16) were above 60 and below 70 years of age. 12% (6) were above 70 years of age. This shows that a younger population is also encountering the danger of STEMI.

11 of our patients died (22%). Rest 39 patients survived (78%). Among 11 patients that died 7 were male and 4 were female.

Logic of modern medicine is that should be less mortality in patients of STEMI with whatever medication available. In our study mortality was 22%. All patients were underwent thrombolysis and were given standard medical treatment. Conventional studies say that early mortality (within 30 days) from AMI is about 30% with more than half of these deaths occurring before patients reached hospital. Chambless L et al, 1997 reported that approximately two third of coronary heart disease deaths within the first 28 days occurred before patients reached hospital.[5]

Acid Base & Survival Status:

If we consider normal Ph ranges 7.35- 7.45 then out of 36 patients of STEMI in this range of pH 6 died. From 5 patients who had pH below 7.35 3 died (60%) & from 9 patients who had pH >7.45 in the alkaline range 2 died (11.11%). It is thus apparent that acidosis in a patient of STEMI at the time of presentation is of ominous significant in our mean pH of STEMI patients who survived (n=39) was 7.40+ 0.057% who died (n=11) was 7.32+0.15. p value was 0.03. It was statistically significant.

Similarly if are consider normal bicarbonate 22-26 meq/dl 35 patients were in these range of Bicarbonate, out of which 6 died. 10 patients have Bicarbonate level <22, out of which 4 died & 5 patients had Bicarbonate level >22, out of which 1 died. (p value 0.12).

Significant Metabolic acidosis as primary abnormality as indicated by pH< 7.35 and Serum bicarbonate <22 Meq/dl was present in 5 patients. Out of which 3 patients died (p value 0.03) and 3 out of 5 patients had developed ventricular Arrhythmias. Out of which 3 patients which died 2 had developed ventricular arrhythmias.

In the similar study by lazzeri et al (2010) which was most similar study with us (only difference that they consider in patients who undergone primary angioplasty instead of thrombolysis) they assessed 445 patients with STEMi submitted to primary percutaneous coronary intervention in identifying the patients at higher risk for in hospital complications (eg. acute pulmonary edema & arrhythmias) they found that acidosis was present in 11 patients (4.2%) and HCO_3 <22 in 62 (24%). They concluded that evaluation of base excess and lactate i.e. evaluation of existence

of acidosis in the early phase of STEMI provides the bedside clinicians with useful tools for early risk stratification and base excess proved to be independent marker.[6]

Serum Sodium & Survival Status:

Hyponatremia is defined as serum sodium level <136 meq/l. Out of 50 patients we studied normal serum sodium level 136-145meq/l found in 38 patients out of which 7 patients died (18%.) 7 patients had serum sodium <136 out of which 3 died (42.8%). 5 patients had serum sodium level >145 out of which 1 died (20%) (p value 0.35). Mean sodium of the alive patients was 139.35 + 5.68 and dead patients was 131.54+15.16 so it was found mortality was higher in patients with hyponatremia, though difference was not statistically significant perhaps due to small sample size. Similarly out of 7 patients who had hyponatremia 4 (47%) patients developed congestive heart failure during hospital stay. Out of 38 patients with normal serum sodium level 5 had developed congestive heart failure. So it evident from out studies that hyponatremia it associated Heart failure and mortality was also on higher side. Flear CT, Hilton P in their study of 235 consecutive patients admitted to a coronary care unit they have concluded that hyponatremia and uremia were common in patients with confirmed myocardial infarction the degree of infarctions correlating well with all the above indices of severity. They also found higher in hospital mortality rates among patients with minimal edema sodium levels < 130 mmol/l.[7]

Serum Potassium & Ventricular Arrhythmias In Acute Myocardial Infarction:

Normal potassium level considered in our study was 3.5-5.5 mmol/L. Hypokalemia as defined as serum potassium level <3.5 was found in 6 patients (12%) 40 patients had normal potassium level (3.5-5.5 mmol/L) (80%0 and 4 patients (8%) had s. potassium value of >5.5. Ventricular Arrhythmias was found in 4 patients (66.77) out of 6 patients with serum potassium <3.5 meq/dl, out of which 2 patients died (p value 0.009). While it was observed in 7 patients out of 40 patients with normal serum potassium level (17.5%). From 40 patients with normal serum potassium level mortality was found in 9 patients. Out of 4 patients who had hyperkalemia 1 patient developed ventricular tachycardia. Mean potassium level of patients without ventricular Arrhythmias was 4.34±0.65 and of patients with ventricular Arrhythmias was 3.8±1.08. Statistically significant association was found between hypokalemia and ventricular Arrhythmias as p value was 0.009.

Similar Study was done by Nordrehaug JE et al In which it was found that serum potassium concentrations obtained on admission were inversely related to incidence of ventricular fibrillation. In 289 women 785 men with acute myocardial infarction 92 of whom developed ventricular fibrillation.[8]

In another study conducted by kafka H et al in 1987, over a 13 month period, serum potassium and magnesium concentration were measured in 590 patients admitted to a coronary care unit. Hypokalemia often in the absence of diuretic use occurred in 17% of 211 patients with acute myocardial infarction. Patients with acute myocardial infarction and a potassium level of less than 4 meq/1 had an increased risk of ventricular Arrhythmias (59% vs 42%) because hypokalemia is common in acute myocardial infarction and is associated with ventricular Arrhythmias routine measurement of serum potassium levels and prompt correction are recommended.

In a study conducted by Taysir s Garadan et al[10] Similar association was found in that study two hundred seventy four consecutive AMI patients were identified from the records of cardiology out patients department and coronary care unit from January 2007 to the end of December 2007. Criteria for sustained MI were the following cardiac pain more than 20 minutes duration of less than 6 hrs onset and the appearance of new Q wave with ST segment elevation or ST segment depression with more than two fold increase of total creatine Kinase (CK), Arrhythmias that developed and diagnosed from the time of admission were classified into two groups supraventricular Arrhythmias (including atrial classified into two groups supraventricular Arrhythmias (including atrial fibrillation & supraventricular tachycardia) and ventricular Arrhythmias (including ventricular tachycardia and ventricular fibrillation) serum potassium levels we measured among 274 patients with AMI patients 84 (3071) had admission serum potassium values< 3.5 mmol/l. The incidence of hypokalemia was significantly higher in patients with Arrhythmias compared to those without Arrhythmias. 61 out of 130 (46.97%) patients with Arrhythmias compared to 23 out of 144 (15.97%) without Arrhythmias. In addition incidence of hypokalemia of <3.5 mmol/L significantly increased with the severity of Arrhythmias 23 out of 144 (15.9) in patients with no Arrhythmias 20 out 64 (31%) patients with supraventricular Arrhythmias and 41 out of 66 (62%) m patients with ventricular Arrhythmias (p<0003).

In all these studies, study design was large in comparison to our study & single variable was studied in them so better correlation (P<0.001) was noted between hypokalemia and Arrhythmias in patients with acute myocardial infarction.

Serum Magnesium & Ventricular Arrhythmias in Acute Myocardial Infarction:

Patients with acute myocardial infarction who have mild hypomagnesemia appear to have two to three folds increased in the frequency of ventricular Arrhythmias in first 24 hr when compared to those with normal plasma magnesium levels.

In our study hypomagnesemia as defined as serum magnesium concentration <1.7 mg/dl was found in 8 subjects had (16%) 39 subjects had normal s. magnesium level (17.23) (78%) & 3 subjects had magnesium level >2.3 (6%) out of 8 subjects with hypomagnesemia 5 subjects had developed ventricular Arrhythmias (62.5%) (p value 0.005) out of 39 subjects with normal serum magnesium level (1.7-2.3 mg/dl) 5 subjects have developed ventricular arrhythmia (12.82) & out of 3 subjects with serum magnesium level no patients had developed ventricular Arrhythmias. Mean value of serum magnesium in patients without ventricular Arrhythmias was 2.05±0.27 and in patients with ventricular Arrhythmias was 1.79±0.38. Thus in our study significant correlation was noted between hypomagnesemia & ventricular Arrhythmias. P value was 0.005.

In a study conducted by Rasmussen et al, Serum magnesium concentrations & rate of magnesium excretion were studies in 24 patients with suspected acute myocardial infarction thirteen of patients were found to have acute myocardial infarction & 11 who did not have AMI served as control had significantly low serum magnesium concentrations. The Serum magnesium concentrations were unchanged in the control group the patient who died 35 hrs after hospitalization showed no tendency towards normalization of serum magnesium concentrations. The cause of death was ventricular fibrillation.[11]

In a study presented by Bigg RP et al, analysis of plasma magnesium and potassium levels in 25 patients presenting with acute myocardial infarction are presented. Three patients were hypomagnesemic & all exhibited serious ventricular Arrhythmias (two exhibited early ventricular fibrillation and the third exhibited ventricular trigeminy and multifocal ventricular ectopic) two of three hypomagnesemic patients were hypokalemic. Two other patients in the series exhibited ventricular tachycardia and both were hypokalemic.[12]

SUMMARY AND CONCLUSIONS

In our study of fifty patients of acute myocardial infarction, Male (n=32), Female (n=18). We estimated their acid base status, serum sodium, serum potassium, serum magnesium before thrombolysis. Outcome of patients with respect to mortality and ventricular Arrhythmias was studied.

- The definite correlation was found between metabolic acidosis and mortality (p value was 0.03). As the Blood pH was decreasing mortality was increasing and 100% mortality was found in pH level<3.
- There was also increased mortality in patients with hyponatremia, but p value was not statistically significant (p value 0.15)
- There was definite correlation between hypokalemia and ventricular arrhythmias and there was increased tendency towards developing ventricular arrhythmias in patients with hypokalemia. (p value 0.009). As the serum potassium was decreasing from 4.5, chance of developing ventricular arrhythmias was increasing and once the value of potassium declined to 3, there was a 100% chance of developing ventricular arrhythmias.
- There was definite correlation between hypomagnesemia and ventricular arrhythmias and there was increased tendency towards developing ventricular arrhythmias in patients with hypomagnesemia. (p value 0.009). As the serum magnesium level was decreasing, chance of developing ventricular Arrhythmias was increasing and as the level declined to 1.4 mg/dl, 100% patients had developed ventricular arrhythmias.
- There was no correlation found between hypernatremia and mortality. There was no correlation found between increased potassium level and ventricular Arrhythmias in our study.

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