DOI: 10.21276/aimdr.2019.5.5.ME6

Original Article ISSN (O):2395-2822; ISSN (P):2395-2814

Study of Serum Sodium, Potassium, Calcium in Patients with Myocardial Infarction in a Tertiary Care Centre, Kerala

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Received: July 2019
Accepted: August 2019

ABSTRACT

Background: Different electrolytes such as sodium, potassium, calcium play an important role in the cell metabolism, membrane excitability and electrical conduction. These electrolyte levels being modifiable hold an important role in altering the prognosis of these patients. **Methods:** This was a descriptive study conducted on 150 Patients admitted with Myocardial Infarction in Medical Intensive Care Unit, Government Medical College, Thrissur. Blood was collected within 24 hours of admission for analysis of serum sodium, potassium and calcium. Data was entered into Microsoft excel and analysed using SPSS software. Quantitative variables were expressed as mean, standard deviation and percentage. Association was assessed and significance was tested. P value less than 0.05 was taken as statistically significant. **Results:** The mean sodium concentration of subjects was 135 mEq/l ± 4.9mEq/l. Hyponatremia was present in 50 patients while the majority had serum sodium in the normal range. The mean potassium concentration was3.9± 0.59 mEq/l. Majority had potassium concentration in the normal range but 38 patients were having hypokalemia. The mean concentration of Calcium was 8.3 ± 0.70 mg/dl. Majority had hypocalcaemia. In the study population, 82% survived and 18% did not survive. **Conclusion:** Hyponatremia was more common in patients than hypernatremia. Hyperkalemia was not a common finding in patients with AMI as compared to hypokalemia. There was statistically significant difference for serum potassium and calcium levels in the survivors and non survivors.

Keywords: Sodium; potassium; calcium; acute myocardial infarction.

INTRODUCTION

Myocardial Infarction (AMI) is a dreadful complication of cardiovascular disease causing increased mortality and morbidity worldwide. AMI is one of the commonest diagnoses in hospitalized patients in developed as well as developing countries. About 3million sudden cardiac death per year occur due to AMI worldwide.[1]

Different electrolytes such as sodium, potassium and calcium play an important role in the cell metabolism, membrane excitability and electrical conduction.[2] Sodium, potassium and calcium are the major determinants of electrophysiological properties of myocardial membrane. The action potential has four phases which are dependent on these electrolytes. The resting membrane potential of cardiac muscle cells is about –90 mV. The initial rapid depolarization -phase 0 is due to opening of voltage-gated sodium channels. Then phase 1 - initial rapid repolarization is due to closure of sodium channels. Subsequent prolonged plateau - phase 2 is due to a prolonged opening of voltage-gated calcium channels. Final repolarization -phase 3 to the resting membrane potential -phase 4 is due to closure of the calcium channels and potassium efflux through various types of potassium channels.[3]

Electrolyte imbalances are common after an acute episode of Myocardial Infarction (MI).These electrolyte levels being modifiable hold an important role in altering the prognosis of patients presenting with AMI. Serum Sodium imbalance has been recorded in early phase of Myocardial Infarction in some studies.[4] Hyponatremia is relatively common among patients hospitalized with Myocardial Infarction and is related to poor outcomes and risk of mortality is increased with severity of hyponatremia .Various mechanisms have been proposed as to explain hyponatremia. This includes non osmotic release of vasopressin in response to pain, nausea and major stress,[5] Heart failure causing arterial underfilling which activates the autonomic nervous system and RAAS which inturn cause an increase in

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aldosterone and angiotensin II leading to an increased water and sodium reabsorption and increased water intake by stimulating thirst centre.

Potassium plays an important role in the maintenance of normal cardiac function. Hypokalemia and hyperkalemia are toxic to heart and there is strong association with life threatening arrhythmias. Hypokalemia is thought to be due to stress induced catecholamine response which causes increased uptake of potassium into the cells.[6] Hypokalemia in patients with Myocardial Infarction is thought to predict increased in-hospital morbidity, particularly arrhythmias and mortality

Calcium ions play a vital role in the sequence of excitation-contraction of the cardiac muscle fibers and they are essential in both the cardiac and systemic vasculature. Ischaemia will cause impaired cell membrane function which leads to an increase in cytosolic calcium and thus hypocalcemia.[7-9] Hypocalcaemia can also cause coronary spasm which can present as chest pain mimicking AMI especially in young adults.

Sodium, potassium and calcium are the major determinants of electrophysiological properties of myocardial membrane. So the pattern of these electrolyte levels in patients presenting with acute myocardial infarction plays a significant role in both mortality and morbidity of these patients. There are conflicting evidences from literature regarding the electrolyte levels in Myocardial Infarction. There are different studies regarding this topic but with contrary results highlighting the need for further studies in this important area.

MATERIALS AND METHODS

The study was done on 150 patients admitted with Myocardial Infarction in Medical Intensive Care Unit and Medicine Wards, Government Medical College, Thrissur.

Inclusion criteria:

a. Patients admitted to the Intensive Care Unit diagnosed as Acute ST segment Elevation Myocardial Infarction with unequivocal rise in ST segment more than 1mm in Electrocardiogram.
b. Patients of both sex

Exclusion criteria:

a. Patients on diuretics
b. Patients having significant renal disease, liver failure, adrenal insufficiency

A short history was obtained through the self-made questionnaire and Informed consent was taken from the patients/bystanders who satisfied the inclusion criteria. The following data were recorded in the proforma for each patient: Name, age, gender, Date of admission, IP No:, Date of discharge, Presenting complaints, History of hypertension/diabetes/renal disease/liver failure-duration of the disease and drugs taken History of smoking /alcohol consumption, Examination: Pallor, Jaundice, Lymph node, pulse rate, BP, System examination: Cardio Vascular System, Respiratory System, Gastro Intestinal System, Nervous System.

About 2ml of blood was taken from the patient along with the blood collected for routine investigation within 24hrs of admission. Blood is allowed to clot at room temperature and then centrifuged to obtain serum. This serum was used for estimation of electrolytes in Department of Biochemistry, Government Medical College Thrissur.

Method used for estimation of each parameter:

Serum Sodium: Ion Selective Electrode Method (ISE),[10]

Serum Potassium: Ion Selective Electrode Method,[10]

Serum Calcium: Calcium Arsenazo Reagent Method.[10]

Following reference values were considered:[10]

Serum Sodium (Adults): 135- 145mEq/L
Serum Calcium (Adult): 8.6 – 10.2 mg/dl
Serum Potassium (Adults): 3.5- 5mEq/L

RESULTS

A descriptive study was conducted at Government Medical College, Thrissur to determine the pattern of serum electrolytes- sodium, potassium and calcium in patients with myocardial infarction and to study the survival status up to fifth day of admission.150 subjects were selected from MICU and Ward from August 2017- January 2018.

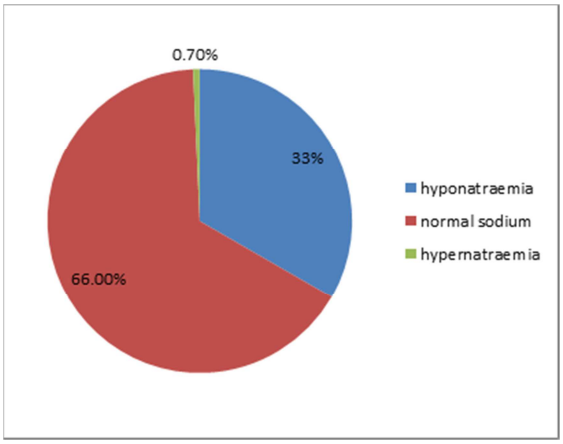

Figure 1: Distribution of Serum Sodium

The mean sodium concentration of subjects was 135 mEq/l with a standard deviation of 4.9 mEq/l. Hyponatremia was present in 50 patients while the majority (99 patients) had serum sodium in the normal range. Only 1 person had hypernatremia [Figure 1].

The mean potassium concentration was 3.9 ± 0.59 mEq/l. Majority (109) had potassium concentration

in the normal range but 38 patients were having hypokalemia. There were 3 patients who had hyperkalemia [Figure 2].

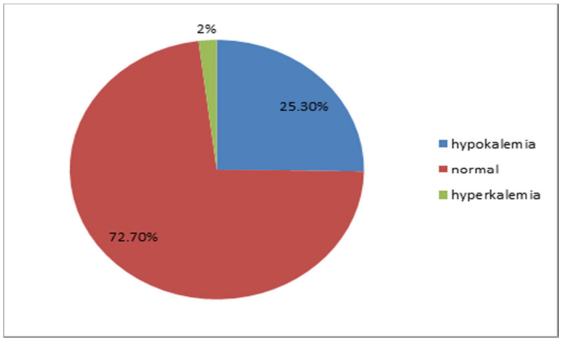

Figure 2: Distribution of Serum Potassium

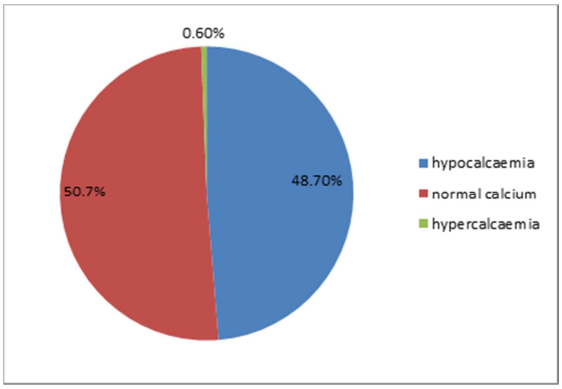

Figure 3: Distribution of Serum Calcium.

The mean concentration of Calcium was 8.3 + 0.70 mg/dl. Majority (80 patients) had hypocalcaemia. The serum calcium concentration was within normal range for 69 patients. Only 1 had hypercalcaemia [Figure 3].

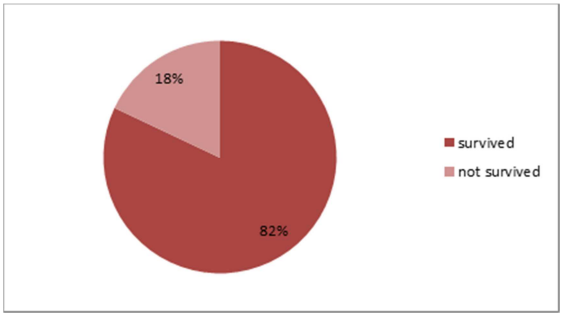

Figure 4: Survival status of the patients up to fifth day of admission.

Out of the total 150 patients, 123 (82%) survived and 27 patients (18%) did not survive [Figure 4].

The mean potassium level of those who survived was significantly higher than those who died with a p value of 0.04. The mean calcium level for those who survived was significantly higher than those who died with a p value of 0.002. But there is no statistically significant difference between the mean sodium levels for survivors and non survivors [Table 1].

Table 1: Association of survival status with serum electrolytes levels.

	Survival status	N	Mean	Std. Deviation
S. Na	Not survived	27	135.48	5.840
	survived	123	135.52	4.735
S. K	Not survived	27	3.681	.7109
	Survived	123	3.936	.5566
S. Ca	Not survived	27	7.970	.7258
	Survived	123	8.423	.6738

DISCUSSION

The present study was done to determine the pattern of serum electrolytes in patients presenting with acute myocardial infarction and also to study the survival status of these patients. The study was carried out on 150 patients. These patients were divided into two groups based on their survival status as survivors (n = 123) and non-survivors (n = 27).

The mean sodium concentration of subjects was 135 mEq/l with a standard deviation of 4.9 mEq/l, which was similar to the study by Lamia et al.[11] But in the study by Vinod wali et al,[1] (n=36) it was 129.47±4.87 and in the study by Amita Gandhi[9] ,it was 137.64±9.08.In this study, 40% of the patients had hyponatremia which was 14% in the study by Amita Gandhi.[9] While in study by Shubhangi Verma,[12]12.5% had hyponatremia. There was no significant association between mean serum sodium levels and survival status from this study. In contrast to the study by Esha et al,[13] in which hyponatraemia was associated with increased morbidity and mortality in myocardial infarction patients. Serum sodium was significantly decreased in hypertensive cases as compared to non-hypertensives. It was contrary to the study by Lamia et al,[11] in which there was no significant difference between the hypertensive and non hypertensive.

Hyponatremia is due to the nonosmotic release of vasopressin may occur in response to pain, nauseaand major stress or in response to theadministration of analgesics and diuretics. It can also occur due to the acute development of left ventriculardys function which is less common. Hyponatremia can also occur due to theincrease in the permeability of sarcolemma to sodium as a responseto hypoxia and ischaemia,

In this study, the mean potassium concentration was3.9 + 0.59 mEq/l while in study by Esha mati et al,[13] it was 3.66 ± 0.56.The mean serum potassium level was4.214±0.79 in study by Amita Gandhi,[9] and in the study by Vinod Wali et al,[1] it was 4.18±0.63.About 27% of the patients with AMI had hypokalemia in this study. In study conducted by Ketan,[14] 30% out of 274patients had hypokalemia while about 12.2% had significant hypokalemia in study by Yuko Tada et al.[15] Out of the 40 patients

with hypokalemia, 32.5% did not survive in this study. The mean potassium level of those who survived was significantly higher than those who died with a p value of 0.04.It was similar to the study by Yuko Tada,[15] in which the total mortality was more frequent in hypokalemic group than normokalemic group (20.6% versus 16.9%). Mortality was more in hypokalemic patients (27.2%) in the study by Shubangi verma et al,[12] also. Serum potassium was significantly decreased in hypertensive cases as compared to non-hypertensives. It was contrary to the study by Lamia et al,[11] in which there was increase in hypertensive cases as compared to non hypertensive.

The main regulation of potassium level in the body is by the renal excretion and shift between the intracellular and extracellular compartments. Mainly the sodium potassium ATPase pump is responsible for preserving the intracellular potassium. Aldosterone and vasopressin stimulate the potassium secretion by up-regulating the luminal sodium potassium ATPase pump and opening the luminal sodium and potassium channels. Hypokalaemia is due to stress induced catecholamine mainly epinephrine response which causes increased uptake of potassium into the cell.

The mean calcium concentration of patients with AMI in this study is 8.3 ± 0.70 mg/dl, which was similar to the study by Shiltpa Patil et al,[3] in which the average value of Calcium was 8.51±0.66 mg/dl. But in the study by Lamia Fazil et al,[11] the mean concentration of total calcium in cases was 7.508 ±1.411mg/dl. Majority (53%) of the patients had hypocalcaemia in this study while in the study by Shilpa patil et al,[3] 49% were found to be hypocalcaemic. The mean calcium level for those who survived was 8.423 mg/dl and for those who died was 7.970 mg/dl. So it was found that mortality was higher in patients with hypocalcaemia as the association between the survival status and serum calcium levels was statistically significant. Calcium ions play an important role in excitation-contraction of the cardiac muscle fibres and so they are essential in both the cardiac and systemic vasculature.[16] Hypocalcaemia impairs the myocardial contractility and there are several reports of congestive heart failure caused by severe hypocalcaemia. The most likely mechanism of chest pain in young patients has been attributed to coronary spasm due to hypocalcaemia. Further studies are required to understand the mechanism of hypocalcaemia in AMI and to determine whether patients with hypocalcaemia would benefit from calcium supplementation.

Limitations of the study also merit consideration. As the number of patients studied was small, prospective trials with larger sample size are required to confirm the findings. As most of the patients were refered from other hospitals, there was a time lapse in collection of samples after the onset of injury.

CONCLUSION

- Serum Calcium was the most affected electrolyte in patients presenting with AMI . Hypocalcaemia was present in about half of the study population.
- Hyponatremia was more common in patients than hypernatremia.
- Hyperkalemia was not a common finding in patients with AMI as compared to hypokalemia.
- There was statistically significant difference for serum potassium and calcium levels in the survivors and non survivors.

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How to cite this article: Soubhagya P, Muttath R, Pushpalatha. Study of Serum Sodium, Potassium, Calcium in Patients with Myocardial Infarction in a Tertiary Care Centre, Kerala. Ann. Int. Med. Den. Res. 2019; 5(5):ME25-ME29.

Source of Support: Nil, **Conflict of Interest:** None declared