International Journal of Basic & Clinical Pharmacology
*Das S et al. Int J Basic Clin Pharmacol. 2022 May;11(3):223-228*
http://www.ijbcp.com
pISSN 2319-2003 | eISSN 2279-0780

DOI: https://dx.doi.org/10.18203/2319-2003.ijbcp20221036

**Original Research Article**

# A study of serum sodium and potassium levels in subjects of acute myocardial infarction in a tertiary care hospital in Eastern India

**Siladitya Das*, Satyendra Nath Saha**

Department of Medicine, Burdwan Medical College, Burdwan, West Bengal, India

**Received:** 14 February 2022
**Accepted:** 05 March 2022

***Correspondence:**
Dr. Siladitya Das,
Email: siladitya.das007@gmail.com



## ABSTRACT

**Background:** Cardiovascular disease is one of the most common causes of morbidity and mortality around the world. In countries like India, there is difference in the lifestyle and behavioural risk factors among different areas. There is existence of rural-urban, Eastern-Western-Northern-Southern zonal differences. Studies done in other parts of India may not completely be applicable to Eastern Indian population. Serum electrolytes play an important role in maintaining electrophysiological homeostasis of the myocardial membrane, and alterations of these electrolyte levels can affect the pathogenesis, complications of myocardial infarction. Major serum electrolytes affecting the myocardial electrophysiological properties are sodium, potassium. Hence, this study was undertaken keeping in mind the miniscule lacunae in current knowledge especially pertaining to diseases in Eastern Indian population.
**Methods:** 50 consecutive patients in the age group of 30-70 years admitted in the medicine department of Burdwan medical college with recent onset acute chest pain, diagnosed to be acute myocardial infarction were taken, their serum sodium, potassium levels were determined and these levels were compared among these patients with and without risk factors.
**Results:** Serum sodium was decreased among patients with history of smoking, hypertension, BMI ≥25, complicated by atrial fibrillations. Serum potassium was decreased in patients with hypertension, BMI ≥25, ventricular premature complexes and increased in smokers, alcoholics.
**Conclusions:** Electrolyte imbalances are common in patients of Acute Myocardial Infarction. Hypokalemia and hyponatremia were present and they were associated with cardiac complications. They adversely affect prognosis, so should be corrected.

**Keywords:** Acute myocardial infarction, Serum electrolytes, Serum sodium levels, Serum potassium levels

## INTRODUCTION

Cardiovascular diseases comprise bulk of the serious disorders in the industrialized countries and also are a rapidly growing problem in developing nations like India. Cardiovascular diseases form a majority of all deaths each year and many of these deaths are sudden. The growing prevalence of obesity, diabetes mellitus and metabolic syndrome are important risk factors for atherosclerosis. Patients with coronary artery disease may be grouped into, patients presenting with stable angina and those with acute coronary syndromes (ACSs). The acute coronary syndrome group, in turn, is composed of patients with acute myocardial infarction (AMI) with S-T segment elevation on presenting electrocardiogram (ECG) and those with unstable angina. According to Harrison's principles of internal medicine, stable angina pectoris is characterized by chest or arm discomfort that may not be described as pain but is reproducibly associated with physical exertion or stress and is relieved within 5-10 minutes by rest and/or sublingual nitroglycerin.[1] Unstable angina is defined as angina pectoris or equivalent ischaemic discomfort with at least one of three features: it

occurs at rest (or with minimal exertion), usually lasting >10 minutes, it is severe and of new onset (i.e. within the prior 4-6 weeks) ; and/or it occurs with a crescendo pattern (i.e. distinctly more severe , prolonged or frequent than previously).[1]

The diagnosis of non ST elevation myocardial infarction is established if a patient with clinical features of unstable angina develops evidence of myocardial necrosis; as reflected in elevated cardiac biomarkers.[1] Diagnosis of ST Elevation Myocardial Infarction is established if a patient with clinical features of chest pain of more than 20 minutes in duration and ST elevation at the J-point in two contiguous leads with the cut-off points: ≥0.2 mV in men or ≥0.15 mV in women in leads V2-V3 and/or ≥0.1mV in other leads and elevated cardiac biomarkers like Trop-T and/or CPK-MB.[2 3]

**S**erum sodium and potassium are considered to be two major electrolytes associated with electrophysiological properties of the myocardial membrane. The normal cardiac impulse is generated by the pace maker cells in the sino atrial node. The impulse is transmitted through the A-V node through the Bundle of His to the Purkinje network.

The ventricular action potential has got several parts and each part is regulated by separate mechanisms. Potassium current is the principal current during phase 4 and determines the resting membrane potential of the myocyte. Sodium current generates the upstroke of the action potential (phase 0), inactivation of the sodium current leads to early repolarization (phase 1). The plateau (phase 2) is generated by a balance of repolarizing potassium current and depolarizing calcium current. Inactivation of this calcium current with persistent activation of potassium currents cause phase 3 repolarization. The sarcolemma of the myocardium has got Na+-K+ ATPase pump that plays an important role in establishing the resting potential and also takes part in action potential formation of cardiac cells. Imbalance of electrolytes in AMI is common.

Serum sodium level changes occur in patients of acute myocardial infarction. In AMI, there is activation of the renin angiotensin aldosterone system. This may lead to sodium retention and potassium loss as well as production of several growth factors that have a remodeling effect on the heart. Besides this, there is release of brain natriuretic peptide (BNP) and N terminal pro BNP from the damaged myocardium, especially the atrium. This leads to hyponatremia.[4] There is also inappropriate release of vasopressin, which leads to increased expression of aquaporin-2 water channels and leads to increased water absorption, ultimately leading to hyponatremia. [5] Hyponatremia may be defined as serum sodium levels of less than 135 meq/l and hypernatremia may be defined as sodium levels of more than 145 meq/l. Some studies have shown hyponatremia to be associated with poor outcomes in both STEMI and NSTEMI.

Potassium is a major intracellular ion and is hugely important for maintaining heartbeat and muscle function. The depolarization and contraction of heart recquires potassium.[6]

Hypokalemia is prognostically important to patients with Acute Myocardial Infarction. Hypokalemia may be defined as serum potassium levels of less than 3.5 meq/l. Hypokalemia is associated with increased mortality and morbidity.[7] Hyperkalemia may be defined as serum potassium values of greater than 5.5 meq/l. It is also associated with increased mortality and morbidity. Hypokalemia is associated with a wide variety of arrhythmias in AMI such as ventricular tachycardia and ventricular fibrillations. Sudden cardiac deaths after MI are mainly due to alteration of environment at the level of myocyte and Purkinje fibers that are mainly caused by electrolyte imbalances.[8] A leading hypothesis for a major mechanism of generation of arrythmias in setting of acute coronary syndromes is alteration of electrophysiological properties of the ischemic myocardium. Hypokalemia may lead to ventricular arrythmias as stated by Jonas Skogestad and Jan Magnus Aronsen.[9]

## METHODS

This was an institution based observational cross-sectional study. The study was conducted in Burdwan Medical College and Hospital situated in Purba Barddhaman district of West Bengal state of India. 50 consecutive patients in the age group of 30-70 years admitted in the medicine department of Burdwan medical college between February 2018 to July 2019 with recent onset acute chest pain and diagnosed to be acute myocardial infarction according to European society of cardiology (ESC), the American college of cardiology (ACC), the American heart association (AHA) and World heart federation (WHF) jointly, were taken.[10 11]

Patients with chronic renal disease, acute kidney injury, acute gastro-enteritis, malignancy, adrenal insufficiency, patients on medications like potassium sparing diuretics and other diuretics, patients with known liver or thyroid disorder, patients of known hemoglobinopathy, patients already on anti-lipidemic drugs, patients on medications like estrogens, progestin, anabolic steroids, retinoid, corticosteroids, cyclosporine, anti-retroviral medications, patients on medications like beta blockers, angiotensin converting enzyme inhibitors, angiotensin receptor blockers were excluded from the study. After taking proper consent, all subjects included in the study, as per inclusion criteria, were assessed by clinical examination, BMI was assessed, ECG, TROP-T performed, blood pressure measured, anthropometric measurements done. Data on history of present illness, past illness, family history, risk factors including diabetes, hypertension, alcohol abuse, and smoking was collected by use of questionnaires. Medication history was taken. Ultrasonography of whole abdomen performed.

Venous blood samples were collected. Blood from cases was taken within twelve (12) hours of admission, from the antecubital vein under strict aseptic techniques in plain vacutainers and sent for biochemical analysis. All biochemical analysis was done at central laboratory & biochemistry department of Burdwan Medical College and Hospital. The values of serum sodium, potassium, so obtained, were then analyzed statistically. The patients were followed up during hospitalized period for first five (5) days and the outcome (recovery or mortality) was found out. Data was compiled, tabulated and analyzed using standard statistical techniques. For continuous variables, unpaired Student's t-test was used. p value was determined, p value of less than 0.05 ($p<0.05$) was considered statistically significant.

## RESULTS

Males formed 76% of the study population while females comprised 24%. Out of them 36% were in the age group of 40-50 years and 50-60 years respectively, 24% were in the age group of 60-70 years and 4% were in the age group of 30-40 years. 68% were smokers, 18% were alcoholics, 52% had hypertension, 52% had BMI ≥25, 48% had BMI <25, 76% had HbA1c ≥5.7%, 24% had HbA1c <5.7%. 12% were complicated by atrial fibrillation, 12% by atrio-ventricular block, 12% by sinus tachycardia, 12% by ventricular premature complexes and 16% by sinus bradycardia (Table 1).

**Table 1: Different types of arrythmias complicating the cases of AMI during 5 day stay in hospital.**

| Type of arrythmia | N |
|---|---|
| **Atrial fibrillation** | 6 |
| **Atrio-ventricular block** | 6 |
| **Sinus bradycardia** | 8 |
| **Sinus tachycardia** | 6 |
| **Ventricular premature complexes** | 6 |
| **Total** | 32 |

It was found that serum sodium values were decreased in the study group, across all age groups. Similarly, it was found that serum potassium values were decreased in the study group, across all age groups. Mean serum level of sodium in patients of AMI with history of smoking was 133.08±2.44, while mean serum sodium level in AMI patients without history of smoking was 135.33±2.67 and p value as per unpaired student's t-test was 0.018. No significant difference was found in serum potassium. But, smoker AMI patients had greater serum potassium levels compared to non-smoker AMI patients (Table 2).

Mean serum levels of potassium in patients of AMI with history of alcoholism was 3.84±0.36, while mean potassium level in AMI patients without history of alcoholism was 3.45±0.39 and p value as per unpaired student's t test was 0.014. No significant difference was found in serum sodium levels among patients with AMI with and without history of alcoholism (Table 3).

**Table 2: Comparison of serum sodium, potassium levels among AMI patients with and without history of smoking.**

| Parameters | AMI with h/o smoking (mean±SD) | AMI without h/o smoking (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 133.08±2.44 | 135.33±2.67 | 0.018 |
| **Potassium (meq/l)** | 3.53±0.40 | 3.49±0.46 | 0.75 |

**Table 3: Comparison of serum sodium, potassium levels among AMI patients with and without history of alcoholism.**

| Parameters | AMI with h/o alcoholism (mean±SD) | AMI without h/o alcoholism (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 133.55±2.18 | 133.707±2.76 | 0.860 |
| **Potassium (meq/l)** | 3.84±0.36 | 3.45±0.39 | 0.014 (<0.05) |

Mean serum levels of sodium in patients of AMI with hypertension was 132.88±2.337, while mean sodium level in AMI patients without hypertension was 134.54±2.75 and p value as per unpaired student's t test was 0.026, and therefore significant difference was found in serum sodium levels among patients with AMI, with and without hypertension. Mean serum levels of potassium in patients of AMI with hypertension was 3.4±0.374, while mean potassium level in AMI patients without hypertension was 3.66±0.42 and p value as per unpaired student's t- test was 0.025, and therefore significant difference was found in serum potassium levels among patients with AMI, with and without hypertension (Table 4).

**Table 4: Comparison of serum sodium, potassium levels among AMI patients with and without hypertension.**

| Parameters | AMI with h/o hypertension (mean±SD) | AMI without h/o hypertension (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 132.88±2.337 | 134.54±2.75 | 0.026 |
| **Potassium (meq/l)** | 3.4±0.374 | 3.66±0.42 | 0.025 |

No significant difference was found in serum sodium, serum potassium levels among AMI patients with HbA1C <5.7 and those with HbA1C ≥5.7 (Table 5).

Mean serum sodium level among AMI patients with atrial fibrillation was 131±1.15, while mean serum sodium level among AMI patients without atrial fibrillation was 133.84±2.5 and the p value was found to be 0.000856 and therefore, significant difference, in serum sodium levels, was found among AMI patients with and without atrial fibrillation. No significant difference was found in serum potassium levels (Table 6).

**Table 5: Comparison of serum sodium, potassium levels among AMI patients with HbA1C <5.7 and AMI patients with HbA1C ≥5.7.**

| Parameters | AMI with HbA1C<5.7 (mean±SD) | AMI with HbA1C≥5.7 (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 134.363±2.37 | 133.578±2.69 | 0.362 |
| **Potassium (meq/l)** | 3.675±0.44 | 3.51±0.46 | 0.291 |

**Table 6: Comparison of serum sodium, potassium levels among AMI patients with and without atrial fibrillation.**

| Parameters | AMI with atrial fibrillation (mean±SD) | AMI without atrial fibrillation (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 131±1.15 | 133.84±2.5 | 0.000856 |
| **Potassium (meq/l)** | 3.5±0.29 | 3.53±0.437 | 0.80 |

Mean serum potassium level among AMI patients with ventricular premature complexes was 3.05±0.339, while mean serum potassium level among AMI patients without ventricular premature complexes was 3.59±0.38 and the p value was found to be 0.0086 and therefore, significant difference, in serum potassium levels, was found among AMI patients with and without ventricular premature complexes. No significant difference was found in serum sodium levels (Table 7). No significant difference in serum potassium and sodium levels were found among AMI patients with and without atrio-ventricular block, Sinus bradycardia and Sinus tachycardia.

Mean serum levels of sodium in patients of AMI with BMI ≥25 was 132.88±2.337, while mean sodium level in AMI patients with BMI <25 was 134.54±2.75 and p value as per unpaired student's t test was 0.026, and therefore significant difference was found in serum sodium levels. Mean serum levels of potassium in patients of AMI with BMI ≥25 was 3.4±0.374, while mean potassium level in AMI patients with BMI <25 was 3.66±0.42 and p value as per unpaired student's t test was 0.025, and therefore significant difference was found in serum potassium levels (Table 8). No significant difference was found in levels of serum sodium, potassium among AMI patients who died on follow up and those who survived on follow up.

**Table 7: Comparison of serum sodium, potassium levels among AMI patients with and without ventricular premature complexes.**

| Para-meters | AMI with ventricular premature complexes (mean±SD) | AMI without ventricular premature complexes (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 135±2.82 | 133.40±2.55 | 0.290 |
| **Potassium (meq/l)** | 3.05±0.339 | 3.59±0.38 | 0.0086 |

**Table 8: Comparison of serum sodium, potassium, levels among AMI patients with BMI≥25 and AMI patients with BMI<25.**

| Para-meters | AMI with BMI≥25 (mean±SD) | AMI with BMI<25 (mean±SD) | P value |
|---|---|---|---|
| **Sodium (meq/l)** | 132.88±2.337 | 134.54±2.75 | 0.026 |
| **Potassium (meq/l)** | 3.4±0.374 | 3.66±0.42 | 0.025 |

## DISCUSSION

Electrolyte imbalances are fairly common in acute myocardial infarction (AMI) patients. In this present study, there was statistically significant decrease in serum sodium levels in the study group as compared to normal healthy control group, across all age groups except 30-40 years group. In the 30-40 years group, there was statistically non-significant decrease in serum sodium levels in the study group compared to control group. These findings are similar to finding of Shah and his co workers et al who reported hyponatremia on day first. Flear and Hilton also reported a progressive fall in the mean daily serum sodium concentration until day 4 and rise thereafter in all cases.[12,13]

Serum sodium levels were found to be significantly decreased in smoker AMI patients as compared to non-smoker AMI patients. Serum sodium levels were also found to be statistically significantly decreased in AMI patients with hypertension as compared to AMI patients without hypertension. This finding is similar to findings of Wali and Yatiraj in their study 'study of serum sodium and potassium in acute myocardial infarction'.[14]

In the present study, serum sodium levels showed no statistically significant difference between AMI patients

with alcoholism and AMI cases without alcoholism. In the present study, no significant difference in serum sodium levels was found among AMI patients with normal HbA1C levels i.e. HbA1C <5.7% and AMI patients with impaired HbA1C levels i.e. HbA1C ≥5.7% (impaired glucose tolerance and diabetes mellitus). Significant decrease in serum sodium levels was found among AMI patients with BMI ≥25 in comparison to AMI patients with BMI <25. Hyponatremia is associated with atrial fibrillation as shown by Cavusoglu et al.[15] In the current study, serum sodium was statistically significantly decreased in AMI patients complicated by atrial fibrillation as compared to AMI cases not complicated by atrial fibrillation. There was no significant difference in serum sodium levels among patients of AMI with and without sinus tachycardia, sinus bradycardia, A-V blocks and ventricular premature complexes. Also, there was no significant difference in serum sodium levels, among AMI patients who died on 5 day follow up and those who survived on 5 day follow up.

Flear and Hilton reported fall in mean daily serum potassium concentrations during first three days in AMI.[13] In this present study, there was statistically significant decrease in serum potassium levels in the study group as compared to normal healthy control group, across all age groups except 30-40 years group. In the 30-40 years group, there was statistically non-significant decrease in serum potassium levels in the study group compared to control group.

In the present study, smoker AMI patients had greater serum potassium levels compared to non-smoker AMI patients. But the difference was not statistically significant. Smoking has shown a strong association with serum potassium level. Higher level has been reported by Wannamethee and his coworkers in normal middle-aged person.[16] Serum potassium levels were also found to be statistically significantly decreased in AMI patients with hypertension as compared to AMI patients without hypertension. This finding is similar to findings of Hamid Ikram and his colleagues, who reported low level of serum potassium in hypertensive coronary heart disease.[17]

In the present study, serum potassium levels were statistically significantly higher among AMI cases with alcoholism as compared to AMI cases without alcoholism. In the present study, no significant difference in serum potassium levels was found among AMI patients with normal HbA1C levels i.e. HbA1C <5.7% and AMI patients with impaired HbA1C levels i.e. HbA1C ≥5.7% (impaired glucose tolerance and diabetes mellitus). Deaner et al reported increased serum potassium levels in diabetic acute myocardial infarction patients.[18]

Significant decrease in serum potassium levels were found among AMI patients with BMI ≥25 compared to AMI patients with BMI <25. Hypokalemia is associated with increased risk of ventricular tachycardia and ventricular fibrillation.[19] In the present study, serum potassium was statistically significantly decreased in patients of AMI complicated by ventricular premature complexes as compared to AMI cases not complicated by ventricular premature complexes. There was no significant difference in serum potassium levels among patients of AMI with and without sinus tachycardia, sinus bradycardia, A-V blocks and atrial fibrillation. Also, there was no significant difference in serum potassium levels, among AMI patients who died on 5 day follow up and those who survived on 5 day follow up.

## CONCLUSION

Thus, to conclude, electrolyte imbalances are common in patients of acute myocardial infarction. Hypokalemia was found to be present in the patients of acute myocardial infarction, and it was associated with ventricular arrhythmias. Similarly, hyponatremia was present in the patients and was associated with atrial fibrillation. Thus, they seem to have adverse effects on the disease outcome and prognosis and therefore need to be corrected.

## ACKNOWLEDGEMENTS

The authors deeply acknowledge the general support of the head of department, department of general medicine, Burdwan medical college and the principal of Burdwan medical college.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Cannon CP, Braunwald E. Unstable angina and non st-segment elevation myocardial infarction. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, eds. Harrison's Principles of Internal Medicine. 18th ed. New York: McGraw-Hill; 2012.
2. Thygesen K, Alpert JS, White HD, Jaffe AS, Apple FS, Galvani M, et al. Universal definition of myocardial infarction. Eur Heart J. 2007;28(20):2525-38.
3. Hygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Fourth universal definition of myocardial infarction. Circulation. 2018;138(20): e618-51.
4. Hosenfuss G, Mann DL. Pathophysiology of Heart Failure. In: Zipes DP, Libby P, Bonow RO, Mann DL, Tomaselli GF, Braunwald E eds. A Textbook of Cardiovascular Medicine. 11th ed. Amsterdam: Elsevier; 2016:442-60.

5. Schaller MD, Nussberger J, Feihl F, Waeber B, Brunner HR, Perret C, et al. Clinical and hemodynamic correlates of elevated plasma arginine vasopressin after acute myocardial infarction. Am J Cardiol. 1987;60:1178-80.
6. Hariprasad S, Basavaraj M. Electrolyte disfunction in myocardial infarction patients. Int J Adv Med. 2018; 5:1172-6.
7. Madias JE, Shah B, Chintalapally G, Chalavarya G, Madias NE. Admission serum potassium in patients with acute myocardial infarction: its correlates and value as a determinant of in hospital outcomes. Chest 2000;118(4):904-13.
8. Goldberg A, Hammerman H, Petcherski S, Zdorovyak A, Yalonetsky S, Kapeliovich M , et al. Prognostic importance of hyponatremia in acute ST elevation myocardial infarction. The Am J Med. 2004;117:242-8.
9. Skogestad J, Aronsen JM. Hypokalemia induced arrhythmias and heart failure:new insights and implications for therapy. Front Physiol. 2018;9:1500.
10. Ovbiagele B, Markovic D, Fonarowet GC. Recent US patterns and predictors of prevalent diabetes among Acute myocardial infarction patients. Cardiol Res Pract. 2011;145615.
11. Nathan DM, Genuth S, Lachin J.The effect of intensive treatment of diabetes on development and progression of long term complications in insulin dependant diabetes mellitus. N Engl J Med. 1993; 329:977-86.
12. Shah PKD, Saxena M, Khangarot D, Banerji K. Sudy of serum sodium in myocardial infarction and its relation to severity and complications. JPI J Assoc Physic. 1986;34(3):195-6.
13. Flear CTG, Hilton P. Hyponatremia and severity and outcome of myocardial infarction. Br Med J. 1979;1(6173):1242-6.
14. Wali V, Yatiraj S. Study of serum sodium and potassium in acute myocardial infarction. J Clin Diag Res. 2014;8(11):CC07-9.
15. Cavusoglu Y, Kaya H, Eraslan S, Yilmaz MB. Hyponatremia is associated with occurrence of atrial fibrillation in outpatients with heart failure and reduced ejection fraction. Hellenic J Cardiol. 2019; 60(2):117-21.
16. Wannamethee SG, Lever AF, Shaper AG, Whincup PH. Serum potassium, cigarette smoking and mortality in middle aged men. Am J Epidemiol. 1997; 145(7):598-606.
17. Ikram H, Espiner EA, Nicholis MG. Diuretics potassium and arrythmias in hypertensive coronary disease. Drugs.1986;31(4):101-8.
18. Foo K, Sekhri N, Deaner A, Knight C, Suliman A, Ranjadayalan K, et al. Effect of diabetes on serum potassium concentrations in acute coronary syndromes. Heart. 2003;89(1):31-5.
19. Solomon RJ, Cole AG. Importance of potassium in patients with acute myocardial infarction. Acta Medica Scand. 1981;647:87-93.

**Cite this article as:** Das S, Saha SN. A study of serum sodium and potassium levels in subjects of acute myocardial infarction in a tertiary care hospital in Eastern India. Int J Basic Clin Pharmacol 2022;11:223-8.