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Prognostic Importance of Serum Potassium in Acute Myocardial Infarction: A Prospective Study

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Abstract

***Background:** Worldwide, acute myocardial infarction (AMI) is associated with high morbidity and mortality in hospitalised patients. The study was aimed to generate evidence regarding prognostic value of serum potassium among newly diagnosed AMI patients in a tertiary care center.*

***Material and Methods:** It was a facility-based, observational study with a prospective design. 120 patients of acute myocardial infarction, during the 18 months period of data collection, were included in study population. Routine blood tests and echocardiography was done for each study subject. Patients were followed up till end of therapy in the study facility and then repeat follow-up was done at 1-month and 3-months of therapy.*

***Results:** Around 50% study subjects had normal serum potassium level, 36.7% study subjects had hypokalaemia and remaining had hyperkalaemia. At 1-month follow-up, minimum serum potassium level was 2.8 mEq/L, maximum serum potassium level was 4.4 mEq/L and mean serum potassium was 3.517 mEq/L. At 3-months follow-up, minimum serum potassium level was 3.0 mEq/L, maximum serum potassium level was 4.4 mEq/L and mean serum potassium was 3.762 mEq/L. Nearly 33.3% study subjects developed post-AMI arrhythmia; among them 55% died in the study facility. Post-AMI arrhythmia was found to be statistically significantly associated with in-hospital treatment outcome (p - value 0.000). Serum potassium status at baseline was found to be statistically significantly associated with in-hospital mortality and ventricular arrhythmia.*

***Conclusion:** Baseline serum potassium level was found to have prognostic significance in early prediction of favourable outcome. Early detection and correction of any serum potassium imbalance could effectively reduce mortality burden of AMI.*

***Key words:** Myocardial infarction, hypokalaemia, follow-up, serum potassium level.*

Introduction

Worldwide acute myocardial infarction (AMI) is associated with high morbidity and mortality in hospitalised patients[1]. Serum sodium, potassium and calcium are major electrolytes involved with electrophysiological properties of myocardial membrane. The sarcolemma is impermeable to Na^+ in the resting state. It has Na^+-K^+ ATPase pump that plays an important role in establishing the resting potential. This pump exports Na^+ from the cell out and imports K^+ inside the cell against their concentration gradient. Thus, when intracellular K^+ is relatively high, then Na^+ is low, and when extracellular Na^+ is high, then K^+ is low. There are 4 phases of action potential dependent on sodium, potassium and calcium. Serum electrolyte imbalances after an episode of acute myocardial infarction are common[3]. But clinical importance of these imbalances in both STEMI and NSTEMI has not been fully understood. These electrolytes play an important role in altering the prognosis of myocardial infarction patients[4]. Hypokalaemia is defined as serum potassium levels <3.5 mEq/L[5]. The prevalence and role of hypokalaemia in myocardial infarction has been under investigation for a long time. Hypokalaemia in patients with AMI is thought to predict increased in-hospital morbidity, particularly arrhythmias and mortality[6]. Several studies have shown an association between hypokalaemia and an increased occurrence of cardiac arrhythmias in AMI patients[7]. Recent guidelines suggest that K^+ levels should be monitored and routinely replaced in patient with heart failure and MI, even if on admission K^+ appears normal[8]. Hyperkalaemia is also associated with increased mortality and should be avoided[9]. The total body potassium levels in the body are 3500 mmoL, out of which 98 % is intracellular. Its main regulation is by the renal excretion and shift between the intracellular and extracellular compartments. The sodium-potassium ATPase pump is mainly responsible for preserving intracellular potassium. Aldosterone and vasopressin stimulate potassium secretion by up-regulating the luminal Na^+-K^+ ATPase pump and opening the luminal Na^+ and K^+ channels[10]. Sudden cardiac death after MI (death within 1 hour) is mainly due to alteration in environment at the level of myocytes and Purkinje fibers that are regulated by electrolyte imbalances and autonomic nervous system activity[11]. Hypokalaemia is associated with a

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wide variety of arrhythmias in AMI such as ventricular tachycardia and ventricular fibrillations[19]. 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. A leading hypothesis for the mechanism of generation of arrythmias in the setting of acute coronary syndromes is alteration of electrophysiological properties of the ischaemic myocardium. There are few studies regarding prognostic value of serum potassium in AMI patients. By assessing the prognostic significance of serum potassium among AMI patients in a prospective manner, this study has provided necessary inputs for ensuring provision of care of AMI patients.

Material and Methods

This observational study was done among newly diagnosed patients of acute myocardial infarction, admitted in IPD of General Medicine, North Bengal Medical College and Hospital, Darjeeling district, West Bengal from April 2024 to October 2025.

Inclusion criteria

1. Newly diagnosed patients of acute myocardial infarction, admitted during the period of data collection.

Exclusion criteria

1. Those who did not give informed consent.
2. Renal insufficiency.
3. Those who were on diuretics.

Sample size

For estimating the incidence rate of adverse outcome of AMI among study participants, considering the relative precision (ε) of 20% and 95% confidence interval (CI), the sample size was calculated by using the following formula[63]:

$N = (Z_{1-\alpha/2} \div \varepsilon)^2$
Thus, the calculated minimum sample size was –
$N = (1.96 \div 0.2)^2$
~96.

Considering anticipated non-response rate 25%,
The final sample size was fixed at:
$96 + (96 \times 25\%)$
~120.

Sampling technique:

Consecutive sampling was applied. Each patient after initial interview and data collection was followed up at 1-month and 3-months of therapy.

Study tools and techniques:

Tools

- A semi-structured, pre-designed, pre-tested schedule to collect background information.
- Serum potassium, urea, creatinine, random blood sugar, CPK-MB, Trop-T
- ECG
- 2D-Doppler echocardiography

Techniques

- Patient-interviews (PI) for background information.
- Relevant record reviews for clinical information.

Data Collection: Data was collected after ethical clearance and approval of the synopsis by the Institutional Ethics Committee of North Bengal Medical College and Hospital, Darjeeling, West Bengal. During the data collection period, 2 - 3 patients were interviewed per day, twice per week.

Data management and analysis: The principles of descriptive statistics were applied to organise and present the data in tables and diagrams. Qualitative data was expressed in proportion. Data analysis was done by using Statistical Package for Social Sciences (SPSS) version 23. Association between serum potassium level and incidence of ventricular arrhythmia was checked by Chi-square test. Association between serum potassium level and in-hospital mortality was checked by unpaired-t test. Correlation between serum potassium and LVEF and LVEDD was checked by using Pearson's correlation co-efficient at 1-month and 3-months of therapy. p-value ≤ 0.05 was considered statistically significant.

Observation and Results

Table I: Distribution of study participants as per their age (n=120).

Age (in years)	Frequency (%)
<50	16 (13.3)
50-60	60 (50)
>60	44 (36.7)
Total	120
Mean age	59.07 years
Standard Deviation (SD)	7.958

Table I shows that out of 120 study subjects, 16 (13.3%) were within <50 years age group. Another 60 (50%) study subjects were within 50 - 60 years age group. Another 44/120 (36.7%) study subjects were within >60 years age group. Mean age was 59.07 years (SD ± 7.958).

Table II: Bivariate analysis between background characteristics of study participants and in-hospital treatment outcome (n = 120).

Background characteristics	Total study subjects (N=120)	Frequency of study subjects based on in-hospital treatment outcome		Chi-Squared test (χ^2)		
		Discharge (n = 96)	Death (n = 24)	(χ^2) value	Degree of freedom (df)	p-value
Age (in years)						
<50	16	16	0	28.485	2	**0.000**
50 - 60	60	56	4			
>60	44	24	20			
Gender						
Male	72	56	16	0.556	1	0.456
Female	48	40	8			
Educational status						
Primary	24	12	12	38.137	3	**0.000**
Mid-school	68	64	4			
Secondary	24	20	4			
Higher-second	4	0	4			
Socio-economic status						
Upper-middle	44	8	36	0.162	2	0.922
Middle	56	12	44			
Lower-middle	20	4	16			
BMI						
Normal	20	16	4	2.778	2	0.249
Overweight	64	48	16			
Obese	36	32	4			
Substance use						
No	40	28	12	11.250	3	**0.010**
Smoking	48	44	4			
Alcohol	8	8	0			
Both	24	16	8			

**Socio-economic status as per modified BG Prasad scale [October 2023; CPI (IW): 138.4]. In table-II statistical association was analysed by using Chi-squared test between in-hospital treatment outcome of study subjects with various background characteristics. In-hospital treatment outcome was found to be statistically significantly associated with age (p-value 0.000), education (p-value 0.000) and substance abuse (p-value 0.010) of study subjects.*

Fig. 2 show that 40/120 (33.3%) study subjects developed post-AMI arrhythmia; among them 22/40 study subjects (55%) died in the study facility. 80/120 study subjects (66.7%) did not have post-AMI arrhythmia; among them 2/80 study subjects (2.5%) died in study facility. Post-AMI arrhythmia was found to be statistically significantly associated with in-hospital treatment outcome (p-value 0.000).

Fig. 2 show that out of 60 study participants with normal serum potassium at baseline, 59/60 (98.3%) were discharged and in-hospital mortality rate was 1/60 (1.7%); but among 44 study subjects with hypokalaemia at baseline, 20/44 (45.5%) was the in-hospital mortality rate; among 16 study participants with hyperkalaemia at baseline, 13/16 (81.2%) were discharged and in-hospital mortality rate was 3/16 (18.7%). Serum potassium status at baseline was found to be statistically significantly associated with in-hospital mortality. Out of 60 study participants with normal serum potassium at baseline, 2/60 (3.3%) study subjects developed ventricular arrhythmia; but among 44 study subjects with hypokalaemia at baseline, 36/44 (81.8%) developed ventricular arrhythmia; among 16 study participants with hyperkalaemia at baseline, 2/16 (12.5%) developed ventricular arrhythmia.

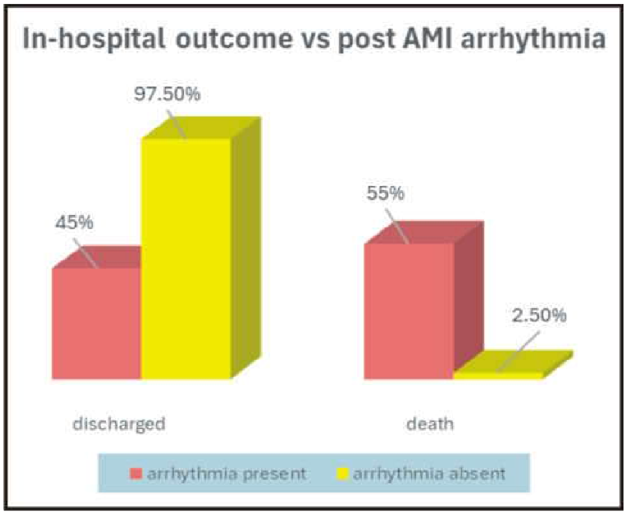

Fig. 1: Distribution of study subjects as per in-hospital treatment outcome (n = 120).

ROC curve shows that serum potassium level at baseline has significant discriminative power (AUC >0.5 and p-value 0.000) in early prediction of favorable outcome of AMI.

Discussion

In our study nearly (50%) study subjects were within 50 - 60 years age group with mean age was 59.07 years (SD ±

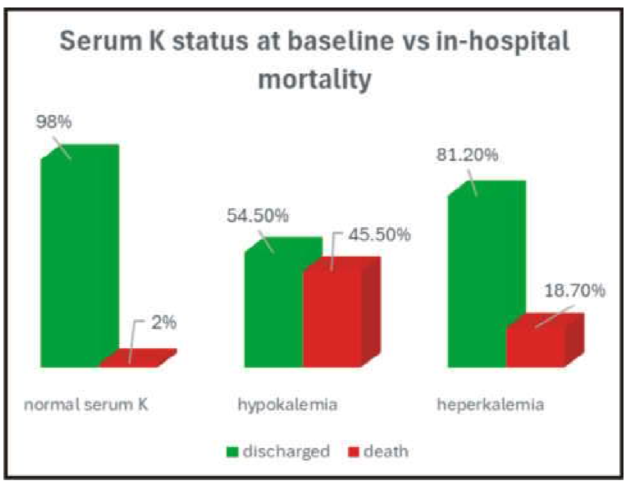

Fig. 2: Distribution of study subjects as per in-hospital treatment outcome (n = 120).

7.958). Nearly 60% study subjects were male and remaining female. Another 26% were from urban area and remaining rural. Around 50% study subjects had normal serum potassium level, 36.7% study subjects had hypokalaemia and remaining had hyperkalaemia. Minimum serum potassium level was 2.1 mEq/L, maximum serum potassium level was 6.1 mEq/L and

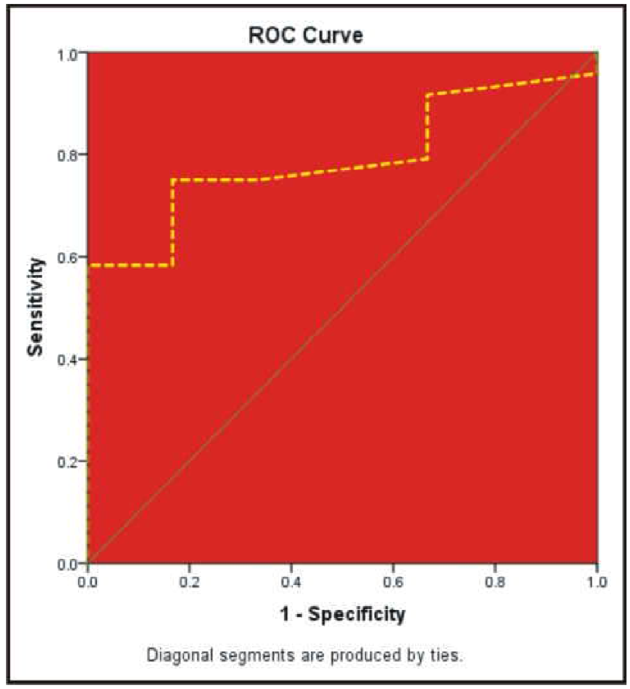

Fig. 3: ROC curve analysis to assess predictive value of baseline serum potassium level regarding in-hospital mortality (n=120).

mean potassium level was 3.780 mEq/L (SD ± 1.108). Regarding LVEF at baseline, minimum observed value was 30%, maximum value was 54% and mean value was 46.233 (SD ± 6.062). Regarding LVEDD, minimum observed value was 38 mm, maximum value was 62 mm, and mean value was 48.667 (SD ± 6.617).

At 1-month follow-up, minimum serum potassium level was 2.8 mEq/L, maximum serum potassium level was 4.4 mEq/L and mean serum potassium was 3.517 mEq/L (SD ± 0.391). At 1-month follow-up, minimum LVEF value was 22%, maximum value 56% and mean LVEF value was 42.708 (SD ± 8.932). Regarding LVEDD at 1-month follow-up, minimum value was 42 mm, and maximum value was 62 mm, and mean value was 51.00 (SD ± 5.954).

At 3-months follow-up, minimum serum potassium level was 3.0 mEq/L, maximum serum potassium level was 4.4 mEq/L and mean serum potassium was 3.762 mEq/L (SD ± 0.351). At 3-months follow-up, minimum LVEF value was 30%, maximum value 58% and mean LVEF value was 50.042 (SD ± 6.961). Regarding LVEDD at 3-months follow-up, minimum value was 44 mm, and maximum value was 57 mm, and mean value was 50.167 (SD±3.620).

96/120 (80%) study subjects were discharged from the study facility and remaining 26/120 (20%) died. Nearly 40/120 (33.3%) study subjects developed post-AMI arrhythmia; among them 22/40 study subjects (55%) died in the study facility. 80/120 study subjects (66.7%) did not have post-

AMI arrhythmia; among them 2/80 study subjects (2.5%) died in study facility. Post-AMI arrhythmia was found to be statistically significantly associated with in-hospital treatment outcome (p-value 0.000).

Out of 60 study participants with normal serum potassium at baseline, most were discharged but among 44 study subjects with hypokalaemia at baseline, 45.5% was the in-hospital mortality among 16 study participants with hyperkalaemia at baseline, mortality rate was 18.7%. So serum potassium status at baseline was found to be statistically significantly associated with in-hospital mortality. Out of 60 study participants with normal serum potassium at baseline, 3.3% study subjects developed ventricular arrhythmia; but in those with hypokalaemia at baseline, 81.8% and 12% in hyperkalemia developed ventricular arrhythmia. Baseline serum potassium level at or above 3.450 mEq/L can predict favorable in-hospital treatment outcome with sensitivity of 75% and specificity of 83.3%. Serum potassium level at baseline has significant discriminative power (AUC >0.5 and p-value 0.000) in early prediction of favourable outcome of AMI.

Serum potassium and LVEF at 1-month follow-up was positively correlated; strength of correlation was high (Pearson correlation coefficient 0.792, p-value 0.000), linear and positive in nature. Serum potassium and LVEDD at 1-month follow-up was negatively correlated; strength of correlation was high (Pearson correlation coefficient 0.794, p-value 0.000), linear and negative in nature. Serum potassium and LVEF at 3-month follow-up was positively correlated; strength of correlation was moderate (Pearson correlation coefficient 0.642, p-value 0.000), linear and positive in nature. Serum potassium and LVEDD at 3-month follow-up was negatively correlated; strength of correlation was mild (Pearson correlation coefficient 0.322, p-value 0.001), linear and negative in nature.

A study done by Kiranmani *et al*[24] showed that there was significant decrease in serum magnesium and serum potassium levels in hypertensives and diabetics on 1st day of AMI when compared to controls (p <0.01) with no significant change in serum Ca^{2+} and serum Na^{+} levels (p >0.05). There was significant decrease in serum magnesium levels in cases with diabetes (p <0.05) when compared to cases without diabetes. There was insignificant lowering of serum magnesium levels in cases with hypertension when compared to cases without hypertension. Another study by Mudaraddi *et al*[25] showed that there were statistically significant decreased levels of serum sodium (p <0.001), potassium (p <0.001) and elevated levels of urea (p <0.001) observed in AMI. But the levels of serum chloride did not show any significant correlation between case and control groups.

The current study was one of those rare studies in West Bengal which assessed the prognostic value of serum potassium among newly diagnosed AMI patients and analyzed association between serum potassium with cardiac function during follow-up at 1-month and 3-month. Future multicentric longitudinal studies should be done for further validation.

Conclusion

Commonest type of serum potassium imbalance was hypokalaemia which was mostly due to the catecholamine response in such patients. Serum potassium imbalance was associated with cardiac arrhythmias and increased in-hospital mortality in post-AMI patients. Close monitoring of serum potassium level and prompt correction of it was necessary to improve AMI treatment outcome and prognosis.

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