ORIGINAL ARTICLE

OUTCOME OF PATIENTS WITH ST ELEVATION MYOCARDIAL INFARCTION (STEMI) BASED ON ADMISSION SERUM POTASSIUM LEVEL

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Background: Potassium levels play a significant role in cardiovascular patients, with hypokalemia and hyperkalemia having profound effects on the mortality rate. The aim of this study was to investigate the correlation of admission serum potassium levels and in-hospital mortality in patients suffering from acute ST-elevation myocardial infarction (STEMI)**. Methods**: The study was conducted in the Department of Cardiology, Ayub Teaching Hospital Abbottabad, and involved 225 patients with STEMI who underwent thrombolysis with streptokinase. The serum potassium levels of patients were recorded at the time of admission, and its correlation was observed with the short-term outcomes, i.e., discharge to home versus those who did not survive during the hospital stay of 72 hrs. **Results:** The mean level of serum potassium at admission was 4.2 mmol/dL and 74.2% patients were discharged alive. T test indicated that a higher risk of death was associated with old age. No significant association between gender, serum potassium levels, systolic blood pressure, heart rate, and outcomes was seen. Logistic regression analysis further showed that age had a significant association with the outcome of death. **Conclusion:** In our study, age had a significant impact on predicting the mortality of patients with STEMI and whereas the serum potassium levels at the time of admission did not exhibit any significant predictive value. Further research is needed to elucidate the complex interplay of various factors in predicting mortality, to improve the management practices of AMI.

Keywords: Serum potassium level; ST elevation myocardial infarction; Outcome; Mortality

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INTRODUCTION

Acute ST elevation myocardial infarction (STEMI) is a medical emergency that affects millions of people around the globe. It is a significant contributor of morbidity and mortality and is linked to high healthcare expenses. [1] According to the American Heart Association (AHA), STEMI is a major cause of death. Approximately 15% of all deaths are attributed to it in high-income countries.[2] Early detection and timely reperfusion therapy are recommended treatments for STEMI as patients have a high risk of developing cardiac complications and mortality.[3] The success of these interventions depends on various factors, including the patient's age, comorbid conditions, and the time from symptom onset to treatment.[4]

Various factors have been identified that can influence the outcomes of patients with STEMI, including the serum potassium levels.[5] Potassium is an important electrolyte that has a critical role in the normal functioning of the cardiovascular system.[5] Abnormal levels of potassium can lead to serious complications, including arrhythmias, heart failure, and sudden death.[6] The significance of serum potassium level at admission has been established as a crucial prognostic factor as it significantly effects the outcomes among patients with AMI.[7] Several studies have demonstrated that both hypokalemia and hyperkalemia on admission are associated with unfavorable cardiac events and increased mortality rates in STEMI patients.[8,9] The findings of a meta-analysis and systematic review comprising 16 studies and 26,979 patients also suggested that the admission serum potassium levels serve as a prognostic indicator for short-term outcomes in patients diagnosed with STEMI.[5]

In human body, 98% of potassium is intracellular and its concentration is regulated within a narrow range of 3.5–5.3 mmol/L by intracellular and extracellular shifts as well as renal excretion. The maintenance of a balanced level of potassium in the serum of cardiac patients is of great significance.[5,10] The pathophysiological mechanisms that underlie the levels of serum potassium and its effect on outcomes of AMI patients is complex. Potassium plays a crucial role in regulating the membrane potential of cardiac myocytes. Fluctuations in potassium levels can lead to alterations in the cardiac conduction system activity and electrical stability of the myocardium.[11] Hypokalemia (Serum K < 3.5mEq/l) can cause tachyarrhythmia, ventricular fibrillation and sudden cardiac death, whereas hyperkalemia (Serum K > 5.0mEq/l) can lead to bradycardia, asystole and sudden death.[10] Both hyperkalemia and hypokalemia have shown a significant impact on the mortality rate in AMI patients.[12] The aim of our study was to investigate whether the serum potassium levels at admission also impacted the outcome of the patients, (being death or discharge within the initial 72 hours of admission) with acute ST-segment elevation myocardial infarction (STEMI).

MATERIAL AND METHODS

This study was conducted in the Department of Cardiology, Ayub Teaching Hospital Abbottabad, Pakistan, a tertiary care hospital, from October 2019 till April 2020. Upon the approval of the hospital's ethical committee, 225 patients who met the inclusion criteria were enrolled for the study, through non-probability convenient sampling. The inclusion criteria for the study was the patients who presented within 12 hours of typical chest pain that lasted for more than 30 minutes, and diagnosed as a case of ST-elevation myocardial infarction (STEMI) which was subsequently treated with streptokinase. The ECG criteria which is advised by the European Society of Cardiology and American Hearts Association was used for the diagnosis of STEMI. The study excluded patients who underwent coronary artery bypass graft surgery, who were undergoing dialysis, and those receiving medical treatment for chronic kidney disease. The WHO software for sample size calculation was used to determine the sample size with a confidence level of 95%, an anticipated proportion of mortality that was in the hypokalemic group of 2.4%, and an absolute precision of 4.4%.[13] The serum potassium levels of patients at admission were recorded, and their short-term outcomes were assessed based on discharge to home, or mortality within 72 hours of hospital stay. All relevant data was recorded on a prescribed *proforma.*

The collected data was analyzed using the SPSS 20 program. Mean and standard deviations for age, serum potassium levels, and BMI were calculated. Categorical variables, such as gender, hypokalemia, hyperkalemia, and outcome were described as frequencies and percentages. In order to address the effect modifier, the data was stratified upon the basis of patients age, gender, heart rate, and value of systolic and diastolic blood pressure at admission. The statistical analysis was done with the student's T test with a significance level of $p \leq 0.05$.

RESULTS

Out of the 225 participants, 132 (58.7%) were male and 93 (41.3%) were female. 167 patients (74.2%) were discharged home and 58 patients (25.8%) died. In this study, there were slightly more male patients than female participants. Additionally, the majority of participants (74.2%) were discharged alive from the hospital.

The mean age of the patients in the study was 57.4±10.5 years with youngest patient being 36 years and the oldest being 90 years of age. The average admission potassium level was 4.18 mmol/dL. The average systolic blood pressure was 134.23 mmHg, the average diastolic blood pressure was 86.28 mmHg, and the average heart rate was 84.6 beats per minute.

Table-2 provides information about the relationship of patient outcomes with age, admission K level, systolic blood pressure, diastolic blood pressure, and heart rate. It demonstrates that patients with increased age, higher systolic blood pressure or fast heart rate may be at a greater risk of dying. The t-test for age showed a significant difference in means between the two groups of the outcome, with those who died being significantly older than those who survived [t (223) = - 2.513, p = 0.013]. The mean difference was -3.97, indicating that the mean age of those who died was almost 4 years higher than those who survived. The 95% confidence interval for the difference was -7.09 to -0.86, which did not include zero, further indicating a significant difference. Conversely, the t-tests for Serum potassium level at admission, systolic blood pressure, diastolic blood pressure, and heart rate did not show any significant differences in means between the two groups.

Table 3 shows the relationship between outcomes (survival and death) of patients with gender, serum potassium levels, systolic blood pressure, and heart rate. The Chi-square statistical analysis was applied to determine the presence of a significant correlation between the parameters and outcomes. The p-values of all four parameters are more than 0.05, indicating no significant association. Therefore, it can be concluded that these parameters do not have a significant impact on the outcome of the patients.

To further validate our results, logistic regression analysis was applied. The analysis predicted whether the patients would survive or die based on several independent variables. As per results of analysis, age had a statistically significant association with the outcome of death (B=0.045, SE=0.016, Wald=8.059, df=1, p=0.005, Exp(B)=1.046). This indicates that for each one-year increase in age, the odds of death increase by a factor of 1.046, holding all other variables constant. None of the other independent variables were statistically significant, as indicated by their high p-values.

Figure 1 shows the graphic distribution of Age by Gender by Outcome. As can be seen, the majority of female patients suffering an AMI are above the age of 50 years whereas more males are suffering from AMI at a younger age. Also, most of the female patients who died were older than the male patients. In patients who survived and were discharged, no difference can be visualized with respect to age.

Table-1: Descriptive statistics of Age, Admission K level, BP systolic, BP diastolic, and Heart Rate

	Age	Admission K level (mmol/dL)	BP systolic (mmHg)	BP diastolic (mmHg)	Heart Rate (bpm)
N	225	225	225	225	225
Mean	57.4133	4.1884	134.23	86.28	84.68
SD	10.49544	.84898	28.199	18.080	20.927
Minimum	36.00	2.60	60	40	34
Maximum	90.00	7.90	200	140	160

Table-2: Relationship between the patient outcomes and continuous variables

	Outcome	N	Mean	SD	T test
Age	Survived	167	56.3892	9.74176	t (223) = - 2.513,
	Expired	58	60.3621	12.02439	***p* = 0.013**
Admission K level	Survived	167	4.1988	.85869	t (223) = 0.316,
	Expired	58	4.1586	.82697	p = 0.753
BP systolic	Survived	167	133.86	28.787	t (223) = - 0.351,
	Expired	58	135.31	26.645	*p* = 0.727
BP diastolic	Survived	167	86.10	18.518	t (223) = - 0.268,
	Expired	58	86.81	16.900	*p* = 0.789
Heart Rate(bpm)	Survived	167	83.90	21.033	t (223) = -0.960,
	Expired	58	86.93	20.634	*p* = 0.340

Table-3: relationship between the patient outcomes and categorical variables

Parameters		Outcome		Total	Chi- Square *p* value
		Survived	Expired		
Gender	Male	97	35	132	
	Female	70	23	93	0.763
Serum Potassium level in mmol/dL	<3.5 (Hypokalemia)	33	13	46	
	3.5- 5.5 (Normal)	112	37	149	
	>5.5 (Hyperkalemia)	22	8	30	0.891
Systolic BP subgroups	SBP < 90 mmHg	19	4	23	
	SBP 90 – 180 mmHg	141	52	193	
	SBP > 180 mmHg	7	2	9	0.594
Heart rate subgroups	HR<60 bpm	24	5	29	
	HR 60 – 110 bpm	121	47	168	0.405
	HR >110 bpm	22	6	28	
Total		167	58	225	

Table-4: Results of a binomial logistic regression analysis

Variables in the Equation							
		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 1[a]	Age	.045	.016	8.059	1	**.005**	1.046
	Gender (1)	.340	.341	.997	1	.318	1.406
	serum potassium level	-.311	.394	.621	1	.431	.733
	Dx of K level			.930	2	.628	
	Dx of K level (1)	-.750	1.152	.424	1	.515	.472
	Dx of K level (2)	-.712	.800	.793	1	.373	.491
	BP systolic	.004	.012	.097	1	.755	1.004
	Systolic BP subgroups			.467	2	.792	
	Systolic BP subgroups (1)	-.357	1.342	.071	1	.790	.700
	Systolic BP subgroups (2)	.117	.956	.015	1	.902	1.124
	BP diastolic	-.011	.017	.423	1	.515	.989
	Heart Rate (bpm)	.022	.014	2.649	1	.104	1.022
	HR > 110 bpm			3.091	2	.213	
	HR < 60 bpm	1.323	1.190	1.236	1	.266	3.755
	HR 60-110 bpm	1.221	.725	2.834	1	.092	3.392
	Constant	-4.578	3.653	1.570	1	.210	.010

a. Variable (s) entered on step 1: Age, Gender, serum potassium level on admission, DxOfKlevel, BP systolic, Systolic BP subgroups, BP diastolic, Heart Rate(bpm), Heart rate subgroups.

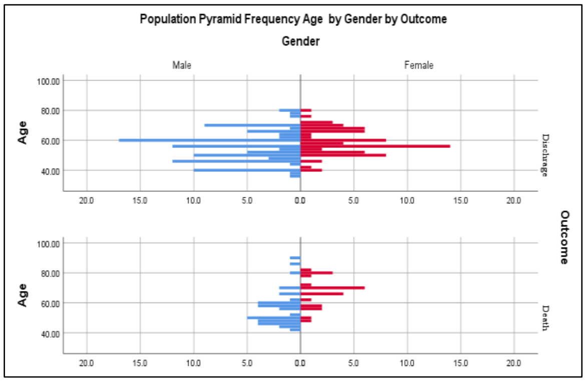

Figure 1: population pyramid frequency Age by Gender by Outcome

DISCUSSION

AMI is a medical emergency that may result in serious complications and even death. [2] The outcome of patients with AMI is affected by various factors, including age, gender, serum potassium levels, systolic and diastolic blood pressure levels, and heart rate.[5,6] Understanding the relationship between these factors and patient outcomes can help in further improving the management of AMI.

In this study, there were slightly more male patients than female patients, and the majority of patients were discharged alive from the hospital. The outcome is consistent with previous research which shows that men have a higher incidence of AMI than women, but women are more likely to have poorer outcomes, including higher mortality rates and greater complications.[14,15] Our results show that age was a significant predictor of death in patients with AMI, with older patients being at a greater risk of dying. This result is consistent with earlier studies, that also demonstrated that older age is a strong predictor of unfavorable outcomes in STEMI patients.[16,17] However, there is some evidence to suggest that mortality may not be predicted by age alone, when other risk factors are taken into account.[18]

A serum potassium concentration lower than 3.5 mEq/l is referred to as hypokalemia. During the acute phase of myocardial infarction, hypokalemic patients are more prone to ventricular arrhythmias and poor prognostic outcome.[5,11,19] Similarly hyperkalemia, which is SPC of >5.0 mEq/l also causes lethal cardiac arrhythmias and deadly outcomes.[5,11,19] Therefore, according to current recommendations, serum potassium levels should be strictly maintained between 4.0 and 5.0 mEq/l or above 4.5 mEq/l in AMI patients.[19] Based on the results of study, no definitive link could be established between the admission serum potassium levels and patient's outcome. These findings are consistent with existing literature, that also exhibits conflicting result regarding the impact of admission serum potassium levels on outcomes of AMI patients.[20] While other studies have not established any conclusive evidence of a correlation, some have hypothesized that hypokalemia on admission may be linked to a higher mortality risk.[21] A study by Sadeghi *et al.*, included 680 patients who underwent primary percutaneous coronary intervention for treatment of acute ST-segment elevation myocardial infarction (STEMI).[22] The study found that hypokalemia was associated with increased likelihood of cardiogenic shock, ventricular fibrillation and in-hospital mortality (OR 2.74, 95% CI 1.39-5.40) compared to normokalaemia. Similarly, hyperkalemia was also associated with a higher risk of cardiogenic shock and in-hospital mortality (OR 4.15, 95% CI 1.57-10.96) compared to normokalaemia. These results advocate that abnormal potassium levels at admission may be a predictor of adverse short-term outcomes in patients with STEMI. Thus, maintaining serum potassium level within normal ranges is crucial in cardiovascular diseases for preventing adverse outcomes, and a careful eye should be kept on serum potassium levels of patients throughout their period of hospital stay.

Neither systolic nor diastolic blood pressure in this study were shown to be significantly correlated to the patient outcomes. Research regarding the association of blood pressure with outcomes in AMI patients have shown mixed findings. [21, 23] A few studies revealed no conclusive evidence of a relationship between low blood pressure at admission and an increased risk of death [24], on the other hand, other research has claimed that. [25] Furthermore, we could not establish any relation between patient's heart rate at admission and adverse outcomes in our study. This finding is also in line with other research, that has also shown mixed results regarding the association between heart rate at admission and prognosis in AMI patients.[26,27] However, higher heart rates upon admission have been linked to higher risk of death in some studies.

CONCLUSION

The study results provide further evidence of the complex interplay between various factors and patient outcomes in AMI. Age proved to be a significant predictor of mortality in patients with STEMI in our study, while other factors, such as gender, serum potassium levels, blood pressure, and heart rate at admission, did not significantly impact the patient outcomes in our study. Further research may elucidate the role of these factors to improve the management and treatment practices of AMI.

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AUTHORS' CONTRIBUTION

SQM: Conceptualization of study design, literature search, Data collection, write up, proof reading. FQ: Literature search, Data collection, Data analysis, write up, Data interpretation. MAK: Organizing the conduct of paper, review of data, final comment about the finished manuscript. HJ: Data Collection, data analysis, data interpretation. AK: Data Collection, data analysis, data interpretation.

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