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Outcomes of Early Development of Hyponatremia in Acute ST-Elevated Myocardial Infarction Patients: A Study in a Tertiary Hospital

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Abstract

Background: Coronary heart disease is a global health problem and a major cause of death in both developed and developing countries. Clinical importance of hyponatremia in ST-elevated acute myocardial infarction (STEMI) is an important topic of study among present researchers.

Objective: To assess the outcomes and prognostic implications of early development of hyponatremia in-hospitalized acute ST-elevated myocardial infarction patients.

Methods: This is a prospective observational study performed in the department of Cardiology, Combined Military Hospital (CMH), Dhaka from July 2018 to June 2019.

A purposive sampling technique was used on 82 patients with ST-elevated acute myocardial infarction admitted in CCU and treated with thrombolysis. They were evaluated for serum sodium level at admission and at 48 hours after admission. Here sodium concentration <135 mmol/L is defined as Hyponartemia. Fourty one patients with hyponatremia were included in Group-I and 41 patients with normal sodium level were included in Group-II. Then the in-hospital outcome variables were analyzed.

Results: Among the study population 86.58% were male and 13.42% were female. Age range was 25 years to 74 years. Considering risk factors highest percentage of study population in group- I had hypertension (60.97%) followed by dyslipidemia (51.21%), diabetes mellitus (51.21%), history of smoking (53.60%), and family history of Coronary Artery Disease (CAD) (31.14%). There were five outcome variables such as heart failure, cardiogenic shock, arrhythmia, duration of hospital stay and death. 10 patients died in Group-I and 2 patients died in Group-II. Among the outcome variables death, heart failure and hospital stay was more in Group-I and was statistically significant. hospital outcome of study population according to serum sodium level. Considering in hospital outcome heart failure occurred in 14 patients (p= .001), arrhythmia developed in 17 patients (p=0.108), cardiogenic shock occurred in 9 patients (p=0.354) and death occurred in 10 patients (p=0.002). P-Value of heart failure and death was statistically significant.

Conclusion: Early developed hyponatremia in patients with ST-elevated acute myocardial infarction was an independent predictor of prognosis. It has been found that heart failure, duration of hospital stay and death was more in hyponatremic patients and prognosis worsen with increasing severity of hyponatremia. Plasma sodium level may serve as a simple marker to identify patients at high risk.

Keywords: Hyponatremia, In- hospital outcome, Acute STEMI, thrombolysis.

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Introduction

Coronary heart disease is a major cause of death and global health problem, both in developed and developing countries.[1] Globally those dying from cardiovascular diseases, 80 percent are in developing countries and not in the western world. Coronary heart disease has been classified as chronic stable angina, acute coronary syndrome, (ACS)and sudden death. ACS encompasses different clinical entities associated acute myocardial ischemia including ST segment elevation myocardial

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infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI) and unstable angina (UA).[2] Acute STEMI continues to be a significant public health problem in industrialized countries and is becoming an increasing by significant problem in developing countries.[3] Hyponatremia is a well-known electrolyte disorder in hospitalized patients and it can make the prognosis worse depending on their background. In congestive heart failure (CHF), hyponatremia is associated with exaggerated activation of baroreceptor-mediated hormones, including arginine vasopressin (AVP), catecholamines and the rennin angiotensin- aldosterone system.[4] In particular, the primary mechanism is the dilutional hyponatremia triggered by osmolality independent secretion of AVP. Baroreceptor mediated hormonal release reflects the severity of heart failure, worsens cardiac remodeling in it-self, and thus could be one of the independent prognostic factors in CHF.[5-8] In patients with acute myocardial infarction (AMI) and successful thrombolysis after acute STEMI, baroreceptor-mediated hormonal activation is similar to that in patients with CHF andhas a prognostic value. Hyponatremia, which developed in the earlyphase of AMI, has also been recently advocated as an important prognostic factor in several studies.[9-10] The present study had the aim to investigate the impact of hyponatremia on in hospital outcomes in patients who received successful thrombolysis after acute STEMI.

Objective:

To assess the in-hospital outcomes and prognostic implications of in acute ST-elevated myocardial infarction on effects of early development of hyponatremia.

Materials and Methods:

This prospective observational study was carried out in the department of Cardiology at Combined Military Hospital, Dhaka, Bangladesh during the period of July 2018 to June 2019. Purposive sampling was done using a structured case record form. All patients with chest pain who were admitted into the department of Cardiology of CMH, Dhaka were examined. With brief clinical history, target physical examination, ECG and Troponin-I the patients with first attack of Acute ST- segment elevation myocardial infarction were selected and thereby 82 patients who were eligible for thrombolysis were selected. Serum electrolyte of those patients were measured. The sample population was divided into two groups. Group-I: Patients with first attack of acute ST-Elevation myocardial infarction who developed hyponatraemia at 48 hours after admission. Group-II: Patients with first attack of acute myocardial infarction who had normal sodium level at 48 hours after admission. Group-I was further divided into 04 sub-groups according to the serum sodium levels. Group-la: Sodium level 130-134 mmol/L, Group-lb: sodium level 125-129 mmol/L, Group-lc: Sodium level 120-124 mmol/L, Group-ld: Sodium level <120 mmol/L. Selection of the study population was done on the basis of history taking and clinical examination of the patients and on some inclusion and exclusion criteria.

Inclusion Criteria included patients admitted into the department of Cardiology with first attack of acute ST elevated myocardial treated with thrombolytic therapy (Streptokinase).

Exclusion Criteria were patient with valvular heart disease, congenital heart disease and cardiomyopathy, patients who have major non cardiovascular disorder which causes hyponatremia such as severe renal impairment, diarrhea and vomiting, any systemic infection, patient not willing to enroll in study, patients who are not treated with thrombolytic agent after acute STEMI, clinical conditions which causes syndrome of inappropriate ADH secretion (SIADH), patients who have already hyponatremia on admission.

Before examination a detailed briefing about the purpose of the study was given to the subjects and written consents were taken for all of the study population.

Variables studied included Age, Sex, Smoking, Hypertension, Diabetes Mellitus, Dyslipidemia, F/H of CAD, Serum Electrolytes, Troponin-I, Heart failure, Arrhythmia like Atrial fibrillation, Ventricular tachycardia, Ventricular fibrillation, Cardiogenic Shock, Death. The data were processed and analyzed by computer software SPSS (Statistical package for social science) Version 20. Level of significance was considered as p value less than 0.05 ($p < 0.05$).

Results:

Total sample population were 82. Group-I (n=41) acute STEMI patient with hyponatremia. Group-II (n=41) Acute STEMI patient with normal sodium level.

Among the 82 study population the mean age of patient was 52.08±12.41 ranging from 25 to 74 years. Majority of the patients (26%) were in 50 to 59 years of age (Table-I)

Table-II shows 86.58% patients were male and 13.42% were female. There was no statistically significant differences between the sex among the study population ($p= 0.436$).

Table-III shows that distribution of study subjects by risk factors. In group-I HTN(60.97%) and diabetes(51.21%), dyslipidaemia (51.21%) are the most prevalent risk factors.

Table-IV shows division of Group-l patients according to plasma sodium level. Group-I Hyponatraemia (sodium level <135 mmol/L), Group–II (normal sodium level). Group-I further divided into 4 sub-groups. Group-Ia: Sodium level 130-134 mmol/L, Group- Ib: Sodium level 125-129 mmol/L, Group-Ic: Sodium level 120-124 mmol/L and Group-Id: Sodium level <120 mmol/L. Twenty eight patients (56%) had sodium level 130-134 mmol/L, fifteen patients (30%) had sodium level 125-129 mmol/L, five patients(10%) had sodium level 120-124 mmol/L and two patients (4%) had sodium level <120 mmol/L.

Table V shows hospital outcome of study population according to serum sodium level. Heart failure occurred in 14 patients (p= .001), arrhythmia developed in 17 patients (p=0.108), cardiogenic shock occurred in 9 patients (p=0.354) and death occurred in 10 patients (p=0.002). P-Value of heart failure and death was statistically significant.

Table-I

Distribution of subjects by age (n=82)

Age in years	Group				Total		P- Value
	Group-I (n=41)		Group-II (n=41)				
	No.	%	No.	%	No.	%	
<30	1	2.43%	1	2.43%	2	2.43%	
30-39	2	4.87%	4	9.75%	6	7.31%	
40-49	7	17.07%	12	29.26%	19	23.17%	
50-59	16	39.02%	10	24.39%	26	30.0%	
60-69	11	26.89%	11	26.89%	22	26.82%	
>70	4	9.74%	3	7.31%	7	8.53%	
Total	41	100.0%	41	100.0%	82	100.0%	
Mean ± SD	51.51±10.48		53.34±11.12		52.08±12.41		0.587

Table-II

Sex Distribution of the study group (n=82)

Sex	Group-1		Group-2		Total		P-Value
	Frequency	%	Frequency	%	Frequency	%	0.436
Male	35	85.36	36	87.80	71	86.58	
Female	6	14.64	5	13.20	11	13.42	

Table-III

Distribution of the study subject by risk factors (n=82)

	Group I, n=41		Group II, n=41		Total	P-value	Sig
	Frequency	%	Frequency	%			
Smoking	22	53.6%	21	51.21%	43	0.352	NS
HTN	25	60.97%	23	60.97%	48	0.641	NS
DM	21	51.21%	15	36.58%	36	0.321	NS
Dyslipidaemia	21	51.21%	20	48.78%	41	0.483	NS
Family H/O CAD	14	31.14%	9	21.95%	23	0.450	NS

Group-I: Patients with hyponatremia. Group-II: Patients with normal sodium level. P-value obtained by Chi-square test.

Table-IV

Distribution of Group-l by serum sodium level (n=41)

Na Level	Group-1	
	Frequency	Percentage
Group1a (Na^+ 130-134 mmol/L)	23	56.09%
Group1b (Na^+ 125-129 mmol/L)	13	31.70%
Group1c (Na^+ 120-124 mmol/L)	4	9.77%
Group1d (Na^+ <120 mmol/L)	1	42.43%
Total	41	100%

Significant at 1% level of probability ($p<0.01$)

Table-V

Distribution of the subjects by in-hospital outcome (n=82)

Outcome		Na+ Level										Total	P value	Sig.
	mmol/ L)	(Na+ >135)		(Na+130-134 mmol/L)		(Na+ 125-129 mmol/L)		(Na+ 120-124 mmol/L)		(Na+ <120 mmol/L)				
		Frequency	%	Frequenc y	%	Frequency	%	Frequenc y	%	Frequen cy	%			
Heart Failure	Yes	3	13.0.4	3	23.07	1	25.0	1	50.0	6	14.63	14	0.001	**
	No	20	86.9	10	76.92.7	3	75.0	1	50.0	34	82.92	68		
Arrhythmia	Yes	2	8.69.0	4	30.76	2	50.0	1	50.0	8	19.51	17	0.108	NS
	No	21	91.30	9	69.23	2	50.0	1	50.0	31	75.60	67		
Cardiogenic shock	Yes	2	8.69	3	23.07	2	50.0	1	50.0	1	2.40	9	0.354	NS
	No	21	51.21	10	76.92.0	2	50.0	1	50.0	39	95.12	73		
Death	Yes	2	7.1	4	33.3	1	40.0	1	50.0	2	4.0	10	0.002	**
No	21	92.9	9	66.7	3	60.0	1	50.0	38	96.0	73			

**= Significant at 1% level of probability ($p<0.01$) NS = Not significant ($p>0.05$).

Table VI shows hospital stay /days of the study population according to serum sodium level.

Table-VI

Distribution of study subject by duration of hospital stay (n=82)

Hospital Stay/day	Na+ Level										P value	Sig.
	(Na+>135 mmol/L		(Na+ 130-134 mmol/L)		(Na+ 125-129 mmol/L)		(Na+ 120-124 mmol/L)		(Na+ <120 mmol/L)			
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%		
2.00	4	17.3	2	13.30	0	0.0	0	0.0	10	24.3		
3.00	12	52.17	2	13.3	0	00.0	0	0.0	22	53.56	0.0 1	**
4.00	4	17..39	5	40.0	0	00.0	0	0.0	8	12.0		
5.00	3	10.7	6	42.0	1	100.0	2	100.0	1	4.0		
Total	23	100. 0	15	100. 0	1	100. 0	2	100.0	41	100.0		

Discussion:

Total 82 patients of acute ST-elevation myocardial infarction were selected for the study. Patients admitted in CCU of the CMH Dhaka with first attack of acute STEMI were evaluated for hyponatremia.

Among the base line characteristics age range were 25 to 74 years, mean age of patient was 52.08±12.41 ranging from 25 to 74 years. Majority of the patients(30%) were in 50 to 69 years of age.

The difference between the age groups were statistically non-significant. Considering sex 86.58% patients were male and 13.42% were female. There was no statistically significant differences between the sex among the study population ($p= 0.436$). This coincides with previous study.[11-13]

Among the important risk factors in group-I HTN (60.97%) and diabetes (51.21%), dyslipidaemia (51.21%) are the most prevalent risk factors. But they were statistically non-significant.

In Group-I patients 53.6% had history of smoking habit and 31.14% had family history of CAD.

In a previous study smoking habit was found 37% among the patient with hyponatremia in setting of acute ST-Elevation MI.[10-11]

In this study total of 10 patients died.

Regger in his study on 1982 found 20% mortality rate in their study with MI. In patient with normal sodium level death occurred in 2 patients (4%) and death occurred in patient with hyponatraemia 10 patients (20%), (P= 0.002)[14]. It coincides with this study.

In this study mortality decreases may be due to early detection and management of hyponatremia.

Hyponatremic patients were categorized in to four groups. Total 10 patients died due to various causes. So mortality increased with increasing severity of hyponatremia compared with patients having normal sodium level. Chi–square test and multivariate regression analysis on mortality was significantly higher among Group-I compared with Group- II.

A previous study done by Flear in 1979 showed in their study that relation of mortality and plasma sodium level. 7% died with normal plasma sodium level, 17% with sodium level 135- 130 mmol/L and 22% died with plasma sodium level less than130 mmol/L.[15] It coincides with this study.

Alexander et al showed in acute STEMI patients without hyponatremia had a mortality rate 6.2%.[16]

After logistic regression analysis and adjustment for other important co-variants they concluded that both hyponatremia on admission and hyponatremia developing after admission remained strong independent predictor of 30 days mortality.

In this study adverse hospital outcome other than mortality included heart failure, arrhythmia, cardiogenic shock and duration of hospital stay. Arrythmia developed in 17 patient and Heart failure in 14 patients.

Another study found that 22.7% patients developed heart failure.[14] It coincides with this study.

Heart failure developed in highest percentage in patients with sodium level <120 mmol/L. So there was a relation between hyponatremia and developing heart failure that was increasing with increased severity of hyponatremia.

Previous study showed that episodes of ventricular fibrillation occurred in relation to sodium level. They got significant ventricular fibrillation in patient with sodium level 132 mmol/L and got no arrhythmia in patients with normal sodium level.[15] It coincides with this study.

Cardiogenic shock occurred in 9 patients of study population. p-value was 0.354, was statistically non-significant.

Duration of hospital stay of the study population according to serum sodium level was statistically significant. Mortality increased with increasing severity of hyponatremia. It was statistically significant.

Other study also concluded that mortality increased with degree of hyponatremia[22]

Conclusion:

This study was done to find out the prognostic implication of hyponatremia in the setting of STEMI. Observations were done to find out the in-hospital outcome of hyponatremic patients and patients with normal sodium level at 72 hours after acute ST-elevation myocardial infarction treated by thrombolysis. Among the parameters of outcome, heart failure, hospital stay and death was statistically significant but arrhythmia and cardiogenic shock was not significant. This study concluded that heart failure, hospital stay and death occur more in hyponatremic patients than patients with normal sodium level and increasing disease severity with increasing severity of hyponatremia. So early developed hyponatremia in patients with ST-elevation acute myocardial infarction treated by thrombolysis considered to be an important predictor of prognosis.

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