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Original Article

Association of Admission Blood Glucose and in-hospital Outcome after Primary Percutaneous Coronary Intervention in Acute Myocardial Infarction

Md. Abdullah-Al- Mamun, M Atahar Ali, M G Azam, Shaila Nabi, Mir Jamal Uddin, Sabina Hashem, Sharadindu Shekhar Roy, Pijous Biswas, Mozammel Haque, Jamil Taufik Imam.

Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka

Key Words :
Glucose, Acute STEMI, Primary PCI, In-hospital outcome.

Abstract

Background: *The effects of glucose abnormalities on in-hospital outcome after Primary Percutaneous Coronary Intervention (PCI) in acute STEMI remain unclear. The study assessed the relationship of admission blood glucose level to in-hospital outcome in patients presenting with a STEMI and treated with Primary PCI.*

Methods: *This prospective study was conducted in the Department of Cardiology, NICVD, Dhaka Bangladesh from May 2018 to April 2019.Total 80 patients with admission normal blood glucose and hyperglycemia with acute STEMI underwent Primary PCI were considered for the study.*

Results: *Mean age of the studied patient was 44.0±9.1 years ranging from 30 to 61 years and the mean age of the group II patients was 48.0±7.8 years ranging from 37 to 61 years. It was found that acute heart failure occurred 10% in group II and 2.5% in group I patients with statistically significant (p=0.04) difference. Cardiogenic shock observed 2.5% patients in group II and 2.5% patients in group I with statistically no significant (p=0.56) difference. Significant arrhythmias were found 5% patients in group II and 2.5% in group I patients with statistically no significant (p=0.40) difference. No myocardial infarction and CVA stroke were developed in both group of patients. In group II, 2.5% patients died and no patients died in group I with statistically no significant (p=0.31) difference.*

Conclusion: *Admission hyperglycemia is a predictor of poor prognosis in STEMI patients undergoing primary PCI.*

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Introduction:

Diabetes mellitus (DM) is an established major cardiovascular risk factor associated with increased prevalence of coronary artery disease (CAD). Patients with diabetes often have numerous concomitant cardiac risk factors with a higher incidence of acute myocardial infarction (AMI) and congestive heart failure (CHF). Poor glycemic control and insulin resistance are associated with significant endothelial cell dysfunction, procoagulability, and diffuse multi-vessel CAD.[1] Patients either with or without a prior history of DM may present with hyperglycemia during ACS. Among patients with no prior history of DM, hyperglycemia may reflect previously undiagnosed diabetes, preexisting carbohydrate intolerance, stress-related carbohydrate intolerance, or a combination of these.[2] Several studies have reported an association between elevated blood glucose upon admission and subsequent increased adverse events including CHF, cardiogenic shock and death.[3] In-hospital death risk of AMI patients without DM was about 2 to 4 times higher in patients with hyperglycemia than in those without hyperglycemia.[4] Higher myocardial necrotic

Address of Correspondence: Dr. Md. Abdullah-Al- Mamun, Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh. email: mamundrnicvd2017@gmail.com

markers and lower left ventricular ejection fraction (LVEF) in patients of AMI without DM with hyperglycemia.[5]

Hyperglycemia itself is arrhythmogenic, due to prolongation of QT interval that may favor the occurrence of arrhythmias like ventricular tachycardia/ventricular fibrillation, atrial fibrillation, 2nd and 3rd degree AV block with potentially fatal outcome more in patients of AMI without DM[6]. Hyperglycemia activates thrombosis. Namely acute blood sugar level increase induces alteration in coagulation by shortening of fibrinogen half-life increases of pro-thrombin fragments and factor VII, together with enhanced platelet aggregation resulting in thromboembolic manifestation.[7]

Although the diagnosis of diabetes may not be made on the basis of a single blood glucose value, casual blood glucose levels of 200 mg/dl (≥11.1 mmol/l) or more suggest the existence of diabetes, and as a consequence, the risk of mortality after AMI in this group may be disproportionately high and should be evaluated separately.[8] Another recent report showed that in patients without a history of DM, there was a linear relation between admission glucose and in hospital mortality. Nondiabetic patients with a glucose level <6 mmol/l had the lowest mortality (2.5%). As admission glucose increased by 1mmol/l, mortality increased by (13% to 21%). In patients with a history of DM, however, there was a U-shape relation between glucose and mortality. Mortality was lowest in diabetic patients with moderate hyperglycemia. Not only severe hyperglycemia but also euglycemia were associated with higher mortality than moderate hyperglycemia in patients with diabetes.[9-10] Primary PCI is generally preferable to fibrinolytic therapy when time until treatment is short and the patient arrives at a high-volume, well-equipped center with experienced operators and support staff. When compared with fibrinolysis, primary PCI produces higher rates of TIMI grade 3 flow and patent infarct-related arteries and lower rates of recurrent ischemia, urgent revascularization, recurrent MI, and death. Primary PCI, when successful. So, results in early hospital discharge and return to activities. [11] Approximately 95% of patients who are treated with primary PCI obtain complete reperfusion versus 50% to 60% of patients who are treated with fibrinolytics. Primary PCI is also associated with lower risk of stroke than treatment with fibrinolysis, and diagnostic angiography quickly defines coronary anatomy, LV function, and mechanical complication.[12]

The widespread use of primary PCI dramatically improved the clinical outcomes after acute STEMI, becoming the preferred treatment of this condition.[13] However, the invasive mechanical reperfusion strategies have their own complications. Major complications include death, MI, or stroke, and minor complications include transient ischemic attacks, vascular complications, contrast induced nephropathy, and angiographic complications. There was no such study carried out in our country to see the association of admission blood glucose and in-hospital outcome after primary PCI in acute myocardial infarction. This study aimed to explore the impact of hyperglycemia on in-hospital outcome of patients with AMI performed primary PCI.

Methods:

This prospective observational study was done in the Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh from May 2018 to April 2019. A total of 80 patients who got admitted into CCU and diagnosed as a case of acute MI with normal or high blood glucose and underwent primary PCI were studied and the sampling was purposive type. The patients with history of DM, h/o of taking anti diabetic drugs, previous coronary artery bypass graft (CABG) or PCI, peripheral vascular disease, cardiomyopathies and the patients with cardiogenic shock, acute heart failure, cardiac arrest at presentation were excluded in thew study. The patients with any severe comorbidities (renal disease, previous stroke, COPD, anemia, malignancy, bleeding disorder) also were excluded.

All patients of the study population were evaluated clinically at first presentation. Demographic data such as, age, sex, occupation was recorded. Risk factors profile including smoking, hypertension, diabetes, dyslipidemia and family history of coronary artery disease was noted. A 12-lead resting ECG was done at a paper speed of 25 mm/s and 10mm standardization at admission. Proper medications were given in CCU including loading dose of anti-platelets and lipid lowering agents. Proper counseling and informed written consent for coronary angiogram was taken and coronary angiogram (CA) was done by transfemoral or trans radial approach. The patients were divided into two groups. Group-I was named normoglycemic group and group-II was named hyperglycemic group according to normal and high blood glucose respectively. In the primary PCI, the goal was to maintain the door to balloon time within 90 minutes. Primary PCI was limited to culprit vessel revascularization, unless the patient was in cardiogenic shock or if the patient had persistent symptoms after PCI to the culprit vessel. After the procedure patient was transferred to CCU and followed up to see the outcome. TIMI grade of coronary flow after primary PCI, cardiogenic shock, acute heart failure, arrhythmia, repeat revascularization, stroke, In-hospital mortality, vascular complications, angiographic complications (dissection, perforation) and failed primary PCI were assessed for in hospital outcome in each group. Data analysis was performed using SPSS version 20. Categorical variables were expressed as frequency and percentage and continuous variables as mean and standard deviation. Data was analyzed by student's t-test, chi-square test and Fisher exact test. Multivariate logistic regression analysis was done to assess the effect of independent variable and adjustment was done for confounding variable. A p-value of less than 0.05 was considered statistically significant.

Results:

The mean age of the studied patients was 46±8.6 years. The mean age of the group I patients (normoglycemic group) was 44.0±9.1 years and the mean age of the group II (hyperglycemic group) patients was 48.0±7.8 years. No significant difference between the mean age (Table-I).

In group I patients, 36 (90%) patients were male and 4 (10%) patients were female. In group II, 40 (100%) patients were male and none were female. Male female ratio was 19:1. Male patients were predominant in the study. No significant (p=0.11) was found between two groups in terms of sex distribution (Fig 1).

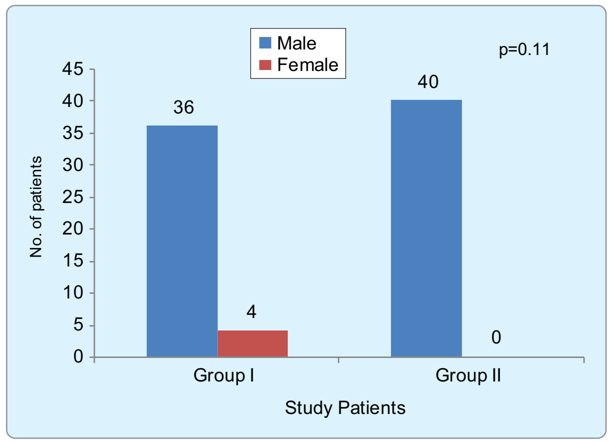

Figure 1: *Sex distribution among the study patients (n=80).*

The mean body mass index of the group I was 24.4±1.7 (kg/m^2) and that of group II was 26.2±1.7 (kg/m^2). BMI demonstrates that patients of group II were more over weighted than group I patients. It was observed that there was no statistically significant difference between the groups regarding BMI (p<0.08) (Table-II).

Table-I

Age distribution of the study patients (n=80).

Age in years	Group I (n=40)		Group II (n= 40)		p value
	Number	%	Number	%	
30 – 39	14	35.0	8	20.0	
40 – 49	14	35.0	12	30.0	
50 – 59	10	25.0	18	45.0	
60 - 69	2	5.0	2	5.0	
Mean ± SD(Range)	44.0±9.1(30-61)		48.0±7.8(37-61)		0.06ns^s

Group I: Normoglycemia Patient with adverse outcome

Group II: Hyperglycemia Patient with adverse outcome

It was found that acute heart failure occurred 10% in group II and 2.5% in group I patients with significant difference (p=0.04). Cardiogenic shock observed 2.5% patients in group II and 2.5% patients in group I with statistically no significant difference (p=0.56). Significant arrhythmias were found 5% patients in group II and 2.5% in group I patients with no significant difference (p=0.40). In group II, 2.5% patients died and no patients died in group I with no significant difference (p=0.31) (Table-IV).

20% of 40 patients in group II experienced adverse in-hospital outcome, on the contrary 7.5% of the patients in group I did have such experience. So, the table revealed that in-hospital outcome significantly more (p=0.02) in hyperglycemia group than normoglycemia group (Table-V).

The table expresses site of MI in study patients and it was found that 65% patients in group II and 55% patients in group I had anterior MI with statistically insignificant association (p=0.36). Inferior MI was also observed in group I and group II as 45% and 35% with statistically insignificant association (p=0.36).

The procedural outcome as described by TIMI flow showed that TIMI flow 0 and I was not found in any patients of each group. But the group I showed TIMI flow II in 12.5% patients and group-II showed TIMI flow III in 87.5% patients. Group -II showed TIMI flow II in 17.5% patients and group-II showed TIMI flow III in 82.5% patients. The difference was not statistically significant (Table-VII). The produral complications were more or less occurred in group II than group I with no statistical association (p>0.05). It also indicates hemorrhage and hematoma were occurred marginally more in group II than group I with p value 0.16 and 0.07 respectively but failed to reach the level of significance. (Table-VII).

The multivariate logistic regression analysis of Odds Ratio for characteristics of the subjects likely to cause of adverse in-hospital outcome. The age e”50 yrs, BMI (over weight) and hyperglycemia are all entered into the model to assess as the predictors for the developing of adverse in-hospital outcome and it revealed that the variable hyperglycemia was found to be significantly associated with adverse in-hospital outcome with OR being 10.39 (Table-VIII).

Table-II

Risk factors of the study patients (n=80).

Risk Factors	Group I (n= 40)		Group II (n=40)		p value
	Number	%	Number	%	
Smoking	28	70.0	38	95.0	0.07^{ns}
Hypertension	4	10.0	6	15.0	0.73^{ns}
Dyslipidaemia	28	70.0	32	80.0	0.30^{ns}
Family H/O of premature CAD	10	25.0	16	40.0	0.15^{ns}

Group I: Normoglycemia patient with adverse outcome
Group II: Hyperglycemia patient with adverse outcome

Table-III

BMI status of the study patients (n=80).

Body Mass Index (kg/m^2)	Group I (n= 40)		Group II (n=40)		p value
	Number	%	Number	%	
Normal (18.5-24.9)	24	60.0	6	15.0	
Overweight (25-29.9)	16	40.0	34	85.0	
Mean ± SD	24.4±1.7		26.2±=1.7		$<0.08^{ns}$

Group I: Normoglycemia patient with adverse outcome.
Group II: Hyperglycemia patient with adverse outcome.
The mean RBS level was 9.1± 1.2 mmol/l in group-I and 14.2± 1.5 mmol/l in group-II. It was observed significantly higher in group II than group I patients. (Table-III).

Table-IV

Biochemical status of the study patients (n=80).

Biochemical parameters	Group I (n=40) Mean SD	Group II (n= 40) Mean ± SD	P value
RBS mmol/l	9.1±1.2	14.2±1.5	<0.001^{s}

Group I: Normoglycemia patient with adverse outcome.
Group II: Hyperglycemia patient with adverse outcome.

Table-V

Distribution of pattern of in-hospital outcome of study patients (n=80)

In-hospital outcome	Study patients				p value
	Group I (n=40)		Group II (n=40)		
	N	%	No	%	
Acute heart failure	1	2.5	4	10.0	0.04^{s}
Cardiogenic shock	1	2.5	1	2.5	0.56^{ns}
Significant Arrhythmia	1	2.5	2	5.0	0.40^{ns}
Vascular complications	1	3.3	8	18	0.16^{ns}
TIMI Flow					
II	5	12.5	7	17.5	0.53^{ns}
III	35	87.5	33	82.5	0.53^{ns}
Death	0	0.0	1	2.5	0.31^{ns}

Group I: Normoglycemia patient with adverse outcome
Group II: Hyperglycemia patient with adverse outcome

Table-VI

Comparison of patients by in-hospital adverse outcome (n=80).

Adverse in-hospital outcome	Group I (n=40)		Group II (n= 40)		P value
	Number	%	Number	%	
Present	3	7.5	8	20.0	0.02^{s}
Absent	37	92.5	32	80.0	

Group I: Normoglycemia patient with adverse outcome
Group II: Hyperglycemia patient with adverse outcome

Table-VII

Distribution of the study patients according to site of MI (n=80).

Site of MI	Group I (n= 40)		Group II (n=40)		p value
	Number	%	Number	%	
Anterior	22	55.0	26	65.0	0.36^{ns}
Inferior	18	45.0	14	35.0	0.36^{ns}

Group I: Normoglycemia patient with adverse outcome
Group II: Hyperglycemia patient with adverse outcome.

Table-VIII

Procedural outcome of the study patients according to TIMI flow after primary PCI (n=80).

TIMI flow	Group I (n=40)		Group II (n= 40)		P value
	Number	%	Number	%	
0	0	0.0	0	0.0	
I	0	0.0	0	0.0	
II	5	12.5	7	17.5	0.53ns
III	35	87.5	33	82.5	0.53ns

Group I: Normoglycemia patient with adverse outcome.
Group II: Hyperglycemia patient with adverse outcome.

Table -IX

Vascular complications of the study patients (n=80)

Outcomes variables	Group I (n = 40)		Group II (n = 40)		Total (n=80)		p value
	Number	%	Number	%	Number	%	
Hemorrhage	1	3.3	4	8.0	5	6.3	0.16^{ns}
Hematoma	0	0.0	3	7.5	3	3.8	0.07^{ns}
A-V fistula	0	0.0	0	0.0	0	0.0	
Infection	0	0.0	1	2.5	1	1.3	0.31^{ns}

Group I: Normoglycemia patient with adverse outcome.
Group II: Hyperglycemia patient with adverse outcome.

Table-X

Multivariate regression analysis of adverse in-hospital outcome with risk factors.

Variables of interest	Standardized (β) coefficient	Odds Ratio (OR)	95% CI of β	p value
Age ≥50 yrs	-0.386	0.68	0.160 – 2.883	0.60^{ns}
BMI (Over weight)	0.750	2.11	0.425 – 10.530	0.36^{ns}
Hyperglycemia	2.341	10.39	1.648 – 65.552	0.01^{s}

Discussion:

Stress Hyperglycemia is a transient increase in blood glucose concentration during acute physiological illness, represents two distinct populations: those with undiagnosed diabetes or impaired glucose tolerance, and those who develop hyperglycemia as the result of the severe stress. Numerous studies have shown that stress hyperglycemia was common in acute critically illnesses even in patients without diabetes mellitus. Hyperglycemic patients with AMI present more extensive myocardial necrosis than normoglycemic. Larger myocardial necrosis increases the risk of congestive heart failure and mortality and other in hospital adverse outcomes[14]. Acute blood glucose level increase in patients with AMI leads to electrophysiological alteration that may favor the occurrence of arrhythmia with potentially fatal outcome. Hyperglycemia itself is arrhythmogenic due to prolongation of QT interval, even in healthy subjects. The effects of glucose abnormalities on in-hospital outcome after Primary Percutaneous Coronary Intervention (PCI) in acute STEMI still remains unclear. This study assessed the relationship of admission blood glucose level to in-hospital outcome in patients presenting with a STEMI and treated with Primary angioplasty. We divided the study population into two groups named normoglycemia and hyperglycemia according to normal and high blood glucose respectively. The study population was AMI patients who underwent primary PCI. The mean age of the studied patients was 46±8.6 years ranging from 30 to 61 years. The mean age of hyperglycemic group was higher than normoglycemic group which was statistically significant (p=0.03). It was found that among the normoglycemic patients, highest percentage were in the range of 30-39 and 40-49 years (35%) followed by 50-59 years 25% and 5% patients in age group of 60-69 years and hyperglycemic group, 45% were in the age group of 50-59 years, 30% patients in age group 40-49 years, 20% patients in age groups 30-39 years and 5% patients were in the age range of 60-69 years. No significant difference was found between two groups in terms of sex distribution. Among the studied patients, highest percentage had history of smoking (95%) followed by dyslipidemia (80%) diabetes mellitus (50%), family history of CAD (40%) and hypertension (15%) in hyperglycemic group and only smoking was found to be significantly higher in this group than normoglycemic group (p=0.006). Studies describe high arterial blood pressure was a risk factor for coronary artery disease and increases the risk of complications after acute coronary syndrome. [15-16] However, we did not find significant differences in level of blood pressure between the two groups. The mean RBS level was observed significantly higher in hyperglycemic group than normoglycemic group with statistically significant difference (p<0.001). No statistical difference (p=0.28) was found between two groups regarding mean serum creatinine level. The serum electrolyte imbalanced was observed between the study groups with statistically significant differences (p>0.05). We found diabetes to increase the risk of MACE in patients who received primary PCI for acute STEMI. Various studies have also highlighted the short-term (during hospitalization and the first year after the disease) and long-term effects of diabetes on the MACE. [17-19] Diabetes can thus be considered as a risk factor for MACE after primary PCI. Mean body mass index of normoglycemic group was 24.4±1.7 (kg/m2) and that of hyperglycemic group was 26.2±1.7 (kg/m2). BMI demonstrates that patients of hyperglycemic group are more over weighted than normoglycemic patients. Acute heart failure occurred 10% in hyperglycemic group and 2.5% in normoglycemic group with significant association (p=0.04). Cardiogenic shock observed 2.5% patients in hyperglycemic group and 2.5% patients in normoglycemic group with statistically no significant association (p=0.56). Significant arrhythmias were found 5% patients in hyperglycemia group and 2.5% in normoglycemic group with no significant association (p=0.40). No MI and CVA were occurred in both group of patients. In hyperglycemic group, 2.5% patients died and no patients died in normoglycemic group. 20% of 40 patients in hyperglycemic group experienced adverse in-hospital outcome, on the contrary 7.5% of the patients in normoglycemic group did have such experience. The in-hospital outcome significantly more (p=0.02) in hyperglycemia group than normoglycemia group. Major adverse cardiac events were found 20% patients in hyperglycemic group and 5% patients in normoglycemic group. Multivariate logistic regression analysis showed hyperglycemia was to be significantly associated with adverse in-hospital outcome with OR being 10.39.

Conclusion:

An elevated admission blood glucose level is significantly associated with an increase in in-hospital adverse outcome in patients who are admitted with an ST- segment elevation myocardial infraction and treated with a Primary angioplasty.

Conflict of Interest - None.

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