

Short Term Outcome of Hyperglycemia in Off Pump Coronary Artery Bypass Graft Surgery in Diabetic versus Non-Diabetic Patients

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Abstract

Background: Coronary Heart Disease (CHD) is the most common form of heart disease and the single most important cause of premature death in all regions of the world. Diabetes Mellitus (DM) is a recognized risk factor for the development of the CAD and an independent risk factor for mortality from myocardial infarction. Cardiovascular mortality rate among diabetes is 3 times higher than in the standard population. In this study our aim was to see the short-term outcome of hyperglycemia in non-diabetic and diabetic patients following off pump CABG.

Method: This observational study was done in Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, during the period of January 2013 to November 2014. Total sample size was 100 which were divided into two groups (diabetic and non-diabetic). Patients with CHD diabetic and non-diabetic undergoing elective Off Pump Coronary Artery Bypass Graft (CABG) were purposively selected for this study. Fasting blood glucose, blood glucose two hours after breakfast and HbA1c were measured before surgery and fasting blood glucose were measured post operatively. Renal dysfunction was measured by preoperative and post-operative serum creatinine and blood urea. Appropriate statistical test with SPSS software were used to test the significance difference between demographical, clinical variables.

Result: The incidence of hyperglycemia was 96.7% in non-diabetic patients after off pump CABG, among them 53.3% were severely hyperglycemic. Serum creatinine and blood urea were found significantly higher in diabetic group in comparison to non-diabetic group. Wound infection compared between two study group, which were found no significant different in diabetic group in comparison to non-diabetic group.

Conclusion: Hyperglycemia occurs in per-operative and post-operative period in diabetic patients and most of non-diabetic patients. Hyperglycemia is more marked in early post-operative period and short-term outcome of hyperglycemia is better in non-diabetic patients than diabetic patients following off pump CABG.

Keywords: CHD, Diabetic Mellitus, CABG

(JNHFB 2019; 8 : 62-67)

Introduction

Incidence of Ischemic Heart Disease (IHD) is increasing in developing countries including Bangladesh. In 1975, the incidence of IHD in Bangladesh was reported to be 3.3 per thousand¹ and that in 1985 was 14 per thousand². According to the latest WHO data published in April 2011 Coronary Heart Disease Deaths in Bangladesh reached 163,769 or 17.11% of total deaths. Bangladesh ranks 25th position in the world in respect to cause of death due to coronary artery disease³.

Diabetes mellitus is a recognized risk factor for the development of the CAD and an independent risk factor for

mortality from myocardial infarction⁴. Cardiovascular mortality rate among diabetes is 3 times higher than in the standard population⁵. Hyperglycemia is commonly present in the perioperative period in patients undergoing cardiac surgery in both diabetic and non-diabetic patients⁶. Hyperglycemia in the immediate postoperative period remains an independent predictor and may be a causal factor in Deep Sternal Wound Infection (DSWI) in diabetic patients⁷.

Over the last decade, the incidence of diabetes mellitus has increased markedly in developed countries. Patient's preoperatively diabetic status lead to perioperative clinical management, including active and continuous blood glucose control with improved clinical outcome⁸. Derangement of glucose metabolism after surgery is not specific to patients with DM. It has been reported that up to 90% of those

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without DM had problems with their blood glucose homeostasis as a result of various surgical stresses⁹.

Patients admitted and diagnosed with diabetes mellitus (Fasting blood glucose [FBG] >126 mg/dl)[7.0 mmol/L] or treated with oral anti diabetic agents or with insulin before their admission were assessed as having known diabetes. Depending on their FBG level, the remaining patients were classified either as having undiagnosed diabetes or as having no diabetes (FBG <126 mg/dl)[7.0 mmol/L]. These groups of patients were compared in terms of their perioperative incidence and short-term outcome of hyperglycemia following off pump coronary artery bypass grafting surgery in diabetic versus non diabetic patients.

Materials and Methods

This observational study conducted in the Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, during the period of January 2013 to November 2014. Purposively selected 100 undergone elective CABG were divided into two groups according to diabetic and non-diabetic. Fasting blood glucose, blood glucose two hours after breakfast and HbA1c were measured before surgery. Renal dysfunction was measured by preoperative and post-operative serum creatinine and blood urea. Wound swab for culture and sensitivity if wound infection present. The permission from the institutional review board and informed written consent from all patients was obtained for this study. Patients admitted for off pump coronary artery bypass grafting that fulfills the selection criteria were enrolled in the study. All patients were premedicated with tablet midazolam 7.5 mg orally the night before surgery. Standard anesthetic technique including induction, maintenance and recovery was followed. Both the group were operated by same surgical team. All patients' blood sample was collected from arterial line for blood glucose measurement. Blood glucose level were measured preoperatively, 3 times during surgery and postoperatively 4 times, immediately after patient shifted to ICU and at the sixth, twelfth, and twenty-fourth postoperative hours. Serum creatinine and blood urea level were measured preoperatively and during 1st, 3rd and 7th post operative day. Wound swab was taken from infected site with sterile swab stick. In post operative period normal and Hartmann's saline was infused in both groups of patients and glucose containing fluid was avoided. All diabetic patients in preoperative and postoperative period in case of hyperglycemia were managed with short acting human insulin according to Portland protocol with continuous intravenous insulin infusion and in non-diabetic patients in case of hyperglycemia were managed with short acting human insulin according to Portland protocol with continuous intravenous insulin infusion when blood glucose ≥ 11.1 mmol/L. Statistical analysis was conducted on SPSS (Statistical package for the social science) latest version-22. Chi-square, unpaired and paired t-test student's t-test were

used to test the significant difference between demographic, clinical variables. The level of significance was defined as p value <0.05.

Results:

In the present study 27(67.50%) in diabetic group and 30(50.0%) were in non-diabetic group were in the age group of 51-75 years and 13(32.5%) were in diabetic group and 30(50.0%) were in non-diabetic group were in the age group of 31-50 years. Mean \pm SD of age of patients in diabetic group and non-diabetic group were 55.95 \pm 9.17 years and 52.65 \pm 9.04 years respectively. Difference between two groups is not statistically significant (p, 0.078). Males were predominant in both groups, which were 34(85.0%) and 57(95.0%) in diabetic group and non-diabetic group respectively. The difference between the two groups is not statistically significant (p = 0.087). In diabetic group out of 40 patients 37(92.5%) had hypertension, 24(60%) were smoker, 28(70.0%) had hyperlipidemia and 2(5.0%) had obesity. On the other hand, in non-diabetic group out of 60 patients 50(83.3%) had hypertension, 35(58.3%) were smoker, 32(53.3%) had hyperlipidemia and 2(3.3%) had obesity. The difference between the two groups is not statistically significant (Table 1).

Mean \pm SD of fasting blood glucose were 6.27 \pm 1.26 mmol/L and 5.42 \pm 0.92 mmol/L in diabetic group and non-diabetic group respectively. Mean \pm SD of blood glucose 2 hours after breakfast were 9.85 \pm 1.79 mol/L and 8.24 \pm 1.30 mmol/L in diabetic group and non-diabetic group respectively. Mean \pm SD of HbA1c was 6.87 \pm 1.11% and 5.75 \pm 0.57% in diabetic group and non-diabetic group respectively. There is significant difference between two groups in preoperative fasting blood sugar, blood sugar 2 hours after breakfast and HbA1c (Table 2).

In diabetic group mean \pm SD of fasting blood glucose were 6.55 \pm 1.22 mmol/L pre-operatively, 8.63 \pm 1.69 mmol/L in 1 hour after induction, 9.81 \pm 3.02 mmol/L in 2 hours after induction, 11.02 \pm 3.82 mmol/L in 3 hours after induction, 12.33 \pm 3.12 mmol/L after arrival in ICU, 11.23 \pm 3.25 mmol/L 6 hours after arrival in ICU, 10.60 \pm 2.67 mmol/L 12 hours after arrival in ICU, 10.17 \pm 2.03 mmol/L 24 hours after arrival in ICU in diabetic group respectively. There was significant difference of pre-operative blood glucose with per-operative and post-operative blood glucose in diabetic patients. All diabetic group patients were hyperglycemic in per-operative and post-operative period. In non-diabetic group patients mean \pm SD of fasting blood glucose were 5.56 \pm 1.17 mmol/L pre-operatively, 7.53 \pm 1.28 mmol/L in 1 hour after induction, 7.93 \pm 1.35 mmol/L in 2 hours after induction, 8.50 \pm 1.52 mmol/L in 3 hours after induction, 9.45 \pm 1.91 mmol/L after arrival in ICU, 8.90 \pm 1.70 mmol/L 6 hours after arrival in ICU, 8.70 \pm 1.56 mmol/L 12 hours after arrival in ICU and 8.23 \pm 1.74 mmol/L 24 hours after arrival in ICU in non-diabetic group

respectively. There was significant difference of pre-operative blood glucose with per-operative and post-operative blood glucose in non-diabetic patients (Table 4).

In diabetic group and non-diabetic group mean \pm SD of serum creatinine pre-operatively were 1.09 \pm 0.16 mg/dl and 1.05 \pm 0.19 mg/dl respectively. On 1st post-operative day that were 1.36 \pm 0.23 mg/dl and 1.28 \pm 0.13 mg/dl in diabetic group and non-diabetic group respectively. On 3rd post-operative day that were 1.28 \pm 0.14 mg/dl and 1.20 \pm 0.13 mg/dl in diabetic group and non-diabetic group respectively and on 7th post-operative day that were 1.18 \pm 0.13 mg/dl and 1.10 \pm 0.12 mg/dl in diabetic group and non-diabetic group respectively. There was no significant difference between two groups preoperatively but there was statistically significant difference between two groups postoperatively (Table 5).

In diabetic group mean \pm SD of serum creatinine were 1.09 \pm 0.16 mg/dl in pre-operatively, 1.36 \pm 0.23 mg/dl in 1st post-operative day, 1.28 \pm 0.14 mg/dl in 3rd post-operative day and 1.19 \pm 0.14 mg/dl in 7th post-operative day in diabetic group respectively. There was significant difference of pre-operative serum creatinine with 1st, 3rd and 7th post-operative day in diabetic patients. In non-diabetic group mean \pm SD of serum creatinine were 1.05 \pm 0.19 mg/dl in pre-operatively, 1.28 \pm 0.13 mg/dl in 1st post-operative day, 1.20 \pm 0.13 mg/dl in 3rd post-operative day and 1.10 \pm 0.12 mg/dl in 7th post-operative day in non-diabetic group respectively. There was significant difference of pre-operative serum creatinine with 1st, 3rd and 7th post-operative day in non-diabetic patients (Table 6).

In the present study comparison of renal dysfunction (serum creatinine > 1.37 mg/dl) between study groups in different post-operative day showed 22(55.0%) patients and 21 (35.0%) patients in diabetic group and non-diabetic group respectively in 1st post operative day, 13(32.50%) patients and 9(15.0%) patients in diabetic group and non-diabetic group respectively in 3rd post operative day. 6(15.0%) patients and 2(3.3%) patients in diabetic group and non-diabetic group respectively in 7th post operative day had renal dysfunction. The difference between the two study groups is statistically significant in 1st, 3rd, 7th post-operative day (Table 7).

In diabetic group and non-diabetic group mean \pm SD of pre-operative blood urea were 28.25 \pm 7.88 mg/dl and 25.50 \pm 7.36 mg/dl respectively. In 1st post-operative day that were 42.82 \pm 7.40 mg/dl and 39.78 \pm 6.54 mg/dl, in 3rd post-operative day 36.63 \pm 7.45 mg/dl and 33.70 \pm 5.18 mg/dl, in 7th post-operative day were 32.33 \pm 6.86 mg/dl and 29.05 \pm 4.95 mg/dl respectively. There was no significant difference between two groups pre-operatively but there was statistically significant difference between two groups post-operatively (Table 8). Wound infections were present

in 3(7.5%) patients and 3(5.0%) patients in diabetic group and non-diabetic group respectively. The difference between the two groups is not statistically significant ($p = 0.606$) (Table 9).

Table 1: Distribution of characteristics of the study population

Variables	Groups		p value
	Group I (n=40) Frequency (%)	Group II (n=60) Frequency (%)	
Age group (years)			
30-50	13(32.5%)	30(50.0%)	
51-75	27(67.5%)	30(50.0%)	
Mean±SD (Range)	55.95±9.17 (36-75)	52.65±9.04 (38-75)	0.078 ^{ns}
Gender			
Male	34(85.0%)	57(95.0%)	0.087 ^{ns}
Female	06(15.0%)	03(5.0%)	
Risk factors			
Hypertension	37(92.5%)	50(83.3%)	0.182 ^{ns}
Smoking	24(60.0%)	35(58.3%)	0.868 ^{ns}
Hyperlipidemia	28(70.0%)	32(53.3%)	0.096 ^{ns}
Obesity	02(05.0%)	02(03.3%)	0.201 ^{ns}

Table 2: Comparison of preoperative blood glucose between study groups

Blood glucose	Groups		p value
	Group I (n=40)	Group II (n=60)	
Fasting blood glucose (mmol/L)	6.27 \pm 1.26	5.42 \pm 0.92	<0.001 ^s
2 hrs after breakfast (mmol/L)	9.85 \pm 1.79	8.24 \pm 1.30	<0.001 ^s
HbA1c (%)	6.87 \pm 1.11	5.75 \pm 0.57	<0.001 ^s

Data were expressed as Mean \pm SD. p value measured by unpaired student's t-test, level of significance was <0.05. (s = significant, ns = not significant)

Table 3: Comparison of pre-operative, per-operative and post-operative blood glucose between study groups

Blood glucose (mmol/L)	Groups		p value
	Group I (n=40)	Group II (n=60)	
Pre-operative	6.55 \pm 1.22	5.56 \pm 1.17	<0.001 ^s
1 hr after induction	8.63 \pm 1.69	7.53 \pm 1.28	<0.001 ^s
2 hrs after induction	9.81 \pm 3.02	7.93 \pm 1.35	<0.001 ^s
3 hrs after induction	11.02 \pm 3.82	8.50 \pm 1.52	<0.001 ^s
After arrival in ICU	12.33 \pm 3.12	9.45 \pm 1.91	0.013 ^s
After 6 hrs in ICU	11.23 \pm 3.25	8.90 \pm 1.70	<0.001 ^s
After 12 hrs in ICU	10.60 \pm 2.67	8.70 \pm 1.56	<0.001 ^s
After 24 hrs in ICU	10.17 \pm 2.03	8.23 \pm 1.74	<0.001 ^s

Data were expressed as Mean \pm SD. p value measured by unpaired student's t-test, level of significance was <0.05. (s = significant)

Table 4: Comparison of pre-operative blood glucose with per-operative and post-operative blood glucose among diabetic patients (Group-I) (n=40) and among non-diabetic patients (Group II)

Blood glucose (mmol/L) on	Groups			
	Group I		Group II	
	Mean±SD	P value	Mean±SD	P value
Preoperative	6.55±1.22		5.56±1.17	
1hr after induction	8.63±1.69	<0.001 ^s	7.53±1.28	<0.001 ^s
Preoperative	6.55±1.22		5.56±1.17	
2hrs after induction	9.81±3.02	<0.001 ^s	7.93±1.35	<0.001 ^s
Preoperative	6.55±1.22		5.56±1.17	
3 hrs after induction	11.02±3.82	<0.001 ^s	8.50±1.52	<0.001 ^s
Preoperative	6.55±1.22		5.56±1.17	
After in ICU	12.33±3.12	<0.001 ^s	9.45±1.91	<0.001 ^s
Preoperative	6.55±1.22		5.56±1.17	
After 6hrs in ICU	11.23±3.25	<0.001 ^s	8.90±1.70	<0.001 ^s
Preoperative	6.55±1.22		5.56±1.17	
After 12 hrs in ICU	10.60±2.67	<0.001 ^s	8.70±1.56	<0.001 ^s
Preoperative	6.55±1.22		5.56±1.17	
After 24 hrs in ICU	10.17±2.03	<0.001 ^s	8.23±1.74	<0.001 ^s

Data were expressed as Mean ± SD. p value measured by unpaired student's t-test, level of significance was <0.05. (s = significant, ns = not significant)

Table 5: Comparison of serum creatinine between study groups

Serum creatinine (mg/dl) on	Groups		p value
	Group I (n=40)	Group II (n=60)	
Preoperative	1.09±0.16	1.05±0.19	0.281 ^{ns}
1 st POD	1.36±0.23	1.28±0.13	0.038 ^s
3 rd POD	1.28±0.14	1.20±0.13	0.003 ^s
7 th POD	1.18±0.13	1.10±0.12	0.002 ^s

Data were expressed as Mean ± SD. p value measured by unpaired student's t-test, level of significance was <0.05. (s = significant, ns = not significant)

Table 6: Comparison of pre-operative serum creatinine with 1st, 3rd and 7th post-operative day among diabetic patients (Group-I) (n=40) and among non-diabetic patients (Group-II) (n=60)

Serum creatinine (mg/dl) on	Groups			
	Group I		Group II	
	Mean±SD	P value	Mean±SD	P value
Preoperative	1.09±0.16		1.05±0.19	
1 st POD	1.36±0.23	<0.001 ^s	1.28±0.13	<0.001 ^s
Preoperative	1.09±0.16		1.05±0.19	
3 rd POD	1.28±0.14	<0.001 ^s	1.20±0.13	<0.001 ^s
Preoperative	1.09±0.16		1.05±0.19	
7 th POD	1.19±0.14	<0.001 ^s	1.10±0.12	0.015 ^s

Data were expressed as Mean ± SD. p value measured by unpaired student's t-test, level of significance was <0.05. (s = significant, ns = not significant)

Table 7: Comparison of renal dysfunction (serum creatinine>1.37 mg/dl) between two study groups in 1st, 3rd and 7th Post-operative day

Serum creatinine (mg/dl)	Groups		P value
	Group I (n=40) Frequency (%)	Group II (n=60) Frequency (%)	
>1.37mg/dl on 1 st POD	22(55.0%)	21(35.0%)	0.04 ^s
>1.37mg/dl on 3 rd POD	13(32.50%)	09(15.0%)	0.03 ^s
>1.37mg/dl on 7 th POD	06(15.0%)	02(03.3%)	0.03 ^s

Table 8: Comparison of blood urea between two study groups

Blood urea (mg/dl) on	Groups		p value
	Group I (n=40)	Group II (n=60)	
Preoperative	28.25±7.88	25.50±7.36	0.078 ^{ns}
1 st POD	42.82±7.40	39.78±6.54	0.033 ^s
3 rd POD	36.63±7.45	33.70±5.18	0.023 ^s
7 th POD	32.33±6.86	29.05±4.95	0.007 ^s

Data were expressed as Mean ± SD. p value measured by unpaired student's t-test, level of significance was <0.05. (s = significant, ns = not significant)

Table 9: Distribution of study population by wound infection

Wound infection	Groups		p value
	Group I (n=40) Frequency (%)	Group II (n=60) Frequency (%)	
Present	03(07.5%)	03(05.0%)	0.606 ^{ns}
Absent	36(92.5%)	58(95.0%)	

p value measured by Pearson chi-square test, level of significance was <0.05. (n = number of patients, ns = not significant)

Discussion

This study was conducted in the Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University between the period of January 2013 and November 2014. Total 100 patients were divided into two groups; 40 patients were diabetic and 60 patients were non diabetic. In our study the patients of both groups had been divided into age ranges of 30-50 years and 51-75 years. The mean age of patients in diabetic group and non-diabetic group were 55.95±9.17 years and 52.65±9.04 years respectively, which is consistent to above study. There is no significant difference (p=0.078) of age distribution between two groups. Guvener et al. (2002)10 in their study reported the average age of patients were 61.6±8.8 years in diabetic patients and 58.5±11.1 years in non-diabetic patients. All the age groups were almost proportionately distributed in both the study groups. In our study 85% patients were male in diabetic group and 95% were male in non-diabetic group. Male patients were predominant in this study. In a study by Azarfarin and Alizadeh (2008)11 reported that male patient was more (78%) in OPCAB. This finding suggests that atherosclerotic coronary artery disease is more prevalent in male than in female.

In the present study majority of the patients were smoker and have had other risk factors like hypertension, hyperlipidemia and obesity. These observations were statistically not significant (p>0.05). In study by Doenst et al. (2005)6 reported that there is no significant difference in risk factor in diabetic patients and non-diabetic patients, as in our study. The pre-operative fasting blood glucose, blood glucose two hours after breakfast and HbA1c were much lower in non-diabetic group than diabetic group. Per-operative and post-operative blood glucose level were much higher in diabetic group than non-diabetic group. All diabetic patients were hyperglycemic post-operatively.

Hiesmayr, (2006)¹² reported the frequency of hyperglycemia up to 95-100% after cardiac surgery in both DM and non-DM patients. Smith et al. (2005)¹³ found that hyperglycemia (blood glucose > 8 mmol/L) occurs in 73% of non-DM patients following renal transplant surgery. Puskas et al. (2007)¹⁴ reported the incidence of hyperglycemia (blood glucose > 11.1 mmol/L) in non-DM (72%) versus in DM patients (83%) after on pump CABG. Estrada et al. (2003)¹⁵ shows the prevalence of hyperglycemia (blood glucose > 8.33 mmol/L) in 51.5% non-DM and in 90.4% DM patients undergoing CABG. Prasad et al. (2007)¹⁶ in their study emphasized on excessive and persistent blood glucose elevation during cardiac surgery in non-diabetic patients with blood glucose > 11.1 mmol/L in 70% patients. Azarfarin and Alizadeh, (2008)¹¹ in their study reported the prevalence of at least one episode of hyperglycemia (blood glucose \geq 7 mmol/L) was 95%, and at least one episode of severe hyperglycemia (blood glucose \geq 10 mmol/L) was 54.6% in non-diabetic patients undergoing CABG surgery. In our study at least one episode of hyperglycemia (blood glucose > 7 mmol/L) was 96.7% in post-operative period in non-diabetic patients undergone OPCABG surgery and severe hyperglycemia (blood glucose \geq 10 mmol/L) was 53.3% and 46.7% were without severe hyperglycemia and all diabetic patients were hyperglycemic post-operatively.

In study by Azarfarin and Alizadeh (2008)¹¹ reported higher prevalence of hyperglycemia in early postoperative period and ascending trend of mean blood sugar concentration from the beginning of operation until the twelfth post-operative hour. In our study maximum frequency of blood glucose was 95.0% after arrival at ICU, 71.7% in 1 hour after induction, 80.0% in 2 hours after induction, 83.3 in 3 hours after induction, 91.7% in 6 hours after arrival at ICU, 86.7% in 12 hours after arrival at ICU, 80.0% 24 hours after arrival at ICU.

In our study renal dysfunction were in 6(15.0%) patients and 2(3.3%) patients in diabetic group and non-diabetic group respectively on 7th post-operative day. In a study by Guvener et al. (2002)¹⁰ reported the renal dysfunction was 9% in diabetic patients and 5% in non-diabetic patients. Our results showed similar finding and consistent with the previously published results.

Azarfarin and Alizadeh (2008)¹¹ in their study reported the renal dysfunction in severe hyperglycemia was 10.4% and 4% in without severe hyperglycemia. In our study Renal dysfunction (serum creatinine > 1.37 mg/dl) was present 1(3.12%) patients and 1(3.57%) patients in severe hyperglycemia group and without severe hyperglycemia group respectively. Wound infection was present 2(6.25%) patients and 1(3.57%) patients in severe hyperglycemia group and without severe hyperglycemia group respectively. There were no significant differences in morbidity in non-diabetic patients with or without severe hyperglycemia (intra-operative and post-operative).

In our study wound infection were present in 3(7.5%) patients and 3(5.0%) patients in diabetic group and non-diabetic group respectively. The difference between the two groups is not statistically significant (p, 0.606). In the study of Estrada et al. (2003)¹⁵ showed that wound infection occurred in 6.6% patients with diabetes and 4.1% patients without diabetes. Studies suggest that perioperative hyperglycemia in patients with diabetes is associated with higher infection rates¹⁷. In our study diabetic patients had more infection rate, which is consistent with above study.

Conclusion

From this study it may be concluded that hyperglycemia occurs in per-operative and post-operative period in diabetic patients and maximum of non diabetic patients. Hyperglycemia is more marked in early post-operative period and short-term outcome of hyperglycemia is better in non diabetic patients than diabetic patients following Off Pump CABG.

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