Prevalence and Predictors of Glycemic Control in Hospitalized Patients with Diabetes

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Abstract

Objective: To assess the level of glycemic control among type 2 diabetic patients and to evaluate the factors associated with glycemic control in hospitalized patients.

Method: The current prospective study included type 2 diabetes patients who were admitted into cardiology and medical wards in King Abdulaziz Medical City in Riyadh from October 2016-February 2017 for at least 3 days and followed for a maximum of 10 days or until discharge. Patients were classified into good glycemic control (average FBG<140mg/dl), or poor glycemic control (average FBG>140mg/dl). Data on demographic and clinical factors were gathered. Predictors of glycemic control were identified using multivariate logistic regression.

Result: A total of 158 patients were included. Average ± SD age was 69.2 ± 11.4 years, with 54% females and average ± SD HbA1C was 8.8% ± 2.0,. Thirty-seven patients (23.4%) had average FBG controlled. Results from multivariate regression showed that higher likelihood of poor glycemic control was significantly associated with use of steroids (OR = 5.56, p = 0.039), use of Aspart (OR = 2.86, p = 0.012) and Human regular 70/30 (OR = 5.88, p = 0.029). Patients with uncontrolled HbA1C had poor glycemic control (OR = 2.34, p = 0.047).

Conclusion: Poor glycemic control appeared to be significantly associated with uncontrolled HbA1C, patients receiving steroids, aspart or human regular insulin. Further studies are warranted to confirm this finding.

Keywords: *Diabetes, Glycemic Control, Uncontrolled Blood Glucose.*

Background

Diabetes has become one of the major health problems worldwide. In Saudi Arabia (SA), recent studies found that 13.4% of Saudis aged 15 years or older have diabetes [(1)]. This number is alarming as it indicates a total of 1,745,532 diabetics in Saudi Arabia. Patients with diabetes are admitted frequently to the hospital to treat conditions other than diabetes. Improvement of diabetes management requires an understanding of the predictors of uncontrolled diabetes in hospitalized patients which include patient related factors and treatment factors.

People with diabetes are admitted to the hospital more frequently. A study of 10,135 patients with diabetes showed that 25% of type 1 and 30% of type 2 had a hospital admission within one year [(2)]. Blood glucose level is likely to be unstable in these patients and the reasons for this uncontrolled blood glucose are unclear. Several explanations have been considered such as stress, changes in dietary intake, and interruption of the patient's usual antihyperglycemic agents [(3)].

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Many studies showed that uncontrolled blood glucose is associated with increased risk of mortality, morbidity, cost and length of hospital stay [4-6]. A study of 6374 patients in non-critical care setting, evaluating the effect of hypoglycemia in people with diabetes, indicated that hypoglycemia is associated with increased length of stay and inpatient mortality [4]. In a retrospective review of 1886 hospitalized diabetic patients, hyperglycemia increased the mortality by 2.5-fold [5]. Another study evaluated intensive insulin therapy versus conventional treatment in adults admitted to intensive care unit showed that maintaining blood glucose level at 110 mg/dl or below reduces in-hospital mortality by 34%. It also, lowers acute renal failure requiring dialysis by 41%, sepsis by 46%, and blood transfusions by 50% in patients receiving intensive insulin therapy [6].

A large number of studies demonstrated that diabetes is a risk factor for complications following different medical and surgical conditions. In patients admitted with acute myocardial infarction (MI), hyperglycemia is a predictor of mortality in patients with and without diabetes [7,8]. This result was driven by a prospective cohort study of MI patients that was done in 2002. Furthermore, a meta-analysis of 15 studies, evaluating the risk of congestive heart failure and in-hospital mortality after MI in patients with and without diabetes, found that blood glucose level more than 110 mg/dl increases the risk of mortality and the rates of congestive heart failure [9].

Diabetes and postoperative hyperglycemia are independent predictor of infections in patients undergoing a cardiac surgical procedure [10]. Adequate control of blood glucose level decreases the incidence of deep wound infection in patients undergoing a cardiac surgery [11]. A cohort study of 275 patients who underwent peripheral vascular surgery found that 31% of patients with high blood glucose level in the first 48 h after surgery developed infections [12]. The study conclude that post-operative hyperglycemia appears to be an independent risk factor for infections after vascular surgery. Stryker et al. found that greater risk for wound complications in patients undergoing arthroplasty surgery with postoperative blood glucose level more than 200 mg/dL [13].

According to the patients with acute ischemic stroke, persistent hyperglycemia increases the risk of infarct expansion, poor functional outcomes, in-hospital mortality and hospital cost [14-16]. In addition, a retrospective study by Gentile et al. reported that normalization of blood glucose level in patients with ischemic stroke during the first 48 hours of hospitalization was associated with a strong survival benefit [17]. In patients with acute lymphocytic leukemia (ALL), hyperglycemia is considered an independent predictor of adverse outcomes. A study involved 278 patients with ALL showed that hyperglycemia during induction chemotherapy decreased the complete remission duration, increased the risk of complicated infections and overall mortality [18].

Gopinath et al. studied the factors associated with uncontrolled blood glucose level in Type 2 diabetic patients. In this study, male gender and hypertriglyceridemia were significantly associated with poor glycemic control in type 2 diabetic patients [19]. A retrospective study of 2,970 diabetic patients with poor glycemic control showed that duration of diabetes, age, number of medications, morbidity, and type of insurance coverage are associated with poor glycemic control [20].

Although glycemic control is crucial in hospital setting to avoid any complications, there is a limited data regarding the predictors of uncontrolled diabetes in hospitalized patients. The aim of this study is to assess the level of glycemic control among type 2 diabetic patients and to evaluate the factors associated with glycemic control in hospitalized patients.

Methods

This is an observational prospective study that was conducted at cardiology and medical words of King Abdulaziz Medical City/ National Guard Health Affairs in Riyadh. Medical charts were reviewed of all non-critical care adult inpatients with type 2 diabetes who were admitted to ward of internal medicine and cardiology from October 2016-February 2017 for at least 3 days and followed for a maximum of 10 days or until discharge. Data were extracted from the electronic health records (Best Care®) and included age, gender, height, weight, BMI, admission date, length of stay, history of diabetes (duration of diabetes, past and current antihyperglycemic agents), treatment protocol for diabetes, admission diagnosis, other diseases, systolic blood pressure (SBP), diastolic blood pressure (DBP), and current medications. Lab data were also collected including glycosylated hemoglobin (HbA1c), 1st blood glucose level, fasting blood glucose level (FBG), random blood sugar (RBG), and fasting lipid profile. Data on presence of diabetic

complications (cardiovascular disease (CVD), stroke, retinopathy, neuropathy, nephropathy, foot problems) were also gathered.

Patients were stratified by mean blood glucose level into: good glycemic control (FBG<140mg/dl), RBG<180mg/dl) or poor glycemic control (FBG>140mg/dl, RBG>180mg/dl) [21,22]. Glucose results were calculated as mean Fasting blood glucose per hospital duration.

Statistical Analysis: Descriptive statistical analyses are performed for the study sample. For continuous variables, measures of central tendency (e.g. mean, median) and standard deviation are provided. Proportions are used for categorical variables.

Patients were compared by glycemic control status in terms of demographic and clinical characteristics. Categorical data were analyzed using the Chi-square test. The distribution of all continuous data were examined. For continuous variables with normal distribution, a t-test was used for comparisons. If there is evidence against normality, the non-parametric Mann-Whitney U test was utilized. Univariate logistic regression models were employed to identify factors associated with poor glycemic control. Demographic and clinical factors significantly associated with glycemic control were examined in a multivariate logistic regression model. The backward elimination procedure was used to obtain the final model where the effect of all significant variables in the univariate models were examined in the multivariate model. Variables showing no further significant improvement to the model fit were removed. Statistical significance is considered as $p<0.05$. All statistical analyses were performed using SPSS 21.0 version [Release 21.0.0.0].

Results

A total of 158 patients were included. Average age was 69.2 (SD = 11.4) years, with 54% females (Table 1). Average HbA1C level was 8.8% (SD = 2.0). The majority of patients were overweight or obese (74%), 6% were extremely obese, 18% had normal BMI and only 2% were underweight. While most patients were non-smokers, 58% had cardiac disease, 37% dyslipidemia, 24% had renal disease and 25% had infections. Out of the 158 patients included in the study, 37 (23.4%) had their average FBG is controlled (Figure 1) and 52 (32.9%) had controlled A1C levels (Figure 2).

Table 1: Profile of Respondents. N = 158.

Factor	Value
Gender n (%)	
Male	73 (46.2%)
Female	85 (53.8%)
Age (years) mean ± SD	69.2 ± 11.4
median (IQR)	70 (60 – 67.3)
A1C (%) mean ± SD	8.8 ± 2.0
median (IQR)	8.5 (7.3 – 10.3)
BMI n (%)	
Underweight (<18.5)	3 (1.9%)
Normal (18.6 – 24.9)	29 (18.4%)
Overweight (25 – 29.9)	5 0 (31.6%)
Obese (30 – 39.9)	67 (42.4%)
Extremely obese (>40)	9 (5.7%)
Smoking n (%)	
No	141 (89.2%)
Yes	7 (4.4%)
Missing	10 (6.3%)
Renal disease n (%)	38 (24.1%)
Cardiac disease n (%)	91 (57.6%)
Dyslipidemia n (%)	59 (37.3%)
Infections n (%)	39 (24.7%)
Systolic BP mean ± SD	131.1 ± 15.4
median (IQR)	130 (120.8 – 143)
Diastolic BP mean ± SD	66.1 ± 8.0
median (IQR)	67 (61 – 71)

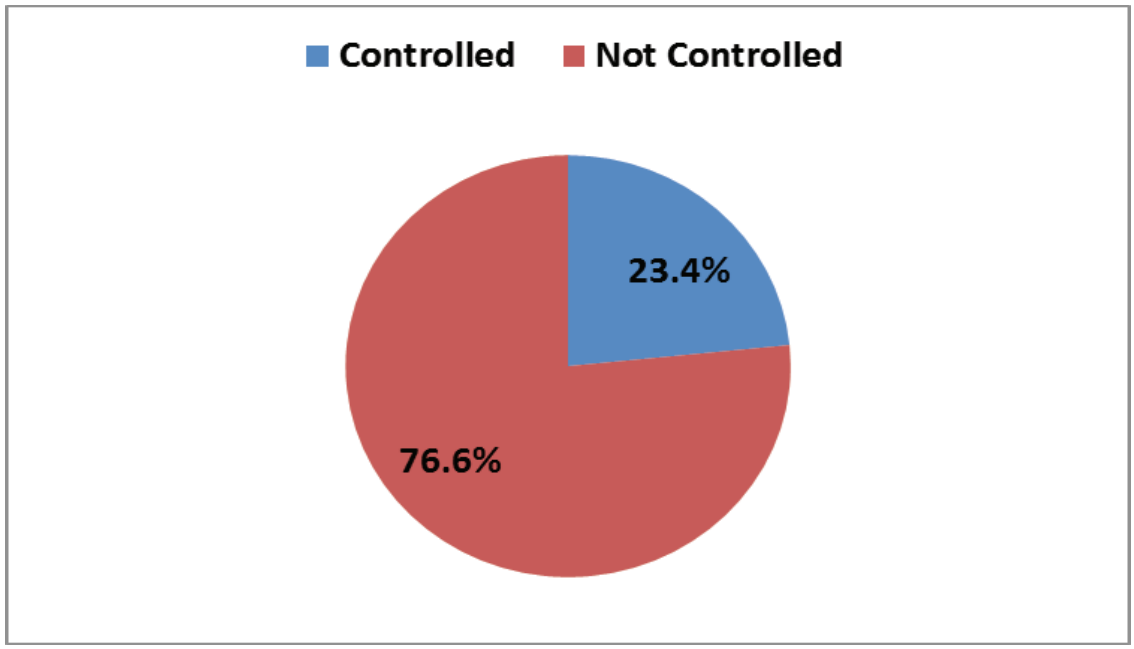

Figure 1: Fasting Blood Glucose Control Status

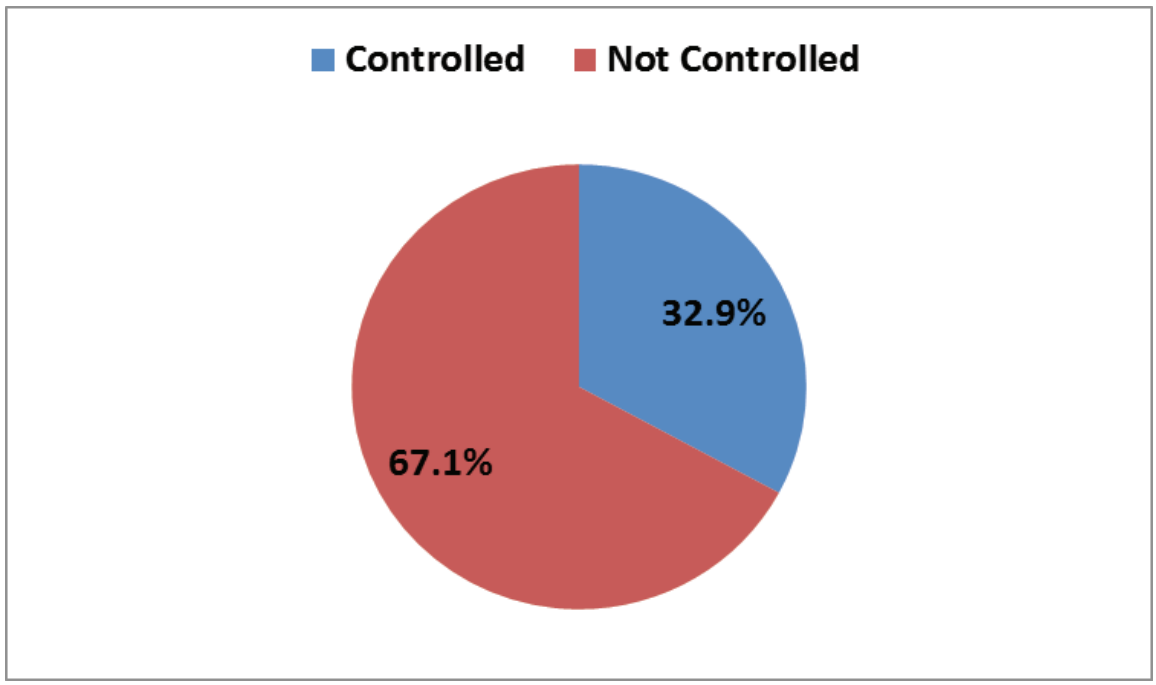

Figure 2: Glycemic Control Status (based on HbA1C)

Patients were receiving a variety of anti-diabetic medications including metformin (27%), Gliclazide (15%), Sitagliptin (8%), Glibenclamide (3%), Aspart (51%), regular insulin (18%), Human regular70/30 (11%) or glargine (56%). Other medications included diuretics (48%), beta-blockers (57.6%), steroids (11%) and antipsychotic medications (4%). Median length of hospital stay was 12.5 days (IQR: 8-21.8).

Results from multivariate logistic regression analysis (Table 2) showed that higher likelihood of poor glycemic control was significantly associated with use of steroids (OR = 5.56, p = 0.039), use of Aspart (OR = 2.86, p = 0.012) and Human regular 70/30 (OR = 5.88, p = 0.029). Patients with uncontrolled HbA1C had a higher likelihood of poor glycemic control (OR = 2.34, p = 0.047). Normal BMI patients were more likely to

have poor glycemic control, however this result did not reach statistical significance. None of the other demographic or clinical factors were associated with glycemic control.

Table 2: Multivariate Logistic Regression Model for Uncontrolled FBG

Factor	Mean or percent	OR	95% CI	p-value
Age (per 10 years)	69.2	0.74	(0.51,1.06)	0.10
BMI (normal vs. overweight/obese)	18.4%	2.63	(0.89,7.69)	0.080
Beta-blockers (yes vs. no)	57.6%	1.79	(0.79,4.00)	0.16
Steroids (yes vs. no)	11.4%	5.56	(1.09,25.00)	0.039
Aspart (yes vs. no)	50.6%	2.86	(1.27,6.67)	0.012
Human regular 70/30 (yes vs. no)	11.4%	5.88	(1.19,33.33)	0.029

OR: Odds Ratio

Discussion

Our study demonstrated that higher likelihood of poor glycemic control appeared to be associated with use of steroids, use of Aspart and Human regular 70/30. Few studies have focused on the factors that associated with poor glycemic control in hospitalized patients with Type -2 of diabetic [23,24].

According to the study that has been done in San Diego, California, the use of steroids was significantly associated with poor glycemic controlled in hospitalized patient with diabetic type1 and 2 [23]. Developing a special treatment therapies that are tailored to patient that will administered steroids during their hospitalization may be consider to improve the glycemic status in these patients .

In the current study, normal BMI patients were more likely to have poor glycemic control but the result did not reach statistical significance. However, as reported by cross-sectional study that have been done in Tanzania, patients with normal BMI were tending to have poor glycemic control. This might be clarified by the fact that patients with poor glycemic control usually lose their weight due to disease process [24] .

In this study, beta-blockers was associated with poor glycemic control, However, the result was not statistically significant. Another study, that examined and compared the effect of beta-blockers (Metoprolol VS Carvedilol) on glycemic control using HbA1c, found that metoprolol was associated with significant increase of HbA1c. Despite that, this study was done to evaluate long term effect using HbA1c, while our study used FBG as marker for control [25]. Another review article, was done to evaluate the effect of beta-blockers on glucose metabolism, concluded that non-vasodilating beta-blockers (propranolol, atenolol, pindolol, metoprolol) was associated with worsening glycemic control [26]. This could be a clue that beta-blockers can affect blood glucose during hospitalization.

The lack of meaningful relationship between age and poor glycemic control in this study is not consistent with the findings of many studies [20,27,28]. which showed that younger age was significantly associated with poor glycemic control. Despite that, these studies main concern of glycemic control were on HbA1c to define the glycemic control and our study was done based on FBG.

Our study is a relatively small study, and a future study should be conducted including a larger and more representative sample from both the inpatient and outpatient setting with more variant demographic and clinical characteristics. However, this study is considered to be one of the first prospective studies that are done to evaluate the factors that are associated with poor glycemic control in inpatient setting in patient with Type -2 Diabetes in Saudi Arabia.

Conclusion

In this study, higher likelihood of poor glycemic control appeared to be associated with uncontrolled HbA1C. Patients receving steroids, and patients using aspart or human regular insulin were significantly more likely to have uncontrolled glycemic levels. Further studies are warranted to confirm this finding and explore other patient and diabetes related factors.

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Ethical Clearance: Our present study got ethical clearance from King Abdullah International Medical Research Center (*KAIMRC)* RC15/078/R .

Abbreviations:

HbA1c = Glycosylated hemoglobin, FPG = Fasting Plasma Glucose, RBG = random blood glucose leve, DM = Diabetes mellitus, CVD = cardiovascular disease, MI = myocardial infarction, ALL = Acute Lymphocytic Leukemia, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, CI = Confidence Interval, BMI = Body Mass Index , OR= Odds Ratio, IQR = interquartile Range

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