

Association between Admission Blood Glucose Levels and Clinical Outcomes among Diabetic Adults Admitted to a Tertiary Care Hospital in Chennai, India: A Retrospective Study

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ABSTRACT

Introduction: Admission blood glucose levels have an impact on hospitalisation and Length Of Stay (LOS). Uncontrolled blood glucose levels have been found to affect patients' outcomes. Elevation of the initial blood glucose level during critical diagnosis was identified as an independent risk factor for in-hospital mortality in critical cases.

Aim: To examine the association between admission blood glucose levels and clinical outcomes in adult diabetic patients.

Materials and Methods: This retrospective study was conducted at a tertiary care hospital in Chennai, Tamil Nadu, India. Data were collected between July 1, 2021, and August 31, 2021, using non-probability convenience sampling from 522 records of adult diabetic patients admitted between January 2019 and March 2020. Capillary random blood glucose levels at the time of admission and their effects on LOS, both in the hospital and Intensive Care Unit (ICU), readmission, and mortality data were

collected. Statistical analysis was performed using the Chi-square test.

Results: Analysis of the records of 522 adult diabetic patients revealed that the mean and standard deviation (SD) of admission Capillary Blood Glucose (CBG) level were 177.46 ± 49.42 mg/dL, and the mean LOS in the hospital was 4.54 ± 3.89 days. It was found that 340 (65.1%) patients had an admission duration of ≤ 4 days. There was a statistically significant association between admission blood glucose levels and LOS in the hospital (p -value=0.01), LOS in the ICU (p -value=0.008), readmission to the hospital (p -value=0.001), and mortality rate (p -value=0.0001).

Conclusion: The study demonstrates that admission blood glucose levels are associated with the clinical outcomes of patients. These findings substantiate the need for maintaining normal glycemic levels through patient education and a proactive team approach to improve patient outcomes.

Keywords: Length of stay, Mortality, Readmission

INTRODUCTION

Hospitalisation and its outcomes are affected by the pre-existing health status of the individual, as well as their current complaints. Comorbidities such as diabetes, its acute and long-term complications, and the associated fluctuations in blood glucose levels, along with the stressors of the current condition and treatment factors, affect clinical outcomes [1]. The number of people living with diabetes is gradually increasing. The cumulative incidence of Type 2 Diabetes Mellitus (T2DM) in Kerala was 21.9%, and the incidence of prediabetes was 36.7%. Nearly 60% of participants who had impaired plasma glucose at baseline converted to T2DM after 10 years [2]. Increased glucose variability among non-diabetic patients was found to be associated with an increased risk of death. A targeted blood glucose range of 70-140 mg/dL was strongly associated with survival in critically ill patients without diabetes [3].

The risk of mortality was found to be higher in diabetic patients admitted with Community-Acquired Pneumonia (CAP) as blood glucose levels affect the immunity of individuals. The median length of stay (LOS) in the hospital was six days. Patients with hypo- or hyperglycemia had higher 30-day mortality rates than patients with normoglycemia [4]. The probability of mortality among diabetic patients with hyperglycemia was higher than those with normoglycemia. Hyperglycemia was associated with requirements for mechanical ventilation, ICU admission, and mortality [5]. There was a significant difference in the median LOS for patients with <6.5 mmol/L on admission (4 days) compared to >6.5 mmol/L (six days). Hyperglycemia was associated with increased 28-day mortality and readmissions [6].

The association between hospitalisation for heart failure and type of diabetes among diabetic patients >30 years showed that a longer duration of diabetes mellitus and higher concentrations of Hemoglobin A1c (HbA1c) also predicted heart failure risk. The incidence of heart failure hospitalisation was two-fold higher in people with diabetes mellitus, with a higher case fatality in those with type 1 DM [7]. A retrospective analysis of glucose variability and its effect on readmission rates revealed that patients who had readmission within 30 days after discharge had higher standard deviation of blood glucose levels than the control group. The study group also had higher HbA1c and LOS. Severe dysglycemia accounted for 24% of 30-day readmission. Blood glucose control targeted at HbA1c may affect postoperative outcomes and readmissions [8].

The above studies reveal that increased blood sugar levels, regardless of whether it's type 1 or type 2 diabetes, are associated with patient outcomes such as morbidity, mortality, the need for intensive care, and readmissions. Medical records provide valuable insights into the management and outcomes of patients. With this view, the present study was undertaken among all patients with medical and surgical conditions with the objective of identifying the association between admission blood glucose levels and clinical outcomes such as LOS in the hospital, LOS in ICU, mortality, and readmissions among diabetic adults admitted to a tertiary care hospital in Chennai, Tamil Nadu, India.

MATERIALS AND METHODS

A retrospective design was used to collect data from the records of 522 adult diabetic patients admitted for the management of various

complaints (respiratory, cardiac, neurological, metabolic, uncontrolled DM, sepsis, gastrointestinal complaints, electrolyte abnormalities, fever, anemia, dehydration and electrolyte imbalance, nephrological and urological) between January 2019 and March 2020 at Sri Ramachandra Medical Centre, Chennai, Tamil Nadu, India. The data collection period was from July 1, 2021, to August 31, 2021. The study received approval from the Institutional Ethics Committee (IEC) for Students, the Medical Superintendent and Medical Director of Sri Ramachandra Hospital and Medical Centre (SRMC), and the Head of the Department of Medical Records (SRMC) (IEC CSP/21/MAR/92/303).

Inclusion criteria: The study included the records of all patients diagnosed with diabetes and admitted for diagnostic, therapeutic, and invasive procedures, as well as follow-up of existing conditions. Patients admitted before the first wave of COVID-19 in the district were also included.

Exclusion criteria: The records of non diabetic patients were excluded from the study.

The instrument consisted of two sections. The first section collected demographic information such as age, gender, and place of residence, while the second section focused on clinical variables including Capillary Blood Glucose (CBG), Hemoglobin, Total WBC Count (TC), and the use of Oral Hypoglycemic Agents (OHA) and insulin, obtained from the admission records. Outcome variables such as Length of Stay (LOS) in the hospital and Intensive Care Unit (ICU), as well as readmission rates and mortality, were obtained from the medical records. Normal fasting blood glucose levels are considered to be 70-110 mg/dL. Random blood glucose levels of 200 mg/dL indicate diabetes, while levels above 200 mg/dL are associated with acute hyperglycemia. The admission blood glucose levels were categorised into four groups: Group-1: <110 mg/dL, Group-2: 111-200 mg/dL, Group-3: 201-300 mg/dL, and Group-4: ≥301 mg/dL. These levels were based on a previous study by Park BS [9].

STATISTICAL ANALYSIS

The collected data was entered into Microsoft Excel 2007 and analysed using the Statistical Package for the Social Sciences (SPSS) version 23.0. Categorical variables were presented as numbers and percentages. The mean and standard deviation (SD) were calculated for variables such as age, Length of Stay (LOS) in the hospital and ICU. Chi-square test was used to determine the association between admission blood glucose and LOS in the hospital, mortality, and readmission. The F statistic was used to determine the association between admission blood glucose and LOS in the ICU. A p-value of <0.05 was considered statistically significant.

RESULTS

The present study revealed that out of 522 adult diabetic patients, 252 (48.3%) were between 41-60 years of age, 291 (55.7%) were male, and 231 (44.3%) were female. A total of 299 (57.3%) resided in urban areas, and 499 (95.5%) of the patients were on Oral Hypoglycemic Agents (OHA). It was found that 381 (73%) of the patients had admission blood glucose levels between 111-200 mg/dL, as shown in [Table/Fig-1]. The mean age of the patients with diabetes was 59.7±11.39 years, and the mean Capillary Blood Glucose (CBG) level was 177.46±49.42 mg/dL. The mean Length of Stay (LOS) in the hospital was 4.54±3.89 days, and this was used as the cutoff value. Those ≤4 days and ≥5 days were considered below and above the normal range for the selected samples.

[Table/Fig-2] displays the frequency and percentage distribution of participants according to their outcome variables. It was found that LOS in the hospital was ≤4 days for 340 (65.1%) participants and ≥5 days for 182 (34.9%) participants. A total of 477 (91.4%) participants did not require Intensive Care Unit (ICU) admission.

Background variables	N (%)
Age in years	
20-40	22 (4.2)
41-60	252 (48.3)
61-80	236 (45.2)
≥81	12 (2.3)
Gender	
Male	291 (55.7)
Female	231 (44.3)
Residence	
Urban	299 (57.3)
Rural	223 (42.7)
CBG mg/dL	
<110	12 (2.3)
111-200	381 (73.0)
201-300	97 (18.6)
≥301	32 (6.1)
Haemoglobin-male	
Normal 13.5-17 gm/dL	80 (27.5)
Below normal	211 (72.5)
Haemoglobin-female	
Normal 12-15.5 gm/dL	94 (40.7)
Below normal	137 (59.30)
Total WBC count	
Normal 4500-11000 cells/mm	325 (62.3)
Above normal	197 (37.7)
Use of OHA	
Yes	499 (95.5)
No	23 (4.5)
Use of insulin	
Yes	32 (6.1)
No	490 (93.9)
Diagnostic category	
Respiratory and cardiac	234 (44.8)
Nephrology and urology	113 (21.6)
Sepsis	25 (4.8)
Neurology	43 (8.2)
Metabolic and uncontrolled DM	65 (12.5)
Others-gastrointestinal, fever/pyrexia, anaemia, diagnostic evaluation, electrolyte imbalance	42 (8)

[Table/Fig-1]: Background variables (N=522).

Outcome variables	N (%)
Days of stay in the hospital	
≤4 days	340 (65.1)
≥5 days	182 (34.9)
Days of stay in ICU (n=45)	
≤4 days	30 (66.7)
≥5 days	15 (33.3)
Mortality	
Yes	11 (2.1)
No	511 (97.9)
Readmission to hospital	
Once	6 (1.1)
Two time	5 (1.0)
Three times	1 (0.2)
No readmission	510 (97.7)

[Table/Fig-2]: Outcome variables of adult diabetic patients. (N=522).

The mortality rate was 11 (2.1%), and the readmission rate was 12 (2.3%) for diabetic patients.

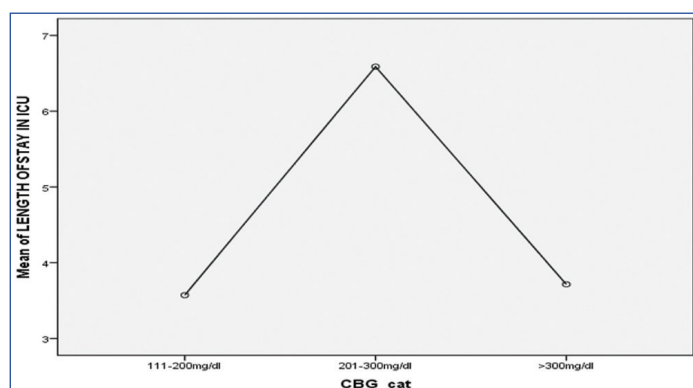
Statistically significant associations were found between admission blood glucose levels and LOS in the hospital (p-value=0.01), mortality (p-value=0.0001), and readmission to the hospital (p-value=0.001), as shown in [Table/Fig-3]. Additionally, a statistically significant association was found between admission blood glucose levels and LOS in the ICU (p-value=0.008), as shown in [Table/Fig-4,5].

Outcome variables	Admission blood glucose level								Chi-square test (χ^2)	p-value
	<110 mg/dL		111-200 mg/dL		201-300 mg/dL		>301 mg/dL			
	n	%	n	%	n	%	n	%		
Length of stay (LOS) in the hospital										
≤4 days	10	2.9	263	77.4	47	13.8	20	5.9	16.27	0.01
≥5 days	2	1.1	118	64.8	50	27.5	12	6.6		
Mortality										
Yes	0	0	0	0	9	81.8	2	18.2	35.30	0.0001
No	12	2.3	381	74.6	88	17.2	30	5.9		
Readmission										
No readmission	12	2.4	378	74.1	90	17.6	30	5.9	33.18	0.001
Once	0	0	2	33.3	4	66.7	0	0		
Twice	0	0	1	20.0	3	60.0	1	20.0		
Thrice	0	0	0	0	0	0	1	100		

[Table/Fig-3]: Association between admission blood glucose level with the selected outcome and clinical variables (N=522). p<0.05*, p<0.01**, p<0.001*** chi-square test

Blood glucose (mg/dL)	Length of stay in ICU			F value and p-value
	n	Mean	SD	
<110	0	0	0	F=5.39 P=0.008
111-200	21	3.57	2.3	
201-300	17	6.59	3.2	
>301	7	3.71	3.7	

[Table/Fig-4]: Association between blood glucose and Length Of Stay (LOS) in ICU among adult diabetic patients. (n=45). p<0.001*** F Statistic



[Table/Fig-5]: Association of admission blood glucose level and LOS in ICU (N=45).

DISCUSSION

The prevalence of diabetes in India has been steadily increasing, reaching 8.9% in 2019. This has resulted in a significant economic burden due to healthcare expenditures, regardless of the socio-economic status of individuals [10]. Non-communicable diseases, including diabetes, have contributed to an increased burden of years lived with disease [11]. Diabetes remains one of the top ten causes of burden, contributing to Disability Adjusted Life Years (DALY) between 1990 and 2019, with an age-standardised DALY rate increase of 24.4% (18.5-29.7). India has a high prevalence of diabetes, with 74.2 million people (20-79 years) affected, ranking among the top five South East Asian regions in terms of prevalence.

The age-adjusted prevalence of diabetes for individuals aged 20-79 years is 9.6%, and the total healthcare expenditure due to diabetes is estimated to be 10 billion USD [12].

The aim of the present study was to examine the association between admission blood glucose levels and clinical outcomes among adult diabetic patients admitted to a tertiary care hospital in Chennai, South India. The sample included the records of 522 patients with diabetes. The study findings, as shown in [Table/Fig-1], revealed that 381 (73%) patients had admission blood glucose levels ranging from 111-200 mg/dL. The mean age of the patients was 59.7±11.39 years, and Oral Hypoglycemic Agents (OHA) were the primary line of treatment for the majority of adult diabetic patients. Out of the sample, 65 (12.5%) were admitted for uncontrolled diabetes mellitus. The patients had various comorbidities including respiratory, cardiac, nephrological, urological, and neurological problems. These findings were consistent with a study on diabetes mellitus and health status outcomes after Myocardial Infarction, where the median age was 49 years and the median initial blood glucose level was 169.50 mg/dL. The common diagnostic categories and reasons for admission in that study were respiratory, renal, cardiac, stroke, and sepsis [13].

This study also found that the mean Length of Stay (LOS) in the hospital was 4.54±3.89 days, and there was a significant association between admission blood glucose levels and LOS in the hospital, LOS in the ICU, and readmissions. These findings are consistent with a study conducted by Regassa LD and Tola A at Government Hospitals of Harar, Eastern Ethiopia [14]. In that study, an analysis of 135 samples revealed that 71 (52.2%) had a readmission rate that increased with the duration of the disease, female gender, inactive lifestyle, BMI greater than 29.9 kg/m², and higher fasting blood glucose levels. Another study analysing the blood glucose levels within 24 hours of admission to the ICU among 14,000 patients found that an average blood glucose level of 110-140 mg/dL was associated with a better prognosis [15]. An increase in glycaemic variability was associated with longer LOS and increased mortality in non-critically ill patients [16]. Factors such as a diverse population with comorbidities, changes in homeostasis due to glucose metabolism or associated hormones, hypo or hyperglycemia, and the methods of measurement and their impact on ICU outcomes should be considered when assessing blood glucose levels in critically ill patients [17].

The present study, as shown in [Table/Fig-3], demonstrated that admission blood glucose levels of 201-300 mg/dL and >300 mg/dL were significantly associated with mortality (p-value=0.0001). This finding aligns with a study that identified controlled glucose status as being associated with a shorter length of hospital stay, reduced 30-day mortality, and improved 1-year mortality. Additionally, achieving glucose control was independently associated with a significant decrease in 1-year mortality. The researchers also recommended efforts to maintain glucose levels within reference ranges in critically ill patients to reduce mortality [18]. Elevation of the initial blood glucose level in critical diagnoses was identified as an independent risk factor for in-hospital mortality in critical cases. Elevation of blood glucose levels predicted worse outcomes in hospitalised patients with COVID-19 [19]. Admission random blood glucose levels of ≥180 mg/dL were found to be associated with low serum sodium levels, low serum bicarbonate levels, Glasgow Coma Scale (GCS) scores <8, increased length of hospital stay, and poor outcomes [20].

The mortality rate was found to be higher among patients with a previous diagnosis of diabetes and those with recent hyperglycemia. Hyperglycemia and stress hyperglycemia have a significant impact on the morbidity and mortality of patients in the Intensive Care Unit (ICU) [21]. These findings highlight the importance of managing blood glucose levels in clinical settings to improve patient outcomes. Further studies could be conducted to examine the effects of admission blood glucose levels on surgical outcomes, explore

individual differences among diabetic adults and their impact on clinical outcomes, investigate the effects of self-management education on blood glucose levels at admission and discharge, and compare the effects of admission blood glucose levels on clinical outcomes between diabetic patients, newly diagnosed diabetic patients, and non-diabetic adults.

Limitation(s)

This study had a few limitations. Firstly, data on HbA1c, Fasting Blood Sugar (FBS), and Post Prandial Blood Sugar (PPBS) were not available for all patients at admission and discharge, so this data was not included in the analysis. Secondly, the study originally planned to include records of patients from the Emergency Room (ER), but separate data for ER patients were not available. Therefore, the author included all adult diabetic patients admitted to the hospital in the study sample.

CONCLUSION(S)

The present study showed that the mean CBG levels of adult diabetic patients were found to be 177.46±49.42 mg/dL. Oral hypoglycemic agents (OHA) were the predominant treatment regimen. There was a significant association between patients' admission blood glucose levels and their clinical outcomes, such as length of stay (LOS) in the hospital, mortality, readmission, and days spent in the ICU. This study identifies the need to improve patient education and enable a proactive team approach in clinical settings. Nurses need to understand the impact of admission blood glucose levels in diabetic patients to facilitate a treatment plan that can reduce LOS and promote early recovery for patients with diabetes.

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