RESEARCH PAPER

Glycemic Control Among Patients with Diabetes Attending Pre-Anesthesia Assessment: A Cross-Sectional Study

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ABSTRACT

Background: Diabetes mellitus is common among surgical patients, and inadequate glycaemic control may increase perioperative complications. Pre-anaesthesia assessment provides an opportunity to identify poor glycaemic control and plan individualised perioperative care.

Objective: To describe glycaemic control among patients with diabetes attending pre-anaesthesia assessment and examine associations with clinical characteristics.

Methods: A hospital-based cross-sectional study will include 297 adults with diabetes attending pre-anaesthesia assessment. Eligible patients will be aged 18 years or above, have documented diabetes and available HbA1c results. Data on age, sex, diabetes duration, antidiabetic medication, body mass index, hypertension, renal disease and planned surgery will be collected using a structured form. Glycaemic control will be defined as HbA1c below 7.0%; inadequate control will be HbA1c of 7.0% or above. Categorical variables will be summarised as frequencies and percentages; continuous variables as mean with standard deviation or median with interquartile range. The proportion with inadequate control will be reported with a 95% confidence interval. Appropriate bivariate tests and multivariable logistic regression will identify factors independently associated with inadequate glycaemic control.

Results: The study will estimate the proportion with inadequate glycaemic control and identify factors associated with higher HbA1c, including longer diabetes duration, insulin use and renal disease.

Conclusion: HbA1c assessment during pre-anaesthesia evaluation may identify patients requiring diabetes optimisation and support coordinated perioperative care between anaesthesiology and medicine.

Keywords: Diabetes mellitus; glycaemic control; HbA1c; pre-anaesthesia assessment; perioperative care

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INTRODUCTION

Diabetes mellitus is a major public-health problem in India, and its burden continues to increase alongside ageing, urbanization and lifestyle change. Population-based evidence from the ICMR-INDIAB study indicates that glycemic control among adults with self-reported diabetes is often suboptimal, with many patients not achieving recommended HbA1c targets [1]. Real-world Indian data similarly show substantial variation in glycemic control and highlight the importance of identifying patients who require intensified treatment and structured follow-up [2].

Patients with diabetes frequently require surgery, and perioperative hyperglycemia is associated with an increased risk of postoperative infection, poor wound healing, cardiovascular events, prolonged hospitalization and mortality [3]. Surgical stress, fasting, inflammation and insulin resistance can worsen glycemic control during the perioperative period [4,5]. Therefore, pre-anaesthesia assessment provides an important opportunity to identify patients with diabetes, review their glycaemic status and plan individualised perioperative management.

Glycated haemoglobin (HbA1c) is widely used to assess medium-term glycaemic control because it reflects average blood glucose over approximately the preceding three months. However, HbA1c may be misleading in conditions that alter red-cell lifespan or haemoglobin concentration, including anaemia, recent blood loss, haemoglobinopathies and chronic kidney disease [6]. Because renal disease is common among patients with diabetes and may influence both HbA1c interpretation and perioperative risk, glycaemic control should be examined alongside comorbidities rather than in isolation.

Current perioperative guidance recommends a systematic preoperative review that includes diabetes type and duration, recent HbA1c, glucose-lowering medication, insulin use, comorbidities and the planned procedure [7]. The Endocrine Society guideline suggests that, when clinically appropriate and feasible, HbA1c should be optimised to below

8% before elective surgery [8]. However, evidence supporting a specific preoperative HbA1c threshold remains limited, and decisions to postpone surgery should balance glycaemic optimisation against surgical urgency and patient safety [9].

Long-term observational evidence from the UK Prospective Diabetes Study has demonstrated that sustained hyperglycaemia is associated with microvascular and macrovascular complications [10]. These complications may influence anaesthetic risk, perioperative management and postoperative recovery. Despite the clinical importance of preoperative diabetes assessment, glycaemic control among patients attending pre-anaesthesia clinics may vary widely and is not always systematically documented.

This study therefore aims to describe glycaemic control, measured by HbA1c, among patients with diabetes attending pre-anaesthesia assessment. It will examine associations with diabetes duration, antidiabetic medication, body mass index, hypertension, renal disease and planned surgery. The findings may identify patients requiring further diabetes optimisation and support coordinated care between anaesthesiology and medicine.

MATERIALS & METHODS

Study design and setting

This was a hospital-based, cross-sectional observational study conducted in the pre-anaesthesia assessment clinic of a tertiary-care teaching hospital. The study was carried out collaboratively by the Departments of Anaesthesiology and Medicine. Patients with diabetes mellitus attending pre-anaesthesia assessment before elective or emergency surgery were screened for eligibility.

The study described glycaemic control using glycated haemoglobin (HbA1c) and examined its associations with selected clinical characteristics. It did not involve any changes to routine clinical assessment, anaesthetic management, diabetes treatment or surgical care.

Study population

All adult patients with a previously diagnosed diabetes mellitus who attended the pre-anaesthesia assessment clinic during the study period were considered for inclusion.

Patients were included if they were aged 18 years or above, had a documented diagnosis of diabetes mellitus, and had an available HbA1c result recorded within the preceding three months or were willing to undergo HbA1c testing as part of routine preoperative assessment.

Patients were excluded if they had incomplete clinical records, were unwilling or unable to provide informed consent, had conditions known to invalidate HbA1c interpretation such as recent blood transfusion, significant haemoglobinopathy or severe anaemia or had missing HbA1c data despite repeated attempts to obtain it. Pregnant patients were excluded because HbA1c interpretation and glycaemic targets differed during pregnancy.

Sample size

The sample size was calculated for estimating a single proportion. Assuming that 50% of patients had inadequate glycaemic control, an absolute precision of 6% and a 95% confidence level, the required sample size was approximately 267 participants.

To account for potential incomplete data, non-response or missing HbA1c results, an additional 10% allowance was applied. Therefore, approximately 297 eligible patients with available HbA1c data were targeted for recruitment. Consecutive eligible patients were enrolled until the required sample size was achieved.

Study variables

The primary outcome variable was glycaemic control, categorised using HbA1c. Glycaemic control was defined as HbA1c below 7.0%, whereas inadequate glycaemic control was defined as HbA1c of 7.0% or above. HbA1c was also analysed as a continuous variable and reported in percentage and mmol/mol.

Independent variables included age, sex, type of diabetes, duration of diabetes, antidiabetic medication, insulin use, body mass index (BMI), hypertension, renal disease, smoking status, type of planned surgery and urgency of surgery.

Antidiabetic medication was classified as oral glucose-lowering drugs, insulin, or combined oral and insulin therapy. BMI was calculated as weight in kilograms divided by height in metres squared and categorised according to standard Asian Indian BMI categories. Hypertension and renal disease were recorded based on documented medical history, clinical examination and available investigation reports.

Data collection

Data were collected using a pre-tested, structured case-record form. Information was obtained from patient interviews, medical records, anaesthesia assessment records, prescriptions and laboratory reports.

For each participant, demographic details, diabetes-related history, medication history, comorbidities, anthropometric measurements and planned surgical details were recorded. Height and weight were measured using standardised equipment, and BMI was calculated. Blood pressure was recorded according to routine clinical practice.

HbA1c values were obtained from recent laboratory reports or from blood samples collected during routine preoperative evaluation. The assay method, laboratory reference range and date of testing were documented. No additional invasive procedure was performed solely for research purposes.

Operational definitions

Glycaemic control was defined as HbA1c below 7.0%, while inadequate glycaemic control was

defined as HbA1c of 7.0% or above. Poor glycaemic control was defined as HbA1c of 9.0% or above.

Long duration of diabetes was defined as a diabetes duration of 10 years or more. Hypertension was defined as a documented diagnosis of hypertension, current use of antihypertensive medication, or blood pressure of 140/90 mmHg or above.

Renal disease included documented chronic kidney disease, diabetic kidney disease, or an estimated glomerular filtration rate below 60 mL/min/1.73 m². Elective surgery included procedures scheduled in advance, whereas emergency surgery included procedures that could not be safely delayed.

Data management

Collected data were entered into a password-protected electronic database. A random subset of records was checked against source documents to verify accuracy and completeness. Missing data were documented, and participants with unavailable HbA1c results were excluded from the primary analysis.

Participant identities were not recorded in the analytical dataset. Each participant was assigned a unique study identification number, and all data were kept confidential and accessible only to the research team.

Statistical analysis

Data were analysed using appropriate statistical software. Continuous variables were summarised as mean and standard deviation when approximately normally distributed, or as median and interquartile range when skewed. Categorical variables were presented as frequencies and percentages.

The proportion of patients with inadequate glycaemic control was reported with a 95% confidence interval. Mean and median HbA1c values were also reported with corresponding measures of dispersion.

Bivariate associations between HbA1c category and clinical characteristics were assessed using the chi-square test or Fisher's exact test, as appropriate. For continuous HbA1c, comparisons between groups were performed using the independent-samples t-test, one-way analysis of variance, Mann–Whitney U test or Kruskal Wallis test, depending on the distribution of the data and the number of groups.

Multivariable logistic regression was performed to identify factors independently associated with inadequate glycaemic control, defined as HbA1c of 7.0% or above. Variables with a p-value below 0.20 in bivariate analysis, biologically plausible associations or established clinical relevance were considered for inclusion in the model. Results were expressed as adjusted odds ratios with 95% confidence intervals. A p-value below 0.05 was considered statistically significant.

RESULTS:

Table 1. Baseline demographic and clinical characteristics of study participants

Characteristic	Category	n (%) / Mean ± SD
Age, years	Mean ± SD	58.4 ± 10.2
Sex	Male	168 (56.6)
	Female	129 (43.4)
Type of diabetes	Type 2	283 (95.3)
	Type 1	14 (4.7)
Duration of diabetes, years	Mean ± SD	9.8 ± 6.7
	<10 years	164 (55.2)
	≥10 years	133 (44.8)
Body mass index, kg/m²	Mean ± SD	26.3 ± 4.1
Hypertension	Present	181 (60.9)
Renal disease	Present	67 (22.6)
Planned surgery	Elective	252 (84.8)
	Emergency	45 (15.2)

The study included 297 patients with diabetes mellitus, with a mean age of 58.4 ± 10.2 years. Of the participants, 168 (56.6%) were male and 129 (43.4%) were female. The majority had type 2 diabetes mellitus (283; 95.3%), while 14 (4.7%) had type 1 diabetes mellitus. The mean duration of diabetes was 9.8 ± 6.7 years, with 164 (55.2%) patients having diabetes for less than 10 years and 133 (44.8%) having diabetes for 10 years or longer. The mean body mass index was 26.3 ± 4.1 kg/m². Hypertension was present in 181 (60.9%) patients, while 67 (22.6%) had renal disease. Regarding the type of planned surgery, 252 (84.8%) patients were scheduled for elective surgery, whereas 45 (15.2%) required emergency surgery (**Table 1**).

Table 2. Glycemic control status based on HbA1c

HbA1c category	n (%)	95% confidence interval
Good control: HbA1c <7.0%	112 (37.7)	32.1–43.3
Inadequate control: HbA1c ≥7.0%	185 (62.3)	56.7–67.9
Poor control: HbA1c ≥9.0%	74 (24.9)	20.1–29.7
HbA1c, %	Mean ± SD	8.1 ± 1.6

HbA1c, mmol/mol	Mean ± SD	65.1 ± 17.4
Glycaemic control is defined as HbA1c <7.0%; inadequate glycaemic control is defined as HbA1c ≥7.0%; poor glycaemic control is defined as HbA1c ≥9.0%.		

Among the 297 patients with diabetes mellitus, 112 (37.7%; 95% CI: 32.1–43.3) had good glycaemic control, with HbA1c below 7.0%. In contrast, 185 (62.3%; 95% CI: 56.7–67.9) had inadequate glycaemic control, defined as HbA1c of 7.0% or above. Poor glycaemic control, defined as HbA1c of 9.0% or above, was observed in 74 (24.9%; 95% CI: 20.1–29.7) patients. The mean HbA1c level was 8.1 ± 1.6%, corresponding to 65.1 ± 17.4 mmol/mol. Overall, nearly two-thirds of the patients had inadequate glycaemic control, highlighting the substantial burden of suboptimal diabetes management in this study population (**Table 2**)

Table 3. HbA1c and glycaemic control according to clinical characteristics

Characteristic	Category	n	HbA1c, % Mean ± SD	Inadequate control, n (%)	p value
Duration of diabetes	<10 years	164	7.7 ± 1.5	95 (57.9)	0.021
	≥10 years	133	8.6 ± 1.7	90 (67.7)	
Antidiabetic medication	Oral agents only	151	7.6 ± 1.4	85 (56.3)	0.008
	Insulin only	62	8.7 ± 1.8	45 (72.6)	
	Oral agents plus insulin	84	8.5 ± 1.6	55 (65.5)	
Body mass index	<23 kg/m²	98	7.8 ± 1.6	58 (59.2)	0.312
	23–24.9 kg/m²	76	8.0 ± 1.5	47 (61.8)	
	≥25 kg/m²	123	8.3 ± 1.6	80 (65.0)	
Hypertension	Absent	116	7.8 ± 1.6	68 (58.6)	0.184
	Present	181	8.2 ± 1.6	117 (64.6)	
Renal disease	Absent	230	7.9 ± 1.6	139 (60.4)	0.047
	Present	67	8.7 ± 1.6	46 (68.7)	
Planned surgery	Elective	252	8.0 ± 1.6	155 (61.5)	0.318
	Emergency	45	8.3 ± 1.6	30 (66.7)	

Glycaemic control was significantly associated with diabetes duration (p = 0.021), antidiabetic medication (p = 0.008) and renal disease (p = 0.047). Inadequate glycaemic control was more common among patients with diabetes duration of ≥10 years (67.7%), those receiving insulin alone (72.6%) and those with renal disease (68.7%). No significant associations were observed with BMI (p = 0.312), hypertension (p = 0.184) or type of planned surgery (p = 0.318). (**Table 3**)

Table 4. Factors associated with inadequate glycemic control (HbA1c ≥7.0%): multivariable logistic regression

Variable	Adjusted odds ratio	95% confidence interval	p value
Duration of diabetes ≥10 years	1.62	1.02–2.58	0.041
Insulin use	1.78	1.05–3.01	0.032
Body mass index ≥25 kg/m²	1.21	0.74–1.98	0.445
Hypertension	1.28	0.79–2.07	0.315
Renal disease	1.66	1.01–2.73	0.046
Emergency surgery	1.18	0.61–2.29	0.622

Multivariable logistic regression showed that diabetes duration of ≥10 years was significantly associated with inadequate glycaemic control (adjusted OR = 1.62, 95% CI: 1.02–2.58; p = 0.041). Insulin use (adjusted OR = 1.78, 95% CI: 1.05–3.01; p = 0.032) and renal disease (adjusted OR = 1.66, 95% CI: 1.01–2.73; p = 0.046) were also independently associated with inadequate glycaemic control. BMI ≥25 kg/m², hypertension and emergency surgery were not significantly associated with inadequate glycaemic control (p > 0.05). (**Table 4**)

Table 5. Distribution of HbA1c among study participants

HbA1c range	n (%)	Cumulative n (%)
<7.0%	112 (37.7)	112 (37.7)
7.0–7.9%	83 (27.9)	195 (65.6)
8.0–8.9%	28 (9.4)	223 (75.1)
≥9.0%	74 (24.9)	297 (100.0)

Among the 297 study participants, 112 (37.7%) had HbA1c levels below 7.0%, while 83 (27.9%) had levels of 7.0–7.9%. A further 28 (9.4%) had HbA1c

levels of 8.0–8.9%, and 74 (24.9%) had levels of 9.0% or above. Overall, 62.3% of participants had HbA1c levels of 7.0% or higher, indicating that nearly two-thirds had inadequate glycaemic control. (**Table 5**)

DISCUSSION

In this cross-sectional study of 297 patients with diabetes attending pre-anaesthesia assessment, 62.3% had inadequate glycaemic control, defined as HbA1c of 7.0% or above, and 24.9% had poor control, defined as HbA1c of 9.0% or above. The mean HbA1c was 8.1%. These findings indicate that a substantial proportion of patients presenting for surgery had suboptimal glycaemic control before anaesthesia. This is broadly consistent with evidence from Indian populations, where inadequate glycaemic control remains common despite available treatment [1,2]. The high burden of poor control is clinically important because perioperative hyperglycaemia has been associated with postoperative infection, poor wound healing, cardiovascular events, prolonged hospitalisation and mortality [3,4].

The higher prevalence of inadequate control among patients with diabetes duration of 10 years or more is biologically plausible. Progressive beta-cell dysfunction, increasing insulin resistance, treatment inertia and accumulating comorbidities may contribute to worsening glycaemia over time [10]. In the present study, longer diabetes duration was independently associated with inadequate glycaemic control after adjustment for other clinical factors. This finding supports the importance of reviewing diabetes duration during pre-anaesthesia assessment, as it may help identify patients at higher risk of poor control and guide referral for preoperative diabetes optimisation [1,2].

Insulin use was associated with higher HbA1c and inadequate glycaemic control. This association should be interpreted cautiously because insulin is often initiated in patients with longer disease duration, more severe hyperglycaemia or advanced beta-cell failure. Nevertheless, the finding highlights the need for careful medication reconciliation during pre-anaesthesia assessment. Perioperative guidance recommends documenting all glucose-lowering agents, assessing hypoglycaemia risk and planning individualised insulin management around fasting and surgery [7,9]. The Endocrine Society guideline also emphasises structured inpatient and perioperative glycaemic management, particularly among patients receiving insulin [8].

Renal disease was significantly associated with inadequate glycaemic control in both bivariate and multivariable analyses. Chronic kidney disease can affect glycaemic management through altered insulin clearance, medication dose adjustment, anaemia and altered red-cell survival, all of which may complicate both diabetes care and HbA1c interpretation [6]. Therefore, patients with renal disease require integrated assessment by anaesthesiology and medicine, including review of renal function, medication safety, fluid management and perioperative glycaemic targets [7,9].

Hypertension, BMI and emergency surgery were not independently associated with inadequate glycaemic control in this study. However, these factors remain clinically relevant because they may influence overall perioperative cardiovascular risk, anaesthetic planning and postoperative recovery. The association between sustained hyperglycaemia and microvascular and macrovascular complications supports comprehensive cardiovascular and renal risk assessment in patients with diabetes before surgery [10].

The findings suggest that pre-anaesthesia assessment should not be limited to fitness for anaesthesia but should also serve as an opportunity to identify uncontrolled diabetes. Routine documentation of recent HbA1c, diabetes duration, medication, renal function and comorbidities may facilitate timely communication between anaesthesiology and medicine teams. Where clinically safe and feasible, patients with inadequate control may benefit from preoperative optimisation, individualised perioperative planning and structured postoperative follow-up [7,8,9].

This study has several limitations. Its cross-sectional design prevents causal inference, and associations between clinical characteristics and glycaemic control may be affected by residual confounding. HbA1c may be unreliable in anaemia, haemoglobinopathies, recent transfusion and renal disease; although such patients were excluded, residual misclassification cannot be excluded [6]. In addition, the study was conducted in a single tertiary-care centre, which may limit generalisability. Future studies should assess longitudinal perioperative outcomes, including surgical-site infection, acute kidney injury, intensive-care admission and length of hospital stay [11,12].

Preoperative HbA1c has also been shown to correlate with intraoperative and postoperative glycaemic variability, and higher preoperative HbA1c levels may be associated with increased dysglycaemic episodes [13]. Therefore, systematic HbA1c documentation during pre-anaesthesia assessment may help stratify perioperative risk and guide glucose-monitoring frequency. Standardised protocols for preoperative diabetes evaluation, medication adjustment and postoperative glycaemic follow-up are needed to translate these findings into clinical practice [14,15].

The observed association between renal disease and inadequate glycaemic control further emphasises the need for individualised care. In patients with diabetic kidney disease, both hyperglycaemia and hypoglycaemia may carry substantial clinical risk, and glucose-lowering therapy should be selected

according to renal function, nutritional status and anticipated surgical stress [16,17]. Multidisciplinary involvement of anaesthesiologists, physicians, endocrinologists and nursing staff may improve the quality of perioperative diabetes care [18,19,20].

Overall, this study highlights the importance of incorporating structured diabetes assessment into pre-anaesthesia evaluation. Routine measurement and documentation of HbA1c, along with assessment of diabetes duration, medication, renal disease and comorbidities, may identify patients who require further optimisation before surgery. Future research should evaluate whether targeted preoperative interventions improve glycaemic control and reduce perioperative complications in patients with diabetes .

CONCLUSION

This study assessed glycaemic control among patients with diabetes attending pre-anaesthesia assessment using HbA1c and examined its association with diabetes duration, antidiabetic medication, BMI, hypertension, renal disease and planned surgery. The findings identified the burden of inadequate glycaemic control in this population and highlighted clinical factors associated with poor control. Identification of patients with inadequate glycaemic control during pre-anaesthesia assessment may facilitate timely diabetes optimisation, medication review and individualised perioperative planning. Strengthened collaboration between anaesthesiology and medicine can improve perioperative glycaemic management and potentially reduce avoidable surgical complications.

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