ARC Journal of Anesthesiology
Volume 10, Issue 2, 2025, PP 14-21
ISSN 2455-9792
DOI: https://doi.org/10.20431/2455-9792.1002003
www.arcjournals.org

Perioperative Blood Glucose Level in Non-Diabetic Patients Having open Abdominal Surgery

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Received: 13 October 2025 Accepted: 27 October 2025 Published: 08 November 2025

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Abstract

Background: *Perioperative blood glucose levels in non-diabetic patients may be related to intraoperative and postoperative critical events. Usually, perioperative capillary blood glucose level measurements are not performed in non-diabetic patients without any critical events. This study investigated perioperative capillary blood glucose levels in non-diabetic adults undergoing open abdominal surgery under general anesthesia.*

Methods: *This hospital-based cross-sectional observational study was conducted at the Department of Anesthesia, Pain, Palliative, and Intensive Care, Dhaka Medical College Hospital, Dhaka, from January 2023 to June 2024. Sixty non- diabetic patients admitted for routine open abdominal surgery under general anaesthesia of 18-60 years of both sex groups were enrolled in the study. Informed written consent was obtained. Baseline, pre-induction, intraoperative, and postoperative data at different time points were recorded in the case record form. The collected data were analyzed using SPSS 26.*

Results: *The majority of patients were in the 41-60 years (73.3%), with a mean age of 45.41±8.11 years. Capillary blood glucose (CBG) monitoring demonstrated that a significant number of patients (30%) developed perioperative hyperglycemia, of which 20% developed severe hyperglycemia and required rescue insulin (RI) therapy. Among the 30% who developed perioperative hyperglycemia, 16.7% developed it in the intraoperative period and 13.3% in the postoperative period.*

Conclusion: *A significant number of non-diabetic patients developed hyperglycemia during the intraoperative and postoperative periods.*

Keywords: *perioperative hyperglycemia, non-diabetic patients, open abdominal surgery, blood glucose monitoring.*

1. Introduction

Surgical intervention imposes a multifaceted physiological insult that encompasses tissue injury, fasting, blood loss, pharmacologic effects, and perioperative thermal fluctuations, all of which contribute to activation of the endocrine and sympathetic nervous systems [1]. This "surgical stress response" is characterized by elevated concentrations of cortisol, glucagon, catecholamines and pituitary hormones, resulting in enhanced gluconeogenesis, insulin resistance and hyperglycaemia [2]. The magnitude of these metabolic changes correlates with the severity of surgical trauma; for example, intra-abdominal procedures evoke a more pronounced rise in plasma cortisol and blood glucose than minor operations in the general surgical patient [3]. Traditionally, perioperative fluid management in fasting patients may include dextrose-free maintenance fluids; yet, in the absence of exogenous carbohydrate, endogenous glycogenolysis and gluconeogenesis accelerate, promoting protein catabolism, whereas dextrose-containing fluids may help attenuate protein breakdown [4]. In this context, the perioperative hyperglycaemic response may serve as a quantifiable marker of the degree of physiological stress incurred by surgery [1].

Although much of the literature has focused on patients with known diabetes, accumulating evidence suggests that even individuals without a pre-existing diagnosis of diabetes are susceptible to significant perioperative blood glucose elevations. For instance, non-diabetic individuals may mount a stress-induced hyperglycaemic response in up to 30 % of surgical cases [5].

In a non-cardiac surgical cohort, intraoperative blood glucose increases were documented in approximately 30–40 % of non-diabetic patients [6]. The recognition of hyperglycaemia in non-diabetics is clinically important because it is increasingly associated with adverse postoperative outcomes, including surgical site infection, increased length of stay, re-operation and mortality [7,8]. Crucially, patients without diabetes may paradoxically incur a higher relative risk of complications at similar glucose thresholds compared with those with known diabetes [8], suggesting that the hyperglycaemic response in non-diabetics may reflect a more severe stress burden or more limited metabolic reserve.

With respect to abdominal surgery under general anaesthesia—a major physiological insult—the perioperative glucose perturbations in non-diabetic patients merit particular attention. A state of elevated perioperative blood glucose may impair immune function and wound healing via mechanisms such as reduced phagocytic activity, increased glycation of proteins, endothelial dysfunction, and enhanced expression of adhesion molecules [9]. Moreover, while guidelines on inpatient glycaemic control emphasize patients with diabetes [10], glucose monitoring and intervention protocols may be less rigorously applied in non-diabetic surgical patients [11]. For example, one observational survey found that only 59 % of general surgical patients without diabetes had postoperative glucose monitoring, and just 54 % of them received insulin when indicated [12]. In orthopaedic settings, up to 40 % of non-diabetic patients underwent postoperative glucose values >7.8 mmol/L, and 25 % had values ≥10.0 mmol/L, yet surveillance was often inadequate [6].

The rationale for closer attention to perioperative glycaemia in non-diabetic patients arises from two converging perspectives. First, hyperglycaemia represents not only a biomarker of the surgical stress response but a potential modifiable risk factor for adverse sequelae. Second, while tight glycaemic control protocols (including insulin therapy) have demonstrated benefit in cardiac and critical-care populations [13,14], their applicability and safety in non-diabetic general surgical patients remain under-explored. Indeed, recent reviews advocate for individualized perioperative glycaemic management, balancing the reduction of hyperglycaemic-associated risk against hypoglycaemia and other hazards of overt control [15].

Given these considerations, the present study addresses a gap in the literature by focusing on non-diabetic patients undergoing elective open abdominal surgery under general anaesthesia. Specifically, the study aims to assess the incidence and magnitude of perioperative capillary blood glucose (CBG) fluctuations and to identify the number of patients requiring "rescue" insulin therapy post-operatively in response to elevated glucose levels. By delineating the perioperative glycaemic profile in this well-defined surgical population, the findings may inform monitoring protocols, glycaemic thresholds for intervention and contribute to optimization of perioperative care in non-diabetic patients.

2. Materials & Methods

This cross-sectional observational study was conducted in the Department of Anaesthesia, Pain, Palliative and Intensive Care, Dhaka Medical College Hospital, Dhaka, Bangladesh. The study was carried out over 18 months, from January 2023 to June 2024. A total of 60 adult non-diabetic patients were included, all scheduled for elective open abdominal surgery under general anaesthesia.

2.1. Sample Selection

Inclusion Criteria

- Adults aged 18–60 years.
- Non-diabetic patients with American Society of Anesthesiologists (ASA) physical status I or II.
- Scheduled for elective open abdominal surgery under general anaesthesia following institutional guidelines.
- Preoperative fasting blood sugar (FBS) between 6–7 mmol/L or random blood sugar (RBS) <10 mmol/L.
- Body mass index (BMI) <35 kg/m².
- HbA1c ≤ 6.5%.

Exclusion Criteria

- Presence of uncontrolled hypertension or significant cardiac, hepatic, renal, or respiratory disease.
- Current corticosteroid therapy or use of medications known to induce hyperglycemia.
- Planned perioperative epidural analgesia in conjunction with general anaesthesia.
- Postoperative admission anticipated in the high-dependency unit (HDU), intensive care unit (ICU), or coronary care unit (CCU).
- Pregnant women or non-pregnant women with a history of gestational diabetes mellitus.

2.2. Study Procedure

After obtaining approval from the institutional ethics committee, eligible patients were approached during their pre-anaesthetic evaluation. The purpose, procedures, and potential benefits of participation were explained, and written informed consent was obtained. Standard institutional anaesthetic protocols were followed for all cases. Baseline capillary blood glucose (CBG) was recorded immediately before intravenous infusion initiation. Intraoperative CBG was measured hourly using a calibrated Accu-Chek® Active blood glucose monitor (Roche Diagnostics, Mannheim, Germany), with a measurement range of 0.56–33.6 mmol/L.

Hyperglycemia was defined as a CBG level >7 mmol/L, with mild hyperglycemia classified between 7–10 mmol/L and severe hyperglycemia as >10 mmol/L. When CBG exceeded 10 mmol/L, a calculated dose of intravenous human soluble insulin was administered as rescue insulin therapy.

The number of patients requiring intraoperative insulin was recorded. Postoperative CBG measurements were taken at the 2nd, 4th, 6th, and 24th hours following surgery. All perioperative events, including hemodynamic fluctuations, insulin administration, and glucose trends, were documented. Data were verified for accuracy and completeness before analysis.

2.3. Ethical Considerations

Ethical clearance was granted by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh. The study adhered to the principles outlined in the Declaration of Helsinki. Participants received detailed information about the study objectives, procedures, and their rights, including voluntary participation and withdrawal without penalty. Written informed consent was obtained from each participant prior to enrollment. Patient confidentiality was strictly maintained throughout the study, and data were anonymized before analysis. No financial incentives were offered, and the research posed minimal risk to participants.

2.4. Statistical Analysis

Data were entered and analyzed using IBM SPSS Statistics version 26. Continuous variables were expressed as mean ± standard deviation (SD) or with 95% confidence intervals (CI), while categorical variables were presented as frequencies and percentages. Comparisons of perioperative glucose levels across time intervals were performed using paired t-tests or repeated-measures ANOVA, as appropriate. The incidence of mild and severe hyperglycemia, as well as the frequency of rescue insulin therapy, was expressed as percentages. A p-value of less than 0.05 was considered statistically significant for all analyses.

3. RESULTS

Table 1. *Baseline characteristics of the study population (n=60)*

Variables		Frequency (n)	Percentage (%)
Age group	18-40 years	16	26.7
	41-60 years	44	73.3
	Mean±SD (years)	45.41±8.11	
Gender	Male	34	56.7

	Female	26	43.3
ASA Classification	Class-I	44	73.3
	Class-II	16	26.7

This table presents the demographic and clinical profile of the study participants. Most patients (73.3%) were between 41–60 years of age, with a mean age of 45.41 ± 8.11 years. The majority were male (56.7%) and classified as ASA physical status I (73.3%), indicating a relatively healthy surgical cohort.

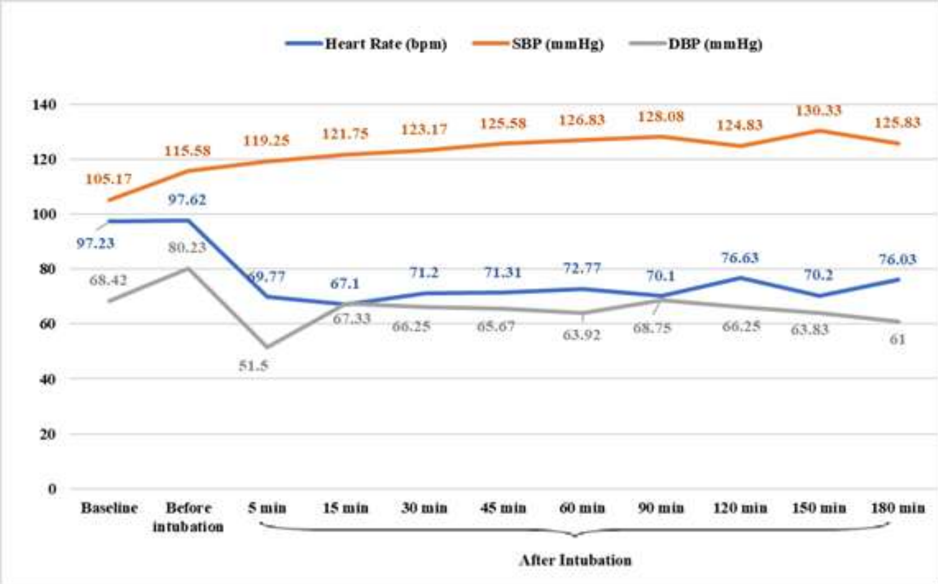

Figure 1. *Preoperative and intraoperative haemodynamic variables, such as HR, SBP and DBP of the study population (n=60)*

This figure illustrates perioperative trends in heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP). Haemodynamic parameters remained largely stable, suggesting adequate intraoperative management and minimal haemodynamic stress response in most patients.

Table 2. *Distribution of patients according to intraoperative glycaemic status (n=60)*

Intraoperative CBG	Frequency (n)	Percentage (%)
Normoglycaemia (6-7 mmol/L)	50	83.3
Mild hyperglycaemia (**>7 - <10 mmol/L)**	4	6.7
Severe hyperglycaemia (>10 mmol/L) (Treated with rescue insulin therapy)	6	10.0

This table demonstrates that 16.7% of patients developed intraoperative hyperglycemia, with 10% experiencing severe hyperglycemia (>10 mmol/L) requiring rescue insulin therapy. The findings highlight that stress-induced hyperglycemia can occur even in non-diabetic individuals during surgery.

Table 3. *Distribution of patients according to postoperative glycaemic status (n=60)*

Postoperative CBG	Frequency (n)	Percentage (%)
Normoglycaemia (6-7 mmol/L)	52	86.7
Mild hyperglycaemia (**>7 - <10** mmol/L)	2	3.3
Severe hyperglycaemia (>10 mmol/L) (Treated with rescue insulin therapy)	6	10.0

This table shows that 13.3% of patients developed postoperative hyperglycemia, with 10% exhibiting severe elevations (>10 mmol/L). These results indicate a continued risk of glucose imbalance in the immediate postoperative period among non-diabetic surgical patients.

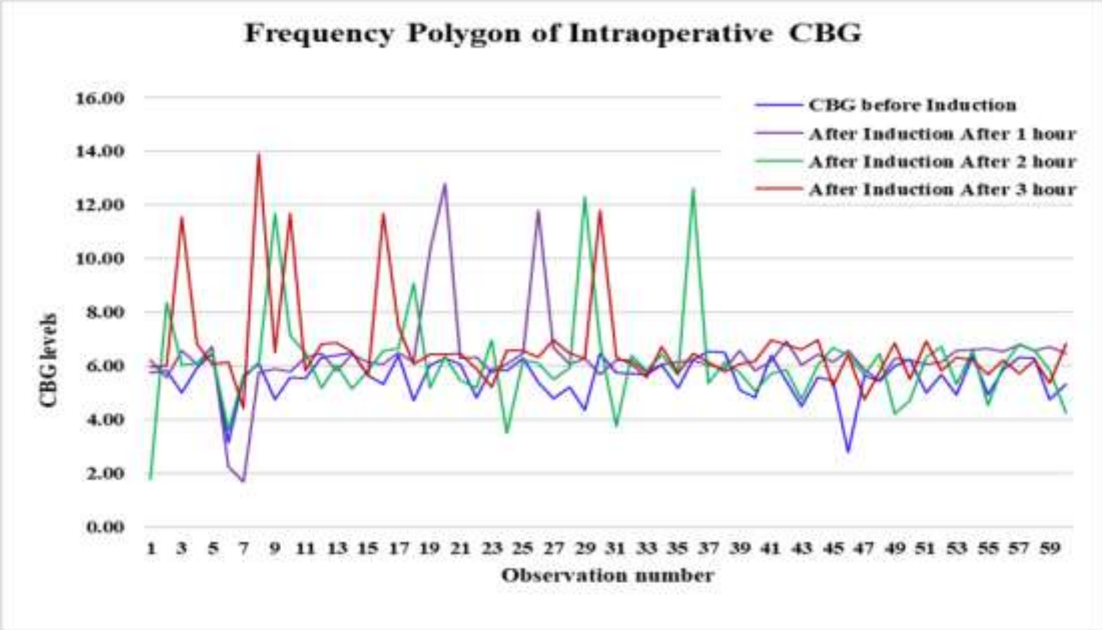

Figure 2. *Frequency polygon of intraoperative CBG of the study population (n=60)*

This figure visualizes the intraoperative distribution of capillary blood glucose (CBG) levels, demonstrating that while most patients remained within the normoglycemic range, a distinct subset showed elevated glucose values consistent with surgical stress response.

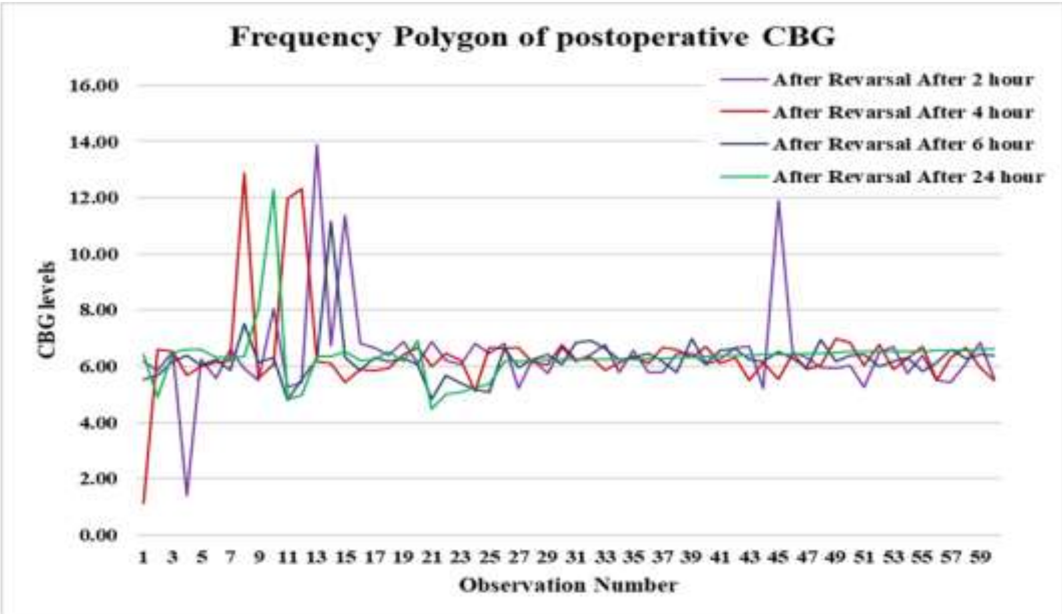

Figure 3. *Frequency polygon of postoperative CBG of the study population (n=60)*

This figure depicts postoperative CBG trends, revealing a modest rightward shift in glucose distribution. It underscores the persistence of hyperglycemic response in a portion of patients during early recovery, emphasizing the need for continued glucose monitoring postoperatively.

4. Discussion

This study demonstrated that 30% of non-diabetic patients undergoing open abdominal surgery developed perioperative hyperglycemia, with 20% requiring rescue insulin therapy after surgery.

Intraoperative hyperglycemia occurred in 16.7% of the patients, a finding comparable to the rates reported by Potisuk et al. and Sermkasemsin et al. [16,17]. Postoperatively, eight patients developed hyperglycemia, and six required insulin therapy; none developed hypoglycemia following treatment.

The highest mean capillary blood glucose (CBG) values were observed during the third hour of surgery ($p < 0.001$), reflecting a peak in the neuroendocrine and inflammatory stress response associated with anesthesia and surgical trauma, consistent with the pathophysiological mechanisms described by Velickovic et al. [18].

The observed prevalence aligns with reports suggesting that perioperative hyperglycemia is common, even in non-diabetic individuals. Goyal et al., Fiorillo et al., and Gachabayov et al. all found that intra- and postoperative hyperglycemia frequently occurs in non-diabetic surgical patients, emphasizing the need for routine glucose monitoring throughout the perioperative period [19,20,21]. These findings collectively support the clinical relevance of stress-induced hyperglycemia as a modifiable perioperative risk factor.

The demographic profile of this cohort (mean age 45.4 ± 8.1 years, with most patients aged 41–50 years) is similar to the observations of Joshi et al. and Kiran et al., who reported heightened perioperative glucose fluctuations among middle-aged adults [22,23]. The predominance of males (56.7%) differs from the regional surgical demographics reported by Bhandarkar et al., who observed a more balanced gender distribution in Indian surgical populations [24]. These demographic variations may influence stress response and glucose metabolism, as hormonal and body composition differences affect perioperative glycemic patterns [25].

Although the relationship between perioperative hyperglycemia and adverse outcomes is well established in patients with diabetes and critically ill patients, its implications for non-diabetic individuals undergoing elective abdominal surgery are less clearly defined. Activation of the hypothalamic–pituitary–adrenal axis and increased secretion of catecholamines, cortisol, and inflammatory cytokines contribute to insulin resistance and hepatic gluconeogenesis, resulting in transient hyperglycemia [5,26]. Several studies have demonstrated that stress-induced hyperglycemia, even when transient, may elevate the risk of postoperative complications, particularly surgical site infections (SSIs). Kwon et al., Ata et al., found that postoperative glucose levels above 180 mg/dL significantly increased SSI risk in both diabetic and non-diabetic patients [27,28]. Similarly, Pinkney et al. and Turina et al. reported that short-term perioperative hyperglycemia disrupts leukocyte function and impairs wound healing [29,30].

Taken together, these findings underscore that perioperative hyperglycemia in non-diabetic patients is not a benign stress response but a potential risk factor for adverse outcomes. Consistent intra- and postoperative glucose monitoring combined with prompt intervention can improve surgical safety. Future research with larger, multicenter cohorts should further clarify the glycemic thresholds that predict complications and refine insulin protocols tailored to non-diabetic populations undergoing major abdominal surgery.

5. Limitations of the Study

1. Anaesthetic management followed routine institutional practice, which may have introduced variability in patient responses.
2. Depth of anaesthesia was not objectively monitored; inadequate depth could have influenced stress-induced glucose elevation.
3. The study included a relatively small sample size (n=60), limiting the generalizability of the findings.
4. Long-term postoperative outcomes related to perioperative glucose fluctuations were not assessed.
5. Only patients undergoing surgery under general anaesthesia were included; comparisons with regional anaesthesia were not possible.

6. Conclusion

This study demonstrated that a considerable proportion (30%) of non-diabetic patients undergoing open abdominal surgery developed perioperative hyperglycemia, with 16.7% occurring intraoperatively and 13.3% occurring postoperatively. The peak incidence of hyperglycemia and rescue insulin use was observed around the third intraoperative hour and within the first four postoperative hours, respectively. These findings suggest that surgical stress and anaesthetic factors can significantly influence glucose metabolism, even in patients without diabetes. Routine perioperative blood glucose monitoring should be incorporated into the management of non-diabetic surgical patients to ensure early detection and timely interventions.

Acknowledgment

I would like to express my sincere gratitude for the invaluable support and cooperation provided by the staff, participants, and my co-authors/ colleagues who contributed to this study.

Conflicts of Interest

There are no conflicts of interest.

Ethical Approval

The study was approved by the Institutional Ethics Committee.

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Citation: *Dr. Saiful Mahmud Tusher et al. "Perioperative Blood Glucose Level in Non-Diabetic Patients Having open Abdominal Surgery". ARC Journal of Anesthesiology. 2025; 10(2):14-21. DOI: https://doi.org/10.20431/2455-9792.1002003.*