STUDY ON PERIOPERATIVE GLYCEMIC CONTROL AND POST-OPERATIVE INFECTIONS

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ABSTRACT;
Diabetes mellitus (DM) represents a significant global health crisis, with its prevalence and complications posing substantial challenges, particularly in low- and middle-income countries like India. The relationship between chronic hyperglycemia, impaired immune response, and increased susceptibility to infections, especially surgical site infections (SSIs), is well-documented. SSIs, defined as infections occurring within 30 days post-surgery or up to one year if an implant is involved, can range from superficial to deep-seated organ infections, leading to prolonged hospital stays, increased morbidity and mortality, and substantial financial burdens on healthcare systems.

This study investigates the impact of perioperative glycemic control on the incidence and severity of SSIs among Indian surgical patients. It aims to elucidate the relationship between preoperative and postoperative glycemic levels and the risk of SSIs, the correlation between the degree of hyperglycemia and SSI severity, and the predominant bacterial pathogens involved, including their antibiotic susceptibility profiles.

Emerging evidence indicates that maintaining optimal glycemic control during the perioperative period is crucial for reducing the risk of SSIs. The study's findings are expected to fill the existing knowledge gap, providing valuable data to inform clinical guidelines and enhance the quality of care for surgical patients with diabetes in India. This research underscores the necessity for a multidisciplinary approach to glycemic management, involving surgeons, anesthesiologists, endocrinologists, and nursing staff, to achieve improved surgical outcomes and mitigate complications associated with hyperglycemia.

KEYWORDS; Diabetes mellitus, Surgical site infections, hyperglycaemia

INTRODUCTION

Diabetes mellitus (DM) has become a global health crisis, with 537 million adults in the age group of 20-79 years, estimated to be living with the condition in 2021, according to the International Diabetes Federation (IDF) Diabetes Atlas. This number is projected to surge to 783 million by 2045, an alarming increase of 46%. The report also postulated that the burden of DM disproportionately affects low- and middle-income countries (like India), wherein it has stated that 3 out of 4 adults with diabetes reside in such low- and middle-income countries[1].

In India, the World Health Organization estimates that 77 million adults over 18 years suffer from type 2 diabetes, with an additional 25 million individuals classified as pre-diabetic. The insidious nature of DM, with over 50% of cases remaining undiagnosed, further exacerbates the problem, leading to delayed treatment and increased risk of complications[2].

Surgical site infections (SSIs) represent a daunting challenge in postoperative care, posing a substantial risk to patient well-being as well as healthcare systems. SSIs are defined as infections occurring within 30 days of surgery or up to one year if an implant is involved. They encompass a spectrum of severity, ranging from superficial incisional infections to deep-seated organ or space infections. This classification system, based on anatomical location and depth, aids in standardizing diagnosis and facilitating targeted treatment strategies[3].

The impact of SSIs extends far beyond the surgical wound, contributing significantly to patient morbidity and mortality. These infections can lead to prolonged hospital stays, delayed recovery, readmissions, and the need for additional interventions such as wound debridement or antibiotic therapy[6]. Moreover, SSIs impose a considerable financial burden on healthcare systems due to increased resource utilization, extended antibiotic use, and potential reoperations. In the United States alone, SSIs are estimated to account for billions of dollars in excess healthcare costs annually[4].

MATERIALS AND METHODS

Study Design

This study was a prospective observational study conducted to evaluate the impact of deranged glycemic control on surgical outcomes.

Study Setting

The study was conducted in the Department of General Surgery at Gandhi Medical College and associated Hospitals (Hamidia Hospital) in Bhopal. The study was carried out from August 2022 to December 2023.

Study Population

The study included patients with deranged glycemic control who were undergoing general surgical procedures during the study period.

Inclusion Criteria

- Patients aged 18 years or older.
- Patients scheduled for a surgical procedure requiring hospitalization.
- Patients who provided informed consent to participate in the study.

Exclusion Criteria

- Patients operated outside the center.
- Patients already infected before coming to the hospital.
- Patients who did not give consent for surgery.

Investigations Performed

The following investigations were performed for all patients enrolled in the study:

- All relevant biochemical investigations
- Random Blood Sugar (RBS)
- Fasting Blood Sugar (FBS)
- HbA1C
- Complete Blood Count (CBC)
- C-reactive protein (CRP)
- Blood cultures
- Wound cultures

These investigations were performed to assess the glycemic status and other relevant health parameters of the patients, as well as to monitor for any infections.

Statistical analysis

Data were analyzed using Epi Info version 7.0. Descriptive statistics were calculated for all variables. Chi-square tests or Fisher's exact tests assessed associations between categorical variables. Independent samples t-tests or ANOVA were used to compare continuous variables between groups. Logistic regression was employed to identify independent risk factors for SSI, while ordinal regression was used to investigate factors influencing SSI severity. Statistical significance was set at $p < 0.05$.

RESULTS AND OBSERVATIONS;

Table 1 – Distribution of patients according to the age group and gender

Age Group	Gender		Total	Chi-square value P value
	Male	Female		
	N (%)	N (%)	N (%)	1.055
≤30	7 (9.6)	4 (12.1)	11 (10.4)	
31-50	29 (39.7)	14 (42.4)	43 (40.6)	0.788

51-70	29 (39.7)	10 (30.3)	39 (36.8)
≥71	8 (11.0)	5 (15.2)	13 (12.3)
Total	73 (100.0)	33 (100.0)	106 (100.0)

Table 1 shows the distribution of patients across age groups and gender. It reveals that the majority of surgical patients (67.9%) were between 31 and 70 years old. While males constituted the larger proportion in each age group, this difference was most pronounced in the oldest age group (≥71 years), where males represented 61.5% compared to 38.5% of females. A chi-square test revealed no statistically significant association between age group and gender ($\chi^2 = 1.055$, $p = 0.788$),

Table 2 – Distribution of patients according to pre-operative glycaemic control

S No	Pre-operative blood glucose level in mg/dl	No of Patients	Percentage
1	<180	38	35.8
2	≥180	68	64.2
Total		106	100

The cut-off good glycaemic control pre-operatively by RBS was set as < 180 mg/dl. Table 2 shows that the majority (64.2%) of patients exhibited pre-operative blood glucose levels equal to or exceeding 180 mg/dL, while 35.8% of patients had levels below this threshold. The mean pre-op RBS level in the patients was noted as 193.29 with an SD of 42.82 mg/dl.

Table 3 - Distribution of patients according to pre-operative glycaemic control by HbA1C

S No	Pre-operative blood glucose level in mg/dl	No of Patients	Percentage
1	<7.0	14	13.2
2	≥7.0	92	86.8
Total		106	100

The cut-off good glycaemic control pre-operatively by HbA1C was set as < 7%. Table 3 shows that the vast majority (86.8%) of patients had a pre-operative HbA1c level of 7.0% or higher, indicating poor glycaemic control before surgery. Only 13.2% of patients had an HbA1c level below 7.0%, suggesting good glycaemic control before their procedure. The mean HbA1C value was noted as 8.44% with an SD of 1.62%

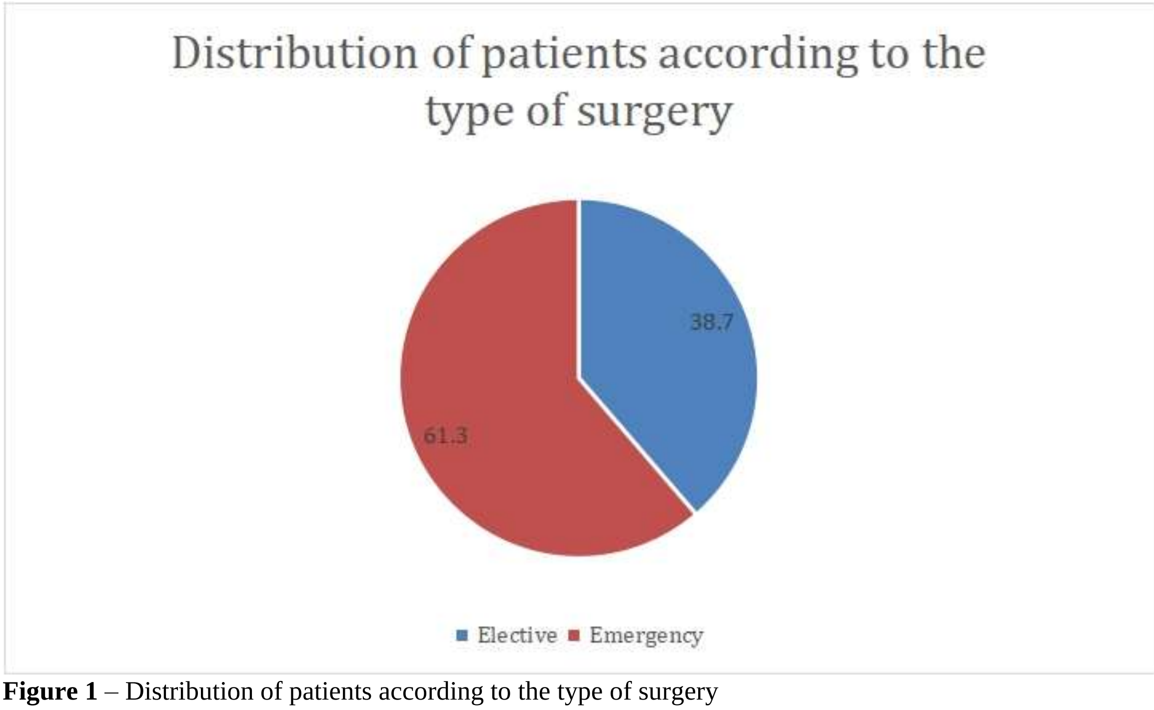

Figure 1 – Distribution of patients according to the type of surgery

Figure 1 depicts that the majority (61.3%) of patients underwent emergency surgery, while 38.7% underwent elective surgery.
Surgical site infections (SSI) were evenly distributed among patients, with 49.1% developing SSI and 50.9% not developing SSI.

Table 4 – Distribution of patients according to the class of SSI

S No	Grading of SSI	No of Patients	Percentage
1	Class I – Clean	54	50.9
2	Class II – Clean-contaminated	5	4.7
3	Class III - Contaminated	23	21.7
4	Class IV – Dirty	24	22.6
Total		106	100

Table 4; depicts that over half (50.9%) of the surgical procedures were classified as Class I - Clean, indicating a low initial risk of infection. However, a substantial proportion of surgeries fell into higher contamination classes: 21.7% were Class III (Contaminated) and 22.6% were Class IV (Dirty), suggesting a significant number of procedures carried a higher inherent risk of surgical site infection.

The majority of patients experienced a hospital stay ranging from 6 to 15 days, with 38.7% staying for 6-10 days and 24.5% staying for 11-15 days. A smaller proportion of patients (23.6%) had shorter stays of 5 days or less, while 13.2% experienced longer stays of 15 days or more. The mean duration of stay among the patients was noted as 10.2 days with a SD of 5.9 days. The mean age of patients who developed surgical site infections (SSI) was 54.04 years, while the mean age of those without SSI was 50.65 years. However, this difference in mean age was not statistically significant (t = 1.119, p = 0.266).

Table 5 – Comparison of mean post-operative RBS among patients with or without SSI

SSI	N	Mean Post Op RBS level in mg/dl	SD	T statistic	P value
Present	52	196.06	41.920	6.423	0.000
Absent	54	145.96	38.350		

Table 5 shows that the patients who developed surgical site infections (SSI) had a significantly higher mean postoperative random blood sugar (RBS) level (196.06 mg/dL) compared to those without SSI (145.96 mg/dL) (t = 6.423, p < 0.001).

A logistic regression model was developed to assess the association between various preoperative, intraoperative, and postoperative factors and the occurrence of surgical site infections (SSI). The analysis revealed that higher HbA1c values were significantly associated with a decreased risk of SSI (OR 0.41, 95% CI 0.21-0.82, p=0.011). Surprisingly, higher postoperative blood glucose levels were also linked to a reduced SSI risk (OR 0.97, 95% CI 0.95-0.99, p=0.002), warranting further investigation. Longer hospital stays were associated with decreased odds of SSI (OR 0.59, 95% CI 0.44-0.78, p<0.001), likely reflecting the increased time for SSI to manifest during hospitalization. Notably, age, sex, preoperative blood glucose, type of surgery, and the constant term were not found to be significant predictors of SSI in this model.

An ordinal regression model was employed to investigate the influence of various factors on the severity of surgical site infections (SSI). The analysis revealed that higher HbA1c values significantly increased the odds of having a more severe SSI (OR 1.76, 95% CI 1.22-2.54, p=0.001). A higher postoperative blood glucose level was also associated with increased SSI severity (OR 1.017, 95% CI 1.006-1.028, p=0.002). Additionally, each additional day of hospital stay was linked to a 33% increase in the odds of a more severe SSI (OR 1.33, 95% CI 1.18-1.51, p<0.001). Notably, sex, age, and preoperative blood glucose did not significantly predict SSI severity in this model. However, a trend towards lower SSI severity was observed with elective surgery, although this was not statistically significant.

DISCUSSION;

The primary aim of this study was to investigate the relationship between perioperative glycemic control and the incidence and severity of surgical site infections (SSI) in a cohort of patients undergoing various surgical procedures. Specifically, we sought to determine the impact of preoperative and postoperative blood glucose levels, as well as glycated hemoglobin (HbA1c), on SSI development and outcomes.

Our findings revealed a complex interplay between glycemic control and SSI risk. While we observed no significant association between preoperative or postoperative blood glucose levels and SSI incidence, HbA1c emerged as a significant predictor. Counterintuitively, higher HbA1c values were associated with a decreased risk of SSI, a finding that warrants further investigation. Notably, postoperative hyperglycemia was associated with increased SSI severity, consistent with previous research by **Kwon S et al. (2013)**[5] and **Long CA et al. (2018)**[6] highlighting the detrimental effects of elevated blood glucose on wound healing and immune function.

Our study revealed a concerning prevalence of poor preoperative glycemic control in our surgical cohort. A staggering 86.8% of patients presented with HbA1c levels ≥ 7%, indicating suboptimal glycemic management prior to surgery. This finding is consistent with previous studies, such as **Kwon S et al. (2013)**[5], who reported that 29.1% of patients undergoing elective colorectal and bariatric surgery experienced preoperative hyperglycemia (blood glucose >180 mg/dL). Similarly, **Estrada CA et al. (2003)**[7] found that 34.6% of patients undergoing coronary artery bypass grafting had diabetes, a known risk factor for glycemic dysregulation. However, our study's prevalence of poor preoperative glycemic control, as reflected by HbA1c, exceeds that reported in these prior studies, underscoring the need for heightened vigilance in assessing and optimizing glycemic status before surgery.

In our study, a significant proportion of patients (74.5%) experienced postoperative hyperglycemia, defined as a random blood sugar (RBS) level ≥ 140 mg/dL. This finding aligns with observations from several previous studies that have reported high rates of postoperative hyperglycemia in surgical patients. For instance, **Golden SH et al. (1999)**[8] found that postoperative glucose levels ranged from 121 to 352 mg/dL in diabetic patients undergoing coronary artery surgery, while **Estrada CA et al. (2003)**[7] reported a mean perioperative blood glucose level above the normal range in patients undergoing coronary artery bypass grafting.

However, there appears to be some discrepancy in the literature regarding the optimal postoperative glycemic control target. While our study used a cutoff of 140 mg/dL to define hyperglycemia, other studies, such as **Takesue et al. (2017)**[9], suggested a more stringent target of 150 mg/dL or lower to reduce the risk of surgical site infections (SSI) in non-diabetic patients. This difference in targets may reflect variations in patient populations, surgical procedures, and study methodologies, highlighting the need for further research to establish standardized and evidence-based glycemic control guidelines in the postoperative setting.

Our study cohort comprised a higher proportion of patients undergoing emergency surgeries (61.3%) compared to elective surgeries (38.7%). This distribution aligns with the findings of **Ramos M et al. (2008)**[10], who also observed a higher frequency of emergency surgeries in their study population. Notably, we found a statistically significant association between emergency surgery and increased SSI risk, with 75% of patients developing SSI in the emergency surgery group compared to 25% in the elective surgery group. This finding underscores the heightened vulnerability to infection in the emergency setting, potentially due to factors such as the underlying acute illness, compromised physiological state, and limited time for preoperative optimization.

In our study cohort, the overall incidence of surgical site infections (SSI) was 49.1%, with 52 out of 106 patients developing SSI. This incidence rate is notably higher than that reported in some previous studies, such as **Boreland L et al. (2015)**[11], who found a significant decrease in SSI occurrence with strict glycemic control in diabetic cardiac surgery patients. However, our findings align with other studies that have reported higher SSI rates in specific surgical populations or settings. For instance, **Hweidi IM et al. (2021)**[12] reported a 30-day postoperative SSI rate of 33.3% in diabetic patients undergoing coronary artery bypass grafting (CABG) surgery, while **Long CA et al. (2018)**[6] found that perioperative hyperglycemia was associated with increased rates of SSI in vascular surgery patients. The variability in SSI incidence across studies may be attributed to differences in patient populations, surgical procedures, and definitions of SSI.

In our study, the mean duration of hospital stay was 10.2 days, with a significant difference observed between patients with SSI (14.00 days) and those without (6.54 days). This finding aligns with observations from previous

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studies, such as **Ramos M et al. (2008)**[10], who reported longer hospitalizations for patients with postoperative hyperglycemia.

CONCLUSION;

This study highlights the critical role of perioperative glycemic control in managing surgical site infections (SSI). Our findings emphasize that poor preoperative glycemic control, particularly high HbA1c levels, is a significant predictor of SSI risk and severity. The study also reveals a higher SSI incidence in males and patients undergoing emergency surgeries. These insights underline the need for individualized glycemic management strategies and vigilant postoperative monitoring to optimize surgical outcomes. Further research is essential to understand the complex interactions between glycemic control and SSI risk, paving the way for tailored interventions to reduce SSIs and enhance patient recovery.

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