Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.6 No. 12 (2025): December 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i12.2348
Original Article

Prospective Observational Study of Surgical Site Infection in Diabetic Patients Undergoing Elective General Surgery.

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Abstract

Background:

Surgical site infections (SSIs) remain a major cause of postoperative morbidity, particularly among patients with diabetes mellitus. Poor perioperative glycaemic control and prolonged surgical exposure increase infection risk. This study assessed the incidence, bacteriological profile, antibiotic susceptibility pattern, and determinants of SSIs in diabetic patients undergoing elective surgery.

Methods:

A prospective observational study was conducted among 70 adult diabetic patients who underwent elective clean and clean-contaminated surgeries at Zoram Medical College and Hospital, Mizoram, between August 2022 and July 2024. Demographic data, perioperative variables, and postoperative glucose levels were recorded. Wound infections were identified using CDC criteria. Culture and antibiotic susceptibility testing were performed using the Kirby–Bauer disc diffusion method.

Results:

The overall SSI incidence was 15.7% (11/70). Infection rates were 5.5% in clean wounds and 19.2% in clean-contaminated wounds. Postoperative hyperglycaemia showed significant association with SSI: 4.2% (≤150 mg/dL), 38.1% (151–200 mg/dL), and 50% (≥201 mg/dL). Increased operative duration (>150 minutes) and prolonged preoperative hospital stay were associated with higher infection rates. Positive wound cultures were obtained in 81.8% of infected cases. *Staphylococcus aureus* and *Escherichia coli* were the predominant isolates. Most organisms showed sensitivity to carbapenems and higher-generation cephalosporins.

Conclusion:

Surgical site infection in diabetic patients is strongly associated with postoperative hyperglycaemia, operative duration, and wound classification. Strict perioperative glycaemic control and rational antibiotic use are essential to reduce infection risk.

Recommendation:

Implementation of standardized perioperative glucose control protocols is recommended.

KeyWords: *Surgical Site Infection; Bacteriology; Diabetes Mellitus; Wound Healing; Hospital Stay*.
Submitted: *September 17, 2025* ***Accepted:*** *October 30, 2025* ***Published:*** *December 30, 2025*

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Introduction

Even though there has been a lot of study on best practices, better surgical procedures, new technologies, and the use of antibiotics before surgery, surgical-site infection is still one of the most common problems for hospitalised patients. Infections at the wound site are a major cause of sickness after surgery and can even kill some individuals. They account for approximately 25% of all nosocomial infections. [1] The surgical site includes infections that happen after surgery in deep organ areas under the skin and soft tissue, like the peritoneum and bone. [2] An SSI must happen within 30 days of surgery. This time frame can be as long as a year if an implanted device or prosthesis is involved. To be called a surgical site infection, there must also be pus, cellulitis, or the need to cut up and drain the surgical site. [3] This study seeks

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to analyse the patterns of organisms isolated from surgical site infections (SSIs), their antibiotic susceptibilities, and the efficacy of preoperative antibiotic prophylactic regimens employed in various surgeries at the Department of Surgery, ZMC Hospital, particularly in diabetic patients.

Materials and Methods

The prospective study was carried out on 70 identified diabetic patients (Type 1 and Type 2) who underwent various elective surgical operations from August 2021 to July 2024 at the Department of General Surgery, ZMC, Aizawl, Mizoram. During this period, it was also looked at the anaerobic bacteriological profile and antimicrobial susceptibility pattern of Surgical Site Infection patients were also examined.

Study Design

This study was a **prospective observational hospital-based cohort study** conducted in the Department of General Surgery at Zoram Medical College and Hospital, Mizoram.

Study Location

This was a tertiary care teaching hospital-based study done in the Department of General Surgery at Zoram Medical College and Hospital, Falkawn, Aizawl, Mizoram.

Study Duration

August 2022 to July 2024.

Sample size

The sample size of 70 participants was determined based on the average number of diabetic patients undergoing elective general surgical procedures at the study center during the previous three years. Considering the feasibility and expected SSI incidence of approximately 15%, all eligible diabetic patients meeting the inclusion criteria during the study period were consecutively recruited.

Inclusion criteria:

1. Diabetic patients (fasting blood glucose ≥ 126 mg/dL [7.0mmol/L]) who underwent various elective surgical procedures at the Department of General Surgery, ZMC, Aizawl, Mizoram.
2. Either sex
3. Aged ≥ 18 years,

Exclusion criteria:

1. Contaminated wounds (C-III)
2. Dirty wounds (C-IV) of the CDC Wound Classification
3. Emergency operative procedures
4. Minor operations under local anaesthesia
5. Laparoscopic procedures.

Procedure methodology

The prospective study involved 70 identified diabetes individuals (Type 1 and Type 2). During this period, a bacteriological profile (anaerobic) and antimicrobial susceptibility pattern of Surgical Site Infection patients were also examined.

Before the study began, the Institutional Ethics Committee gave its clearance for the research to be done. All participants also gave their written consent. A comprehensive clinico-bacteriological assessment was conducted, encompassing demographic information, the kind and duration of the surgery, preoperative and postoperative hospitalisation, and the total length of stay. Routine preoperative procedures included checking blood sugar levels before and after meals, a complete blood count, a urinalysis, tests of kidney function, serum electrolytes, an electrocardiogram, and any necessary imaging studies. During procedures that lasted more than 60 minutes, blood glucose levels were checked. Within 24 hours of surgery, the patient's capillary blood glucose levels were checked, and glucose-insulin infusion and sliding-scale insulin therapy were used to keep blood sugar levels stable.

The Centers for Disease Control and Prevention's rules were used to find superficial surgical site infections. [3] In suspected instances of SSI, wound exudate or pus was obtained with sterile swabs and promptly dispatched to the Department of Microbiology for Gram stain, culture, organism identification, and antibiotic susceptibility testing by the Kirby–Bauer disc diffusion method.

Bias Control

Potential sources of bias were minimized through:

1. Consecutive sampling of eligible patients
2. Standard CDC criteria for SSI diagnosis
3. Uniform perioperative antibiotic protocol
4. Standardized microbiological testing procedures
5. Objective laboratory-based glucose measurement

Statistical analysis.

Statistical analyses were performed using SPSS 20 for Windows (SPSS Inc., Chicago, IL, USA) and Epi Info™ software. A 'P' value of <0.05 was considered significant. Data were analyzed, and post-operative outcomes were determined.

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Result

Participant Flow

During the study period from August 2022 to July 2024, a total of 82 diabetic patients scheduled for elective general surgical procedures were assessed for eligibility. Eight patients were excluded due to emergency procedures, contaminated or dirty wounds, and laparoscopic surgeries. Of the 74 eligible patients, four declined participation. Seventy patients were enrolled, completed follow-up, and were included in the final analysis.

Table 1. Participant Flow

Stage of Study	Number of Patients (n)
Assessed for eligibility	82
Excluded	8
Eligible	74
Declined participation	4
Enrolled and analyzed	70

Socio-Demographic and Clinical Characteristics

The study included 70 adult diabetic patients undergoing elective clean and clean-contaminated procedures. Male patients constituted a slightly higher proportion of the study population. The incidence of surgical site infection increased with advancing age. The distribution of patients according to sex and wound classification is shown in Table 2.

Table 2. Baseline Socio-Demographic and Clinical Characteristics (n=70)

Variable	Total (n=70)	SSI (n=11)	No SSI (n=59)
Male	45	7	38
Female	25	4	21
Clean wounds	36	2	34
Clean-contaminated wounds	34	9	25

The overall SSI incidence was 15.7% (11/70). Infection rates were comparable between males (15.6%) and females (15.1%). Clean-contaminated wounds demonstrated a higher infection rate (19.2%) compared to clean wounds (5.5%).

Postoperative Glycaemic Control and SSI

Postoperative blood glucose levels showed a significant association with the development of surgical site infection. Patients with glucose levels ≤150 mg/dL had a markedly lower infection rate compared to those with higher levels.

Table 3. Postoperative Blood Glucose Level and SSI Rate

Postoperative Blood Glucose (mg/dL)	Total Patients (n)	SSI (n)	SSI Rate (%)
≤150	47	2	4.2%
151–200	21	8	38.1%
≥201	2	1	50%

A progressive increase in SSI incidence was observed with rising postoperative glucose levels, indicating a strong correlation between hyperglycaemia and infection risk.

Duration of Surgery and SSI

An increased duration of surgery was associated with a higher incidence of SSI. Procedures lasting less than 30 minutes did not result in infection, whereas prolonged surgeries demonstrated significantly higher infection rates.

Table 4. Duration of Surgery and SSI

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Duration of Surgery (minutes)	Total Patients (n)	SSI (n)	SSI Rate (%)
<30	6	0	0%
31–60	38	2	5.2%
61–150	21	5	23.8%
>150	5	4	80%

A clear trend of increasing SSI incidence was noted with longer operative duration.

Timing and Clinical Presentation of SSI

All surgical site infections were identified within two weeks postoperatively. Most infections were detected during routine postoperative dressing, commonly around the third postoperative day. Clinical features included erythema, serosanguineous discharge, wound gaping, and purulent discharge.

Bacteriological Profile and Antibiotic Susceptibility

Positive wound cultures were obtained in 9 out of 11 infected cases (81.8%). The predominant organisms isolated were *Staphylococcus aureus* and *Escherichia coli*. One isolate of methicillin-resistant *Staphylococcus aureus* (MRSA) was identified.

Table 5. Organisms Isolated from SSI Cases (n=11)

Organism	Number of Isolates	Percentage (%)
Staphylococcus aureus	4	36.4%
Escherichia coli	3	27.3%
Coagulase-negative Staphylococcus	1	9.1%
Klebsiella pneumoniae	1	9.1%
No growth	2	18.2%

The antimicrobial susceptibility pattern demonstrated the highest sensitivity to carbapenems (imipenem, meropenem), followed by third- and fourth-generation cephalosporins and glycopeptides such as vancomycin.

Discussion

Surgical site infections continue to be a common postoperative consequence in surgical practice, despite advancements in surgical methods, aseptic procedures, and antimicrobial medication. The function of microorganisms in wound infection was originally established through the foundational work of Koch, and later reinforced by the contributions of Semmelweis, Lister, and Pasteur, which provided the basis for modern infection control methods in surgery. [4] Even with these improvements, surgical site infections still cause a lot of problems and deaths after surgery. They represent a big part of healthcare-associated infections in hospitalised surgical patients. Numerous research has examined the correlation between diabetes mellitus and the risk of surgical site infection, yielding contradictory results. The National Academy of Sciences–National Research Council Cooperative Study indicated comparable age-adjusted incidence of wound infection between diabetes and non-diabetic individuals. [6] Conversely, Cruse and Foord, in their prospective investigations, exhibited a greater prevalence of surgical site infections in diabetes patients, especially in clean surgical wounds. Hjortrup et al. also found that there was no significant difference in the rates of wound infections between diabetic and non-diabetic individuals who had vascular and abdominal surgery. [8] These findings indicate that diabetes may not be the exclusive factor influencing postoperative infection risk.

Postoperative glycaemic management seems to be a more important factor in the development of surgical site infections. McConnell et al. showed that bad control of blood sugar levels after surgery, which they defined as average blood sugar levels over 200 mg/dL, was linked to an increased risk of surgical site infection in people with diabetes who had colon surgery. [9] The results of this investigation corroborate this observation, revealing a significantly raised SSI risk in patients with increased postoperative blood glucose levels, hence underscoring the necessity of stringent postoperative glycaemic control.

It has also been demonstrated that the occurrence of surgical site infections can be affected by factors such as wound contamination and the operation itself. Kune et al. found that clean surgical procedures were mostly linked to Gram-positive organisms, especially Staphylococcus aureus. On the other hand, procedures involving the gastrointestinal system had a larger number of Gram-negative organisms. [10] Kamat et al. identified a prevalence of Gram-negative organisms in surgical site infections within their research population. [11].

In this investigation, positive cultures were acquired in the majority of surgical site infection patients. Staphylococcus aureus and Escherichia coli were the predominant pathogens isolated. These results align with observations made by Nichols et al., Vriesendorp et al., and Giacometti et al., who documented analogous pathogen distributions in surgical site infections. [1][12][13] The antimicrobial susceptibility pattern identified in this investigation exhibited increased sensitivity to carbapenems and higher-generation cephalosporins, indicating the changing patterns of resistance among frequently isolated bacteria.

Overall, the results of this study show that surgical site infections in diabetes patients are caused by more than one thing. Hyperglycemia after surgery, the length of the surgery, and the length of the hospital stay all considerably increase the risk of infection.

Generalizability

The findings may be generalizable to tertiary care hospitals managing diabetic patients undergoing elective general surgery in similar resource-limited settings. However, microbiological patterns may vary across geographical regions.

Conclusion

Fifteen-point seven percent of diabetic patients who had elective clean and clean-contaminated procedures had superficial surgical site infections. Poor glycaemic control after surgery, especially blood glucose levels above 200 mg/dl, was linked to a higher risk of ssi and a longer hospital stay. These results underscore the necessity of stringent perioperative blood glucose regulation and judicious antibiotic administration to mitigate surgical infections in diabetic patients.

Study limitations

This study had certain limitations. The sample size was relatively small and conducted in a single center, which may limit external validity. Only elective procedures were included, excluding emergency surgeries. Anaerobic cultures were not performed in all cases. Glycaemic variability beyond the early postoperative period was not assessed.

Recommendations

1. Strict postoperative glucose control (<150 mg/dl)
2. Standardized ssi surveillance program
3. Periodic antibiotic resistance monitoring
4. Institutional antibiotic stewardship strengthening

Acknowledgment

The authors acknowledge the Department of Microbiology, Zoram Medical College, for laboratory support and all surgical staff involved in patient care during the study period.

List of abbreviations

SSI – surgical site infection
cdc – centers for disease control and prevention
MRSA – methicillin-resistant Staphylococcus aureus
SPSS – Statistical Package for the Social Sciences

Source of funding

This study did not receive any external funding.

Conflict of interest

The authors declare no conflict of interest.

Availability of data

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Author contributions

Samuel L. Sailo contributed to study conception, data collection, statistical analysis, and manuscript drafting. Hnamte Ram Buatsaiha contributed to study design, supervision, manuscript review, and final approval.

Author biography

Dr. Samuel l sailo is an associate professor in the Department of General Surgery at Zoram Medical College, Mizoram, with clinical and research interests in surgical infections and diabetic wound management.

Dr. Hnamte Ram Buatsaiha is a faculty member in the department of general surgery at Zoram Medical College, Mizoram, with an interest in gastrointestinal surgery and infection control.

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Vol.6 No. 12 (2025): December 2025 Issue
https://doi.org/10.51168/sjhrafrica.v6i12.2348
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PUBLISHER DETAILS

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa