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PREVALENCE AND RISK FACTORS OF SURGICAL SITE INFECTIONS FOLLOWING ELECTIVE GENERAL SURGERY PROCEDURES.

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ABSTRACT

BACKGROUND: In low- and middle-income countries like Pakistan, surgical site infections (SSIs) result in increased health care expenditures, prolonged hospital stays, and increased morbidity. Establishing successful preventive measures requires identifying region-specific risk factors and prevalences. **OBJECTIVE:** To assess the prevalence of surgical site infections and identify associated risk factors among patients who undergo elective general surgical procedures in a tertiary care hospital. **METHODS:** It was a prospective observational study conducted between July 2023 and December 2024 at Hayatabad Medical Complex (HMC), Peshawar. There were 398 patients who underwent elective general surgery procedures during the study period. The elective surgeries involved were not emergency surgeries but they were scheduled to take place and occurred in sterile conditions. Amongst the total, 18 patients were lost to followup. **RESULTS:** Of all the procedures, 172 (45.3%) were laparoscopic and 208 (54.7%) were open surgery. The most common surgeries were appendectomy (14.5%), laparoscopic cholecystectomy (26.3%), and hernia repair (28.2%). Based on wound classification, 238 cases (62.6%) were clean, 115 cases (30.3%) were clean-contaminated, and 27 cases (7.1%) were contaminated. Overall, the SSI rate was observed in 42(11.1%,) patients. Amongst which 28(7.4%) were superficial infections, 4(1.1%) organ/space infections, and 10(2.6%) deep incisional infections. **CONCLUSION:** In elective general surgery, SSIs play a significant role as postoperative complications and there are several modifiable risk factors. Targeting procedures such as improved preoperative risk stratification, glycemic control, weight reduction, consistent aseptic technique, may decrease the incidence of SSI and improve the overall surgical experience.

KEYWORDS: SSI, surgery, risk factors, prevalence, diabetes, obesity.

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INTRODUCTION

Surgical site infections (SSIs) are a major problem of modern healthcare; also, low- and middle-income countries are concerned by SSIs, as infection control measures are frequently suboptimal. SSIs are defined as infections that take place at or near a surgical incision site within 30 days after surgery (one year if an implant is inserted), and they are among the most frequently encountered postoperative complications worldwide, leading to higher morbidity, longer hospitalization, and greater medical expenses[1,2].

Worldwide, SSIs represent 20% of all nosocomial infections, whose prevalence varies between 2%-20% depending on the nature of surgery and the quality of perioperative care [3]. In elective general surgical procedures, the rates of SSI are 5 - 15% globally, even reaching higher in low and middle-income countries [4,5]. In Pakistan, the frequency of the SSI have been reported ranging from 7% to 25% and the necessity for indigenous data is noted to aid in decision making regarding prevention and control of SSI [6].

A number of risk factors have been linked to the development of surgical site infections (SSIs). These include factors related to the patient, such as age, diabetes, obesity, anemia, smoking, and immunosuppression; and factors related to the procedure, such as the length of the surgery, the degree of contamination, the length of the hospital stay before the procedure, proper sterilization, and the use of antibiotic prophylaxis [7, 8.] Particularly high rates of inappropriate antibiotic usage occur during the perioperative phase, and the underdeveloped world is rife with disregard for asepsis guidelines. [9].

Despite the fact that both worldwide and local standards have advised preventive actions, many hospitals, particularly those with low resources, often do not adhere to standardized protocols [10.] Additionally, SSI reporting is usually inadequate or nonexistent, which leads to underreporting and a delayed response to outbreaks.[11] Therefore, in order to modify infection control measures and improve patient safety, it is crucial to ascertain the local incidence and contributing factors of SSIs in elective procedures.

The objective of this study is to estimate the frequency of SSIs and evaluate the risk factors associated with patients undergoing elective general surgical operations. The results of this and other similar studies would help to develop a data-driven approach to targeted interventions to lower the incidence of SSIs in surgical departments.

MATERIALS AND METHODS

It was a prospective observational study conducted between July 2023 and December 2024 at Hayatabad Medical Complex (HMC), Peshawar, Khyber Pakhtunkhwa (KPK), Pakistan. There were 398 patients who underwent elective general surgery procedures during the study period. The elective surgeries involved were not emergency surgeries but they were scheduled to take place and occurred in sterile conditions. The specific types of general procedures that were commonly conducted were thyroidectomies, appendectomies, hernia repairs, laparoscopic cholecystectomies, open cholecystectomies, and gastrointestinal resections.

We included patients of at least 18 years of age who underwent elective general surgery at the Hayatabad Medical Complex, Peshawar. Only patients who provided written informed consent and were available for follow-up for at least 30 days following surgery were eligible to enrol. Exclusion criteria included emergency surgery, previous infections at the time of surgery, and immunocompromised patients (e.g., receiving chemotherapy, long-term corticosteroids, or diagnosed with HIV/AIDS). Additionally 18 patients who were lost to follow-up & those who declined to participate in the trial were excluded.

A standardized proforma was utilized to collect data from clinical observations, direct patient interviews, and a study of hospital records. Preoperative characteristics included age, gender, comorbidities (e.g. diabetes mellitus, hypertension), smoking status, BMI, hemoglobin levels, and duration of hospitalization. Intraoperative variables included the type and duration of the procedure, the type of anesthetic used, the physical state score of the American Society of Anesthesiologists, and the classification of the wound as clean, clean-contaminated, or contaminated.

Postoperative variables included the length of the hospital stay following surgery, wound care practices, and the use of antibacterial prophylaxis. Infections of the skin, subcutaneous tissue, fascia, or organ/space at the surgical site that occurred within 30 days following surgery were included in the criteria for SSI, set by the Centers for Disease Control and Prevention (CDC). The clinical diagnosis was made using symptoms such as fever, heat, erythema, discomfort, regional swelling, and purulent discharge. In suspected cases, microbial etiology was confirmed by culture and sensitivity testing of wound discharge.

Up to 30 days after surgery, all patients were monitored by phone consultations or in-person visits. Follow-up evaluations were scheduled for postoperative days 7, 14, and 30. Individuals displaying symptoms of SSI were assessed and examined physically. The study received ethical approval from the Hayatabad Medical Complex's Institutional Review Board (IRB) Peshawar. Each participant gave written informed consent after being fully told about the study's objectives, procedures, risks, and benefits. Anonymity and confidentiality of patient data were strictly maintained.

Data were collected and analyzed using SPSS (version 25.0). Patient demographics and clinical characteristics were summarized with the use of descriptive statistics. Data were presented as means and standard deviations (SD) for continuous variables, and as percentages and frequencies for categorical variables. As a result of the prevalence of SSIs, which is defined as the percentage of patients who had at least one SSI in the total cohort, the rate of SSIs was calculated. In univariate analysis, the student's t-test (continuous variables) and chi-squared test or Fisher's exact test (categorical variables) were used to identify risk factors linked to SSI. These variables were incorporated into a multivariate logistic regression model after univariate analysis was performed to identify independent risk factors for SSI. A p-value ≤ 0.05 was deemed statistically significant.

RESULTS

The mean age was 42.6 ± 15.3 years (range: 18–79 years), with 216 (56.8%) male and 164 (43.2%) female patients. Among them, 78 (20.5%) smoked, and 96 (25.3%) had diabetes. 52 patients (13.7%) had a mean BMI of 26.4 ± 3.9 kg/m², making them obese (BMI ≥30 kg/m²). Preoperative anemia (Hb <10 g/dL) was present in sixty-one patients (16.1%). The average preoperative hospital stay was 2.3 ± 1.2 days. Table 1

TABLE 1: DEMOGRAPHIC AND CLINICAL CHARACTERISTICS

Variable	Value
Mean Age (years)	42.6 ± 15.3
Gender (Male/Female)	216 (56.8%) / 164 (43.2%)
Male	216 (56.8%)
Female	164 (43.2%)
Smokers	78 (20.5%)
Diabetics	96 (25.3%)
Mean BMI (kg/m²)	26.4 ± 3.9
Obese (BMI ≥30)	52 (13.7%)
Preoperative anemia	61 (16.1%)
Preoperative hospital stay	2.3 ± 1.2 days

Of all the procedures, 172 (45.3%) were laparoscopic and 208 (54.7%) were open surgery. The most common surgeries were appendectomy (14.5%), laparoscopic cholecystectomy (26.3%), and hernia repair (28.2%). The average time for the surgery was 93 ± 27 minutes. Based on wound classification, 238 cases (62.6%) were clean, 115 cases (30.3%) were clean-contaminated, and 27 cases (7.1%) were contaminated. 205 patients (53.9%) were categorized as ASA-I, 131 patients (34.5%) as ASA-II, and 44 patients (11.6%) as ASA-III based on the ASA physical status classification. Table-2

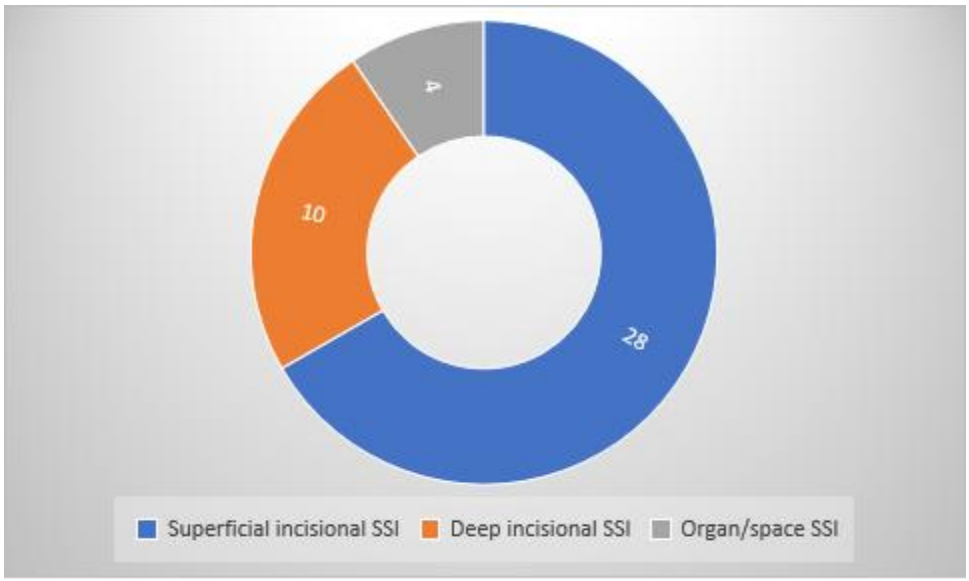
TABLE 2: SURGICAL AND INTRAOPERATIVE VARIABLES

Variable	Value
Mean duration of surgery	93 ± 27 minutes
Type of surgery	
Laparoscopic	172 (45.3%)
Open	208 (54.7%)
Procedures	
Hernia	(28.2%)
Cholecystectomy	(26.3%)
Appendectomy	(14.5%)
Wound classification	
Clean	238 (62.6%)
Clean-contaminated:	115 (30.3%)
Contaminated:	27 (7.1%)
ASA status	
I:	205 (53.9%)
II	131 (34.5%)
III	44 (11.6%)

Before surgery, 342 patients (90.0%) were given antibiotic prophylaxis. Following surgery, the average length of stay in the hospital was 3.4 ± 1.6 days. Postoperative wound care regimens were documented to be followed in 356 cases (93.7%).

Overall, the SSI rate was observed in 42(11.1%,) patients. Amongst which 28(7.4%) were superficial infections, 4(1.1%) organ/space infections, and 10(2.6%) deep incisional infections. Figure 1

Figure-1: Distribution of Surgical Site Infection types among affected patients (n = 42)



Diabetes, obesity, preoperative anemia, smoking, wound classification (clean-contaminated and contaminated), prolonged surgery duration (>120 minutes), and ASA class II/III were all found to be significantly associated with SSI ($p < 0.05$) according to univariate analysis. Table 3

TABLE 3: UNIVARIATE ANALYSIS OF RISK FACTORS

Risk Factor	SSI Present (n = 42)	SSI Absent (n = 338)	p-value
Diabetes	22 (52.4%)	74 (21.9%)	<0.001
Obesity (BMI ≥30)	16 (38.1%)	36 (10.6%)	<0.001
Smoking	15 (35.7%)	63 (18.6%)	0.009
Preoperative anemia	14 (33.3%)	47 (13.9%)	0.002
Wound classification	Contaminated (7.1%)	Clean (2.1%)	0.004
Duration >120 minutes	19 (45.2%)	51 (15.1%)	<0.001
ASA II/III	28 (66.7%)	147 (43.5%)	0.01

Multivariate analysis revealed that diabetes (OR 2.74, 95% CI: 1.33–5.63), obesity (OR 3.02, 95% CI: 1.38–6.62), contaminated wound classification (OR 4.15, 95% CI: 1.46–11.76), and surgery duration >120 minutes (OR 2.59, 95% CI: 1.24–5.39) were independent predictors of SSI. Table-4

Table 4: Multivariate Logistic Regression of Independent SSI Risk Factors

Risk Factor	Odds Ratio (OR)	95% CI	p-value
Diabetes	2.74	1.33 – 5.63	0.006
Obesity (BMI ≥30)	3.02	1.38 – 6.62	0.005
Contaminated wound	4.15	1.46 – 11.76	0.008
Duration >120 minutes	2.59	1.24 – 5.39	0.011

DISCUSSION

The observed overall SSI rate was 11.1%, which is close to rates previously recorded in similar circumstances but higher than that of high-income countries. In a local study by Khan et al [12] reported an SSI incidence of 9.8% in KPK, which is consistent with our findings and highlights the need for better perioperative infection management in the region. However, Jatoliya et al ([13]) discovered that SSI rates in high-income countries were as low as 2–5% due to better surveillance, infrastructure, and antimicrobial stewardship.

Age did not statistically significantly predict SSI in our analysis, although older patients had a somewhat higher propensity for infection, which is similar to the findings of Alkaaki et al. [13], who found that concomitant diseases and compromised immunity increased the risk of SSI with age. The results of a multicenter study by Curcio et al. [14] that also found no significant association between sex and SSI risk are consistent with our cohort's lack of gender as a significant factor.

Numerous studies have found that diabetes is a strong independent predictor of SSI (OR 2.74, p=0.006). For instance, diabetes was found to be a significant risk factor in Tanzania by Singh et al. [15] because it affects wound healing and immune

response. In order to reduce postoperative infections, Edis et al. [16] also emphasized the significance of stringent glycemic control.

Obesity (BMI ≥30) was significantly associated with higher SSI risk (OR 3.02, p=0.005). This supports the findings of Aghdassi et al. [17], who discovered that excessive adipose tissue inhibits healing by reducing tissue perfusion and oxygenation. Furthermore, Sawada et al. [18] found that obese patients often need lengthier surgeries and wider incisions, both of which raise the incidence of SSI.

In univariate analysis, we found a statistically significant correlation between smoking and SSI (p=0.009); however, in multivariate analysis, this relationship ceased to be significant. This trend supports the findings of Duran et al. [19] that smoking increases the likelihood of infection and impedes wound healing, even though other factors may mask its independent effect.

The findings of Duran et al.[20] showed that low hemoglobin increases vulnerability to infection by decreasing tissue oxygenation and immunological function. In univariate analysis, SSI was substantially correlated with preoperative anemia (p=0.002). This connection did not hold up in multivariate analysis, possibly due to interaction with other comorbidities such chronic disease and dietary inadequacies.

Our study clearly demonstrated a gradient in SSI prevalence by wound class, with the highest infection rates occurring in contaminated wounds. This is consistent with the findings of Wenzel et al. [21], who pointed out that wound class is a strong predictor of postoperative infection due to tissue stress and an increase in bacterial load. Furthermore, our multivariate analysis confirmed that the classification of infected wounds was an independent predictor (OR 4.15, p=0.008).

A longer operation duration (>120 minutes) significantly increased the incidence of SSI (OR 2.59, p=0.011), which is consistent with the findings of Olufemi et al. [22], who pointed out that longer surgeries expose tissues to prolonged contamination risk, dehydration, and ischemia. Longer operating times are also often associated with increased technical difficulties and blood loss, which further increases the risk of infection.

Although ASA II/III status had a significant univariate correlation (p=0.01) with SSI, it did not appear as an independent predictor in the multivariate model. This suggests that while ASA classification reflects underlying health state, its effect on SSI may be mediated by more specific criteria such as diabetes, obesity, and surgical length. Similar findings were observed by Lakoh et al. [23], who emphasized that ASA score is a useful but indirect indicator of SSI risk.

In our study, a considerable proportion of patients still developed SSIs despite the fact that 90% of them got antibiotic prophylaxis. This highlights the possibility of issues with the selection, timing, or dosage of antibiotics. The need of ensuring appropriate spectrum coverage and administering antibiotics within 60 minutes of the incision is emphasized by Olowo et al. [24]. The high rate of wound care protocol adherence (93.7%) raises the possibility that postoperative treatment alone may not be sufficient to offset intraoperative and systemic risk factors.

This study has some limitations. The results may not be as applicable to other healthcare settings because the study was limited to a single tertiary care facility. Second, infections that appeared after the 30-day postoperative follow-up period might have gone unnoticed. Third, pathogen-specific analysis was limited because not all patients underwent microbiological confirmation and antibiotic sensitivity testing. In order to increase generalizability, future research should seek to validate these findings through larger, multicenter trials carried out in different healthcare settings. More precise detection of infection patterns, including late-onset SSIs, would be

possible by including microbiological studies and prolonging the surgical follow-up period. Research like this would help create stronger, evidence-based plans for managing and preventing surgical site infections.

CONCLUSION

Diabetes, obesity, contaminated wounds, and extended operating times were found to be substantial independent risk factors for surgical site infections, which were found to be quite common in patients receiving elective general surgery. To reduce SSI rates and enhance surgical outcomes in comparable clinical settings, targeted therapies that address these modifiable factors are required.

ETHICS APPROVAL: The ERC gave ethical review approval.

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

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AUTHORS' CONTRIBUTIONS:

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

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