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The Prevalence of Surgical Site Infections (SSI) in Surgical Patients at Al-Jala' Hospital, Benghazi, Libya (2023)

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ABSTRACT.

Background: Surgical site infections (SSI) are the third most frequently reported nosocomial infection. SSIs pose a significant threat to the lives of millions of patients annually and contribute to the proliferation of antibiotic resistance. The World Health Organization (WHO) has emphasized the importance of addressing the financial implications and patient morbidity associated with SSIs globally.

Objectives: To ascertain the prevalence of SSI, identify the pathogenic organisms involved, and analyze the risk factors implicated.

Methods: This research was conducted across all the surgical departments at Al-Jalla Teaching Hospital, Benghazi, Libya. It constitutes a descriptive-case series study, involving the retrospective collection and analysis of data from 199 surgical patients who underwent surgeries in 2023, utilizing SPSS version 25 for data analysis.

Results: The analysis of the clinical data from the 199 patients indicated a prevalence of 8.5% for SSI. The most common bacteria isolated was *Staphylococcus aureus*. Most SSI cases were found in General and orthopedic surgeries. The statistically significant risk factors identified for SSI in these patients include; anemia (P=0.001), blood transfusion (P=0.001), and the type of operation (P=0.011).

Conclusions: The infection rate observed in this study was higher compared to those in developed countries. Some certain risk factors demonstrated a significant correlation with increased SSI rates. underscoring the need for continuous surveillance and targeted infection control. Despite important findings, some limitations may have introduced biases, potentially underestimating the true prevalence and risk factors for SSIs.

Introduction

Healthcare-associated infections (HAIs) are infections that patients develop while receiving medical or surgical treatment which are the most frequent adverse event during the process of care delivery [(1)]. Surgical site infections (SSIs) are among the most reported healthcare-associated infections (HAI). SSI approximately represents 20% of all HAIs and is associated with a two-eleven-fold increase in the risk of mortality, and 75% of deaths linked to SSI are directly attributable to SSI and remain a significant contributor to morbidity, extended hospital stays, and death, despite the improvements of infection control practices that have been made [(2)]. The reported worldwide SSI rate varies from a low of 2.5% to a high of 41.9% [(3)]. With an estimated yearly cost of about $3.3 billion, SSI is the most costly type of HAI. Furthermore, it's reported that it increases the length of hospital stay by around 9.7 days [(2)].

Surgical wound infection is defined as purulent discharge formed within fourteen days of surgery most often between the fifth and tenth postoperative days. In which there is an invasion of organisms into tissues following a breakdown of local and systemic host defenses, leading to cellulitis, lymphangitis, abscess formation, or bacteremia [(4)]. In 1992, the term "surgical wound infection" was replaced with "surgical site infection"[(5)]. SSIs can also be defined by the Centers for Disease Control and Prevention (CDC) as infections that occur within thirty days of operation or one year if prosthesis or implant placement has been used [(6)]. According to the National Nosocomial Infection Surveillance Program (NNIS), SSIs are classified into superficial, deep, and organ/space infections. The infection of most surgical wounds is referred to as superficial surgical site infections (SSSIs) that involve the skin and subcutaneous tissue. The other categories include deep SSI (30%) which includes the infection in the fascia and muscle layer, and organ space infection (20%) such as an abdominal abscess after an anastomotic leak or pelvic abscess after perforated appendicitis. The site of infection may be limited to the suture line or may become extensive in the operative site [(2)].

The risk factors associated with the development of an SSI vary according to specific patient factors and clinical characteristics, in addition to the type of surgery. In general, conditions including diabetes due to damage to peripheral vasculature and an impaired immune response associated with high blood glucose levels are shown to be associated with a doubling of the risk of SSI compared with patients without diabetes. Obesity due to poor vascularization of adipose tissue combined with increased complexity of surgery may increase the risk of SSI in patients with a body mass index of 35kg/m² or more, smoking, peripheral neuropathy, and increased duration of surgery and hospital stay contribute to increasing the risk of SSIs [(7)].

The development of a postoperative wound infection depends on the complex interplay of many factors. Any infection that occurs postoperatively may be termed endogenous or exogenous, depending on the source of the bacterial contamination [(8)]. Endogenous organisms are present on or in the patient at the time of surgery, whereas exogenous organisms come from outside the patient. Exogenous infections are mainly acquired from the nose or skin flora of the operating team and transmitted through the hands of the surgeon or improper operation theater sterilization, which includes preoperative, intraoperative, and postoperative care. In modern hospital practice, endogenous organisms colonizing the patient are the most common source of infection [(9)]. The most commonly associated organisms are *Staphylococcus aureus* and *Escherichia coli.* The human body harbors approximately 1014 organisms. They can be released into tissues before, during, or after surgery, contamination being most severe when a hollow viscus perforates such as fecal peritonitis following a diverticular perforation. However, the period of greatest risk remains at the time between opening and closing the operative site. Concurrent wound assessment allows early diagnosis of SSI [(6)].

SSIs present with purulent drainage, pain or tenderness, localized swelling, redness, or hotness. They usually become apparent by the end of the first week after surgery. SSI can be manifested as a cellulitis of soft tissue at the place of surgery or wound abscess. In the case of deep and organ/ space SSIs, the local signs of infection can be less expressed and the first clinical signs can be purulent drainage from the wound, unexplainable fewer pathological patient’s blood test results such as— high C-reactive protein (CRP), erythrocyte sedimentation rate (ESR) and pro-calcitonin level, as well as high leukocyte counts. Systemic inflammatory response of the body may occur but it is uncommon. Dehiscence of the incision, if the site is tender or if the patient has a fever, may indicate the presence of infection. According to Sandy-Hodgetts et al., dehiscence may be attributable to non-microbial causes such as obesity or pre-existing chronic disease in some cases [(6,7)].

In diagnostics of deep and organ/space SSIs, it is necessary to carry out a full clinical assessment of the patient and the place of surgery, plain X-rays, and further imaging (e.g. MRI scan, CT scan, USS), blood cultures (particularly in acute cases), organ, bone and/or soft tissue biopsies and/or surgical sampling [(7)].

The serious consequences imposed on patients who developed SSI determine the need for efforts to create strategies for the prevention of this infection. One of the strategies used is the determination of risk factors, which allows identifying clinical conditions that predispose to the development of SSI. In this sense, the identification of risk factors for SSI contributes to the early adoption of nursing interventions that aim to minimize this type of postoperative complication [(10)].

In superficial SSI wound margins separation and skin suture removal can be sufficient. Drain the wound using non-adherent antiseptic dressing straps, keep the skin open, and dress the wound with antiseptic dressings. Cleansing the wound with antiseptic lavage through the syringe may also be appropriate. Surgical debridement has an important role in the open wound management. Deep SSIs may require a more aggressive approach with careful revision of fascia and affected muscles, especially in cases of chronic limb ischemia. Treatment of organ space SSI often requires admission into the acute care setting, targeted antibiotic treatment, drainage of the pus collection, and complex management of the infection with a focus on the affected organ [(7)].

Nowadays surgeons cannot escape the responsibility of facing infections and, the knowledge of the appropriate use of aseptic and antiseptic techniques, the proper use of prophylactic and therapeutic antibiotics, and adequate monitoring and support with novel surgical and pharmacological modalities as well as non-pharmacological aids. It's important to note that improved adherence to evidence-based preventive measures is related to appropriate antimicrobial prophylaxis and proper sterilization techniques. As well as hand hygiene protocols can decrease the rate of SSI. Foreign bodies inserted such as implants must be monitored for early diagnosis and treatment of suspected biofilm activity on the implant. Additionally, individual patient factors and specific surgical procedures can influence the likelihood of infection. Therefore, it's always best to consult with healthcare professionals for personalized information and guidance regarding surgical site infections. [(6)]

In view of the above information, this study was conducted with the aim of assessing the prevalence of SSI and its associated risk factors among patients who underwent any kind of surgery both elective and emergency in Al-Jala Teaching Hospital.

Aim of the study

Aim

To address the six-year gap in surgical site infection (SSI) surveillance and to systematically investigate the prevalence and associated risk factors of SSIs at Al-Jala Teaching Hospital.

Objectives

1. To ascertain the prevalence of SSI in Al-Jala Hospital in 2023.
2. To identify the most common pathogens involved.
3. To determine the risk factors involved.

Materials and Methods

1. Study period

The study was performed throughout Eleven months' duration from the 1st of January up to the 30th of November.

2. Period of data collection

The data were collected over three months from the 7th of July up to the 28th of September.

3. Study area

The study was conducted at Al-Jala Teaching Hospital which is a Teaching hospital providing emergency and trauma services, in Benghazi, Libya. During the year 2023, 20,300 patients had surgery at Al-Jala Hospital. The hospital serves the city of Benghazi with a population of approximately 650,000. It is the referral hospital for most of the eastern half of Libya, with 560-bed an average daily census of 460, and a monthly admission rate of approximately 15070 patients.

4. Study population

Patients underwent different types of surgery at Al-Jala Teaching Hospital.

Inclusion criteria: all patients of all ages of both genders who underwent any type of surgery with clean non-contaminated wounds and were admitted to the surgical wards.

Exclusion criteria: patients who underwent second surgery at the same site for any reason, patients on immunosuppressant therapy or any known immunodeficiency disease, patients on antibiotics already for any other infections, and surgeries with already contaminated wounds were excluded from the study.

5. Study design

A cross-sectional study was selected to determine the prevalence of SSI at Al-Jala Teaching Hospital in 2023. Owing to the fact that this type of study design is appropriate for establishing the frequency of medical conditions in a specific population at a given period.

6. Study sample

6.1. Sample type: the sample includes all surgical patients who meet the inclusion criteria.

6.2. Sample size Out of the 3132 surgeries recorded at the hospital in 2023, only 831 cases with comprehensible and clear data were included in the study population due to the poor quality of the remaining records. The sample size was 263 out of a population of 831 cases, calculated using the Raosoft version (2004) with a margin of error of 5% and a confidence level of 95%. Only 199 cases were available to obtain their data due to several limitations.

6.3. Sampling technique A systematic random sampling technique was used, selecting all patients who met the inclusion criteria. The 831 chosen population were divided by the desired sample size of 263, resulting in a ratio of approximately 3:1. Consequently, one case was selected for every third case in the sequence.

7. Variables definition

7.1. Independent variables: ward, age, gender, family income, place of residency, nationality, period of admission, type of operation, type of procedure, site of wound, length of operation, emergency or elective, preoperative patient condition, type of organism, past medical history, serology, hemoglobin, white blood cells, postoperative antibiotics given, and blood transfusion.

7.2. Dependent variables: the occurrence of surgical site infections

8. Tools for data collection:

A pre-prepared data collection form was used to collect the data from the files.

9. Method of data collection

data were collected retrospectively from patients' files at Al-Jala Hospital, including medical and surgical records, information on patient demographics, surgical details, and infection status extracted from the culture and sensitivity records from the microbiology lab. All data were recorded using a pre-prepared data collection form.

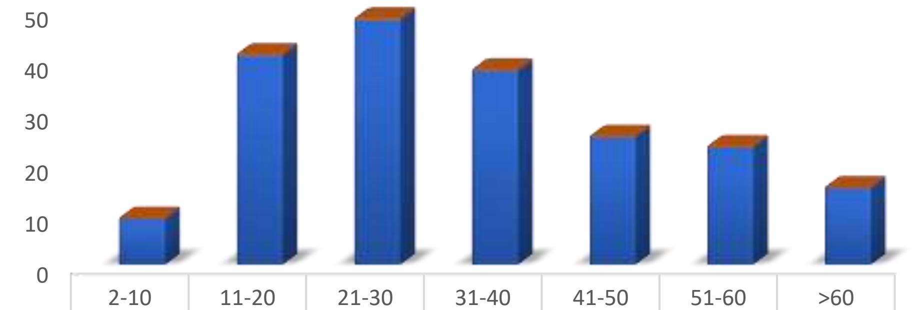
10. Data analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 25.0. Data were summarized using descriptive statistics, including mean, median, and standard deviation. The chi-square test was used to assess associations between risk factors and SSI occurrence. A P-value of <0.05 was taken as a threshold for significance.

Results

A total of 199 patients underwent different types of surgeries, including elective as well as emergency procedures. About 17 SSI cases were documented, and hence, the overall prevalence of SSI rate was found to be 8.5%. The most common bacteria were determined to be *Staphylococcus aureus.* Low hemoglobin levels, blood transfusion and type of operation were discovered as a significant risk factor associated with SSI occurrence.

The age distribution ranged from 2 to 95 years, most of the patients included in this study fall in the age group between 21 to 30 years (24.1%) (**Figure 1**).



	2-10	11-20	21-30	31-40	41-50	51-60	>60
%	4.5%	20.6%	24.1%	19.1%	12.6%	11.6%	7.5%
No.	9	41	48	38	25	23	15

Figure 1*: Distribution of the patients according to the age groups*.

Out of the 199 participants involved in this study, 100 cases were female (50.3%) and ninety-nine cases were male (49.7%) (**Figure 2**). z

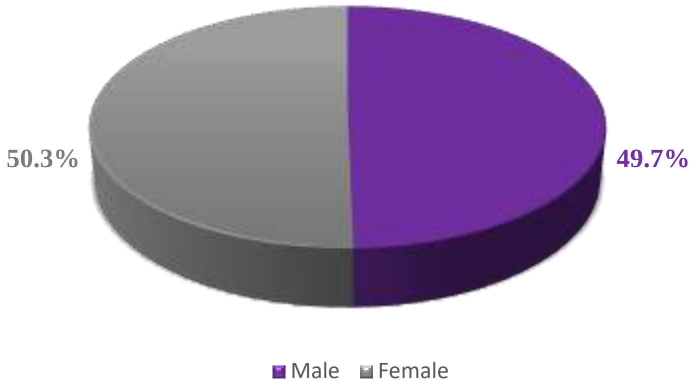


Figure 2*: Distribution of the patients according to their gender*

The general surgery ward accounted for the majority of patients (75%) followed by the orthopedic ward (20%), neurosurgery (4%), and lastly plastic surgery (1%) (**Figure 3**).

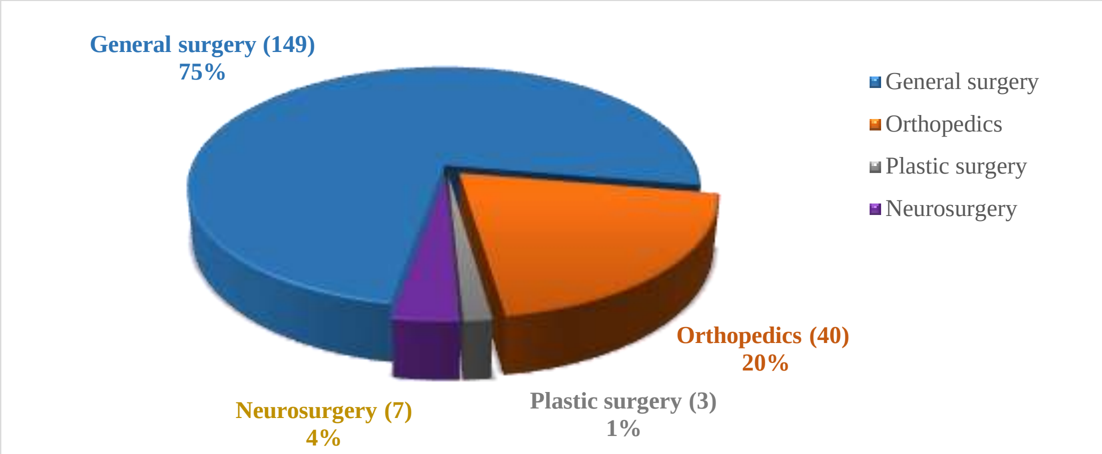


Figure 3*: The distribution of the patients according to the surgical ward.*

Most of the patients in this study were Libyans 187 (94%), and 12 (6%) were non-Libyans. According to the place of residency, 173 (86.9%) live in Benghazi and the rest 26 (13.2%) outside of Benghazi. The distribution of patients concerning family income falls into three groups; less than 1000 L.D (24.6%), between 1000-2000 L.D (73.4%), and more than 2000 L.D (2%) groups.

Among 199 patients 17 of them had SSI accounting for the prevalence of 8.5% (**Figure 4**). The culture and sensitivity were available only in seventeen cases, four patients' tests showed no bacterial growth results, while in eleven patients' culture and sensitivity tests showed different types of bacteria.

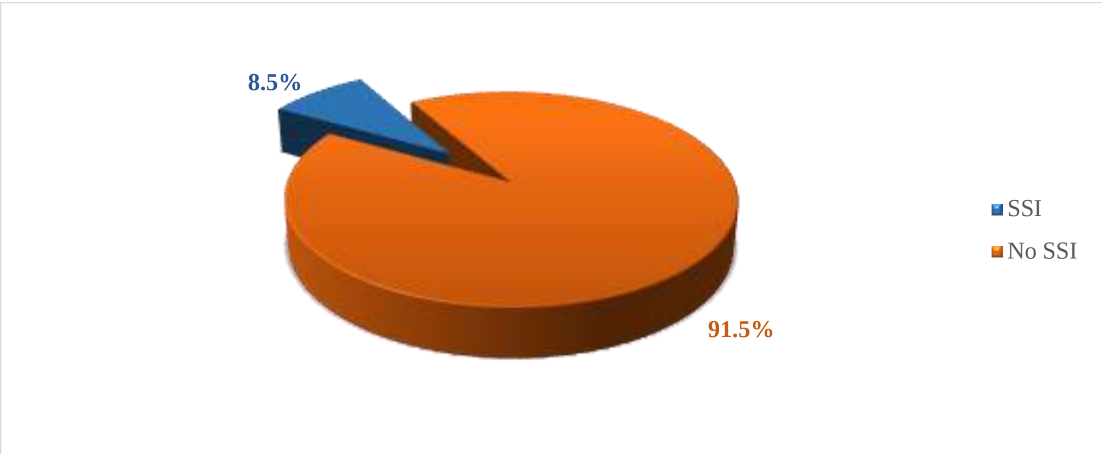


Figure 4*: The prevalence of surgical site infection (SSI).*

The most common bacteria were determined to be *Staphylococcus aureus* 26.3%, followed by *Escherichia coli* 15.7%, *Pseudomonas aeruginosa*15.7%, *Staphylococcus albus, Klebsiella* and *Actinobacteria* (**Figure 5**).

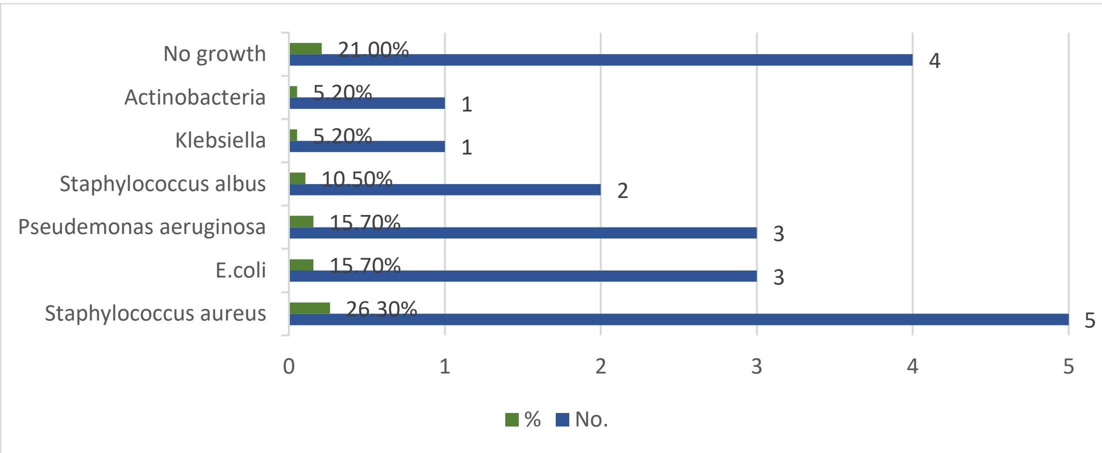


Figure 5*: Types of bacteria isolated from the infected wounds.*

The prevalence of SSI in the surgical wards was significant (P=0.005) which is more prominent in general and orthopedic surgery wards at equal percentages of 41.2% for each, followed by Neurosurgery, and plastic surgery (**Figure 6**).

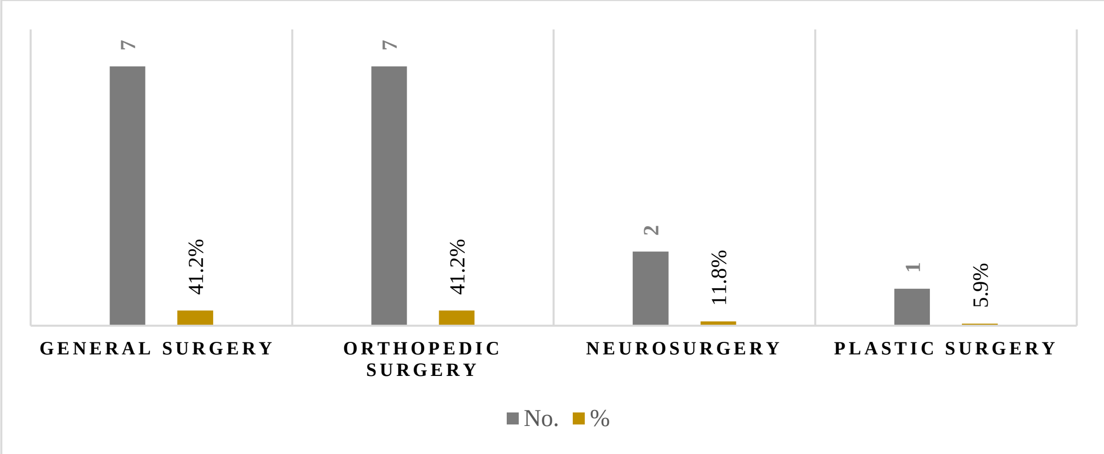


***Figure 6**: The frequency of SSI in different surgical wards(P<0.05).*

According to the hemoglobin levels, there was a significant association between the occurrence of SSI and anemic patients (P<0.001) (**Figure 7**).

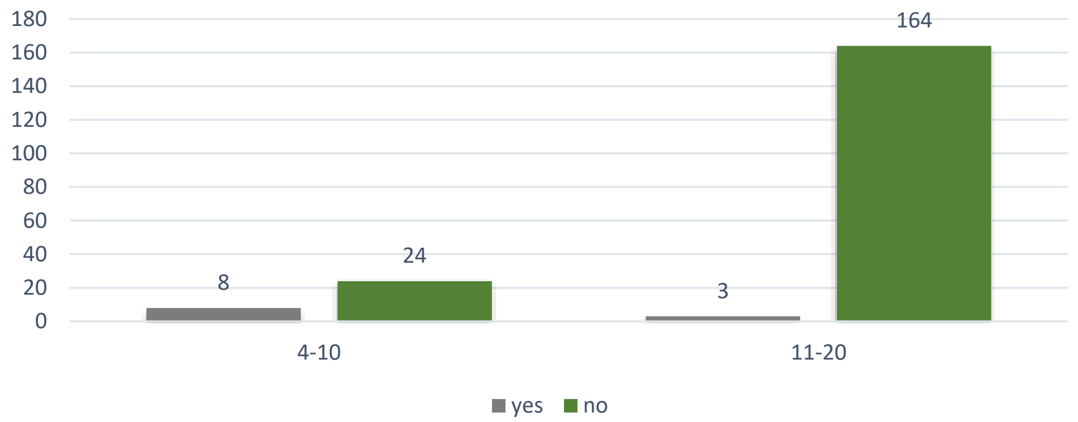


***Figure 7**:: The frequency of SSIs according to the hemoglobin level (P< 0.05).*

According to the type of operation, it was significantly related to the occurrence of SSI (P=0.011). Most of SSI cases were found in internal fixation 35.3% followed by cholecystectomy 23.5% (**Table 1**). Additionally, the operation location especially the thigh, was not significantly associated with SSI occurrence (P=0.053).

***Table 1:** The frequency of SSI according to the type of operation, (other types of operation that are not listed above did not have SSI cases).*

Type of operation	Yes	No
Appendectomy	2 (11.8%)	60 (33.0%)
Internal fixation	6 (35.3%)	27 (14.8%)
Vertebral fixation	1 (5.9%)	2 (1.1%)
K wire	1 (5.9%)	3 (1.6%)
Colloid excision	1 (5.9%)	0 (0.0%)
Evacuation of depressed fracture	1 (5.9%)	0 (0.0%)
Cholecystectomy	4 (23.5%)	40 (22.0%)
Hernia repair	1 (5.9%)	19 (10.4%)

Blood transfusion was statistically significant concerning SSI occurrence, three (17.6%) SSI patients received blood during their hospital stay (P=0.001) (**Figure 8**).

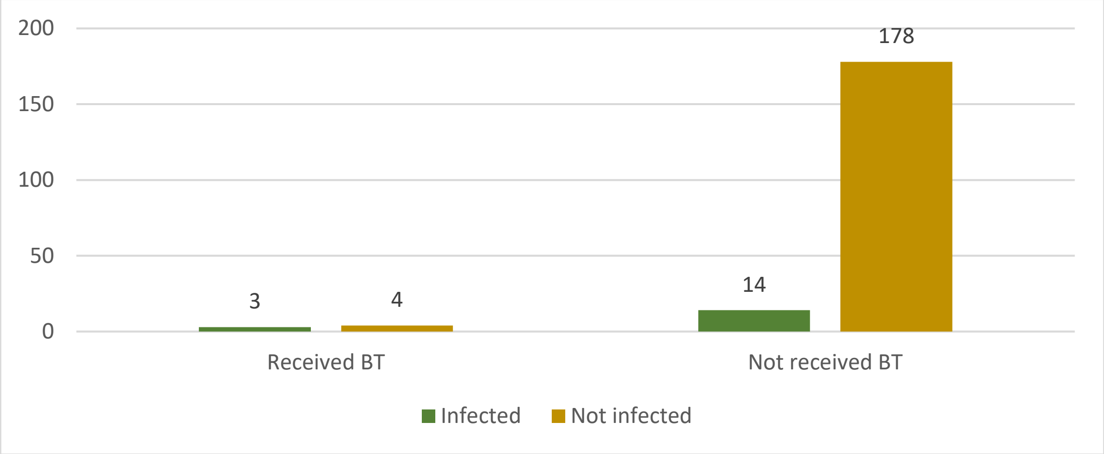


***Figure 8**: The frequency of SSI according to blood transfusion (BT)(P<0.05).*

Most SSI cases were free of diseases (76.5%), but hypertension was the most common disease observed in our cases (17.6%) (**Table 2**). Despite that, the past medical history, statistically, was non-significant concerning the SSI rate (P=0.265).

***Table 2**: The frequency of SSI according to the past medical history (P>0.05).*

Chronic illness	wound infection		Total
	yes	No	
DM	1 (5.9%)	4 (2.2%)	5 (2.5%)
Hypothyroid	0 (0%)	2 (1.1%)	2 (1.0%)
Asthma	0 (0%)	1 (0.5%)	1 (0.5%)
FREE (no disease)	13 (76.5%)	165 (90.7%)	178 (89.4%)
Cancer	0 (0%)	1 (0.5%)	1 (0.5%)
HTN	3 (17.6%)	7 (3.8%)	10 (5%)
DM + HTN	0 (0%)	2 (1.1%)	2 (1%)
Total	17 (100%)	188 (100%)	199 (100%)

The length of hospital stay was not significantly related to the frequency of SSI occurrence. Most SSI cases were found in the period between 1-10 days (**Figure 9**).

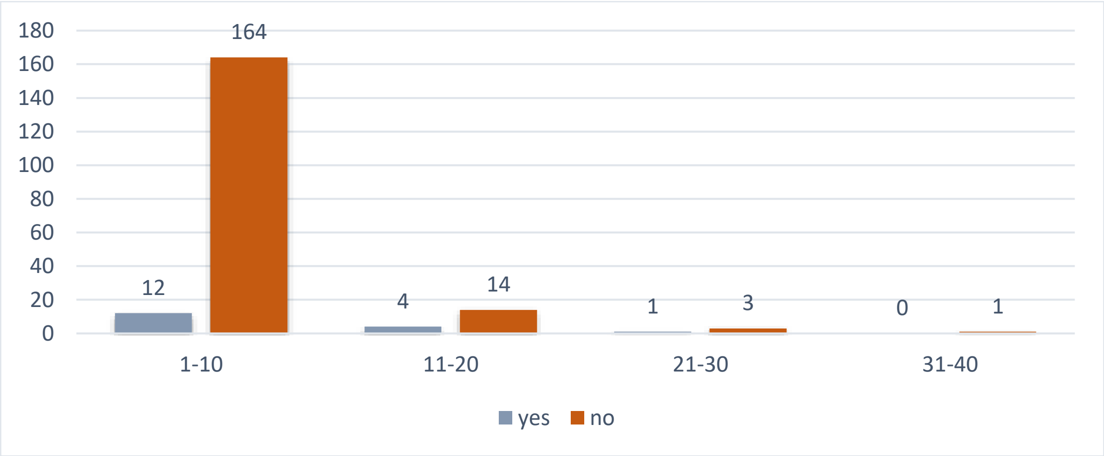


***Figure 9**: the frequency of SSI according to the length of hospital stay (P=0.091).*

Statistical analysis results showed no significance (P>0.05) between the occurrence of SSI and gender (**Figure 10**).

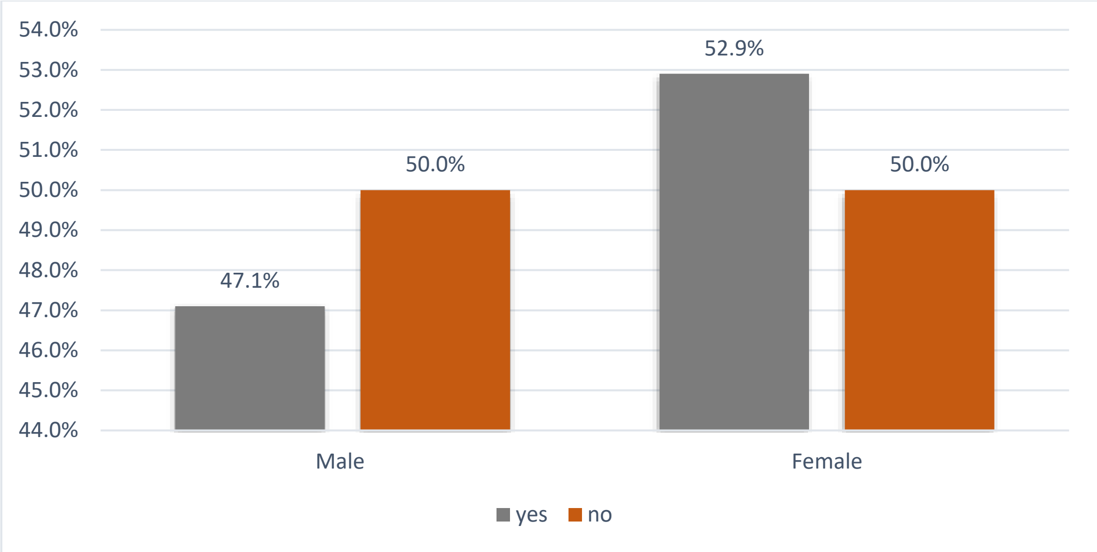


***Figure 10**: the frequency of SSI according to gender (P=0.817).*

Additionally, most SSIs occurred in the age group between 41 and 50; however, there was no significant relation between the occurrence of SSI and age groups (P=0.642) (**Figure11**).

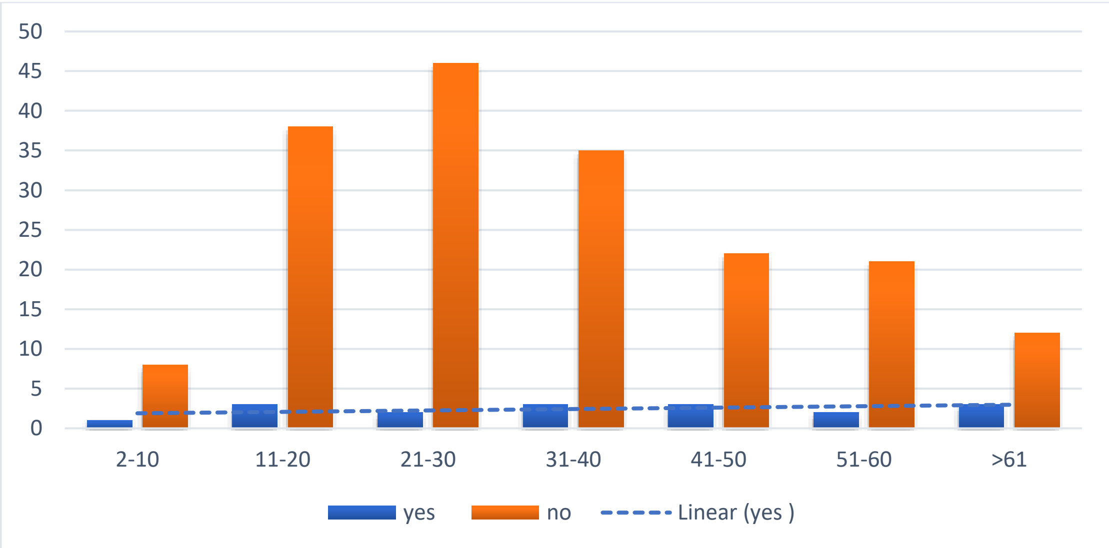


***Figure 11**: The frequency of SSIs by the age group (P> 0.05).*

Regarding whether the operation was emergency or elective; it was not significantly related to SSI occurrence (P>0.05) (**Table 3**).

***Table 3**: The frequency of SSI in emergency vs elective operations (P=0.131).*

Emergency / Elective	wound infection		Total
	yes	No	
Elective	11 (64.7%)	83 (45.6%)	94 (47.2%)
Emergency	6 (35.5%)	99 (54.4%)	105 (52.8%)
Total	17 (100%)	182 (100%)	199 (100%)

All patients who have developed SSI have been underwent open and laparoscopic procedures. Despite that, the type of procedure was not significantly associated with SSI frequency (P>0.700) (**Table 4**).

***Table 4**: The SSI frequency according to the procedure type (P=0.700).*

Type of procedure	wound infection		Total
	yes	No	
Open	14 (82.4%)	134 (73.6%)	148 (74.4%)
Lap	3 (17.6%)	46 (25.3%)	49 (24.6%)
Closed	0 (0%)	2 (1.1%)	2 (1%)
Total	17 (100%)	182 (100%)	199 (100%)

According to the length of operation, there was no significant association found between the operation duration and SSI occurrence (P > 0.05) (**Table 5**).

***Table 5**: The frequency of SSI according to the length of operation in hours (P=0.281).*

Length of operation	wound infection		Total
	yes	No	
≤1 hr	9 (52.9%)	122 (67.0%)	131 (65.8%)
≥ 2 hr	8 (47.1%)	60 (32.5%)	68 (34.2%)
Total	17 (100%)	182 (100%)	199 (100%)

most of patients with SSI was stable before surgery, however, there was no significant association between the preoperative conditions and the occurrence of SSI (P>0.05) (**Table 6**).

***Table 6**: The frequency of SSI according to the patient's preoperative condition (P=0.643).*

Patient condition preoperative	wound infection		Total
	yes	No	
Stable	12 (63.6%)	118 (65.4%)	130 (65.3%)
Critical case	5 (36.4%)	64 (34.6%)	69 (34.7%)
Total	17 (100%)	182 (100%)	199 (100%)

There was no significant association (P>0.05) between the occurrence of SSI and the leukocyte count (**Table 7**).

***Table 7**: The frequency of SSI according to WBC count (P=0.626).*

WBC Count	wound infection		Total
	yes	No	
3-10	11 (63.6%)	132 (72.3%)	143 (71.9%)
11-20	6 (36.4%)	47 (26.1%)	53 (26.6%)
21-30	0 (0%)	3 (1.6%)	3 (1.5%)
Total	11 (100%)	188 (100%)	199 (100%)

No significant association was observed between SSI and the postoperative antibiotic given, and the most antibiotic used after operations was Rocephin (**Figure 12**).

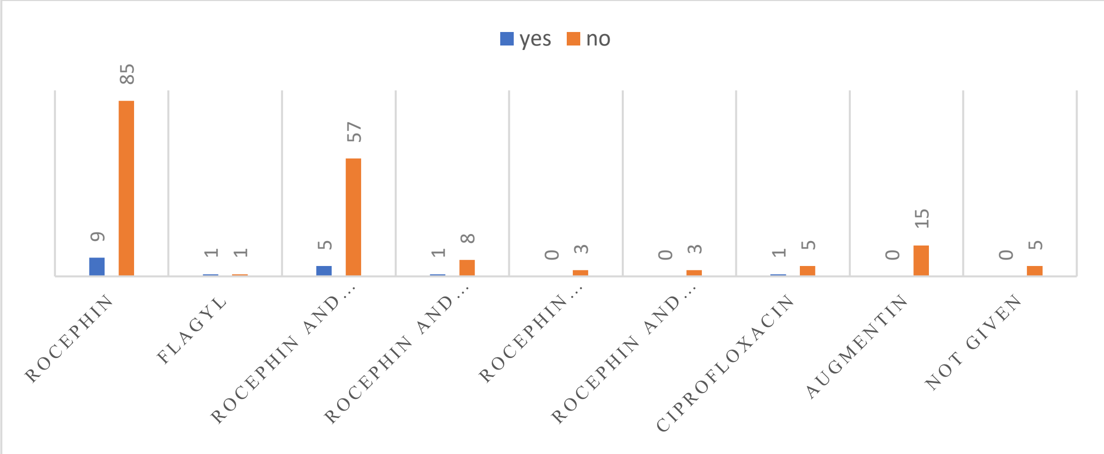


Figure 12*: The frequency of SSI according to the antibiotics given (P=0.478*).

Discussion

This research aimed to ascertain the prevalence rate of surgical site infections (SSI) at Al-Jala Teaching Hospital, Benghazi, Libya, identify the most common organisms, and evaluate the associated risk factors, specifically in patients undergoing either emergency or elective surgery. The findings show a notable SSI prevalence of 8.5% among 199 surgical patients, with *Staphylococcus aureus* identified as the prominent organism. The occurrence of SSI is correlated with statistically significant risk factors including anemia, the operation type, and blood transfusion.

The 8.5% SSI prevalence rate determined in this study is inconsistent with the findings from a similar study conducted at the same hospital by Tajoury O. et al., 2018, which reported a comparatively higher SSI rate of 14.7% [12]. This reduction could be attributed to the improvement of infection control strategies, surgical techniques, or variations in patient demographics. In contrast, in a study carried out in Libya's four largest teaching and referral hospitals in Tripoli, Benghazi, and Sabha reported SSI as the most prevalent at 31.3%. SSI rates in Uganda, specifically Kampala, and Mbarara stand at 11.9% and 16.4% respectively [13,14], in sub-Saharan Africa at 14.8% [17], and in Ethiopia at 24.6% [15]. Lower SSI rates are observed in the US at 2-3% [18], Seoul, South Korea at 3.3% [19], and mainland China at 4.5% [20] This variability may be influenced by the difference in factors such as healthcare access, infection control protocols, socioeconomic conditions, and the burden of comorbidities. Further investigations into these variables could provide effective practices for reducing SSI rates.

Staphylococcus aureus has been identified as the most common pathogen associated with SSI occurrence at al-Jala Hospital in 2023 (36.36%) (the present study), consistent with findings from 2018 (53.3%) [12]. This may contribute to its strong ability as it is a part of the normal skin flora to colonize the skin when the skin is breached during surgical procedures. In contrast, in Mbarara, Uganda, *Klebsiella pneumoniae* predominates at *50%* [14], which may reflect the variances in antibiotic usage, patient demographics, hospital settings, or antibiotic resistance. This underscores the importance of stringent preoperative antisepsis and intraoperative aseptic techniques to minimize the risk of infection.

SSI cases were notably the highest in general and orthopedic surgeries at 41.2% each, consistent with Tajoury O. et al., 2018, where general surgeries also had the highest rate 23.5%[12]. Additionally, the highest rate observed in Ethiopia was in orthopedic surgeries at 54.3% [15]. The type of operation performed was significantly associated with SSI occurrence, with internal fixation and cholecystectomy procedures exhibiting the highest SSI rates at 35.3% and 23.5% respectively. This suggests that certain surgical procedures inherently carry higher risks due to factors such as increased exposure, presence of implants, the type of tissues involved, the potential for exposure to a variety of pathogens in contaminated fields, and operative complexities[21]. These findings highlight the necessity for tailored infection prevention strategies.

Anemia in this study was discerned as a statistically significant risk factor associated with SSI. This aligns with existing research [12,14,22] which suggests that anemic patients are more susceptible to infections. This could be due to compromised immune function and reduced oxygen delivery to tissues, which are critical for wound healing, thereby increasing the likelihood of infection. Therefore, it is essential to address anemia preoperatively through proper interventions to minimize infection risks and enhance postoperative outcomes.

Patients who received blood transfusions were more susceptible to develop SSI. This increased risk may be due to the immunomodulatory effects of transfusions, which can suppress the immune system and introduce pathogens. Consequently, judicious use of blood products, including restrictive transfusion protocols and preoperative optimization of hemoglobin levels, is essential to minimize unnecessary transfusions and reduce SSI rates.

Concerning the anatomical operation location, this research's findings found no significant association. However; Preceding studies have illustrated that regions exhibiting substantial muscle mass and dense tissue are more susceptible to SSIs [23].

In terms of patient medical history, in this study, most participants were free from disease, however; a subset exhibited a history of hypertension and diabetes, but that was not significantly related. Divergently, the National Academy of Science reported a higher infection rate in patients with Diabetes mellitus[16].

Prolonged hospital stay have been widely recognized to increase the likelihood of SSI as this would provide more opportunities for the hospital-associated pathogens to colonize and infect the wounds according to previous research [12,15,16]. However; our study did not show a significant correlation. This discrepancy could be attributed to several factors. First, variations in patient demographics, health conditions, and surgical procedures might have influenced outcomes. Second, stringent infection control measures, such as enhanced sterilization, proper wound care, and prophylactic antibiotics, may have mitigated the impact of prolonged stays. Finally, the sample size and study design, including potential uncontrolled confounding variables, could have contributed to the differing results.

Age and gender are often mentioned as demographic factors influencing infection rates as many studies have indicated that males and older age groups are important risk factors [24,25]. Contrary to these findings, the occurrence of SSIs in the present study was higher in females (52.5%) compared to males (47.1%), furthermore the majority of SSI cases were occurred in individuals over 40 years of age, however, our analysis did not support significant correlations between these factors and SSI occurrence. This could imply that in the context of our study population, the overall health status of patients and immunological responses may play a larger role than demographic characteristics alone.

Concerning the length of operation, while frequently highlighted in the literature as a risk factor for SSIs [12,26,27], our findings did not demonstrate a significant correlation. This may suggest that factors such as surgical technique and adherence to aseptic protocols may be more critical than the surgery duration itself.

The type of surgical procedure performed whether it is open, laparoscopic, or closed was also not significantly associated with SSI occurrence in our research. This is particularly interesting given that laparoscopic procedures are generally thought to cause lower infection rates due to less tissue injury. Our findings suggest that other factors, such as the surgical environment and postoperative care practices, may reduce the risks irrespective of the surgical method used.

According to emergency and elective surgeries, no significant impact was shown on the SSI rate in our study. This is inconsistent with other literature reviews as emergency operations have a considerable impact on SSI occurrence [12,16]. Our finding could reflect advancements in surgical techniques and perioperative care at Al-Jala Hospital but also warrants further investigation in diverse healthcare environments.

Lastly, we examined preoperative conditions, WBC count, and the administration of prophylactic antibiotics, which are typically considered important risk factors for SSI. However, our results did not indicate a significant relationship between these variables and the occurrence of infections. This could suggest that while elevated WBC counts may indicate infection risk, they do not directly correlate with SSI outcomes in our population. Similarly, the lack of significant findings regarding antibiotic prophylaxis raises important questions about the timing, appropriateness, and spectrum of antibiotics used in our surgical protocols.

These findings highlight the complexity of factors contributing to SSI and suggest the need for a multifaceted approach to infection prevention that goes beyond traditional risk factors. Future studies should explore the interplay of various clinical practices, patient health status, and environmental factors to develop a more comprehensive understanding of SSI in surgical patients at Al-Jala Hospital.

Conclusion

In conclusion. The overall SSI prevalence at Al-Jala Hospital found at 8.5%, with *Staphylococcus aureus* identified as the most common pathogen. Our analysis revealed several significant risk factors for SSIs, including anemia, the type of surgical procedure, and blood transfusion. highlighting the necessity for continuous surveillance and targeted infection control measures. However, despite the significant associations found, our study faced several limitations such as a relatively small sample size, reliance on retrospective data, and incomplete recording of patient information which may led to biases and inaccuracies.

Recommendations

To enhance infection prevention strategies at Al-Jala Teaching Hospital, it is recommended to strengthen sterilization and disinfection protocols, implement preoperative management of anemia and other risk factors, tailor surgical techniques to minimize exposure and operative time, and adopt restrictive transfusion protocols to reduce unnecessary blood transfusions. Additionally, developing stringent postoperative care protocols, educating patients on wound care, establishing a robust surveillance system to monitor SSI rates, and conducting regular audits of infection control practices are essential. Further research should explore additional risk factors and validate findings across diverse healthcare settings to develop comprehensive and effective interventions for infection control.

Ethical consideration

The study protocol was approved by the Ethics Committee of Al-Jalla Hospital; written consent was obtained from the medical affairs of Al-Jalla Hospital and the Ethics Committee of the Libyan International Medical University (LIMU). The study adhered to ethical guidelines for medical research involving human subjects, ensuring confidentiality and anonymity of patient data.

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List of abbreviation

Abbreviations	Meaning
AIDS	Acquired Immunodeficiency Syndrome
ASA	American Society of Anesthesiologists
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CRP	C-Reactive Protein
CT	Computed Tomography
ESR	Erythrocyte Sedimentation Rate
HAIs	Healthcare-Associated Infections
HIV	Human Immunodeficiency Virus
ICU	Intensive Care Unit
MRI	Magnetic resonance imaging
NNIS	National Nosocomial Infection Surveillance Program
PMH	Past Medical History
SPSS	Statistical Package for the Social Sciences
SSIs	Surgical Site Infections
SSSIs	Superficial surgical site infections
US	United States
USS	Ultrasound Scan
WBC	White Blood Cell
WHO	World Health Organization