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Surgical Site Infection Overview; Cross-Sectional Study

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ABSTRACT

Background and Objectives: One of the significant complications of the surgery is surgical site infections. The aim of this study was to focus on the prevalence of surgical site infection, demonstrate the commonest encountered bacteria for a proper postoperative antibiotic coverup and identify some key risk factors.

Methodology: a cross-sectional, descriptive study on the cases undergoing surgical procedure was done. The study was conducted during a period of one-year interval from March 2024 until March 2025. A total of 382 cases were included in the study. All cases were assessed properly pre and post operatively with cases suspected to have an infection were sent for culture and sensitivity report.

Results: The mean age of participants was 34.9 ± 17.9 and the mean of duration of Hospitalization for cases was 21.4 ± 27.5 hours. The prevalence of postoperative wound infection was 31/382 cases accounting for 8.1% and 100% culture positive. Relation of SSIs to the duration of operation, type of surgical wound, and emergency degree of operation was statistically significant , P value = 0.044, < 0.001 and 0.013, respectively. While the duration of post-operative hospitalization was not related to the risk of infection, P value = 0.069.

Conclusion: - The commonest responsible bacteria isolated from infection were *Staphylococcus spp, Klebsiella spp* and *Streptococcus spp*. Additionally, the risk of infection increased according to the contamination degree of the wound, 1 in every 3 cases of dirty infected wound develop infection and 1/3, of the samples for cases lasting > 120 minutes in operation developed infection.

Keywords: *Surgical Site Infections; Surgical operations; Types of the Surgical Wounds.*

1. INTRODUCTION

One of the significant complications of the surgeries is Surgical Site Infection (SSI) also known as surgical wound infection [1] which are the second commonest healthcare associated infection that occur at the site of surgery with in 30 days following operation [2-4]. They are classified according to the depth of infected tissue into; superficial incisional infection which involves the skin and subcutaneous tissues, deep incisional infections that involves tissues deeper such as the muscle and fascia, and organ or space infection which involve the infection affecting any part of anatomy which was manipulated during procedure except for incisions [5].

SSI remains the major cause of morbidity and mortality worldwide. According to a systematic review and metanalysis, the overall pooled incidence was 2.5% [6]. The disease poses a significant concern post-operatively. Several important risk factors contribute to the development of the disease which include; patient's related risk factors such as diabetes mellitus, obesity, and malnutrition [7-9], as well as surgery related risk factors such as the complexity of the surgery as in laparotomies, longer duration surgeries, wound classification according to the contamination degree as in contaminated and dirty infected wounds, and significant intraoperative blood loss [9-12] and procedure related risk factors such as type of the surgery such as colorectal surgeries and the medical devices used such as urinary catheterization and prosthesis used in orthopedic surgeries [9, 14].

The risk of infection can be minimized using several important preventive methods through pre-operative optimization of medical condition [14-15], minimizing operative time, laparoscopic approaches and meticulous surgical techniques [13, 16], as well as a proper postoperative patients care focusing on shortening the hospital stay [17] can reduce the risk of SSI.

The aim of this study was to focus on the prevalence of surgical site infection, demonstrate the commonest encountered bacteria for a proper postoperative antibiotic coverup and identify some key risk factors.

2. PATIENTS AND METHODOLOGY

This study was conducted as a cross-sectional, descriptive study on the cases undergoing surgical procedure in the governmental hospital, Zakho Emergency hospital and Nawroz Privet Hospital in Zakho City. The study was conducted during a period of one-year interval from March 2024 until March 2025. A total of 402 cases were collected, from which 20 cases were excluded due to missing data and 382 cases were included. The inclusion criteria were; all cases undergoing surgical interventions regardless of the age, gender, emergency degree or the types of surgery were included. While the exclusion criteria focused on excluding cases with old operation older than 30 days and those beyond the data collection period.

Prior to study and data collection, permissions were obtained from the necessary committee. All cases were prepared to undergo operation. Their sociodemographic data were taken. Following the operation, further data were taken such as; emergency degree of the operation whether elective or emergency, duration of the operation, type of the operation, type of the surgical wound whether clean, clean contaminated, contaminated or dirty infected, and post-operative status of the wound. Any infected wound was sent for culture and sensitivity to confirm and identify the type of the micro-organism as well as identify the most suitable antibiotic coverage according to their culture and sensitivity reports.

Consent to Participate: All participants were informed about the purpose, procedures, and potential risks of the study. Written informed consent was obtained from all individual participants prior to their inclusion in the study.

The data were input into an Excel sheet and was later converted to SPSS version 26. All data were analyzed using SPSS version 26. The descriptive statistics of the cases and their frequency were obtained. Chi-square test was used to analyze the relation of post-operative surgical site infection to the duration of operation, type of surgical wound, electiveness of the operation and duration of hospitalization. The findings were found significant at P values < 0.05.

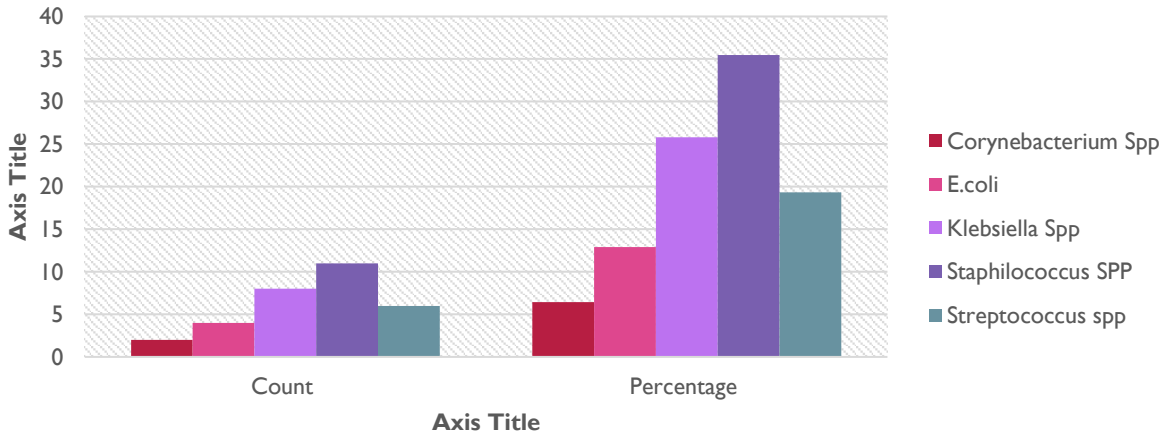
3. RESULTS

The mean of age of the participants in this study was 34.93 ± 17.96. The mean of duration of Hospitalization for cases was 21.42 ± 27.52 hours. Table (1) further demonstrates the sociodemographic features of the sample. The majority of the cases were females 58.38% compared to males 41.62%. Most of the cases were at young age group 18-44 years of age (55.5%), while those < 18 years accounted for 17.3%, middle aged participants accounted for 18.6% and elderly who are ≥ 63 years of age accounted for 8.6% of the total cases. The prevalence of postoperative wound infection which also shown to be culture positive accounted for 31/382 cases accounting for 8.1% of the total sample. The surgical wound according to the tidiness of the filed was further categorized and their prevalence's were as following; clean wound cases accounted for 37.4%, clean contaminated cases were the commonest 54.5%, while contaminated cases accounted for 7.3% and dirty-infected cases despite being low 0.8%, yet were still seen. The sample was also categorized according to the duration of the operation; nearly 35.3% of the cases lasted ≤ 30 minutes, while the majority of the cases 55.2% lasted between 31-60 minutes. Operations longer than one hour such as those with laparotomies were also seen; 60-120 minutes accounted for 7.1% of the cases and 2.4% of the cases remained in the operation for > 120 minutes. The majority of the cases were elective 81.2%, nevertheless, 18.8% were emergency cases.

Figure (1) demonstrates the frequency of the bacteria which were seen to grow on culture and sensitivity samples. The commonest micro-organism encountered on the surgical site infection was *Staphylococcus spp* accounting for 35.48% of the cases, followed by *Klebsiella spp* accounting for 25.81% and *Streptococcus spp* accounting for 19.35%. Other micro-organisms seen were *E. coli* 12.9% and *Corynebacterium spp* 6.54%.

Table 1. Sociodemographic features of the sample			
Socio-demographic features		**Count**	**Percentage**
Gender	Female	223	58.38
	Male	159	41.62
Age	< 18	66	17.3
	18-44	212	55.5
	45-62	71	18.6
	≥ 63	33	8.6
Post-operative Wound Infection	Yes	31	8.1
	No	351	91.9
Results of Culture and Sensitivity	Culture Positive	31	8.1
	Culture Negative	351	91.9
Types of Surgical Wound	Clean wound	143	37.4
	Clean contaminated wound	208	54.5
	Contaminated wounds	28	7.3
	Dirty-infected wound	3	0.8
Duration of the operation	≤ 30 minutes	135	35.3
	31 – 60 minutes	211	55.2
	60 - 120 minutes	27	7.1
	> 120 minutes	9	2.4
Emergency degree of the operation	Elective	310	81.2
	Emergency	72	18.8
Total		382	100

Figure 1. Frequency of Micro-oragasnim among positvie cultures



In this study, as has been demonstrated in table (2), 21 different types of operation were done. The commonest operation was cholecystectomy, both open and laparoscopic, accounting for 29.6% of the cases followed by surgical repairs of hernia, which accounted for 19.1% of the cases and this involved incisional, paraumbilical and inguinal hernias. Additionally, nearly 17.3% of the cases were those with mass or suspicious lesion excision such as melanoma, basal cell carcinoma, breast mass, lipoma, and granuloma. Appendectomy, including both open and laparoscopic, accounted for 12.6% of the cases. Less frequent cases included; perianal diseases 8.9%, breast related operation such as mastectomy 2.6%, laparotomy 2.3%, thyroidectomy and thyroglossal cyst removal 1.8%, and Hydatid cyst of the liver 0.8%.

Table (3) demonstrates the correlation of surgical site infection to several important factors. A statistically significant correlation was seen between the duration of operation and the positivity of the cultures taken, i.e. infection, P value = 0.044. As the duration of operation increased, the risk of infection increased reaching 33.3%, i.e. 1/3, of the samples for cases lasting > 120 minutes. Additionally, the type of tidiness of the operation was significantly related to the risk of infection. The more the surgical field is getting contaminated and dirty, the higher the risk of infection, P value < 0.001. The risk of infection in clean filed and clean contaminated was 6.3% each, while for the contaminated fields was 28.6% and dirty infected fields accounted for 33.3% of the cases. The emergencies of the cases also play a statically significant role, P value = 0.013, the frequency of infection in emergency cases was 15.3% while in elective cases was 6.5%. Finally, the duration of post-operative hospitalization was not related to the risk of infection P value = 0.069. Nevertheless, nearly 25.0% of those cases remained more than 3 days hospitalized showed positive culture results.

Table 2. The frequency of operation among the samples.

No.	Types of surgeries	No.	Percentage
1	Amputation (big toes)	1	0.3
2	Appendectomy	48	12.6
3	Breast related operation	10	2.6
4	Carpal Tunnel Syndrome	1	0.3
6	Chest tube insertion	1	0.3
7	Cholecystectomy	113	29.6
8	Closure ileostomy	1	0.3
9	Hemicolectomy	6	1.6
10	Hernia Repair (incisional, paraumbilical, and inguinal)	73	19.1
11	Hydatid Cyst of the Liver	3	0.8
12	Ingrown nail	1	0.3
13	Laparotomy (gastrojejunostomy, perforated duodenal ulcer, common bile duct … etc.).	9	2.3
14	Lymph node excision	1	0.3
15	Mass and suspicious lesion excision (abdominal, lipoma, shoulder, supraorbital, scalp, subcutaneous mass, melanoma, Basal Cell Carcinoma, and granuloma)	66	17.3

16	Obstetric and gynecological	1	0.3
17	Perianal diseases (Fistula, Pilonidal sinuses, and Hemorrhoids)	34	8.9
18	Secondary Wound Closure	2	0.5
19	Stab wound	1	0.3
20	Testicular operation	3	0.8
21	Thyroid related (thyroidectomy and thyroglossal cyst)	7	1.8
	Total	382	100%

Table 3. Correlation of Culture and sensitivity to different risk factors.

			Result of culture sensitivity test		Pearson Chi-square value	P value
			Negative	Positive		
Duration of operation	≤ 30 min	Count	126	9	8.075	0.044
		% within Duration of operation	93.3%	6.7%		
	30 - 60 min	Count	194	17		
		% within Duration of operation	91.9%	8.1%		
	60 - 120 min	Count	25	2		
		% within Duration of operation	92.6%	7.4%		
	> 120 min	Count	6	3		
		% within Duration of operation	66.7%	33.3%		
Type of wound	Clean wound	Count	134	9	19.879	< 0.001
		% within Type of wound	93.7%	6.3%		
	Clean Contaminated wound	Count	195	13		
		% within Type of wound	93.8%	6.3%		

	Contaminated wounds	Count	20	8		
		% within Type of wound	71.4%	28.6%		
	Dirty-infected wound	Count	2	1		
		% within Type of wound	66.7%	33.3%		
Elective / Emergency	Elective	Count	290	20	6.10	0.013
		% within elective/emergency	93.5%	6.5%		
	Emergency	Count	61	11		
		% within elective/emergency	84.7%	15.3%		
Duration of Hospitalization	≤ 24 hours	Count	227	15	5.35	0.069
		% within Duration	93.8%	6.2%		
	1 – 3 days	Count	118	14		
		% within Duration	89.4%	10.6%		
	> 3 days	Count	6	2		
		% within Duration	75.0%	25.0%		

4. DISCUSSION

Surgical site infections (SSIs) are one of the most significant surgical related complication impacting patient's duration of hospitalization and outcomes [1-2, 6, 18]. The most important risk factors associated with SSIs include; presence of diabetes mellitus, obesity, duration of operation, type of operation, and age [7-12, 19]. In this study, several important aspects of infection among cases undergoing surgeries is discussed and highlighted.

The commonest micro-organisms encountered responsible for SSIs include gram-positive bacteria such as *Staphylococcus aureus* and *Streptococci* which are usually from the patient themselves [20-21]. Other bacteria commonly isolated include; Gram-negative such as *Escherichia coli* and *Klebsiella pneumoniae* [22-23] and Multi-drug resistant organisms such as *Enterobacterales* [24]. The commonest bacteria isolated in this study was *Staphylococcus spp* accounted for 35.48% of the cases, followed by *Klebsiella spp* accounted for 25.81% and *Streptococcus spp* accounting for 19.35% with an overall prevalence of infection of 8.1%. In a study by Ali and colleagues [25], 14.5% of their cases developed SSIs, a higher prevalence than what seen in this study. However, similar findings were seen regarding the commonest bacteria, yet, with a higher prevalence *Staphylococcus aureus* (66.67%). The second commonest was *E. Coli* at a prevalence of 33.33%. The commonest group of bacteria in this study was gram positive accounting for 61.37% while according to *Ali et al. and Worku et al.,* the commonest were gram negative bacteria 56.25% and 57.9%, respectively [25-26]. The identification of the type of micro-organism and their gram stain is of significant importance as it can guide a proper antibiotic coverage, improving patient's overall health [27]. This discrepancy in the type of bacteria, gram positive or negative, could be attributed to the types of surgeries. Additionally, the sources of infection must not be overlooked. A significant number of SSIs can trace back their origin to patient's own microbiota such as the skin and nares [28].

The type of surgical wound is one of the most crucial part to be identified per surgery as it can significantly impact SSIs outcome [29-30]. Generally, the prevalence of infection in clean wounds ranges from 1.76 to 6.66% [30-31] for clean-contaminated is seen at 9.3-12% [30, 32], while for contaminated to be at 17.6% - 24.8% [32-33]. In this study, the overall prevalence of infection was 8.1% with 100% bacterial growth. The prevalence of infection support to the previous studies in the clean wound 6.3% and lower in clean-contaminated cases 6.3%, while for contaminated cases was slightly higher 28.6%. In the dirty-infected cases, it was seen that one in every three cases (33.33%) developed infection. These finds support the

common ground of the more contaminated the wound, the higher the risk of infection, taking into a count no neglectable degrees in clean cases (6.3%) and a significant number in dirty cases 1/3. Additionally, another factor which significantly impact the risk of infection is the duration of surgical operation; the longer the duration of the operation the higher the risk of infection [34]. Similarly, in this study, a significant correlation was found with a risk reaching one-third of the cases in case of operation lasting longer than two hours. Additionally, the infection rate in emergency cases is seen to be higher compared to elective cases due to several factors; lack of pre-operative preparation with a higher chance of contaminated and dirty-infected form of wounds [35-36]. Jatoliya and colleagues [35] found a higher prevalence among emergency cases. This study significantly supports these findings. However, the rate of infection in emergency cases was lower compared to Jatoliya *et al.* [35], 15.3% vs 26% and similar was seen in elective cases 6.5% vs 8%. Nevertheless, the relation of rate of infection to the duration of infection was nonsignificant despite a significant correlation being present in old studies [37].

5. CONCLUSION

Surgical Site Infections represent a significant factor which impact patient outcome. The mean age of participants in this study was 34.9 ± 17.9 while the mean of duration of Hospitalization for cases was 21.4 ± 27.5 hours. The commonest responsible bacteria isolated from infection was *Staphylococcus spp* as the commonest followed by *Klebsiella spp* and *Streptococcus spp*. Additionally, the risk of infection increased according to the contamination degree of the wound, 1 in every 3 cases of dirty infected wound develop infection; the more contaminated the more infected. The duration of the operation and the emergency degree of the operation each separately increased the risk; the longer the duration of operation and presence of emergency cases the more likely the infection. While the duration of hospitalization was not associated with infection.

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Conflict of Interest

None to declare.

Clinical Trail

Not applicable

Ethical Approval

The ethical approval was obtained from the university college.

Contribution

F. MR. A. was the sole author behind the idea conception, data collection and case assessment, operation and post-operative evaluation. The first and final draft was written and assessed by F. MR. A.

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