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Burden and associated risk factors for surgical site infections in General Surgery Department of Ndola Teaching Hospital (NTH) from January to December 2021: A Hospital-based retrospective study

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Abstract

Background: Surgical Site Infections are the second most common type of health care-associated infection. Prior to this study, no research of this kind had been done at Ndola Teaching Hospital in Ndola, Zambia, to determine the prevalence of SSI after general surgery. This study therefore aimed at determining the burden and associated risk factors for surgical site infections in General Surgery Department of Ndola Teaching Hospital.

Materials and Methods: A hospital-based retrospective descriptive study conducted Ndola Teaching Hospital general surgery dept. Selected and operated patients' hospital records were reviewed. Pearson Chi-square test and Odds ratio were used to test for each risk factor's association with SSI followed by their 95% confidence interval. Only p-value less than 0.05 was considered statistically significant.

Results: The burden of surgical site infections was 18% [OR=0.394; 95%CI = (0.179-0.867)]. Factors that showed a significant association with the burden were gender [OR=3.394; 95%CI= (1.179-8.867), p=0.014], post-operative duration of hospital stay [OR=20.308; 95%CI= (3.364-27.798), p=0.00], emergency surgeries [OR=3.445; 95%CI = (1.625-7.304), p= 0.001] and intra-operative duration [OR=12.476; 95%CI= (4.104-37.925), p= 0.000]. However, there was no association observed between the qualification of the surgeon and the development of the infection.

Conclusion: Surgical site infections were high and associated with the duration of hospital stay, intra-op duration of the procedure, the type of surgery and gender. It remains imperative to find possible interventions to reduce the risk of suffering from surgical site infections among patients who go to theatre.

Keywords: Burden; Risk Factors associated; Surgical site infection; Zambia

1 Introduction

Healthcare-associated infections (HAIs) are a well-known cause of morbidity and mortality that can be avoided. Surgical site infections make up more than 30% of these illnesses (SSI). The second most frequent kind of infection related to healthcare is SSI (HAI). The most common cause of SSI is Staphylococcus aureus, which accounts for up to 37% of SSIs in community hospitals in the United States and 20% of all SSIs among hospitals that report to the Centers for Disease Control and Prevention (CDC) (1).

According to their definition, surgical site infections (SSIs) are infections connected to surgical operations that happen at or close to the site of surgical incisions within 30 days of a surgical treatment, or within 90 days if prosthetic components are installed during surgery (2). They affect 2% to 5% of surgery patients in high-income nations, making

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them a common and devastating hospitalization complication. Infections at surgical sites can affect deep subcutaneous tissues, organ spaces, and the skin and superficial subcutaneous tissues around the incision sites. The incidence of SSI is significantly higher in low- and middle-income countries than in high-income countries as a result of inadequate infection prevention practices among healthcare facilities in these nations (3).

SSIs continue to be a significant cause of morbidity and mortality among hospitalized patients despite increased advances (improved operating room ventilation, sterilization methods, surgical technique, and accessibility to antimicrobial prophylaxis) made by various health systems to combat infections (4). The advent of bacteria that are resistant to antibiotics and the rise in the proportion of older surgical patients—who fare much worse if they have a range of chronic, incapacitating, or immunocompromising underlying diseases—may help to explain this. Additionally, the number of organ and prosthetic implant surgeries is rising (5).

SSI lengthens hospital stays and raises the price of lab work and antibiotic prescriptions. It's important to note that of all patients who have an infection, 60% are more likely to spend time in an ICU, they're also five times more likely to be readmitted, and their mortality rate is double that of patients who do not have an infection (6,7).

Factors connected to both patients and procedures have already been discovered. According to Martin and friends, factors that increased the risk of SSIs included diabetes mellitus (a preoperative serum glucose level of >125 mg/dL (>6.9 mmol/L) or a postoperative serum glucose level of >200 mg/dL), prior surgery, longer hospital stays, insufficient antiseptic skin preparation, a lack of antibiotic prophylaxis, hypothermia and hypoxia during the procedure, as well as concurrent diseases like malnutrition, and morbid obesity (8).

Age greater than 60, smoking, diabetes, previous surgical infection, increased body mass index, and alcohol usage were also discovered by Fang A et al. as statistically significant preoperative risk factors for SSI after spine surgery (9).

The prevalence of this devastating surgical complication is not known among Zambian hospitals before this study. It is imperative therefore that the burden is assessed for the benefits of patients. This research therefore was purported at filling this knowledge gap by determining the burden and associated risk factors for surgical site infections at Ndola Teaching Hospital (NTH) Zambia.

2 Methods

2.1 Study Site

This study was conducted at Ndola Teaching Hospital surgical wards. Ndola Teaching Hospital is located on the Copperbelt province of Zambia. It is the second largest referral third level hospital in the country with 800 bed spaces that receives patients from the Northern part of Zambia. It has an elevation of 1300 meters at the Latitude of 12 degrees South and Longitude of 28 degrees East. It is situated nearby to Tropical Diseases Research Center.

2.2 Study Design

A hospital based retrospective study design was used to carry out this study.

2.3 Sample Size

A simple random sampling technique was used to choose files to review and the sample size was determined using the Thrushfield (2005)(10) formula:

$$\text{Sample size } (n) = \frac{Z^2 x\ P\ (1 - P)}{d^2}$$

The sample size (n) was determined based on 15.5% expected prevalence rate (P), absolute desired precision (d) of 5% at confidence interval (CI) of 95% and Z2 (standard normal variate) which at 5% Type 1 error is 1.96.

Using these values, the following is how the sample size was found:

$n = 1.962 \times 0.155(1\text{-}0.155)/0.052 = 203.26 \approx 204$ patients' records were reviewed.

2.4 Data Collection

A structured data collection tool was used to collect data as adopted from a variety of literature following a literature review. The collection tool gathered the patient's socio-demographic characteristics, clinical profiles and surgical procedure relating characteristics were collected from patient medical records and surgeon's operation notes. Three clinical personnel and one supervisor were requested to be involved in the data collection process to aid in sorting out files of patients who went to theatre. The research team was oriented on how to select study participants and review medical documents.

Socio-demographic variables that were collected include age, sex, and residence while the clinical characteristics that were collected are; length of hospital stay, duration of surgical operation and the surgeon, comorbidities. Surgical site infection: An infection related to an operative procedure that occurs at or near the surgical incision within 30 days of the procedure or within 90 days if prosthetic material is implanted at the surgery.

2.4.1 Diagnosis of SSI

The diagnosis of a SSI was made based on the criteria of the Centers for Disease Control and Infection (11), based on the presence of pain, swelling, purulence, a fistula(s), and/or dehiscence, which resulted in the need for antibiotic treatment. In an instance where none of these was found in the file, the surgeon's diagnosis of the infection and the prescribed antibiotic treatment was used to confirm that someone had a surgical site infection.

2.5 Inclusion and Exclusion Criteria

2.5.1 Inclusion Criteria

- All patients who were operated from NTH in the year 2021 from January to December 2021.
- All files from general surgery department dating from January 1st to December 31st 2021.
- Files that had all the information relevant to the study.

2.5.2 Exclusion Criteria

- Patients not operated from NTH.
- Patients' files not belonging to general surgery.
- All patients who were in the surgical ward but were not operated on.
- Patients not from within the specified study period i.e. those operated before January 2021 and after December 2021.

2.6 Statistical Analysis

All raw data was entered into Microsoft Excel for temporal storage. For statistical analysis, patients were divided into groups: age, gender, medical status, smoking status, duration of surgery, and the type of surgery.

Both regression (binary & multinomial) and Chi-square analysis with a two-tailed p-value was used to compare categorical variables against the burden of infection to determine the relationship. Regression analysis was used to test for each risk factor's association with SSI. Post-op length of hospital stays and duration of surgery, being continuous variables, were compared against the prevalence of infection using binary logistic regression analyses in order to determine any significant associations at a confidence interval of 95%. All statistical tests were considered when they had a p-value of less than 0.05 to be significant. SPSS statistics software version 26.0 was used for analyses.

2.7 Study Limitations

This study was self-sponsored and as such the researcher faced some financial constraints in terms of transport and other requirement in collecting data from the hospital. The design for the research only allowed the use of secondary data from hospital records. Some of these records did not have all the information intended to be collected so as to meet the objectives.

3 Results

3.1 Demographics Characteristics of Participants

Female participants were predominantly high with 54.4% compared to males, 45.6%. Majority (63.2%) of patients operated were in the age range of 30-60 years. More than half were non-smokers, 73% while 65.7% took alcohol. The most representative sample was for those who came from rural areas i.e., 63.2% as shown in **table 1.**

Table 1 Demographic characteristics of study participants

No.	Variables	Frequency (n=204)	Percentage (%)
Gender			
	Male	93	45.6
	Female	111	54.4
Age groups in years			
	Less than 30 years	66	32.4
	30-60 years	129	63.2
	>60 years	9	4.4
Smoking status			
	Yes	55	27.0
	No	149	73.0
Alcohol intake			
	Yes	70	34.3
	No	134	65.7
Place of residence			
	Urban	75	36.8
	Rural	129	63.2
Associated chronic pathology			
	Renal condition	1	.5
	Diabetes	18	8.8
	Asthma	6	2.9
	TB	4	2.0
	Hypertension	13	6.4
	HIV	6	2.9
	No known comorbidity	156	76.5

3.2 Burden of Surgical Site Infections

Of the total number of patients operated at NTH, 18% of patients were found to have developed surgical site infection as shown in figure 1 below. Of this burden, emergency surgeries reported 28.8% while elective surgeries 10.5% surgical site infections.

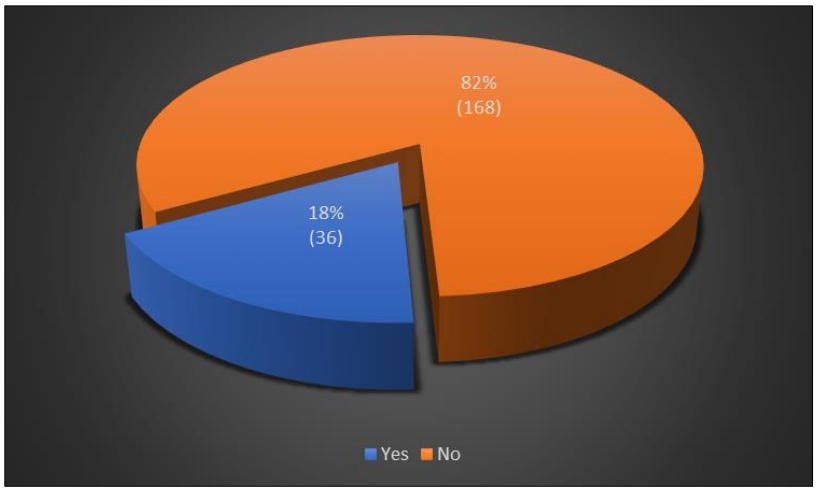

Figure 1 Burden of surgical site infections

3.3 Procedural Related Factors

More than half (59.3%) of patients stayed less than one week in the hospital following the procedure. Most procedures (59.3%) were performed by resident doctors. All patients were pre-operatively medicated with antibiotics as tabulated in table 3 below.

Table 2 Characteristics related to the operative procedure in patients who went to theatre in 2021 from general surgery department

No.	Variables	Frequency (n=204)	Percentage (%)
Duration of surgical procedure			
	Less than 1 hour	72	35.3
	1-2 hours	82	40.2
	Greater than 2 hours	50	24.5
Post-operative length of hospital stay			
	less than one week	121	59.3
	One weeks	18	8.8
	Two weeks	48	23.5
	Greater or equal to 3 weeks	17	8.3
Operating Surgeon's qualifications			
	General medical officer	2	1.0
	Resident doctor	121	59.3
	Consultant/senior doctor	81	39.7
Pre-operative antibiotic therapy			
	Yes	204	100.0
Type of surgery			
	Elective	132	64.7
	Emergency	72	35.3

3.4 Associations between Surgical Site Infections and Socio-Demographics Characteristics

This study showed that 10.8% of patients with surgical site infection were males while 23.4% were females. This shows a statistically significant association (p=0.014) between gender and surgical site infection as females were more likely to suffer from surgical site infection than males.

Regarding age and the prevalence, there was found no statistically significant association (p=0.346) as 19.7% were below 30 years, 15.5% were between 30-60 years and 33.3% were above 60 years.

About 13.3% of patients were from urban area while only 20.2% were from rural area. This shows no statistically significant association between likeliness of a patient developing surgical site infection and their place of residence (p=0.148) as shown in Table 3.

Table 3 The relationship between surgical site infection and demographic information

Variables (n=204)			**Prevalence of surgical site infections**		**Chi-square (*p-value*)**
			Yes	**No**	
Relationship between gender and the burden of surgical site infection					
Gender	Male	Count	10	83	0.014
		% Within gender	10.8%	89.2%	
	Female	Count	26	85	
		% Within gender	23.4%	76.6%	
Relationship between age and the burden of surgical site infection					
Age	Less than 30 years	Count	13	53	0.346
		% Within age	19.7%	80.3%	
	30-60 years	Count	20	109	
		% Within Age	15.5%	84.5%	
	>60 years	Count	3	6	
		% Within Age	33.3%	66.7%	
Relationship between place of residence and the burden of SSIs					
Place of residence	Urban	Count	10	65	0.148
		% Within residence	13.3%	86.7%	
	Rural	Count	26	103	
		% Within residence	20.2%	79.8%	

3.5 Association between Surgical Site Infection and Procedural Related Factors

In this study, it is noted that post operative duration of hospital stay and duration of surgical procedure were strongly and statistically associated to the development of surgical site infections. Patients who stayed for more than two weeks had a greater risk [OR=29.05; 95% CI= (3.364-27.798)] of having surgical site infections compared to those patients who stayed for one week or less [OR=29.051;95% CI= (9.952-84.804)]. Length of the surgical procedure was significantly associated with increased risk [OR=12.476; 95% CI= (4.104-37.925) for those patents who stayed in theatre for 1-2 hours] of getting infected with surgical site infection. The risk increased in those who stayed on the theater table for longer than 2 hours [OR=1.098;95% CI= (0.674-20.112)]. Another significant association [OR=3.445; 95% CI= (1.625-7.304)] was observed between the type of surgery performed and the development of surgical site infection. However, there was no association observed between the qualification of the surgeon and the development of the infection as shown in the table below.

Table 4 Relationship between surgical site infection and procedural related factors

No.	Variables	Odds Ratio (OR)	Confidence interval (95%)	p-value
Post operative duration of hospital stay				
	Less than one week	13.221	9.952-84.804	0.125
	One weeks	29.051	2.360-174.711	0.006
	Two weeks	20.308	3.364-27.798	0.003
	Greater or equal to 3 weeks	9.670	2.541-19.212	
Duration of surgical procedure				
	Less than 1 hour	46.122	6.056-351.276	0.240
	1-2 hours	12.476	4.104-37.925	0.001
	Greater than 2 hours	1.098	0.674-20.112	0.007
Qualification of the operating surgeon				
	General medical officer	8.865	1.234-2.235	0.986
	Resident doctor	.940	8.865-871.865	0.234
	Consultant/senior doctor	0.234	0.449-1.968	0.870
Type of surgery				
	Elective	1.391	0.667-2.902	0.179
	Emergency	3.445	1.625-7.304	0.008

4 Discussion

The most often reported complication in both developed and developing nations' surgical patients is surgical site infection. A quarter of all nosocomial infections are surgical site infections (SSI), which are the third most frequently reported nosocomial infection (12). This undertaking sought to estimate the burden of SSI at Ndola Teaching Hospital by determining not only its incidence but also associated risk factors.

The overall burden estimate from this study was found to be 18%; emergency surgeries reported 28.8% while elective surgeries 10.5% surgical site infections. Kumar *et al*. (2017) in their study reported a prevalence rate of 12.5% of SSI in the department of general surgery. About 17.7% of SSI was reported among emergency surgeries while 12.5% from elective surgeries.

The overall SSIs burden and that from emergency surgeries was lower while from elective surgeries was slightly higher compared to their study. Dégbey *et al* (2021) found a prevalence of 7.81%, which is lower than that in our study. The difference could be explained by the fact that their study was conducted in the traumatology clinic which receives a limited number of patients compared to ours from the general surgery. In Tunisia, Latifa *et al.* reported a prevalence of 19.1% of SSIs in general surgery department. In Benin, a study reported a prevalence of surgical site infections of 33.8% and a Nigerian based study found a prevalence of SSI of 27.6% (13). Findings from these studies were higher than those in the present study. Possible explanation to this could be the differences in sample sizes; they had larger sample sizes compared to the one used in this study.

In this undertaking, 10.8% of patients who developed surgical site infection were males while 23.4% were females. These findings are in tandem with those found in the UK where SSI-rates were significantly higher for female patients than males (14). These findings are supported by numerous additional investigations (15–17), although the reasons why this is the case are not well understood yet. However, other authors have hypothesized in the past that gender-specific changes in fat distribution—with women typically having greater fat tissue in case of re-vascularization following arterial occlusion—may explain these discrepancies (14).

In terms of age, no significant association was found in our participants. It was inconsistent with findings of Kaye *et al*. where age and the risk of SSI were found significantly associated (P = 0.006). Between the ages of 17 and 65, the risk of SSI increased by 1.1%/year (P = 0.002). When older than or equal to 65, the chance of SSI dropped by 1.2% per year (P =.008) (18,19). Several researchers came to the conclusion that being older was linked to a higher risk of all postoperative infections; in some of these investigations, getting older was linked to a higher chance of developing SSI (20,21). The causes of the aforementioned observations, however, are still debatable.

The real causes of older individuals appearing to have an increased risk of SSI include an increase in comorbid illnesses, an increase in acute disease severity, and a weaker host immune responses to bacterial invasion (20).

The length of the postoperative stay is increased by surgical site infection. The risk of site infection increases with the length of the postoperative stay. This study found that patients who stayed for a week or more had increased odds of developing surgical site infections. According to various authors' studies, patients who stayed in the hospital after surgery for 5 weeks or more had a higher chance of developing an infection at the surgery site than those who stayed for less than one week. It was noted that the risk increased starting from one week and more. These findings were in line with several other studies (3,22,23). This could be as a result of the public hospital receiving a huge number of patients and using poor or ineffective infection control measures. Infections at surgical sites occurred more frequently as a result of this. Over a two-hour surgery seems to provide a particularly high risk of surgical site infection.

Length of the surgical procedure was significantly associated with increased risk of surgical site infections. This result was in line with other research (24,25). This may be because lengthy activities expose workers to additional surroundings, which could raise the risk of contamination. Additionally, extended operating times may result in more organ leakage and damage, intensification of surgical stress, an increase in sutures, an increase in blood loss, and a decrease in the effectiveness of preventive antibiotics.

This study found that there was no association observed between the qualification of the operating surgeon and the development of the surgical site infection. This could be because most surgical procedures at the institution are done in attendance of senior surgeons. Other studies however found different findings. Compared to surgeries performed by surgeons, surgeries carried out by residents and general practitioners were more likely to result in surgical site infections (3). This can be because the success of the operation depends on the surgeon's training and expertise. The inexperience and lack of training of residents and general practitioners may have raised the likelihood of complications, including surgical site infections.

Another significant association found in our study was between type of surgery performed and the development of surgical site infection. Emergency surgeries had increased risk of surgical site infections. This was in line with findings of (20) and (3). In order to explain this increased risk, a number of causes are listed, including an increase in wound contamination, intensification of surgical trauma, an increase in the number of sutures, an increase in blood loss, and a decrease in the effectiveness of preventive antibiotics because everything is done in a rash during this type of surgery

5 Conclusion

Surgery site infections continue biting and hindering patients from having a post-operative healthy experience. Based on the findings of this study, surgical site infections were high and it was associated with the duration of hospital stay, intra-op duration of the procedure, the type of surgery and gender. The occurrence of surgical site infections may also be linked to insufficient hygienic measures. It is imperative and urgent to find possible interventions to reduce the risk. This will significantly help improve the health of patients after surgery.

Recommendations

Pre-surgical exams, treating underlying illnesses and performing elective surgery should be performed before patients are admitted for surgery to reduce the time they spend in the hospital. Caregivers should teach patients how to care for their incision sites, and report any issues if they arise. We further recommend that a study be done that will assess the bacterial profile and antimicrobial susceptibility patterns of isolates among patients diagnosed with surgical site infection at Ndola Teaching Hospital.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no competing interests.

Statement of ethical approval

All ethical principles were considered before the research was undertaken. No names from files were requested for inclusion in the data collection sheet for confidentiality's sake. Numerical codes were used instead. The commencement of this research was only done after being approved by the research ethics committee based at the Tropical Diseases Research Centre (TDRC) on the sixth and seventh floor of Ndola Teaching Hospital (NTH) through the Copperbelt University School of Medicine authorities.

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Authors Contributions

Clyde Moono Hakayuwa: Took part in the planning of the project, its execution, the data collection, data analysis, data interpretation, and paper preparation.

David Mulenga: Took part in mentoring, manuscript drafting, and general reviewing. The final text has been reviewed and approved by both authors.

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