Original Article

Prevalence of Surgical site Infection among Adult Patients at a Rural District Hospital in Southern Province, Rwanda

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Abstract

Background
Globally, postoperative surgical site infection (SSI) is among the top causes of morbidity and mortality in patients undergoing surgery.
Objectives
This study aimed to determine the prevalence of SSI among adult patients that underwent surgery at a hospital in the Southern Province, Rwanda.
Method
The study design was cross-sectional and used structured questionnaires, interviews and reviewed patients' file records. Data were collected on 122 participants selected using the convenient sampling strategy. Statistical Package for Social Sciences version 2020 was used to analyze the data.
Results
Most (86.1%) of the participants were females, the majority (48.4%) were aged 28-37 years. The prevalence of SSI was 8.2%, and most (90%) of the infected patients had undergone Caesarean section. Being HIV positive increased the risk for developing SSI. (X2: 9.604, df:1, CI: 1.7053; 19.8652; p value=0.014).
Conclusion
The prevalence of SSI was 8.2%. Therefore, there is a need for enhancing preventive measures, early detection and treatment that will reduce the comorbidities of infected patients. HIV patients would need further attention.

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Keywords: Prevalence, risk factors and surgical site infections

Introduction

Globally, SSIs continue to cause morbidity and mortality to patients who have undergone surgical procedures.[1] Postoperative deaths related to SSI occur in more than one-third of postoperative patients globally.[2] The effects of SSI on the patients include discomfort, delayed wound healing, wound dehiscence, gas gangrene, and tetanus. The SSIs prolong the duration of hospital stay, place a high demand on medical resources, increase healthcare costs, and increase a financial burden to providers of healthcare services and the patients' families.[1,3] Patients without any health insurance can be impacted by losing much money due to hospital bills.[3]

In the United States of America (USA), an epidemic study done in 2010 in acute care hospitals showed that about 16 million surgical operations were performed, and SSI was the most common medical-related infection, accounting for 31% of all hospitalized patients with Healthcare-associated Infection (HAI).[4] The CDC healthcare-associated infection (HAI) prevalence survey found 157,500 surgical site infections associated with inpatient surgeries in 2013.[4] In Europe, SSIs' prevalence ranged between 3.5–14.8%, with an average of 7.1% in 2008, which was the cause of an economic burden of EUR 7 billion per year.[5]

According to WHO results, developing countries, especially those in sub-Saharan Africa, are at a higher risk of developing SSI than developed countries.[6] The study done in Algeria and Tanzania found that in 2011 SSI incidence was 11.9% and 19.4% of operated patients, respectively. Another study in Tanzania identified that 35.6% of 118 surgical patients developed postoperative SSIs.[10] In Nigeria, the incidence of SSIs was 13% in 2012 at a tertiary hospital.[6,3] The prevalence of SSI was 2.5% among patients who underwent orthopedic surgery at King Fahd Hospital of a University in Saudi Arabia.[9] Study conducted at three public hospitals in Cameroon showed that the prevalence of SSI was 9.2% among patients who had underwent surgery and the predominant SSI type was superficial.[10]The study done in Sub Saharan Africa at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria revealed SSI prevalence of 15.5%. [3] In Rwanda, a study done in a teaching hospital in 2015 among women with cesarean section, SSI prevalence was at 4.9%,[8] and the rate increases to almost 11% if the late SSIs are included.[12]

The commonly identified risk factors for SSIs increased morbidity and mortality among operated patients were diabetes and obesity (1.95 times) in the United States.[9] and HIV/ AIDS in Tanzania. [10] Other factors may be associated with the surgeon's skill, like poor operation procedures, improper hemostasis, and the existence of dead space.[9]

The studies looking for SSI should be done periodically to identify associated risk factors and enhance national prevention measures.[6] In Rwanda, 32,944 patients underwent surgery at the district level in 2010,[11] and SSI cannot be ruled out. Kabgayi annual report of 2015-2016 shows that about 2,521 patients underwent surgery, but no retrieved study addressed SSI. That is why this study aimed to determine the prevalence of SSI among adult patients underwent surgery at Kabgayi hospital.

Methods

Study design and setting

We conducted a two-month cross-sectional study at Kabgayi district hospital from 13rd February to 12th April 2017 to determine the prevalence of surgical site infections among adults who underwent surgery. The study took place in the gyneco-obstetrical and surgical units at Kabgayi district hospital located in Rwanda country, southern Province, Muhanga District. Kabgayi hospital is a Muhanga district hospital.

The hospital provides different services to include outpatient consultation for surgery, maternity, dentistry, mental health, ophthalmology and other pathologies; hospitalization: there are surgery wards, pediatric ward, emergency ward, maternity ward, neonate ward and internal medicine wards; for paraclinical services there are GBV, physiotherapy, medical imagery, and laboratory. Other units include administration, social service, and hygiene and nutrition services.

The bed capacity of the hospital is 372. The hospital has two operating theatres, one reserved for general cases and the other is reserved for gyneco-obstetric patients. The hospital has capacity to carry out 210 surgical operation per month. The Kabgayi Hospital annual report of 2015-2016 showed that 2,521 patients underwent surgery, and among them 1,965 were of gynaecology and obstetrics, while 556 were general surgeries.

Study population and sample size

The study population included patients who underwent surgery at Kabgayi hospital. The target population was 420 patients, who corresponded with the number of surgeries that the hospital expected to do. To be included in the study, the respondent had to meet the following criteria: to have undergone surgery, aged 18 years and above, accepted to voluntarily participate in the study and was fully conscious of making an informed consent.

The patients were excluded if they were under 18 years, critically sick and unconscious, or refused to participate. A sample size was calculated using the formula $N=(Z)^2.\ p\ .q/(d)^2$[15]and a sample size of 135 participants was obtained. Where, N = wanted sample size, Z = standard deviation 1.96 at 5% level, which is equivalent to 95% level of confidence, p= Expected proportion SSI in population-based on previous studies: here P was 15.5% (i.e., 0.155) [2]; q = 1- p= 1-0.155=0.845, d = Absolute error and in this study it was 5% (i.e., 0.05). Estimated sample size therefore, was: N=(1.96)2.(0.155).(0.845)/(0.05)2=201. As the study population was less than 10,000 to adjust sample size the following formula was used nf=n/1+(n)/(N)

Where,

nf = wanted sample size, if size of population N < 10,000

n = wanted sample size, when size of population, N > 10,000

N = estimated size of population.

In this study estimation population will be 420 and the sample size will be nf=420/[1+(420/201)]=135. [15]

Sampling technique

Convenient sampling strategy was used where the researcher picked population who met the criteria. During data collection, the number of patients admitted in the surgical unit was slightly lower than expected due to the unprecedented sickness of the surgeon. The surgeon sickness led to a higher number of surgical cancellations and referral of emergence cases to other hospitals for a period of three weeks during the time of data collection. Therefore, we recruited all the available patients who met the inclusion criteria for the study, totaling 122 patients.

Data collection instrument and procedure

We used a questionnaire specifically prepared to collect the data from patients and records in their medical files. The questionnaire was developed by Surgical Site Infection Surveillance Service in England [12] and validated by the European Centre for Disease Prevention and Control (ECDC) in 2012. This tool contained several sections; the first section contained the general information regarding the patient's demographic data and health condition (comorbidities). The second section dealt with the American Society of Anesthesiology (ASA) score [17]and CDC wound classifications .[18] The third section was concerned with collecting data related to surgery, like a type of surgery, duration of surgery, type of anaesthesia given, and amount of blood lost in bleeding. The last section described SSIs. The questionnaire content validity was established through the team meeting that evaluated its completeness to answer the study objectives.

We conducted a pilot study among patients who had undergone surgery in surgical and maternity wards for questionnaire reliability. Ten patients were used for the pilot study. The reliability of the tool was measured by the author and had a 0.73 Cronbach alpha score. The data from the pilot study was not included in the final analysis.
After getting administrative permits and individual consent, we conducted interviews directly with the surgical patients using the structured questionnaire, complemented with the patients' records in the medical files.

Data analysis
SPSS version 20 was used to summarize and analyze collected data. The first step was a descriptive presentation of data with frequencies and percentages. The second step was to test the association between having surgical site infection and demographic and surgical characteristics using Fisher's exact test. Multivariable logistic regression was used to determine independent factors for postoperative surgical site infections.

Ethics considerations
This study was approved by the Institutional Review Board (IRB) of the University of Rwanda, College of Medicine and health sciences (CMHS/IRB/039/2017). Participation in this study was voluntary. Data collection from selected patients started after receiving signed informed consent from the patients. Neither name nor location of the participants was mentioned on the questionnaire, and the recorded electronic data were protected with a password.

Results

One hundred and twenty two (122) surgical patients responded to the study. As shown in Table 1, close to half of the respondents (48.4%) were aged 28-37 years old, and 86.1% were females. The majority of them had stayed in hospital for less than five days before the surgery and one to five days after the surgery. The majority (92.6%) of the patients had been referred, and most participants were HIV negative (96.7%); 97.5% did not smoke, and 75.4% of patients were in normal nutritional status. In addition, 91.8% of the patients were in normal health status (ASA score 1), 77% had wounds in the clean-contaminated category, at the end of the surgery. According to surgical characteristics, 63.9% of the patients were emergency cases, 91% of the surgeries were non-traumatic, 87.7%, and abdominal, 97.5%, operated under a local anaesthesia and 59.8% had lasted less than 1hour. All the patients had received antibiotic prophylaxis within 60 minutes before surgery, and 85.2% had lost less than 500ml of blood (Table 1).

Table 1.Demographic characteristics and surgical characteristics

Patients characteristics	Frequency	Percentage (%)	Patients characteristics	Frequency	Percentage (%)
Age			**ASA Score**		
18-27	39	32.0	ASA 1	112	91.8
28-37	59	48.4	ASA 2	9	7.4
38-47	16	13.1	ASA 3	1	.8
48-57	7	5.7	Total	122	100.0
>57	1	0.8	**Class of wound**		
Total	**122**	**100.0**	Clean	17	13.9
Sex			Clean–contaminated	94	77.0
Male	17	13.9	Contaminated	4	3.3
Female	105	86.1	dirty or infected	7	5.7
Total	**122**	**100.0**	**Total**	**122**	**100.0**
			Surgical factors		
Hosp. stay before operation				**Type of surgery**	
<1 day	55	45.1	Elective	44	36.1
1-5 days	56	45.9	Total	122	100.0
> 5 days	11	9.0	**Area of surgery**		
Total	122	100.0	Abdomen	107	87.7
Days post-operation			Limb	15	12.3
1-5 days	108	88.5	Total	122	100.0
6-10 days	6	4.9	**Operation due to trauma**		
> 10 days	8	6.6	Yes	11	9.0
Total	122	100.0	No	111	91.0
Referred			**Total**	**122**	**100.0**
Yes	113	92.6	**Prophylaxis within 60 minutes**		
No	9	7.4	**Yes**	122	100.0
Total	122	100.0	**Procedure**		
Patient HIV status			Appendectomy	1	0.8
Positive	4	3.3	Osteosynthesis	8	6.6
Negative	118	96.7	Hernia	8	6.6
Total	122	100.0	Cesarean section	93	76.2
Patient nicotine use			Hysterectomy	1	0.8
			other laparotomy	1	.8
Yes	3	2.5	Other	10	8.2
No	119	97.5	Total	122	100.0
Total	122	100.0	**Bleeding**		
Patient nutritional status			Normal(< 500 ml)	104	85.2
Normal	92	75.4	Abnormal (>500ml)	18	14.8
			Total	122	100.0
Obesity	28	23.0	**Type of anesthesia**		
Malnutrition	2	1.6	General anesthesia	3	2.5
Total	122	100.0	Local anesthesia	119	97.5
			Total	122	100.0
			Duration of operation		
			Less than 1 Hour	73	59.8

Among 122 respondents, the study identified SSIs among ten cases (8.2%), and the patients who underwent cesarean section were more affected 9 (90%).

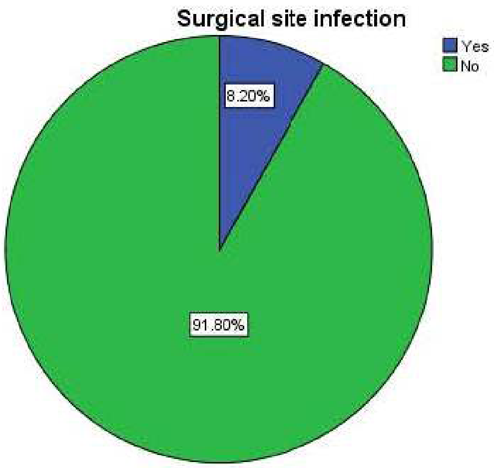

Figure 1. Prevalence of surgical site infection

Association between patients'characteristics and surgical site infection

Factors associated with SSI were determined using chi-square statistics, and only HIV status was also found to be associated with SSI (Fisher's exact test: 9.604; P-value: 0.033).As the sample size was small, Fisher's exact test was used to check the association between SSI and related risk factors (Table 2)

Table 2.Bivariate analysis to determine surgical and patients' factors associated with surgical site infection

Patients factors	SSI			
	Yes (%)	No (%)	Chi-square#	P-value
Age			4.402	0.325
18-27	6(15.54)	33(84.6)		
28-37	4(6.8%)	55(93.2)		
38-47	0(0.0)	16(100)		
48-57	0(0.0)	7(100)		
>57	0(0.0)	1(100)		
Hospitalization days before operation (df:2)			0.438	0.896
< 1 day	5(9.1)	50(90.9)		
1-5 days	4(7.1)	52(92.9)		
> 5 days	1(9.1)	10(90.9)		
Patients HIV status			9.604	**0.033***
Positive	2(50)	2(50)		
Negative	8(6.8)	110(93.2)		
Patient nicotine use			0.275	1.000
Yes	0(0.0)	3(100)		
No	10(8.4)	109(91.6)		
Patient nutritional status			4.456	0.116
Normal	5(5.4)	87(94.6)		
Overweight or obese	5(17.9)	23(83.1)		
Underweight or malnutrition	0	2(100)		
ASA Score			3.558	0.231
ASA 1	8(7.1)	104(92.9)		
ASA 2	2(22.2)	7(77.8)		
ASA 3	0(0.0)	1(100)		

#= Fisher's exact test; *p<0.05

Table 2.Bivariate analysis to determine surgical and patients' factors associated with surgical site infection

Patients factors	SSI			
	Yes (%)	No (%)	Chi-square#	P-value
Wound class			2.179	0.472
Clean	0(0.0)	17(100)		
Clean – contaminated	9(9.6)	85(90.4)		
Contaminated	0(0.0)	4(100)		
Dirty or infected	1(14.3)	6(85.7)		
Surgical factors				
Type of surgery			0.073	0.787
elective	4(9.1)	40(90.9)		
emergency	6(7.7)	72(92.3)		
Area of surgery			0.053	0.818
Abdomen	9(8.4)	98(91.6)		
limb	1(6.7)	14(93.3)		
Operation due to trauma			1.079	0.299
Yes	0(0.0)	11(100)		
No	10(9)	101(91)		
Procedure			3.629	1.000
Appendectomy	0(0.0)	1(100)		
Osteosynthesess	0(0.0)	8(100)		
Hernia	0(0.0)	8(100)		
Caesarean section	9(9.7)	84(90.3)		
Hysterectomy	0(0.0)	1(100)		
other lapalatomy	0(0.0)	1(100)		
Other	1(10)	9(90)		
Blood loss			1.885	0.17
Normal (<500ml)	10(9.6)	94(90.4)		
Abnormal (>500 ml)	0(0.0)	18(100)		
Type of anesthesia			**	1.00
General anesthesia	0(0.0)	3(100)		
Local anesthesia	10(8.4)	109(91.6)		
Duration of operation			1.671	0.47
< 1hour	8(11)	65(89)		
1-2 hours	2(4.3)	44(95.7)		
>2 hours	0	3(100)		

#= Fisher's exact test; *p<0.05

Multivariable analysis for factors associated with SSI.

The risk of developing SSI for the patients with HIV positive status was found to be 14 times compared to those with HIV negative status (OR: 13.7, P-value: 0.014, CI: 1.7053; 19.8652) (Table 3)

Table 3. Multivariable analysis for factors associated to SSI among patients who underwent surgery at Kabgayi Hospital.

Variable	OR	95% CI	p-Value
HIV status			
Negative	1		
Positive	13.7	[1.7053; 19.8652]	0.014*
Operation due to trauma			
No	1		
Yes	0.368	[0.044; 3.038]	0.299
Blood loss			
Normal (<500ml)	1		
Abnormal (>500 ml)	0.269	[0.048; 1.516]	0.17

N= 122, outcome : SSI , *p<0.05, OR: odd ratio

Discussion

In this study, the analysis of the demographic variables of the patients revealed that the females operated on were the majority, at 105 (86.1%) out of 122 participants. This may be partially explained by the fact that the number of patients recruited from the gyneco-obstetrics unit was more than those recruited from the other surgery units. These results were similar to what was found in the study conducted at Alshaab Teaching Hospital in Khartoum, Sudan.[12] In addition, cesarean deliveries accounted for more than 60% of surgeries that took place at district level hospitals in Rwanda.[20].The higher number of gynecology and obstetrics surgeries in the present study explains why the majority of respondents were 18 to 47 years old, corresponding to childbearing age (15-49)[21]Therefore, differences in surgical procedures on patients may partly explain age differences among Iranian,[13] Cameroonian,[14] and Ethiopian[13] studies.

The rate of surgical site infections in the present study was found to be 8.2%, which was slightly similar to the results found in a study done in Cameroon (9.16%),[14] on the prevalence of surgical site infections and the evaluation of risk factors after surgery. A lower rate of infection(2.5%) was reported in a study conducted at King Abdulaziz Airbase Hospital, Dhahran in Saudi Arabia, on the prevalence of surgical site infection in orthopaedic surgery.[16] The highest SSI risk was reported in a study conducted at Osaka City University Hospital in Japan on the Nutritional risk index as an independent predictive factor for the development of surgical site infection after pancreaticoduodenectomy.[17] In this study, most of the patients stayed one day to five days before operation(45.9%); and SSI was predominant in the patients hospitalized less than one day and those hospitalized over five days with 9.1% for each. Pre-operation hospital stay was not found to be associated with increased risk of SSI; this was different from the results found in the study conducted at a tertiary care hospital, in western India.[18] However, some factors such as prolonged postoperative follow up that helped capture late SSIs symptoms, prolonged hospitalizations before surgery, health status differences in study participants contribute so much to the differences.[11,24] The study identified the majority of SSI (79%) after discharge, and yet the current study focused on hospitalized patients, and the majority had stayed one to five days after surgery.[25]

HIV positive status was found to increase the risk for SSI. The results were similar to the study done on predictors of surgical site infections among patients undergoing major surgery at Bugando Medical Centre in Northwestern Tanzania and the study conducted on risk factors of surgical site infection at Muhimbili National Hospital, Dar es Salaam, Tanzania, where it was found that the rate of SSI was significantly higher in HIV positive patients than patients with HIV negative status.[19,20] It is clear that HIV increases the susceptibility to infection as it plays a vital role in weakening the host immune system.

This study revealed that nutritional status (obesity or malnutrition), was not associated with increasing the risk of SSI. These results were similar to the results found in the study done about SSI risk factors on abdominal surgery, where they found that there was no significant association between obesity, malnutrition and SSI ($p = 0.692$). [13]Contrary results were found in another study done on predisposing factors of SSI after heart surgery, where they found that obesity and malnutrition increased the risk for SSI.[21]

According to the ASA score, most of the patients with SSI had ASA score 1, 112 (91.8%) out of 122. These findings were similar to the findings of the study done on risk factors and the cost of developing surgical site infection after primary hip arthroplasty in Norway. Maybe this was due to the area of surgery,[22]but the association between ASA score and SSI were statistically insignificant (p value> 0.05). Contrary results were found in the study conducted in Cameroon on risk factors of SSI where there was a significant association between SSI rate and ASA score.[14]

Most of the wounds in the current study (77%) were classified as clean-contaminated, out of which only 9 (9.6%) had SSI, and wound class was not found to increase a risk to SSI. Elsewhere, contrary results were found in the study assessing risk factors of SSI after abdominal surgery,[13]this may be due to a systematic administration of antibiotics within 60 minutes before surgery. In addition, the study focused only on abdominal sites, contrary to the present study that involved various operation sites.

In this study, most patients underwent emergency surgery 78(63.9%), and SSI among patients who underwent elective surgery was found to be 4(9.1%) out of 44 cases. However, the association between type of surgery and SSI was insignificant (P value >0.05). Similar results were found in a study done in Cameroon on risk factors of SSI.[14] In this study, a small number (9%) of respondents underwent surgery due to trauma, and the association with SSI was not significant. The contrary results were found in a study done in England in Royal Surrey County Hospital, on SSI after arthroplasty of the hip, where they reported a significant association between operation due to trauma and SSI, [23] The explanation is that most orthopaedic cases resulted from physical harm, injured by dirty objects and skin openings are likely to last longer compared to surgically created wounds, which make them vulnerable to infections. Unlike the present study, the most performed procedures were not due to trauma. Therefore, all of the participants received antibiotics prophylaxis within 60 minutes before operation and good preparation before operation.

Caesarean section was the most performed procedure at 76.2% of the122 participants. This finding was similar to the findings in a retrospective review of national data in Rwanda on Surgical Volumes at a District Hospital,[25] but the association between surgical procedure and SSI was not significant (p value>0.05). In this study, blood loss during surgery in all the cases of SSI was in the normal range (≤ 500ml), and the association between SSI and blood loss was not statistically significant ($p > 0.05$). Different results were found in the study conducted at a university-affiliated tertiary care centre in China on Risk factors for surgical site infection.[22]

In this study, most patients were operated under local anaesthesia (97.5%), and there was no association found between the type of anaesthesia used and SSI. These results were similar to the results found in a study conducted at a university-affiliated tertiary care centre in China on risk factors for surgical site infection.[22]Most (59.8%) operations were performed in less than an hour, and this is attributed to the great number of patients who underwent caesarean section compared to other procedures. Patients with SSI were 8 (11%) among patients with the operation of less than one hour, but the association between the duration of operation and SSI was not significant. These results were different from the results found in the study done on incidence and risk factors for surgical site infection after gastric surgery, where prolonged operation time was a risk factor for SSI after gastric surgery.[26]

Limitations of the study

This study was limited only to patients and risk factors for SSI. A small and non-probability sample limits the generalization of study findings to other hospitals in Rwanda. In addition, the study did not follow up the study respondents after discharge. The numbers of reported SSIs are likely to increase about 60% if post-discharge surveillance lasts up to 30 postoperative days.[11]

Conclusion

In this study, the prevalence of SSI was 8.2% before patients discharge. HIV positivity was found to be a risk factor for SSI. It is observed that the prevalence of SSI is high as it is likely to increase with post-discharge surveillance. Therefore, there is a need for enhancement of prevention measures, early detection, and treatment will reduce the comorbidities for infected patients. Special consideration to HIV positive patients would reduce the risk for SSIs morbidity,mortality and associated financial cost.

Conflict of interests

No conflict of interest addressed in this research

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Authors' Contributions

MD: Research idea, design, data analysis and interpretation, and writing of the manuscript.

LO: Study design, data analysis and interpretation; and manuscript writing and editing

BV, UMC, IC, NC, MJ, NE, BV and NI: Manuscript writing

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