Original Article

Prevalence and Risk Factors for Surgical Site Infections among Patients in Referral Hospitals in Rwanda

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Abstract

Background
Post-operative surgical site infections (SSIs) are a global public health problem, disproportionately affecting developing countries. The purpose of this study was to identify the prevalence and risk factors for SSIs among patients admitted to tertiary hospitals in Rwanda.
Methods
A retrospective cross-sectional involving 396 medical files for surgical patients discharged between July 2020, and December 2021 to assess the prevalence and risk factors associated with surgical site infections. Univariate and multivariable logistic regression analyses were performed using SPSS version 25.
Results
Of 396 participants,121(30.6%) developed SSIs. SSIs was significantly associated with spending more than 120 minutes (COR = 2.87, 95% CI: 1.58-5.23) in operation and undergoing emergency admission (COR = 1.66, 95% CI: 1.08-2.57) were associated with higher odds of developing surgical site infections. In multivariable analysis, after controlling for covariates, spending more than 120 minutes in operation (AOR = 2.52, 95% CI: 1.29-4.93) and undergoing emergency admission (AOR = 1.68, 95% CI: 1.03-2.73) remained significantly associated with surgical site infections.
Conclusion
The 30.6% of surgical patients developed post-operative SSIs despite receiving prophylactic antibiotic. Therefore, regular infection surveillance and adherence to preoperative, intraoperative, and postoperative infection prevention measures are crucial to reduce the burden of SSIs.
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Keywords: Design, population, postoperative infection, retrospective study, study area, surgical patient, surgical wound

Background

Surgical site infections (SSIs) are defined as infections occurring up to 30days after surgery or up to one year after surgery in patients receiving implants and affecting either the incision or deep tissue at the operation site.[1,2] SSIs remain a major cause of morbidity and mortality across the world for patients undergoing surgical operations.[3] SSIs range between 2% and 20% of patients post-surgery in the world.[4]Globally, it has been reported that more than one-third of postoperative deaths are related to SSIs.[5] The effects of SSIs on the patients include discomfort, delayed wound healing, readmission, longer hospital stay, increasing costs, gas gangrene, and tetanus.[1,6,7] In addition, Complications associated with SSIs may include wound dehiscence, bacteraemia, sepsis and abscess[8]

In the United States, SSIs are found to be a serious complication with an incidence ranging from 2 to 5% in patients undergoing surgery complicating approximately 300,000 to 500,000 surgeries per year and imposing a financial burden on the healthcare system that exceeds $1.6 billion.[9] The prevalence survey conducted by the Centers for Disease Control and Prevention (CDC) revealed that in 2011, there were approximately 157,500 surgical site infections linked to inpatient surgical procedures.[10] In European countries, epidemiological surveillance conducted in 2017 revealed that among 648,512 surgical procedures, 10,149 SSIs were reported.[11]

The World Health Organization (WHO) identifies surgical site infection (SSI) as the most commonly monitored and prevalent healthcare-associated infection in low- and middle-income countries (LMICs), with the potential to impact as many as one-third of individuals undergoing surgical procedures.[12] SSIs in low- and middle-income countries (LMICs) affect 8 to 30% of surgical operation.[13]SSIs are associated with 38% of deaths in patients with such infections in low- and middle-income countries (LMICs).[14]

In African nations, SSIs is the most common complication following surgical procedures with approximately 20% of women undergoing caesarean section experiencing postoperative wound infections.[15] A study conducted in Nigeria in 2019 revealed that the overall incidence of surgical site infections (SSIs) among patients who underwent surgery was 27.6%.[16] Another study done in Cameroon in 2022 indicated that the incidence of surgical site infections (SSIs) among patients who underwent surgery was 12.2%, accompanied by a mortality rate of 2%.[17] The prevalence of SSIs post-major surgery in Uganda was 28.6%,[18] which is comparable with the infection rate in Tanzania, where the prevalence of SSIs was 26% ,[19] and the prevalence of SSIs in Ethiopia was 24.6%.[20]

In Rwanda, the prevalence of SSIs identified at Kirehe district hospital was 10.9% [21] for pregnant women who delivered by C/section, at Kabgayi hospital was 8.2%, [7] at University Teaching Hospital of Butare for pregnant women who underwent caesarean delivery was 4.9%.[22]

SSIs are influenced by many factors like specific setting in which surgery takes place, resources availability and external contamination risk, including use of improper surgical attire, improper techniques, and inadequate hand hygiene.[2,6] Patient-related factors include pre-existing infections, malnutrition, obesity, low serum albumin levels, being elderly, smoking, and immunosuppression, age, American Society of Anaesthesiologists (ASA) classification, Body Mass Index(BMI), wound classifications while surgery related factors include contaminated procedures, emergency surgery, inadequate sterilization, improper instrument handling, and antiseptic of surgical site, skills and experience of a surgeon, longer duration of surgery greater than 2hours,duration of hospital stay, blood transfusion during surgery.[4,24]

SSIs can be reduced by up to 60% by implementing evidence-based practices such antibiotic prophylaxis, care bundles, perioperative glucose management, and healthcare professional education.[23] According to National Institute For Health And Care Excellence (NICE) guideline for the management of postoperative wound, the post-operative SSIs prevention and management can be done using proper cleaning and dressing of the wound, treatment with antibiotics and debridement of the wound.[24]

The dearth of updated data on the prevalence and risk factors associated with SSIs hampers further thoughts regarding shaping further interventions necessary to prevent SSIs. Therefore, there is a great need to deeply analyse the magnitude of SSIs in selected referral hospitals, which provides updated data to be the basis of shaping further interventions to prevent SSIs among surgical patients in Rwanda. The purpose of this study was to assess the prevalence and risk factors associated with SSIs among surgical patients in selected tertiary hospitals.

Methods and Materials

Study design

A quantitative approach was used in this study, which utilized a retrospective cross-sectional design. Patients' medical files considered during chart review were those closed from July 2020 to December 2021. The data collection was conducted in a period of four months from September to December 2022. It is noticed that similar studies in the literature have also utilized this particular design indicating its relevance and applicability in this study.[25,26]

Study settings

The data were collected in the surgical, gynaecology and obstetrics units of University Teaching hospital of Kigali and Butare located in Rwanda. The two public study settings were purposefully chosen because of their universal access to healthcare services regardless of financial means. Patients covered by community-based health insurance were able to easily utilize referral hospital services for their healthcare needs. The access to data from these public tertiary hospitals given the profile of surgical patients was fully facilitated.

Study population

The population of this study was made of medical files for discharged surgical patients who underwent major surgeries. The total number of medical files was 39,232. Selected medical files of operated patients included files of both elective and emergency surgeries who were 18 years and above. Patients who were having another operation within one month before study period were excluded.

Sample size determination and sampling strategies

The sample size (n) of 396 was determined by the following formula n = N / (1 + Ne2) and the calculation was performed as follows: n=39232/ [1+39232*(0.05*0.05)] =396 for a given population (N=396), in which error (e) margin was 0.05 and a 95% confidence level and a power of 80%.[30] The 95 % confidence level meant that the sample result fell within a certain range of the true population level. A systematic sampling strategy was used to select medical files fulfilling the inclusion criteria. The team of researchers arranged all medical files (39232) of surgical patients, each files was numbered, sample size was calculated, then, sampling interval was also calculated and fixed (population size divided by sample size which approximately equal to 99), researchers chose randomly starting point between 1 and 99, we repeated adding sampling interval to choose subsequent elements and so forth.[27]

Data collection tool

A checklist was used as the data collection tool,[7,9] the tool was made of three sections. The first section was about socioeconomic characteristics of participants. The variables measured in this section included age, sex, education, experience, occupation, weight, height, BMI, type of admission, smoking, alcohol consumption, recreational drug, patient diagnosis, underlying comorbidity, preoperative hemoglobin level, preoperative liver transaminases and postoperative kidney function test.

The second section targeted perioperative data. The variable measured included type of anaesthesia, ASA score, category of surgical procedure, wound classification, patient skin bath preoperatively, shaving of the site to be operated, shaving method, shaving time, anti-septic used by surgeon for hand scrubbing, anti-septic used for skin preparation, prophylactic antibiotic administration, time for prophylactic antibiotic administration, name of prophylactic antibiotics, grade of surgeon, duration of operation, major intraoperative events that occurred during the procedure, number of participants in the operation, intraoperative blood loss, blood transfusion, and drain insertion.

The third section focused on postoperative data. The variables tackled included type of dressing, frequency of wound dressing, and duration of hospital stay postoperatively. The data collection tool indicated SSIs following surgical procedures as the outcome variable. The wound infection was suspected referring to Centre for Diseases Control(CDC) wound infection classification such as superficial infection, deep infection and organ or space of infection.[28,29]

Data collection process

Following the approval of this research project by the College of Medicine and Health Sciences (CMHS) Institutional Review Board (IRB) and authorization to commence data collection from the two study settings, the investigators and two trained research assistants, proceeded to review all selected medical files of surgical patients. Those medical files for discharged surgical patients who were admitted in surgical and maternity units. These specific units were chosen due to the fact that surgical patients are typically admitted to the surgical and maternity units. Data collection was collected from September to December 2022.

Data analysis

The data analysis was done using IBM SPSS Statistics for Windows version 25.0 (IBM Corp, Armonk, NY, USA). It involved a quantitative approach, utilizing frequencies and percentages to outline the characteristics of the participants as well as the prevalence SSI among patients. For bivariate analysis, a chi-square test was used to compare the prevalence of surgical site infections among patients with different characteristics. Additionally, univariate and multivariable analysis were used to identify factors associated with surgical site infections. Independent variables were selected based on the results of Wald tests, with those having p-values below 0.25 being retained for further analysis.

Ethical considerations

This study was approved by the CMHS Institutional Review Board with approval notice N0384/CMHS/2022. Prior to gathering data, researchers obtained approval from the designated tertiary hospitals. Every data collection checklist was assigned a unique identification number to safeguard the anonymity of participants. The information obtained was kept confidentially. The gathered information was intended merely for the research study's purposes.

Results

Sociodemographic characteristics of participants

Out of 396 participants involved in this study,192(48.5%) were aged between 18 and 29 years, 215(54.3%) were female, 221(55.8%) had completed primary education, and 231(58.3%) were farmers. Underlying co-morbidities were anemia 52(13.2%), HIV/AIDS 22(5.6%) and obesity 31(7.8%). Smoking was detected in 22(5.6%), and alcohol consumption was identified in 79(19. 9%).Regarding wound classification before operation, 185(46.7%)

of the wounds were classified as cleanly contaminated (Table 1). For prophylactic antibiotic administration,217(78.9%) received prophylactic antibiotic between 30minutes and one hour before surgery. In regards to duration of hospital stay,234(59.1%)exceeded 10days of hospitalization. The majority243(61.4%) of surgical patients were admitted for elective surgery, whereas 153(38.6%) were admitted for emergency surgery. General anaesthesia was administered to 241(61.1%) of the surgical patients(Table1).

Table1. Sociodemographic characteristics of participants(N=396)

Variables		Has surgical site infection			P-value
	N (%)	No	Yes		
		N (%)	N (%)		
Age group	18-29	192(48.5)	134(69.8)	58(30.2)	0.322
	30-39	109(27.5)	76(69.7)	33(30.3)	
	40-49	48(12.1)	37(77.1)	11(22.9)	
	50 years and above	47(11.9)	28(59.6)	19(40.4)	
Gender	Male	181(45.7)	125(69.1)	56(30.9)	0.879
	Female	215(54.3)	150(69.8)	65(30.2)	
Level of education	No formal schooling	41(10.5)	32(78.0)	9(22.0)	0.267
	Primary	221(56.4)	146(66.1)	75(33.9)	
	Secondary	114(29.1)	84(73.7)	30(26.3)	
	University education	16(4.1)	10(62.5)	6(37.5)	
Diabetes	Yes	11(2.8)	6(54.5)	5(45.5)	0.277
	No	385(97.2)	269(69.9)	116(30.1)	
Liver disease	Yes	6(1.5)	5(83.3)	1(16.7)	0.457
	No	390(98.5)	270(69.2)	120(30.8)	
Anemia	Yes	52(13.2)	32(61.5)	20(38.5)	0.174
	No	343(86.8)	243(70.8)	100(29.2)	
HIV/AIDS	Yes	22(5.6)	12(54.5)	10(45.5)	0.119
	No	374(94.4)	263(70.3)	111(29.7)	
Chronic renal disease	Yes	5(1.3)	3(60.0)	2(40.0)	0.645
	No	391(98.7)	272(69.6)	119(30.4)	
Cardiac disease	Yes	11(2.8)	10(90.9)	1(9.1)	0.117
	No	385(97.2)	265(68.8)	120(31.2)	
Obesity	Yes	31(7.8)	19(61.3)	12(38.7)	0.305
Patient's occupation	Famer	231(58.3)	156(67.5)	75(32.5)	0.174
	Housewife	36(9.1)	24(66.7)	12(33.3)	
	Student	56(14.1)	46(82.1)	10(17.9)	
	Other	73(18.4)	49(67.1)	24(32.9)	
Type of admission	Emergency	153(38.6)	96(62.7)	57(37.3)	**0.022**
	Elective	243(61.4)	179(73.7)	64(26.3)	
Type of anesthesia administered	General	242(61.1)	166(68.6)	76(31.4)	0.646
	Regional	154(38.9)	109(70.8)	45(29.2)	
ASA Score	Normal healthy patient	190(48.0)	141(74.2)	49(25.8)	0.069
	Patient with mild systemic disease	153(38.6)	103(67.3)	50(32.7)	
	Patient with severe systemic disease	53(13.4)	31(58.5)	22(41.5)	
Has smoking history	Yes	22(5.6)	11(50.0)	11(50.0)	**0.042**
	No	374(94.4)	264(70.6)	110(29.4)	

Table 1. Continued

Variables			Has surgical site infection		P-value
	N (%)	No N (%)	Yes N (%)		
Alcohol consumption	Yes	79(19.9)	50(63.3)	29(36.7)	0.185
	No	317(80.1)	225(71.0)	92(29.0)	
Recreational drug use history	Yes	9(2.3)	3(33.3)	6(66.7)	**0.017**
	No	387(97.7)	272(70.3)	115(29.7)	
prophylactic antibiotic administered before surgery	Yes	270(68.2)	196(72.6)	74(27.4)	**0.046**
	No	126(31.8)	79(62.7)	47(37.3)	
Wound class before operation	Clean	88(22.2)	61(69.3)	27(30.7)	0.666
	Clean contaminated	185(46.7)	133(71.9)	52(28.1)	
	Contaminated	50(12.6)	33(66.0)	17(34.0)	
	Dirty or infected	63(15.9)	40(63.5)	23(36.5)	
	None	10(2.5)	8(80.0)	2(20.0)	
when was the prophylactic antibiotic administered	Less than 15 minutes before operation	13(4.7)	10(76.9)	3(23.1)	0.194
	15-30 minutes before the operation	23(8.4)	14(60.9)	9(39.1)	
	Between 30 minutes and 1 hour before operation	217(78.9)	164(75.6)	53(24.4)	
	Above one 1 hour before operation	22(8.0)	13(59.1)	9(40.9)	
Operation time	1-60minutes	156(39.4)	122(78.2)	34(21.8)	**0.002**
	61-120 minutes	168(42.4)	113(67.3)	55(32.7)	
	>120minutes	72(18.2)	40(55.6)	32(44.4)	
Major intraoperative event that occurred during the procedure	Hemorrhage	17(4.7)	7(41.2)	10(58.8)	**0.003**
	Major contamination	11(3.0)	4(36.4)	7(63.6)	
	Other/none	336(92.3)	236(70.2)	100(29.8)	
Duration of hospital stay post-surgery	1-5 days	76(19.2)	68(89.5)	8(10.5)	**<0.001**
	6-10 days	86(21.7)	76(88.4)	10(11.6)	
	above 10days	234(59.1)	131(56.0)	103(44.0)	

Prevalence of surgical site infections

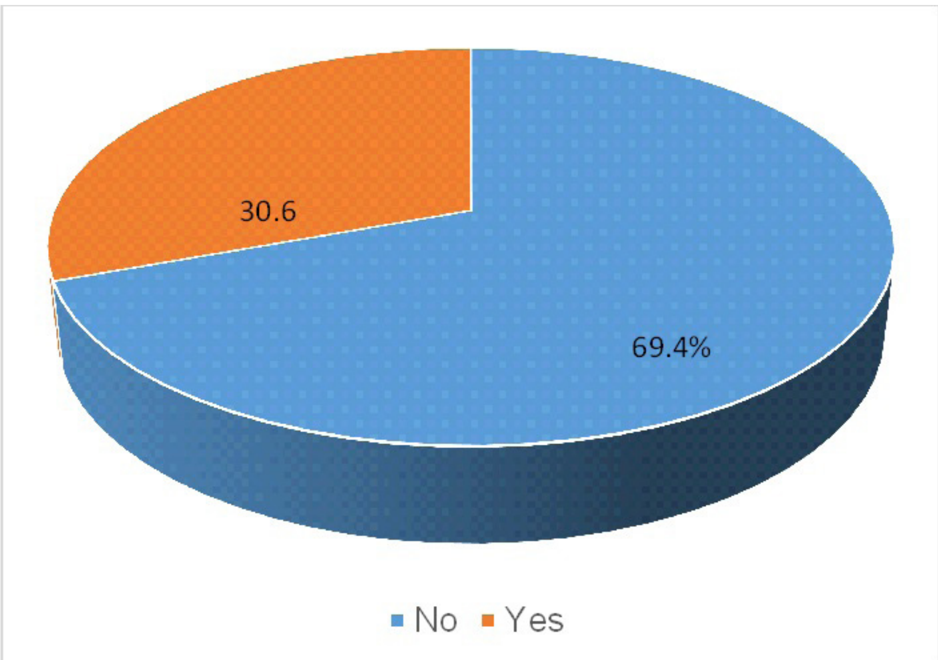

Figure1. Prevalence of surgical site infections (N=396)

Figure 1 presents information regarding the prevalence of site infections among patients in referral hospitals in Rwanda. Out of 396 patients included in this study, 121(30.6%) were found to have surgical site infections.

Bivariate analysis to identify association between patient characteristics and surgical site infection

During the bivariate analysis, a chi-square test was used to compare the prevalence of surgical site infections among patients with different characteristics. The results show that having a smoking history (50%), a recreational drug use history (66.7%), staying in the hospital for more than 10 days before the operation (44.4%), having an operation time greater than 120 minutes (44.4%), experiencing major contamination during the procedure (63.7%) and undergoing into emergency admission (37.3%) were all significantly associated with surgical site infections ($p<0.05$). (Table1)

Factors associated with surgical site infection

According to the univariate logistic regression model, it was shown that having a severe systemic disease (COR = 2.04, 95% CI: 1.08-3.86), experiencing haemorrhage (COR = 3.37, 95% CI: 1.25-9.11) or major contamination (COR = 4.13, 95% CI: 1.83-14.42) during the procedure, spending between 61 and 120 minutes (COR = 1.75, 95% CI: 1.06-2.88) or more than 120 minutes (COR = 2.87, 95% CI: 1.58-5.23) in operation, having a recreational drug use history (COR = 4.73, 95% CI: 1.16-19.24) or smoking history (COR = 2.4, 95% CI: 1.01-5.70), and undergoing emergency admission (COR = 1.66, 95% CI: 1.08-2.57) were associated with higher odds of developing surgical site infections. (Table2)

Table 2. Logistic regression analysis of factors associated with surgical site infections among surgical patients

Variables	P-value	COR (95%CI)	P-value	AOR (95%CI)
ASA Score				
Normal		Ref		Ref
Mild systemic disease	0.162	1.40(0.87-2.23)	0.420	1.24(0.73-2.10)
Severe systemic disease	**0.028**	**2.04(1.08-3.86)**	0.325	1.45(0.69-3.02)
Major intraoperative event that occurred during the procedure				
Hemorrhage	**0.017**	**3.37(1.25-9.11)**	0.336	1.70(0.58-5.05)
Major contamination	**0.026**	**4.13(1.18-14.42)**	**0.040**	**4.60(1.07-19.69)**
Other/none		Ref		Ref
Operation time				
1-60minutes		Ref		Ref
61-120 minutes	**0.028**	**1.75(1.06-2.88)**	0.226	1.40(0.81-2.41)
>120minutes	**<.001**	**2.87(1.58-5.23)**	**0.007**	**2.52(1.29-4.93)**
Has a recreational drug use history				
No		Ref		Ref
Yes	**0.03**	**4.73(1.16-19.24)**	0.069	4.66(0.89-24.48)
HIV/AIDS				
No		Ref		Ref
Yes	0.125	1.97(0.83-4.70)	0.588	1.33(0.47-3.74)
Anemia				
No		Ref		Ref
Yes	0.176	1.52(0.83-2.78)	0.802	1.09(0.55-2.18)
Cardiac disease				
No		Ref		Ref
Yes	0.152	0.22(0.03-1.75)	0.067	0.12(0.01-1.16)
Type of admission				
Emergency	**0.022**	**1.66(1.08-2.57)**	**0.036**	**1.68(1.03-2.73)**
Elective		Ref		Ref
Smoking history				
No		Ref		Ref
Yes	**0.047**	**2.40(1.01-5.70)**	0.186	1.94(0.73-5.15)

Ref: Reference category, **Bold:** Statistically significant with $p<0.05$

In multivariable analysis, after controlling for covariates, spending more than 120 minutes in operation (AOR = 2.52, 95% CI: 1.29-4.93), experiencing major contamination during the procedure (AOR = 4.60, 95% CI: 1.07-19.69), and undergoing emergency admission (AOR = 1.68, 95% CI: 1.03-2.73) remained significantly associated with surgical site infections. (Table 2)

Discussion

This study found that the prevalence of SSIs was 30.6%. The prevalence of SSIs described in this study was higher compared to the prevalence reported in the study conducted in Shirati KMT Hospital in Tanzania and the University Clinic of Traumatology and Urology of the National University Hospital Center Hubert Cotonou, where the prevalence of SSIs was 10.9% and 7.81%, respectively.[30,31] This difference could be explained by the fact that the above hospitals complied with infection prevention and control precautions, surveillance of SSIs which contributed to the prevention of SSIs.[13]

In addition, such observed difference in the prevalence of SSIs between the findings the other studies could be attributed to the small sample size of those studies and the short time period for retrospective data coverage. The prevalence of SSIs was high compared to the findings of studies conducted in high-income countries, such as the USA, where patients who underwent peripheral vascular bypass developed 3.1% SSIs, those who underwent colon surgery developed 2.4% SSIs, those who underwent laparotomy developed 1.4% SSIs, India developed 5% SSIs, and China developed 4% SSIs.[32–34] Such difference between SSI prevalence in this study and those of high-income countries may be related to strong infection prevention and control measures, improved surgical techniques, well-developed hospital settings, sufficiently trained healthcare professionals on infection prevention and control, a high level of understanding of surgical patients, and high adherence to the use SSI prevention guidelines, which are more advanced in high-income countries than in LMICs, such as Rwanda. These results are slightly similar to the findings of the studies completed in Dilla University Hospital, Abuja Nigeria, at St Francis Hospital Uganda, Academic Trauma and Burn Center in Ethiopia, Bugando Medical Center in Tanzania, and Hawassa University Comprehensive Specialized Hospital Southern Ethiopia, which revealed that the SSIs rates were 19.3%, 27.6%, 28.6%, 24.6%, 26.0% and 24.6%, respectively.[16,18–20,29] SSIs are still high in Sub-Saharan countries. Therefore, concerted efforts are needed to be implemented to improve postoperative outcome and safe surgery among surgical patients.

Several factors could account for the variation in SSIs infection rates between developed and developing nations, including Rwanda. These factors include poor hospital design (lack of supplies and equipment needed to maintain strict asepsis guidelines), poor patient hygiene that promotes bacterial flora colonization of the skin, late patient presentation to the healthcare system that results in contaminated wounds, and overburdened emergency services due to population burden.[9] Risk factors such as age, American Society of Anaesthesiologists classes, wound classification, surgeon skills and experience, duration of surgery, blood transfusion and emergency surgery were found to be associated with SSIs. Contaminated and dirty wounds were also identified as contributing to SSIs.[9,35]

The health of patients and their families is adversely affected by SSIs, which also leads to longer hospital stays and higher healthcare expenses. The family spends a lot of time and money, which has an impact on the patient's and the family members' mental and emotional health. A study found that perioperative care, safety, and infection control in the operating room, adequate surgical site preparation, timely administration of antibiotic prophylaxis, and monitoring of patient physiology during and immediately following the procedure by a perioperative nurse who should be familiar with SSI prevention measures as well as the fundamental pathophysiology of postoperative wound infection.[36]

This study identified factors associated with SSIs, including emergency surgery, smoking, use of recreational drugs, intraoperative haemorrhage, major contamination, duration of surgical operation (61-120 minutes, >120 minutes). These findings corroborate the findings of previous studies.[9,37–39] The findings of this study identified emergency surgeries as risk factors associated with SSI due to inadequate preparation of surgical patients preoperatively and lack of sufficient time to control underlying comorbidities such as diabetes and breech in sterilization protocol.[40] Smoking was also found to be a risk factor associated with SSI explained by the fact that smoking endothelial dysfunction, inflammation, progression of atherothrombotic disease, impaired systemic immune response, suppress immunoglobulin level which contribute to altered wound healing process and may induce more wound infections complications.[41] Recreational drugs were identified as a contributing factor to SSI justified by the fact that recreational drugs contribute to vasoconstriction which can lead to ischemia, alter the immune response, poor wound healing, increase infections and other post-surgery complications.[42]

Intra-operative complications such as haemorrhage and major contamination were identified to be risk factors associated with SSI. For intraoperative haemorrhage may lead to reduced haemoglobin and cause hypoxia with impairment in tissue oxygenation and healing to favour wound infections. Major contamination of the surgical wound intraoperatively was identified to be a risk factor associated to SSI which is therefore linked to numerous bacteria growth and colonization and in turn become source of infection of the incision site.[9] Duration of surgical operation has also been identified to be associated with SSI because of prolonged exposure of tissues to surrounding environment, increase the surgical team fatigue and room for more technical errors, prolonged hypothermia and declining level of antibiotics administered prophylactically, hospital stay, which can be explained by prolonged stay providing further opportunity for bacterial colonization.[43] Observational study should be conducted to identify factors associated with surgical site infections and identify cause and effect relationship.

Limitations of this study

The researchers did not perform culture and sensitivity due to the retrospective nature of the study, and the research team considered results from culture and sensitivity performed by study settings. In addition, the study did not follow up surgical patients after discharge.

Conclusion

The prevalence rate of SSI was 30.6% in this study. Emergency surgery, smoking, use of recreational drugs, antibiotic prophylaxis administration, intraoperative hemorrhage, experiencing major contamination, and duration of hospital stay were statistically associated with SSIs.Most risk factors are hospital-acquired, which may be related to the non-availability of evidence-based SSI prevention guidelines in the study settings and inadequate implementation of infection prevention and control measures. There is a need to conduct a large study covering all hospitals in Rwanda practicing surgery to determine the real prevalence of SSIs in Rwanda and explore factors associated with SSIs to improve the generalizability of the study results. Further research is also needed to adapt and implement SSI prevention guidelines in Rwanda, which might contribute to the reduction of SSI rate in the study settings.

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Availability of datasets and materials
The datasets of analysed data can be obtained from the corresponding author upon request.

Authors contribution
All authors (AN, MM, GC, AC, FB) contributed to the design, preparation of the study proposal, data analysis and manuscript preparation.

Consent for publication
Not applicable

Conflict of interest
The authors confirm that they have no conflicts of interest related to this study.

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