Original Article

Knowledge and Practice of Health Care Professionals Regarding the Prevention of Surgical Site Infections at Tertiary Hospitals in Rwanda

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Abstract

Background

The prevention of surgical site infections heavily relies on healthcare professionals who adhere to appropriate use of guidelines. However, there is limited evidence on their knowledge and practices regarding surgical site infections prevention in Rwanda. Therefore, this study aimed to evaluate the knowledge and practice of health care professionals regarding the prevention of surgical site infections at tertiary hospitals in Rwanda.

Methodology

A cross-sectional study involving 213 healthcare professionals was conducted to assess the practice and knowledge of surgical site infection preventions. Univariate and multivariable logistic regression analyses were performed using SPSS version 25.

Results

This study indicated that 53.1% of healthcare professionals had good knowledge regarding surgical site infections prevention, while 57% reported good practices. Nurses were significantly more likely to have good practices, with a 4.7 times higher likelihood (AOR=4.66, 95% CI=1.23-17.77) than other healthcare professionals. Healthcare professionals who received in-service training on infection prevention were more likely to demonstrate good practices compared to those who are not trained (AOR=2.99, 95% CI=1.29-6.92).

Conclusion

The current study revealed that 43% of study participants reported poor surgical site infections prevention practices. Therefore, healthcare professionals' knowledge on surgical site infections prevention needs upgrading, and in-service training on infection prevention necessary.

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Keywords: Knowledge, practice, surgical site infection, health care professionals

Introduction

Globally, surgical patients and healthcare systems bear a heavy cost from surgical site infections (SSIs).[1] The SSIs affect 2%–20% of operated patients worldwide.[2] SSIs are influenced by factors like specific setting in which surgery takes place, resource availability, and external contamination risk, including use of improper surgical attire, improper techniques, and inadequate hand hygiene.[2,3] Patient-related factors include pre-existing infections, malnutrition, obesity, low serum albumin levels, being elderly, smoking, and immunosuppression, while surgery-related factors include contaminated procedures, emergency surgeries, inadequate sterilization, improper instrument handling, and insufficient antiseptic preparation of surgical site.[4] SSIs increase morbidity risk, hospital stays, more antibiotic use, readmissions, long-term patient outcomes, and more surgical procedures.[5] Of individuals with SSIs, 38% die as a result of their conditions.[6] SSIs raise patient mortality and morbidity and have a detrimental effect on patients' emotional and physical well-being.[7] Moreover, SSIs can lead to lower productivity, longer hospital admissions, a lower standard of living, and a larger financial burden.[8] The prevalence of SSIs is up to four times higher in low- and middle-income countries than in high-income countries.[9] Depending on the type of surgical operation, a study carried out in European countries revealed that the percentage of SSIs varied from 0.5% to 10%.[10] According to an Indian study, the variability in SSIs rates varies depending on the study context and ranges from 4 to 40%.[8]

Postoperative wound infections affect up to 20% of women who underwent cesarean sections, affecting their ability to care for their infants and their own health. Infection is the most common surgical complication in African countries.[11,12] According to the study conducted in Ethiopian teaching hospitals, the general surgical wards had an overall SSIs prevalence of 21 percent.[13] A study in Rwanda found that 10.9% of pregnant women who underwent cesarean sections experienced superficial SSIs during their recovery, of which 75% are superficial SSIs.[14] A study conducted in Rwanda showed that the prevalence of SSIs was 8.2%,[15] whereas in another study the incidence of SSIs was 10.9%.[9]

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. [16] Small-scale studies in a Western Maharashtra tertiary institution revealed that 70% of staff nurses, consultants, interns, and residents lacked adequate knowledge.[17] According to a study in Saudi Arabia, 30.2% of physicians knew very little about SSI prevention.[18] A study in Western Maharashtra revealed that healthcare workers, despite demonstrating acceptable infection control practices, lacked sufficient knowledge of SSI preventive actions techniques.[17] Another study conducted in China indicated that nurses knowledge of surgical site infection prevention was at a low level.[19] A study in Ireland found that healthcare professionals' lack of knowledge about SSIs prevention guidelines is a significant contributor to SSIs.[20]

Studies in Ethiopia and Cameroon reveal insufficient knowledge and practice among nurses in preventing SSIs due to factors like limited experience, education, workload, infection prevention training, and patient safety guidelines.[21,22] In addition, another study conducted in Ethiopian showed that the level of practice of nurses towards the prevention of SSIs was poor. [23] The literature on factors contributing to inadequate knowledge and practice in Rwanda regarding SSIs prevention among healthcare professionals is limited.

Poor implementation of SSIs preventive measures is attributed to various obstacles such as insufficient knowledge, funding, inadequate surveillance, performance

monitoring, excessive workload, staff, training, and poor orientation programme. [24] Additionally, insufficient in-service training and skill renewal are significant issues that impact SSIs prevention strategies in hospital settings.[25] Several studies have been published discussing knowledge and practice levels of nurses, midwives as well as the knowledge levels of doctors.[18,24,26] Nurses and midwives are vital in preventing surgical site infections, but it's crucial to consider the roles of doctors, anesthesiologists, and other medical professionals in the surgical team. [27] In Rwanda, evidence showed that SSIs was 10.9%, but there is a lack of studies on prevention measures and healthcare professionals' knowledge and practice. Therefore, the objective of this study was to assess the level of knowledge and practice of healthcare professionals regarding the prevention of SSIs at tertiary hospitals in Rwanda.

Methods

Study design

A quantitative approach was used in this study, which utilized a cross-sectional design. The study 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.[15,28,29]

Study setting

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 easy.

Population

The study covered a multidisciplinary study population of 455 healthcare professionals, including doctors, nurses, midwives, anaesthetists, and anaesthesiologists. This research aimed to gather ideas from a multidisciplinary team involved in healthcare delivery to surgical patients.

Sample size

The sample size (n) of 213 was determined by the following formula n = N / (1 + Ne2) and the calculation was performed as follows: n=455/[1+455*(0.05*0.05)]=212.8 approximately 213,for a given population (N=455), in which error (e) margin was 0.05 and a 95% confidence level.[30] The 95 % confidence level meant that the sample result fell within a certain range of the true population level.

Sampling strategy

The participants in this study were selected using a convenient sampling technique because of the absence of sampling frame

Data collection tool

A self-administered, structured English version questionnaire was employed in the study settings to gather data from the participants.[24,31,32] The tool consisted of three sections: The first section focused on gathering information regarding the socio-demographic characteristics of the participants. The second section was dedicated to assessing the knowledge of health care professionals on the prevention of SSIs. This section comprised 25 questions, each offering three multiple-choice answers. For each correct answer, one mark was awarded, while an incorrect answer received zero mark. The total marks attainable ranged from 0 to 25, which were then converted into a percentage for ease of interpretation.

The mean was established as the cut-off score for determining knowledge level, with scores above the mean indicating good knowledge and scores below the mean indicating poor knowledge. In the third section,

the focus was on evaluating the level of practice among healthcare professionals in relation to preventing SSIs. This section consisted of 25 questions, each answered using a Likert scale (ranging from "Not sure=1"; "Never=2"; "Occasionally=3"; "Sometimes=4"; to "Always=5").[28,29,33] The mean score was used as the cut-off point, with scores above the mean indicating good practice and scores below the mean indicating poor practice. This approach allowed for a comprehensive assessment of healthcare professionals' knowledge and practice in preventing SSIs.

Prior to data collection, the instrument underwent a pretest on a subset of 10% of the total sample size within the study settings. Evidences indicated that utilizing 10% of the main survey population for the pretest phase is acceptable.[34] Accurate and careful phrasing of each question using the same wording and sequencing consistency of responses and lack of ambiguities during the pretest gave the researcher confidence that the instrument was reliable and free from misinterpretation. The Cronbach's alpha coefficient was computed to determine the internal consistency reliability of the tool, yielding a value of 0.77. This indicates that the tool was considered acceptable for measuring variables related to knowledge and practice.[35,35,36]

The study examined knowledge and practice as dependent variables, while age, sex, profession, education, working area, marital status, experience, presence of SSIs prevention guidelines in the workplace, and completion of infection prevention in-service training were considered independent variables.

Validity and reliability of data collection tool

The study utilized a self-administered questionnaire to gather data from participants, focusing on relevant practices and knowledge-related inquiries. In order to make sure that all topics were covered and that the tool could gather the necessary data, a few questions were also extracted from the comprehensive literature review. The tool was modified to ensure content validity and translated into Kinyarwanda by a non-research team translator. This ensured comprehensive coverage of all study variables.

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 a research assistant, proceeded to administer questionnaires to participants employed in the maternity, surgical, and intensive care units (ICU) of the study settings. This study targeted nurses, midwives, physicians, anaesthetists, and anaesthesiologists working 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, while those experiencing severe postoperative complications are usually transferred to the ICU. Upon elucidating the study's objectives to the participants, the authors distributed the questionnaires to participants who returned them to authors after completion. Data was collected from September to December 2022, with a 100% response rate.

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. For bivariate analysis, a chi-square test was employed to examine the relationship between sociodemographic factors and the knowledge and practices related to the prevention of SSIs. Additionally, univariate and multivariate logistic regression methods were used to explore the factors associated with good knowledge and practices in preventing SSIs. Independent variables were selected based on the results of Wald tests, with those having p-values below 0.25 being retained for further analysis.

The findings were presented in terms of odd ratios (ORs), where an OR greater than 1 indicated a positive association, while an OR less than 1 signified a negative association, along with their corresponding 95% confidence intervals. Statistical significance was determined by P values less than or equal to 0.05, indicating the presence of a significant relationship between the variables under investigation.

Ethical consideration

The CMHS Institutional Review Board (IRB) granted approval for this study, as indicated by the approval Notice: N0384/CMHS/2022. The researcher assured the participants that their participation in the study was completely voluntary. To ensure confidentiality, the questionnaires did not include any names. The researchers informed all participants that their information would be treated as confidential and solely used for the study's purposes. Each participant signed consent forms, granting permission for the researcher to conduct the study.

Results

Sociodemographic characteristics of participants

Out of 213 participants involved in this study, 105(49.3%) were aged between of 31 to 40 years while 90(42.3%) were older than 40 years. The distribution of participants based on gender, showed that the majority 152(71.4%) of the participants were females. The marital status of the participants revealed that a significant number180 (84.5%) were married. In terms of occupation, more than half 119(55.9%) of participants were nurses, 48(22.5%) midwives, 20(9.5%) physicians, while the remaining 26(12.2%) were engaged in the field of anesthesia (Table 1). In terms of education, 105 (49.3%) held a diploma, 98(46%) possessed a bachelor's degree, and 10(4.7%) had a master's degree. The majority 156(73.2%) had a minimum of five years of professional experience in the field. When questioned about their specific areas of expertise within the healthcare sector, findings showed that 64(30.2%) of respondents were working in surgical unit, while 58(27.4%) were in the gynaecology and obstetrics unit. Additionally, 45(21.1%) of participants noted that their workplace had guidelines for preventing surgical site infections, and 68(31.9%) mentioned receiving in-service training on infection prevention (Table 1).

Table 1. Sociodemographic characteristics of the participants (N=213)

		Knowledge of respondent			Practice of respondents		
Variables	**No. (%)**	**Poor**	**Good**	**P value**	**Poor**	**Good**	**P value**
Age							
20-30	18(8.5)	10(55.6)	8(44.4)	0.745	9(50.0)	9(50.0)	0.428
31-40	105(49.3)	51(48.6)	54(51.4)		41(39.0)	64(61.0)	
41-50	73(34.3)	31(42.5)	42(57.5)		31(42.5)	42(57.5)	
>50	17(8.0)	8(47.1)	9(52.0)		10(58.8)	7(41.2)	
Gender							
Male	61(28.6)	27(44.3)	34(55.7)	0.619	31(50.8)	30(49.2)	0.130
Female	152(71.4)	73(48.0)	79(52.0)		60(39.5)	92(60.5)	
Profession							
Nursing	119(55.9)	54(45.4)	65(54.6)	**0.027**	42(35.3)	77(64.7)	**<0.001***
Medicine	20(9.4)	4(20.0)	16(80.0)		7(35.0)	13(65.0)	
Anesthesia	26(12.2)	16(61.5)	10(38.5)		22(84.6)	4(15.4)	
Midwife	48(22.5)	26(54.2)	22(45.8)		20(41.7)	28(58.3)	

Table 1. Continued

		Knowledge of respondent			Practice of respondents		
Variables	**No. (%)**	**Poor**	**Good**	**P value**	**Poor**	**Good**	**P value**
Education							
Diploma	105(49.3)	54(51.4)	51(48.6)	0.140	53(50.5)	52(49.5)	0.075
Bachelor	98(46.0)	44(44.9)	54(55.1)		34(34.7)	64(65.3)	
Masters	10(4.7)	2(20.0)	8(80.0)		4(40.0)	6(60.0)	
Work Experience							
<1year	3(1.4)	0(0.0)	3(100)	0.374	0(0.0)	3(100)	**0.008***
1-5years	54(25.4)	27(50.0)	27(50.0)		33(61.1)	21(38.9)	
6-10years	108(50.7)	52(48.1)	56(51.9)		41(38.0)	67(62.0)	
>10years	48(22.5)	21(43.8)	27(56.3)		17(35.4)	31(64.6)	
Surgical site infection prevention guideline present							
Yes	45(21.1)	15(33.3)	30(66.7)	**0.039**	13(28.9)	32(71.1)	**0.035***
No	168(78.9)	85(50.6)	83(49.4)		78(46.4)	90(53.6)	
In-service training on SSI prevention							
Yes	68(31.9)	27(39.7)	41(60.3)	0.147	19(27.9)	49(72.1)	**0.003***
No	145(68.1)	73(50.3)	72(49.7)		72(49.7)	73(50.3)	

Knowledge on the prevention of surgical site infections at tertiary hospital

The results of the study revealed that a significant majority of the participants demonstrated a high level of knowledge in various areas related to SSIs prevention. Specifically, 195(91.5%) provided the most accurate responses. Moreover, an impressive 196(92%) of the participants correctly answered questions regarding prophylactic antibiotics, while 184(86.4%) demonstrated their understanding of selecting an appropriate dressing solution for surgical wounds. Additionally, an overwhelming majority of 196(92%) recognized the importance of maintaining a normal nutritional status for surgical patients. Furthermore, 191(89.7%) of the participants reported being familiar with the laboratory tests necessary for identifying SSIs, and 184(86.4%) of the participants claimed to possess knowledge on preventing infections in patients with immunodeficiency diseases. Lastly, 186(87.3%) claimed to be aware of the appropriate foods for preoperative patients necessary to prevent SSIs. These findings highlight the participants' commendable level of knowledge in various aspects related to SSIs prevention and surgical patient care (Table 1).

Findings from this study revealed that a majority 139(65.1%) of the participants provided an inaccurate answer regarding the optimal blood sugar level required to boost white blood cell activity effectively in order to reduce the risk of SSIs. Additionally, 143(67.1%) of the participants demonstrated a lack of knowledge concerning the most appropriate method for shaving prior to undergoing surgery, while 129(60.6%) of the participants were uninformed about the appropriate timing for administering prophylactic antibiotics (Table 2)

Table 2. Health care professionals' response to each knowledge item (N=213)

Knowledge items	Incorrect answer (%)	Correct answer (%)
The best method for preoperative shaving	143(67.1)	70(32.9)
The best time for preoperative hair removal	80(37.6)	133(62.4)
When should you administer antibiotic prophylaxis	129(60.6)	84(39.4)
The correct answer for prophylaxis antibiotics	17(8.0)	196(92.0)
The primary purpose of preoperative showering	33(15.5)	180(84.5)
The best agent for preoperative showering to prevent surgical site infections	78(36.6)	135(63.4)
The purpose of preoperative skin preparation	31(14.6)	182(85.4)
The best agent for preoperative skin preparation	52(24.4)	161(75.6)
How would you disinfect surgical site before operation?	41(19.2)	172(80.8)
The best antiseptic solution to disinfect the surface of the trolley?	91(42.7)	122(57.3)
The correct purpose of surgical hand washing?	52(24.4)	161(75.6)
The correct step of handwashing	62(29.1)	151(70.9)
Kinds of diet should be provided for preoperative patients	27(12.7)	186(87.3)
The purpose of maintenance of normal nutritional status for surgical patients	17(8.0)	196(92.0)
Which one is correct answer for surgical patients with immunocompromised immune system?	25(11.7)	188(88.3)
How do you prevent infection of patients with immunodeficiency disorder	29(13.6)	184(86.4)
What are laboratories in assessing patient's nutritional status	40(18.8)	173(81.2)
The correct level of blood sugar which enhances functions of white blood cells adequate to prevent SSI	139(65.3)	74(34.7)
The correct answer for malnourished surgical patients	56(26.3)	157(73.7)
When to change the surgical wound dressing	73(34.3)	140(65.7)
How do you select dressing solution for surgical wound	29(13.6)	184(86.4)
The correct answer for benefit of wound dressing	70(32.9)	143(67.1)
the correct statement for diagnosis of surgical site infections	106(49.8)	107(50.2)
The best answer to indicate no signs of SSI	18(8.5)	195(91.5)
The laboratory test used to diagnose surgical site infections	22(10.3)	191(89.7)

Level of knowledge of healthcare professionals on prevention of SSIs (N=213)

The research participants' mean knowledge score was 18.15 out of 25 dichotomized items, with a standard deviation of 3.01. The lowest score recorded was 7, while the highest score achieved was 24. The results of this research revealed that 113(53.1%) of healthcare professionals, exhibited a good knowledge in preventing SSIs, whereas 100(46.9%) of the participants, showed a poor knowledge in preventing SSIs (Figure1).

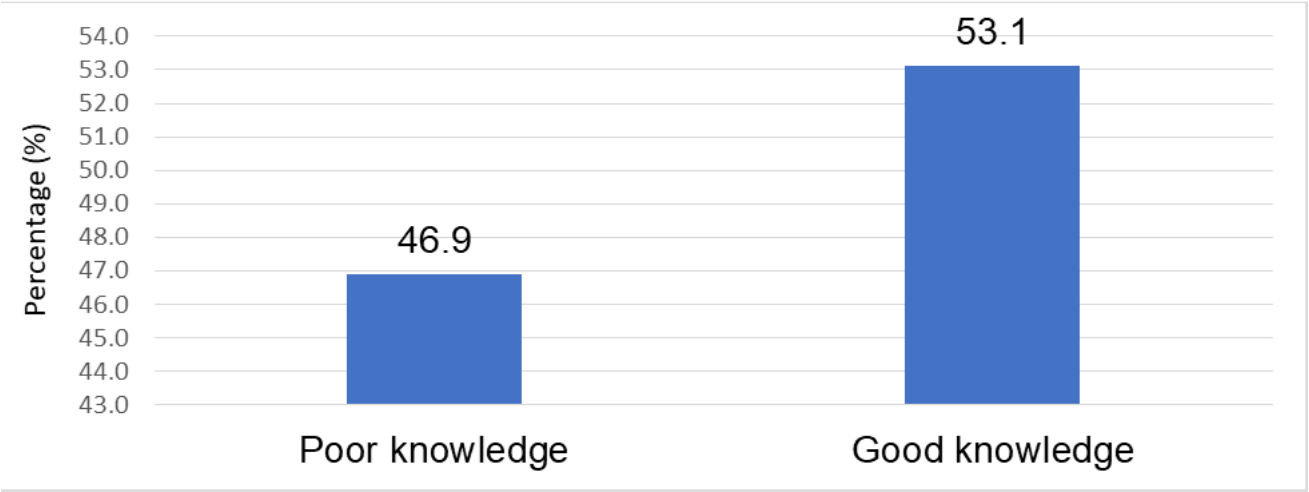

Figure1. Level of knowledge of healthcare professionals on prevention of SSIs (N=213)

Practice among healthcare professionals on prevention of SSIs

In relation to the practice items, a majority 161(75.6%) of the participants stated that they consistently employed antiseptic solutions to effectively cleanse and disinfect the surface of the dressing trolley. Similarly, 156(73.2%) of the participants reported that they always utilized sterile forceps and sterilized dressing materials to clean surgical wound dressings. Furthermore, 154(72.3%) of the participants mentioned that they consistently evaluated and monitored the conditions of the surgical site. Additionally, 139(65.3%) participants stated that they always adhered to the practice of washing their hands before and after coming into contact with the surgical site. Lastly, 144(67.6%) of the participants reported that they consistently employed aseptic technique when dressing surgical wounds (Table 3)

Table 3. Healthcare professionals' response to each practice item (N=213)

Practice items	Not sure (%)	Never (%)	Occasionally (%)	Sometimes (%)	Always (%)
How often do you use alcohol and chlorhexidine gluconate as an antimicrobial in your ward?	28(13.1)	25(11.7)	27(12.7)	56(26.3)	77(36.2)
How often do you wash your hands before and after changing wound dressings and touching surgical site	12(5.6)	4(1.9)	15(7.0)	43(20.2)	139(65.3)
How often do you wash your hands before wearing surgical gloves	11(5.2)	4(1.9)	19(8.9)	78(36.6)	101(47.4)
How often do you use sterile forceps and sterilized dressing materials for cleaning surgical wound dressing	12(5.6)	7(3.3)	12(5.6)	26(12.2)	156(73.2)
How often do you follow an aseptic technique during surgical wound swab culture	8(3.8)	15(7.0)	8(3.8)	30(14.1)	152(71.4)
How often do you follow an aseptic technique during surgical wound dressing	9(4.2)	11(5.2)	14(6.6)	35(16.4)	144(67.6)
How often do you use povidone-iodine and normal saline for cleaning surgical wound dressing	3(1.4)	12(5.6)	17(8.0)	38(17.8)	143(67.1)
How often do you assess and monitor surgical site conditions	6(2.8)	9(4.2)	12(5.6)	32(15.0)	154(72.3)
How often do you separate infected dressing from non-infected dressing	7(3.3)	8(3.8)	10(4.7)	36(16.9)	152(71.4)
How often do you perform cleaning and disinfect surface of the dressing trolley with anti-septic solutions	4(1.9)	12(5.6)	11(5.2)	25(11.7)	161(75.6)

Level of practice of healthcare professionals on the prevention of SSIs (N=213)

Conversely, the mean practice score of the participants was 102.43 out of 125 Likert-scaled items, with a standard deviation of 13.1. The lowest practice score observed was 63, and the highest score attained was 125.

The findings of this research showed that (57%) of healthcare professionals, exhibited a good practice in preventing SSIs, whereas (43%) of the participants, showed a poor practice in preventing SSIs (Figure2).

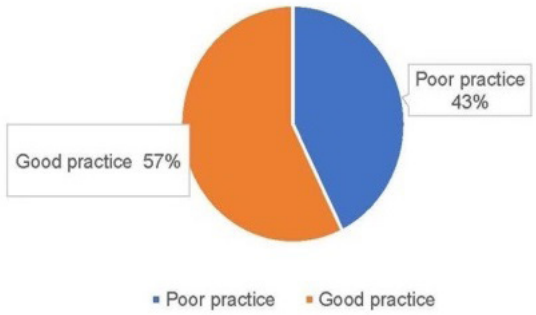

Figure 2. Level of practice among healthcare professionals on prevention of SSIs (N=213)

Factors associated with the knowledge and practice of health care professionals regarding the prevention of surgical site infections at tertiary hospitals in Rwanda

The bivariate analysis revealed that the knowledge of healthcare professionals regarding the prevention of SSIs at tertiary hospitals in Rwanda was found to be significantly associated with their profession and the presence of a SSIs prevention guideline in their workplace (Table4).

On the other hand, factors such as profession, work experience, the utilization of a SSIs prevention guideline at work, and receiving in-service training on infection prevention were identified as being associated with the practice of healthcare professionals in preventing SSIs (Table 4).

In this study, all variables with a bivariate logistic regression model P-value below 0.25 were considered for the multivariate analysis. The findings from the multivariate analysis indicated that nurses exhibited a 4.66 times higher odds of demonstrating good practice (AOR=4.66, 95% CI=1.23-17.77). Moreover, individuals who underwent infection prevention in-service training were approximately 3 times more likely to exhibit good practice compared to those who did not receive such training (AOR=2.99, 95% CI=1.29-6.92). Conversely, the likelihood of demonstrating good practice was lower among male participants (AOR=0.39, 95% CI=0.17-0.94) and individuals with 1–5 years of experience (AOR=0.21, 95% CI=0.078-0.607) (Table 4)

Table 4. Logistic regression analysis of factors associated with knowledge and Practice of healthcare professionals regarding the prevention of SSIs

a .Knowledge of respondents				
Variables	**COR (95%CI)**	**P-Value**	**AoR(95%CI)**	**P-Value**
Profession				
Nursing	1.423(0.726-2.788)	0.305	1.578(0.789-3.156)	0.197
Medicine	4.727(1.376-16.238)	0.014	3.570(0.785-16.232)	0.100
Anesthesia	0.739(0.279-1.954)	0.542	0.770(0.286-2.074)	0.605
Midwife	1		1	
There is a surgical site infection Prevention guideline in ward/setting				
Yes	0.488(0.245-0.973)	0.042	1.766(0.825-3.779)	0.598
No	1		1	
Ever took infection prevention in service training				
Yes	1.540(0.858-2.763)	0.148	1.196(0.615-2.326)	0.147
No	1		1	
b. Practice of respondents				
Variables	**COR(95%CI)**	**P-Value**	**AoR(95%CI)**	**P-Value**
Gender				
Male	0.631(0.347-1.148)	0.132	0.399(0.169-0.944)	**0.036**
Female	1		1	
Profession				
Nursing	1.423(0.726-2.788)	0.305	4.669(1.227-17.771)	**0.025**
Medicine	4.727(1.376-16.238)	0.014	3.443(0.510-23.266)	0.205
Anesthesia	0.739(0.279-1.954)	0.542	0.425(0.075-2.391).	0.331
Midwife	1		1	
Years of working experience				
1-5years	.349(0.156-0.781)	0.010	0.217(0.078-0.607)	0.004
6-10years	0.896(0.442-1.819)	0.761	1.136(0.498-2.591)	0.076
>10years	1		1	
There is a surgical site infection prevention guideline in word/setting				
Yes	2.133(1.046-4.349)	0.037	1.415(0.577-3.467)	0.448
No	1		1	
Ever took Infection prevention in service training				
Yes	2.544(1.366-4.737)	0.003	2.998(1.299-6.918)	**0.010**
No	1		1	

COR: Crude Odd Ratio AOR: Adjusted Odd Ratio

Discussion

The prevention of SSIs remains a significant challenge in ensuring optimal care for surgical patients. Despite the availability of advanced surgical techniques and sterilization methods aimed at reducing SSIs, these infections continue to pose a major obstacle in healthcare settings. SSIs not only lead to prolonged hospital stays, increased morbidity and mortality rates, and higher healthcare costs but they also have detrimental impact on the overall quality of life for patients. The literature primarily emphasizes the crucial role of nurses in preventing SSIs compared to physicians, anaesthetists, and anaesthesiologists, highlighting their active involvement in infection control measures and minimizing risk of SSIs among surgical patients. It is evident that all healthcare professionals involved in the care of surgical patients share the responsibility of ensuring patient safety and delivering high-quality care to prevent SSIs. Healthcare professionals must possess knowledge and infection prevention best practices to prevent SSIs. Collaborative efforts from multidisciplinary teams, including nurses, physicians, anaesthetists, and anaesthesiologists, are crucial for promoting patient safety in surgical care settings.

The findings of this study revealed that knowledge and practice among healthcare professionals regarding the prevention of SSIs was good. A study in Ethiopia's Wogdie district found that 70.8% and 55% of healthcare providers had adequate knowledge and practice about infection prevention respectively, corroborating these findings.[38] Likewise, The results of a research conducted in Greece, indicating that healthcare professionals achieved an average knowledge score of 59.4% are in consonance with the findings of this present study.[39] A study conducted in Uganda which found that 76.7% and 81.6% of healthcare professionals demonstrated good knowledge and practice respectively in preventing SSIs, is also in accord with this study.[40]

The study at Debre Markos Referral Hospital in Northwest Ethiopia found that 57.3% of individuals showed good implementation of infection prevention measures and 84.7% of healthcare professionals were knowledgeable about infection prevention measures.[41] The findings of this study contradict the findings of a systematic review, which indicated that healthcare professionals' knowledge of SSIs prevention was poor.[16] In contrast to the present study's findings, a study conducted in India revealed that the majority of healthcare workers had low level of knowledge, among these professionals, 68.7% of consultants indicated high practice, followed by nurses with 64.5%.[17] The results of this study are supported by those of a study done in Ethiopia, which showed that a sizable portion of participants (46.3%) in the healthcare institutions under investigation had insufficient knowledge regarding infection prevention and control.[42] This study contradicts the results of another study conducted in Ethiopian revealing a 40.7% knowledge gap in SSIs prevention. [26] The study's findings contrast with a previous study in China, which revealed that 43.5% of participants exhibited a low level of knowledge.[19] This study involved healthcare professionals including nurses, midwives, physicians, anaesthetists, and anaesthesiologists from the surgical team, who significantly contribute to preventing SSIs in surgical patients during preoperative, intraoperative, and postoperative periods.

This study found that in-service training on SSIs prevention is a key factor in enhancing knowledge and practice in this area. Another study carried out in Ethiopia provided evidence to support the results of this study. [38] The category of healthcare professionals is another factor linked to knowledge and practice; nurses were more likely to have good practices. Nurses, regardless of their academic level, make up the majority of healthcare professionals. They are actively involved in in-service training, exhibit good compliance, and dedicate a significant amount of time to patient care.

Limitation

The healthcare professionals' samples were collected from two referral hospitals in Rwanda due to constraints in time and funds. Likewise, it is important to note that the knowledge and practice of healthcare professionals from both public and private sectors were not compared in this study. Therefore, it is not appropriate to generalize the findings of this research to represent the overall circumstances across the entire country. It is worth mentioning that the study's cross-sectional design limits its ability to establish a cause and effect relationship.

Conclusion

The healthcare professionals had good knowledge and practice in SSIs prevention. However, the results of the study indicated that a significant number of healthcare professionals did not undergo effective on-the-job training in SSIs prevention, highlighting the necessity for continuous training in this area. Additionally, the SSIs prevention guidelines should be adapted and made available in both maternity and surgical units within the two study settings to aid healthcare professionals as surgical team in implementing SSIs preventive measures. Moreover, further observational studies are recommended to assess the practices of healthcare professionals concerning the prevention of SSIs.

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Availability of datasets and materials

The datasets of analyzed data can be obtained from the corresponding author when requested.

Author contribution

Each author (AN, MM, GC, and CA) made a contribution to the design, data analysis, study proposal preparation, and paper writing.

Conflict for interest

The authors attest that they have no competing interests in relation to this research.

References

1. Allegranzi B, Bischoff P, Jonge S De, Kubilay NZ, Zayed B, Gomes SM, et al. Surgical site infections 1 New WHO recommendations on preoperative measures for surgical site infection prevention : an evidence-based. *Lancet Infect Dis*. 2016;16:e276–87. http://dx.doi.org/10.1016/S1473-3099(16)30398-X
2. Rickard J, Beilman G, Forrester J, Sawyer R, Stephen A, Weiser TG, et al. Surgical Infections in Low- And Middle-Income Countries: A Global Assessment of the Burden and Management Needs. *Surg Infect (Larchmt)*. 2020;21:478–94. doi: 10.1089/sur.2019.142.
3. Waltz PK, Zuckerbraun BS. Surgical site infections and associated operative characteristics. *Surg Infect (Larchmt*). 2017;18:447–50. doi: 10.1089/sur.2017.062.
4. Ansari S, Hassan M, Barry HD, Bhatti TA, Hussain SZM, Jabeen S, et al. Risk Factors Associated with Surgical Site Infections: A Retrospective Report from a Developing Country. *Cureus*. 2019;11. doi: 10.7759/cureus.4801.
5. Costabella F, Patel KB, Adepoju A V, Singh P, Attia Hussein Mahmoud H, Zafar A, et al. Healthcare Cost and Outcomes Associated With Surgical Site Infection and Patient Outcomes in Low- and Middle-Income Countries. *Cureus*. 2023;15. doi: 10.7759/cureus.42493.

6. Id MM, Id SJ, Id TP, Brocklehurst P, Morton G, Abdali Z, et al. Surgical site infection and costs in low- and middle-income countries : A systematic review of the economic burden. *Plos One.* 2020;1–21.http://dx.doi.org/10.1371/journal.pone.0232960
7. Badia JM, Casey AL, Petrosillo N, Hudson PM, Mitchell SA, Crosby C. Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. *J Hosp Infect.* 2017;96:1–15. http://dx.doi.org/10.1016/j.jhin.2017.03.004
8. Nayan A, Sarang B, Khajanchi M, Roy N, Jesudian G, Menon N, et al. Exploring the perioperative infection control practices & incidence of surgical site infections in rural India. *Antimicrob Resist Infect Control.* 2023;12:1–8. https://doi.org/10.1186/s13756-023-01258-4.
9. Mukagendaneza MJ, Munyaneza E, Muhawenayo E, Nyirasebura D, Abahuje E, Nyirigira J, et al. Incidence, root causes, and outcomes of surgical site infections in a tertiary care hospital in Rwanda: A prospective observational cohort study. *Patient Saf Surg.* 2019;13:4–11. doi: 10.1186/s13037-019-0190-8.
10. European Center for Disease Prevention and Control. Healthcare-associated infections: surgical site infections. Annual epidemiological report for 2017. *ECDC website.* 2019; https://www.ecdc.europa.eu/sites/default/files/documents/AER_for_2017-SSI.pdf
11. World Health Organization, Allegranzi B, Kilpatrick C, Edmonson L, Berry WR, Weiser T, et al. Preventing Surgical Site Infections: Implementation Approaches for Evidence-Based Recommendations. *who website.* 2018. https://iris.who.int/bitstream/handle/10665/273154/9789241514385-eng.pdf?sequence=1
12. Leaper DJ, Edmiston CE. World Health Organization: global guidelines for the prevention of surgical site infection. *J Hosp Infect.* 2017;95:135–6. https://doi.org/10.1016/j.jhin.2016.12.016.
13. Bizimana JK, Ndoli J, Bayingana C, Baluhe I, Gilson GJ, Habimana E. Prevalence and Risk Factors for Post Cesarean Delivery Surgical Site Infection in a Teaching Hospital Setting in Rural Rwanda : A Prospective Cross Sectional Study. *IJCMAS.* 2016;5:631–41. http://dx.doi.org/10.20546/ijcmas.2016.506.069.
14. Nkurunziza T, Kateera F, Sonderman K, Gruendl M, Nihiwacu E, Ramadhan B, et al. Prevalence and predictors of surgical-site infection after caesarean section at a rural district hospital in Rwanda. *bjs.* 2019;121–8. doi: 10.1002/bjs.11060.
15. Mukamuhirwa D, Lilian O, Baziga V, Ingabire C, Ntakirutimana C, Mukantwari J, et al. Prevalence of Surgical site Infection among Adult Patients at a Rural District Hospital in Southern Province, Rwanda. *Rwanda J Med Heal Sci.* 2022;5:34–45. https://doi.org/10.4314/rjmhs.v5i1.5.
16. Horgan S, Saab MM, Drennan J, Keane D, Hegarty J. Healthcare professionals' knowledge and attitudes of surgical site infection and surveillance: A narrative systematic review. *Nurse Educ Pract.* 2023;69. doi: 10.1016/j.nepr.2023.103637.
17. Patil VB, Raval RM, Chavan G. Knowledge and practices of health care professionals to prevent surgical site infection in a tertiary health care centre. *International Surgery Journal.*2018;5:2248–51. http://dx.doi.org/10.18203/2349-2902.isj20182231.
18. Albishi, W., Albeshri, M. A., Mortada, H. H., Alzahrani, K., Alharbi, R., Aljuhani, F., & Aldaqal, S. Awareness and Level of Knowledge About Surgical Site Infections and Risks of Wound Infection Among Medical Physicians in King Abdulaziz University Hospital: Cross-Sectional Study. *Interactive Journal of Medical Research.*2019. 8(1), e12769. https://doi.org/10.2196/12769
19. Feng, W., Sae-Sia, W., & Kitrungrote, L.Knowledge, attitude, and practice of surgical site infection prevention among operating room nurses in southwest China. *Belitung Nursing Journal.* 2022. 8(2), 124–131. https://doi.org/10.33546/bnj.2018
20. Feng W, Sae-Sia W, Kitrungrote L. Knowledge, attitude, and practice of surgical site infection prevention among operating room nurses in southwest China. *Belitung Nurs J.* 2022;8:124–31. https://doi.org/10.33546/bnj.2018.

21. Horgan S, Drennan J, Andrews E, Saab MM, Hegarty J. Healthcare professionals' knowledge and attitudes towards surgical site infection and surveillance: A quasi-experimental study. *Nurs Open*. 2024;11:1–13. doi: 10.1002/nop2.2048.
22. Teshager FA, Engeda EH, Worku WZ. Knowledge, Practice, and Associated Factors towards Prevention of Surgical Site Infection among Nurses Working in Amhara Regional State Referral Hospitals, Northwest Ethiopia. *Surg Res Pract.* 2015;2015:1–6. doi: 10.1155/2015/736175.
23. Vivian Enow Ayamba E, Agnes Namondo L, Sintieh Nchinda Ngek E, Ngala E. Nurses' Knowledge and Practices on Surgical Site Infections in Sub-Saharan Africa: The Case of Buea Regional Hospital, South West Region in Cameroon. *Am J Humanit Soc Sci Res* . 2022;105–11.
24. Tesfaye T, Dheresa M, Worku T. Surgical site infection prevention practice and associated factors among nurses working at public hospitals of the western part of southern nation, nationalities, and peoples' region, Ethiopia: A cross-sectional study. *Front Surg.* 2022;1–10. doi: 10.3389/fsurg.2022.1013726.
25. Mengesha A, Tewfik N, Argaw Z, Beletew B, Wudu M. Practice of and associated factors regarding prevention of surgical site infection among nurses working in the surgical units of public hospitals in Addis Ababa city, Ethiopia: A cross-sectional study. *PLoS One* . 2020;15:1–12. http://dx.doi.org/10.1371/journal.pone.0231270
26. Sickder HK, Lertwathanawilat W, Sethabouppha H, Viseskul N. Nurses' Surgical Site Infection Prevention Practices in Bangladesh. *PRIJNR* . 2017 Jul. 10 [cited 2024 Mar. 27];21(3):244-57. https://he02.tci-thaijo.org/index.php/PRIJNR/article/view/74701
27. Teshager FA, Engeda EH, Worku WZ. Knowledge, Practice, and Associated Factors towards Prevention of Surgical Site Infection among Nurses Working in Amhara Regional State Referral Hospitals, Northwest Ethiopia. *Surg Res Pract.* 2015;2015:1–6. doi: 10.1155/2015/736175.
28. Albishi W, Albeshri MA, Mortada HH, Alzahrani K, Alharbi R, Aljuhani F, et al. Awareness and Level of Knowledge About Surgical Site Infections and Risks of Wound Infection Among Medical Physicians in King Abdulaziz University Hospital: Cross-Sectional Study. *Interact J Med Res.* 2019;8:e12769. doi: 10.2196/12769.
29. Saleem J, Saleem S, Ikram S, Inam S, Siddiqui A,, Ain QU. Self-esteem and Social Intelligence in Visually Impaired Adolescents. *Pakistan J Med Heal Sci.* 2023;17:5–7. https://doi.org/10.53350/pjmhs20231715.
30. Jaleta P, Adimasu M, Amentie M. Nurses Knowledge, Practice, and Associated Factors Toward Prevention of Surgical Site Infection in Benishangul Gumuz Hospitals Northwest Ethiopia 2021. *Am J Lab Med* . 2021;6:58–65.
31. Uakarn C. Sample size estimation using Yamane and Cochran and Krejcie and Morgan and Green formulas and Cohen statistical power analysis by G*power and comparisons. *Apheit Int J.* 2021;10:76–88.
32. Mengesha, Ayelign; Tewfik, Nete; Argaw, Zeleke; Beletew, Biruk; Wudu, Mesfin; Seale, Holly . Practice of and associated factors regarding prevention of surgical site infection among nurses working in the surgical units of public hospitals in Addis Ababa city, Ethiopia: A cross-sectional study. *PLOS ONE*. 2020. 15(4), e0231270–. doi:10.1371/journal.pone.0231270
33. Ndayisaba A, Uwizeyimana A, Tuyisenge MJ, Chironda G. Knowledge and practices of mothers on home management of diarrhoea in under-fives children at selected primary health care Centre, Rwanda: A descriptive cross-sectional study. *Int J Africa Nurs Sci.* 2022;17:100508. https://doi.org/10.1016/j.ijans.2022.100508

34. Al MM et. Effects of hospital service quality on patients satisfaction and behavioural intention of doctors and nurses. *Saudi J Med Pharm Sci.* 2017
35. Hazzi OA, Maaldaon IS. A pilot study: Vital methodological issues. *Vilnius Tech Journal.* 2015;16:53–62. https://doi.org/10.3846/btp.2015.437
36. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ.* 2011;2:53–5.
37. Taber KS. The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Res Sci Educ.* 2018;48:1273–96. doi 10.1007/s11165-016-9602-2.
38. Marie J, Borges Q, Augusto F, Marson L. Prevalence and risk predictors of onychomycosis in patients on hemodialysis : an observation , prospective , and unicenter study in Brazil. *Front. Med* .2023;1–13. https://doi.org/10.3389/fmed.2023.1268324.
39. Assefa J, Diress G, Adane S. Infection prevention knowledge, practice, and its associated factors among healthcare providers in primary healthcare unit of Wogdie District, Northeast Ethiopia, 2019: A cross-sectional study. *Antimicrob Resist Infect Control.* 2020;9:1–9. https://doi.org/10.1186/s13756-020-00802-w.
40. Galanisn, Petros, Kokkoliou, Katerina, Vraka, Irene, et al. Healthcare professionals' knowledge and practices towards hospital infections in surgical clinics .*medrxiv.* 2021;1–18. https://doi.org/10.1101/2021.11.05.21265982.
41. Amito P, Okello TR. Knowledge, Practice of Health Workers and Surgical Site Infections at Lira Regional Referral Hospital (LRRH) And Lira University Teaching Hospital (LUTH). *Int J Sci Acad Res .* 2022;03:3836–40.
42. Desta M, Ayenew T, Sitotaw N, Tegegne N, Dires M, Getie M. Knowledge, practice and associated factors of infection prevention among healthcare workers in Debre Markos referral hospital, Northwest Ethiopia. *BMC Health Serv Res.* 2018;18:1–10. doi: 10.1186/s12913-018-3277-5.
43. Geberemariyam BS, Donka GM, Wordofa B. Assessment of knowledge and practices of healthcare workers towards infection prevention and associated factors in healthcare facilities of West Arsi District, Southeast Ethiopia: A facility-based cross-sectional study. *Arch Public Heal.* 2018;76:1–11. doi: 10.1186/s13690-018-0314-0.