European Journal of Clinical and Biomedical Sciences
2026, Vol. 12, No. 4, pp. 67–76
https://doi.org/10.11648/j.ejcbs.20261204.12

Research Article

Pre-Operative Surgical Asepsis and Associated Factors in Operating Theatres at a Tertiary Hospital in Southwestern Uganda: A Cross-Sectional Study

Edwin Onsongo Ondicho[1], Yakobo Nsubuga[2], Joel Bazira[3], Daniel Kisitu Kyengera[1, *]

[1]Department of Surgery, Mbarara University of Science and Technology, Mbarara, Uganda
[2]Department of Orthopedics Surgery, Mulago National Referral Hospital, Kampala, Uganda
[3]Department of Microbiology, Mbarara University of Science and Technology, Mbarara, Uganda

Abstract

Background: Pre-operative surgical asepsis is essential for preventing surgical site infections (SSI), yet evidence on pre-operative contamination and associated factors in Ugandan operating theatres remains limited. This study assessed the proportion of pre-operative surgical asepsis, the microorganisms involved in contamination, and factors associated with pre-operative contamination at Mbarara Regional Referral Hospital (MRRH), Uganda. Methodology: A hospital-based cross-sectional study was conducted between June and September 2022 among 71 surgical procedures. Four microbiological swabs were collected from each procedure before skin incision, including the patient's surgical site, surgeon glove-gown interface, assistant surgeon glove-gown interface, and Cheatle forceps. Pre-operative surgical asepsis was defined as the absence of pathogenic bacterial growth in all four specimens. Descriptive statistics summarized contamination patterns, while Fisher's exact test assessed factors associated with pre-operative asepsis. Results: Overall pre-operative surgical asepsis was 77.5% (95% CI 66.0–85.9). Staphylococcus aureus was the predominant isolate (16.9%), followed by Klebsiella pneumoniae (7.0%). Cheatle forceps had the highest contamination rate (15.5%), while no contamination occurred at the prepared surgical site. In multivariable analysis, surgeon scrubbing for less than one minute (AOR 6.37, 95% CI 1.03–39.47; p = 0.047) and assistant surgeon open gloving (AOR 9.18, 95% CI 2.25–37.34; p = 0.002) were independently associated with pre-operative contamination. Conclusion: Approximately one in five surgical procedures demonstrated pre-operative contamination, predominantly involving the Cheatle forceps and glove gown interfaces. Staphylococcus aureus was the predominant isolate. Surgeon scrubbing for less than one minute and assistant surgeon open gloving were independently associated with pre-operative contamination. Strengthening adherence to the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) recommended surgical hand preparation duration, closed-gloving techniques, appropriate handling of sterile equipment, and routine microbiological surveillance may improve pre-operative surgical asepsis in resource limited operating theatres.

Keywords

Pre-operative Surgical Asepsis, Surgical Site Infection, Operating Theatre, Bacterial Contamination

*Correspondence: Daniel Kisitu Kyengera (kisitukd@yahoo.com)

Received: 17 September 2026; **Accepted:** 20 October 2026; **Published:** 6 November 2026

Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

1. Background

Pre-operative surgical asepsis (POSA) is the absence of pathogenic microorganisms before an invasive surgical procedure and is a fundamental strategy for preventing surgical site infections (SSIs) [1]. SSIs remain a major cause of postoperative morbidity and healthcare costs, arising from patient-, procedure-, and health system-related factors [2]. Consequently, international guidelines emphasize adherence to standardized pre-operative aseptic practices, including instrument sterilization, surgical hand preparation, sterile gowning and gloving, and surgical site antisepsis [3, 4].

Proper sterilization of surgical instruments requires standardized cleaning, packaging, autoclaving, storage, and routine quality assurance using biological and chemical indicators [5]. Similarly, surgical hand preparation aims to eliminate transient microorganisms and reduce resident skin flora, thereby minimizing microbial transfer during surgery [6-8]. Recommended surgical hand-preparation practices emphasize adequate duration and technique, but compliance remains inconsistent in many low-resource settings [8, 39].

Appropriate surgical site preparation is equally important because most pathogens causing SSIs originate from the patient's endogenous skin flora [9]. Current WHO guidelines recommend alcohol-based chlorhexidine solutions because of their rapid and sustained antimicrobial activity, although iodine-based preparations remain in use depending on surgical indication, availability, and cost [10, 11]. In addition, contamination during gowning and gloving has been associated with glove-donning technique, with closed gloving consistently demonstrating lower contamination than open gloving [13, 14].

Despite established infection prevention guidelines, important gaps remain in many resource-limited hospitals. And although Uganda continues to report a relatively high burden of SSIs, few studies have investigated the extent of microbial contamination occurring before skin incision or evaluated factors associated with inadequate pre-operative surgical asepsis. Previous Ugandan studies have primarily focused on postoperative SSI prevalence and antimicrobial susceptibility patterns rather than contamination occurring within the operating theatre itself [15, 16].

Mbarara Regional Referral Hospital is a major teaching and referral hospital serving southwestern Uganda. The sterility related concerns at the hospital include lack of modern technologies in monitoring the sterilization and storage processes of re-usable equipment such as such as Cheatle forceps which once opened can used for a repeated number of surgical procedures before re-sterilizing it, variable surgical hand preparation practices and surgical site antiseptics, use of non-water proof gowns and patients' drapes. Thus understanding the magnitude and determinants of pre-operative contamination is essential for strengthening infection prevention and control programs, improving compliance with evidence-based aseptic practices, and ultimately reducing SSI incidence.

Therefore, this study aimed to determine the proportion of adequate pre-operative surgical asepsis, identify bacterial contaminants isolated before skin incision, and determine factors associated with pre-operative contamination among surgical procedures performed at Mbarara Regional Referral Hospital.

2. Methods

2.1. Study Design and Setting

A hospital-based descriptive cross-sectional study was conducted between June and September 2022 in the operating theatre complex of Mbarara Regional Referral Hospital (MRRH), a regional referral and teaching hospital serving southwestern Uganda. The theatre complex comprises five operating rooms providing elective and emergency surgical services across multiple surgical specialties.

2.2. Study Population

The study included adult patients undergoing clean elective or emergency surgical procedures together with their operating surgeons, assistant surgeons, and the Cheatle forceps used during each procedure. Procedures involving contaminated wounds, highly contaminated anatomical sites, or compromised sterile gowns were excluded.

2.3. Sample Size and Sampling

A minimum sample size of 71 surgical procedures was calculated using Daniel's finite population formula with a presumed prevalence of 50%, a 95% confidence level, and a 5% margin of error. Eligible procedures were consecutively enrolled until the required sample size was attained. Four microbiological swabs were collected from each procedure, giving a total of 284 specimens.

2.4. Data Collection

Data were collected using a structured interviewer-administered questionnaire, direct observation of pre-operative aseptic practices, and microbiological specimen collection. A pretested modified Royal College of Surgeons (2014) Good Surgical Practice checklist was used [41] to assess adherence to standard aseptic procedures. The scrubbing duration for both the surgeons and assistant surgeons was recorded on a digital clock by a member of the research unknown to the participants through unobtrusive observation. Immediately before skin incision, a dry swab was aseptically taken from the prepared surgical site, surgeon glove-gown interface, assistant surgeon glove-gown interface, and a pre-moistened swab from the tip of the shaft of the Cheatle forcep used in the procedure. Specimens were transported in a leak-proof biohazard specimen bag within 15 minutes to the microbiology laboratory for

culture and organism identification.

2.5. Study Variables

The primary outcome was pre-operative surgical asepsis, defined as the absence of pathogenic bacterial growth in all four microbiological specimens collected before skin incision. Independent variables included patient characteristics, healthcare provider factors (including hand preparation, gowning and gloving practices), and theatre-related factors.

2.6. Laboratory Procedures

Swab was emulsified in 1ml of sterile saline, which was then introduced into a sterile petri-dish with addition of agar. Once solidified it was incubated at 35–37 ℃ for up to 48 hours. The colonies that appeared were counted and reported as colony forming units per ml then sub-cultured onto blood and MacConkey agar and incubated at 35–37 ℃ for up to 48 hours. A Gram stain procedure was then performed on each colony followed by a catalase test, coagulase test, Dnase test and mannitol fermentation test on Gram positive cocci prior to confirming *Staphylococcus aureus*. A citrate test, Indole test, Hydrogen sulfide test, motility test and triple sugar iron tests were performed on gram negative bacilli prior to confirmation of *Klebsiella* species. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines [40].

2.7. Data Analysis

Data were entered, cleaned, and analyzed using STATA version 18.0 (StataCorp, College Station, TX, USA). Categorical variables were summarized using frequencies and percentages, while continuous variables were summarized using means with standard deviations or medians with interquartile ranges, as appropriate. Associations between explanatory variables and pre-operative contamination were initially assessed using bivariable logistic regression. Variables with a bivariable p value <0.20 and those considered clinically relevant were entered into a multivariable logistic regression model. Crude odds ratios (CORs) and adjusted odds ratios (AORs) with 95% confidence intervals were reported. Statistical significance was set at $p < 0.05$.

2.8. Data Quality Assurance

Standardized data collection tools, trained research assistants, daily data checks, and standardized laboratory procedures were used to ensure data quality throughout the study.

2.9. Ethical Clearance

We received clearance from the Mbarara University of Science and Technology Research Ethics Committee (MUST-REC IRB) under Approval No. MUST-2022-399 and administrative clearance from the Mbarara Regional Referral Hospital. Written informed consent was obtained from all participants before enrolment, and the study was conducted in accordance with the Declaration of Helsinki as well as the Uganda National Council for Science and Technology (UNCST) guidelines for research involving human participants. The datasets generated and analysed during this study, together with the corresponding STATA do-files, are available from the corresponding author upon reasonable request.

3. Results

3.1. Characteristics of the Study Participants

A total of 71 participants were enrolled in the study, with a mean age of 44.0 ± 19.4 years. Most participants were male (69.0%) and aged ≥50 years (45.1%). The commonest occupation was peasant farming (42.2%). Approximately one third of participants had been ill for less than one week (33.8%) or for more than four weeks (32.4%). Most participants (87.3%) had a pre-operative hospital stay of less than one week and 16.9% underwent pre-operative surgical site shaving.

Table 1. *Characteristics of the study participants.*

Characteristic	n (%)
Age group (years)	
18–29	23 (32.4)
30–49	16 (22.5)
≥50	32 (45.1)
Sex	
Male	49 (69.0)
Female	22 (31.0)
Occupation	
Peasant	30 (42.2)
Unemployed	18 (25.4)
Manual worker	9 (12.7)
Formal employment	8 (11.2)
Business	6 (8.5)
Duration of illness	
<1 week	24 (33.8)
1–2 weeks	13 (18.3)
2–4 weeks	11 (15.5)
>4 weeks	23 (32.4)
Pre-operative hospital stay	

Characteristic	n (%)
<1 week	62 (87.3)
≥1 week	9 (12.7)
Pre-operative surgical-site shaving	
Yes	12 (16.9)
No	59 (83.1)

3.2. Surgical Procedure Characteristics

Most procedures were emergency surgeries (74.7%). Abdominal procedures accounted for the largest proportion of operations (69.0%). Chlorhexidine (0.3% chlorhexidine gluconate, 0.6% cetrimide) was used for surgical-site preparation in 97.2% of procedures, while 5% iodine was used in 2.8%.

Table 2. *Surgical procedure characteristics (N=71).*

Characteristic	n (%)
Procedure indication	
Elective	18 (25.3)
Emergency	53 (74.7)
Surgical site	
Abdomen	49 (69.0)
Head	12 (17.0)
Lower limb	5 (7.0)
Chest	3 (4.2)
Upper limb	2 (2.8)
Skin antiseptic used	
Chlorhexidine (0.3% chlorhexidine gluconate, 0.6% cetrimide)	69 (97.2)
Iodine (5%)	2 (2.8)

3.3. Surgeon and Assistant Surgeon Characteristics

Approximately half of both the surgeons and assistant surgeons scrubbed for less than one minute (50.7% and 53.5%, respectively). Medicated soap was the most commonly used antiseptic for surgical hand preparation among surgeons (57.8%) and assistant surgeons (60.6%), while the closed gloving technique was the predominant method in both groups, although it was less frequently used by assistant surgeons (69.0%) than surgeons (84.5%).

Table 3. *Surgeon and assistant surgeon characteristics (N=71 in each group).*

Characteristic	Surgeons n (%)	Assistant surgeons n (%)
Scrubbing duration		
<1 minute	36 (50.7)	38 (53.5)
1–2 minutes	35 (49.3)	33 (46.5)
Hand antiseptic used		
Medicated soap	41 (57.8)	43 (60.6)
Non-medicated soap	24 (33.8)	25 (35.2)
Chlorhexidine (0.3% chlorhexidine gluconate, 0.6% cetrimide)	5 (7.0)	3 (4.2)
Alcohol (70%)	1 (1.4)	0 (0.0)
Scrubbing technique		
Mechanical scrub	70 (98.6)	71 (100.0)
Alcohol hand rub only	1 (1.4)	0 (0.0)
Gowning technique		
Unassisted gown-first	71 (100.0)	71 (100.0)
Gloving technique		
Open	11 (15.5)	22 (31.0)

Characteristic	Surgeons n (%)	Assistant surgeons n (%)
Closed	60 (84.5)	49 (69.0)

3.4. Pre-operative Asepsis by Sampled Site

Among the 71 surgical procedures, n=55 (77.5%; 95% CI: 66.0–85.9) achieved completely no detectable bacterial growth pre-operative, while n=16 (22.5%) demonstrated bacterial contamination out of which 11 resulted from a single source and 5 from two sources within the same procedure, hence 21 contaminated swabs. The prepared surgical site remained completely aseptic (100%), whereas contamination was highest on the Cheatle forceps (15.5%), followed by the assistant surgeon glove gown interface (8.5%) and surgeon glove gown interface (5.6%).

Table 4. *Pre-operative asepsis by sampled site. (N = 71).*

Sampled site	Total (N)	Aseptic n (%)	Contaminated n (%)
Patient surgical site	71	71 (100.0)	0 (0.0)
Surgeon glove–gown interface	71	67 (94.4)	4 (5.6)
Assistant surgeon glove–gown interface	71	65 (91.5)	6 (8.5)
Cheatle forceps	71	60 (84.5)	11 (15.5)
Overall	71	55 (77.5)	16 (22.5)

3.5. Bacterial Isolates and Distribution by Sampled Site

Among the 71 surgical procedures, bacterial contamination was identified in a total of 16 (22.5%) procedures. Staphylococcus aureus was the predominant contaminant (12/71, 16.9%), followed by Klebsiella pneumoniae (5/71, 7.0%). Most S. aureus isolates were recovered from the Cheatle forceps (12.7%), whereas K. pneumoniae was isolated mainly from the assistant surgeon glove–gown interface (5.6%). Multiple bacterial isolates were recovered from some contaminated procedures, 1 swab had a growth of both S. Areus and K pneumonia making the total number of isolates to exceed the number of contaminated procedures. No bacterial growth was detected from prepared surgical-site swabs.

Table 5. *Bacterial isolates and distribution by sampled site.*

Organism	Procedures contaminated n (%)	Patient	Surgeon	Assistant surgeon	Cheatle forceps
Staphylococcus aureus	12 (16.9)	0	3 (4.2)	3 (4.2)	9 (12.7)
Klebsiella pneumoniae	5 (7.0)	0	1 (1.4)	4 (5.6)	2 (2.8)

3.6. Antibiotic Susceptibility Profile of Bacterial Isolates

All Staphylococcus aureus and Klebsiella pneumoniae isolates were susceptible to ceftriaxone. Staphylococcus aureus demonstrated complete resistance to penicillin, while variable susceptibility was observed for azithromycin, chloramphenicol, tetracycline, and oxacillin. All K. pneumoniae isolates were susceptible to azithromycin, ciprofloxacin, clindamycin, and ceftriaxone, with reduced susceptibility to tetracycline and chloramphenicol.

Table 6. Antibiotic susceptibility profile of bacterial isolates.

Organism	Antibiotic	Sensitive n (%)	Resistant n (%)
Staphylococcus aureus (n=12)	Penicillin	0 (0.0)	12 (100.0)
	Azithromycin	9 (75.0)	3 (25.0)
	Ciprofloxacin	12 (100.0)	0 (0.0)
	Clindamycin	11 (91.7)	1 (8.3)
	Ceftriaxone	12 (100.0)	0 (0.0)
	Tetracycline	10 (83.3)	2 (16.7)
	Chloramphenicol	8 (66.7)	4 (33.3)
	Oxacillin	11 (91.7)	1 (8.3)
Klebsiella pneumoniae (n=5)	Azithromycin	5 (100.0)	0 (0.0)
	Ciprofloxacin	5 (100.0)	0 (0.0)
	Clindamycin	5 (100.0)	0 (0.0)
	Ceftriaxone	5 (100.0)	0 (0.0)
	Tetracycline	4 (80.0)	1 (20.0)
	Chloramphenicol	4 (80.0)	1 (20.0)

3.7. Factors Associated with Pre-operative Contamination

In bivariable analysis, surgeon scrubbing for less than one minute (COR 10.50, 95% CI 2.17–50.81; p = 0.003) and assistant surgeon open gloving (COR 13.50, 95% CI 3.60–50.68; p < 0.001) were associated with increased odds of pre-operative contamination. After adjustment, surgeon scrubbing for less than one minute remained associated with approximately six fold higher odds of contamination (AOR 6.37, 95% CI 1.03–39.47; p = 0.047), while assistant surgeon open gloving was associated with approximately ninefold higher odds (AOR 9.18, 95% CI 2.25–37.34; p = 0.002). Assistant surgeon scrubbing duration was not independently associated with contamination (AOR 0.98, 95% CI 0.21–4.57; p = 0.983).

Table 7. Logistic regression analysis of factors associated with pre-operative contamination.

Variable	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Surgeon scrub duration				
1–2 minutes	1.00	—	1.00	—
<1 minute	10.50 (2.17–50.81)	0.003	6.37 (1.03–39.47)	0.047
Assistant surgeon scrub duration				
1–2 minutes	1.00	—	1.00	—
<1 minute	2.28 (0.70–7.44)	0.171	0.98 (0.21–4.57)	0.983
Assistant surgeon gloving technique				
Closed gloving	1.00	—	1.00	—
Open gloving	13.50 (3.60–50.68)	<0.001	9.18 (2.25–37.34)	0.002

4. Discussion

The study shows a 77.5% rate of pre-operative surgical asepsis, indicating that nearly one in five surgical procedures had bacterial contamination before skin incision (22.5% contamination). This contamination rate is comparable to that reported in Palestine [19], but higher than findings from Baghdad [18] and lower than those reported in Bangladesh [17]. These differences are likely attributable to variations in microbiological sampling methods and operating theatre practices across study settings. The prepared surgical site remained free of bacterial contamination in the present study. This finding is consistent with evidence supporting effective preoperative skin antisepsis, particularly chlorhexidine-alcohol compared with povidone-iodine in clean-contaminated surgery [9, 20-23]. In contrast, contamination occurred mainly at the glove-gown interfaces and on Cheatle forceps, emphasizing the importance of theatre personnel practices and reusable sterile equipment as potential sources of pre-operative contamination [12, 13, 19, 24, 25]. And although there was an observed association between the antiseptic agent used by assistant surgeons and bacterial contamination, this should be interpreted cautiously. This finding just identifies a potential relationship within the study setting but does not demonstrate that one antiseptic agent is more effective than another. The observational design, sample size, and possible influence of other aseptic practices limit causal interpretation.

Only two organisms were isolated, Staphylococcus aureus and Klebsiella pneumoniae, with S. aureus predominating. This finding is consistent with reports of staphylococci as important operating-theatre contaminants [26], whereas Matinyi et al. reported Pseudomonas aeruginosa as the predominant organism in operating theatres in eastern Uganda [27]. The difference may reflect variation in sampling sites and inclusion of air and environmental samples. Recovery of K. pneumoniae from glove-gown interfaces may indicate transient contamination associated with inadequate hand preparation, while its previous identification among postoperative SSI pathogens at MRRH provides local microbiological context [14].

All isolates in the present study were susceptible to ceftriaxone. However, because only a small number of isolates were recovered, this finding should not by itself be interpreted as evidence that ceftriaxone should be used as the preferred prophylactic agent. Local studies have documented susceptibility of postoperative wound isolates to ceftriaxone while also demonstrating substantial antimicrobial resistance, supporting continued surveillance and antimicrobial stewardship [15, 28].

Assistant surgeon open gloving was the strongest independent predictor of pre-operative contamination, increasing the adjusted odds approximately ninefold compared with closed gloving. This association is biologically plausible because the glove-gown interface is recognized as a potential contamination pathway [12]. Experimental studies have also demonstrated differences in gown contamination according to glove-donning technique, including lower contamination with closed techniques and very low contamination with gloves-first approaches in specific experimental settings [13, 14]. The results therefore support strengthening closed gloving practice among assistant surgeons.

Greater contamination was initially observed among assistant surgeons using non-medicated soap, but this factor was not identified as an independent predictor in the final multivariable model. The finding should therefore be interpreted as an unadjusted observation rather than evidence of an independent effect. Nthumba et al. found no clinically significant difference in SSI between plain soap and water and alcohol-based handrub when appropriate preparation protocols were used [29]. Evidence also supports alcohol-based preparations as effective alternatives to conventional surgical hand scrubbing under appropriate conditions [30-34].

Surgeon scrubbing for less than one minute independently increased the odds of pre-operative contamination approximately sixfold. This observed higher frequency of contamination among participants may indicate a potential relationship between scrub duration and aseptic outcomes. This finding is consistent with experimental evidence showing that surgical hand-scrub duration influences subsequent bacterial counts [35, 36, 38], while systematic evidence indicates that surgical hand antisepsis practices and their duration can affect microbial burden and SSI prevention [37]. The absence of visible timing devices at the scrub stations may have contributed to poor adherence hence representing a simple, modifiable barrier to compliance with recommended surgical hand preparation. In contrast, assistant surgeon scrub duration was not independently associated with contamination after adjustment, suggesting that its crude relationship may have been explained by gloving technique or other correlated practices. The adjusted estimates had wide confidence intervals, particularly for surgeon scrubbing duration, reflecting the small number of contaminated procedures. The magnitude of these associations should therefore be interpreted cautiously and confirmed in larger multicentre studies because this study was not designed to establish an optimal scrub duration, and the limited representation of longer preparation times hence preventing meaningful comparisons of extended protocols. Therefore, the findings should not be interpreted as establishing a minimum effective or optimal duration.

Strengths and limitations

This study is among the few Ugandan studies to combine direct observation of operating theatre practices with microbiological confirmation of pre-operative contamination. Standardized laboratory procedures and validated data collection tools strengthened the reliability of the findings. However, the cross-sectional single-centre design limits causal inference and generalizability, and postoperative follow-up was not undertaken to determine subsequent surgical site infections. There might have been an Observer effects (Hawthorne effect)

which may have influenced participants' practices, and adherence to aseptic procedures leading to overestimation of routine adherence to aseptic procedures and an underestimation of contamination. This was minimized, by the switching of research assistants and the researchers making frequent visits to the operating theatre to familiarize participants with their presence. The detection of contamination depended on the culture-based methods used to collect and analyze the specimens which might have been affected by specimen collection, transport and processing, microbial load, culture media, and incubation conditions. And the study focused on bacterial contaminants, hence other microbes such as fungi, and viruses may have been missed thus underestimating the full range of microbial contamination. The study could not establish whether the organisms recovered from the different sampling sites shared a common source or it was transmitted between sites.

5. Conclusion and Recommendations

Pre-operative surgical asepsis was achieved in most procedures; however, approximately one in five demonstrated bacterial contaminations, predominantly involving Cheatle forceps and glove–gown interfaces. Staphylococcus aureus was the predominant isolate. Surgeon scrubbing for less than one minute and assistant surgeon open gloving were independently associated with contamination. Strengthening adherence to recommended surgical hand-preparation duration, closed gloving, appropriate sterile-equipment handling and routine microbiological surveillance may improve operating theatre asepsis. Larger prospective multicentre studies incorporating postoperative SSI surveillance are needed to confirm these findings.

Abbreviations

POSA	Pre-Operative Surgical Asepsis
SSIs	Surgical Site Infections
WHO	World Health Organization
CDC	Centers for Disease Control and Prevention
MRRH	Mbarara Regional Referral Hospital
CLSI	Clinical and Laboratory Standards Institute
MUST-REC	Mbarara University of Science and Technology Research Ethics Committee
UNCST	Uganda National council for Science and Technology

Acknowledgments

We express our sincere gratitude to the healthcare workers at Mbarara Regional Referral Hospital for their participation and cooperation during data collection. We also extend our appreciation to the Mbarara University of Science and Technology Research Ethics Committee for their guidance and ethical oversight throughout the study.

Author Contributions

Edwin Onsongo Ondicho: Conceptualization, Data curation, Writing – original draft

Yakobo Nsubuga: Formal Analysis, Writing – original draft, Writing – review & editing

Joel Bazira: Conceptualization, Resources, Supervision, Writing – review & editing

Daniel Kisitu Kyengera: Conceptualization, Data curation, Supervision, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Doyle GR, McCutcheon JA. Surgical asepsis and the principles of sterile technique. In: Clinical Procedures for Safer Patient Care. BCcampus 2015, https://opentextbc.ca/clinicalskills/chapter/surgical-asepsis/

[2] Bashaw MA, Keister KJ. Perioperative strategies for surgical site infection prevention. AORN J. 2019 109(1): 68-78. https://doi.org/10.1002/aorn.12536

[3] Gaines S, Luo JN, Gilbert J, Zaborina O, Alverdy JC. Optimum operating room environment for the prevention of surgical site infections. Surg Infect (Larchmt). 2017 18(4): 503-507. https://doi.org/10.1089/sur.2017.020

[4] Khan HA, Ahmad A, Mehboob R. Nosocomial infections and their control strategies. Asian Pac J Trop Biomed. 2015 5(7): 509-514. https://doi.org/10.1016/j.apjtb.2015.05.001

[5] Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee. *Guideline for disinfection and sterilization in healthcare facilities, 2008*. Updated May 2019. Centers for Disease Control and Prevention 2019, https://stacks.cdc.gov/view/cdc/134910

[6] Bhasme AS, Menezes RJ, D'souza T, Ipe J. Duration of surgical hand scrub in orthopaedic surgeries. Int J Orthop Sci. 2017 3(3): 34-36. https://doi.org/10.22271/ortho.2017.v3.i3a.08

[7] Parlak EA, Iyigun E, Albay A, Bedir O. Impact of methods and duration of surgical hand scrub on bacterial count: A randomized controlled trial. Am J Infect Control. 2021 49(11): 1376-1383. https://doi.org/10.1016/j.ajic.2021.05.006

[8] World Health Organization. (2009). WHO guidelines on hand hygiene in health care: First global patient safety challenge—Clean care is safer care. https://www.who.int/publications/i/item/9789241597906

[9] Darouiche RO, Wall MJ Jr, Itani KMF, Otterson MF, Webb AL, Carrick MM, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. N Engl J Med. 2010 362(1): 18-26. https://doi.org/10.1056/NEJMoa0810988

[10] Hemani ML, Lepor H. Skin preparation for the prevention of surgical site infection: which agent is best? Rev Urol. 2009 Fall 11(4): 190-195.

[11] World Health Organization. Global guidelines for the prevention of surgical site infection. Geneva: World Health Organization 2016: https://www.who.int/publications/b/31381

[12] Fraser JF, Young SW, Valentine KA, Probst NE, Spangehl MJ. The gown-glove interface is a source of contamination: a comparative study. Clin Orthop Relat Res. 2015 473(7): 2291-2297. https://doi.org/10.1007/s11999-014-4094-8

[13] Byrd WA, Kavolus JJ, Penrose CT, Wellman SS. Donning gloves before surgical gown eliminates sleeve contamination. J Arthroplasty. 2019 34(6): 1184-1188. https://doi.org/10.1016/j.arth.2019.01.015

[14] Newman JB, Bullock M, Goyal R. Comparison of glove donning techniques for the likelihood of gown contamination: an infection control study. Acta Orthop Belg. 2007 73(6): 765-771: https://www.actaorthopaedica.be/assets/1448/14-Newman_et_al.pdf

[15] Lubega A, Bazira J, Najjuka JL. Incidence and etiology of surgical site infections among emergency postoperative patients in Mbarara Regional Referral Hospital, South Western Uganda. Surg Res Pract. 2017 2017: 6365172. https://doi.org/10.1155/2017/6365172

[16] Ariho SB, Lule H, Agwu E, Shaban A. Abdominal surgical site infection incidence, risk factors, and antibiotic susceptibility at a university teaching hospital in western Uganda: a cross-sectional study. East Cent Afr J Surg. 2020 25(4): https://www.utupub.fi/items/4e38a020-2d95-44da-bb8b-95affc12eadc

[17] Rahman M, Shamsuzzaman AK, Sirajee A, Miah AG, Hossain MA. Pattern of bacteria and their antimicrobial susceptibility isolated from inanimate objects and hospital personnel. Mymensingh Med J. 2003 12(2): 104-107.

[18] Ensayef S, Al-Shalchi S, Sabbar M. Microbial contamination in the operating theatre: a study in a hospital in Baghdad. East Mediterr Health J. 2009 15(1): 219-223. https://doi.org/10.26719/2009.15.1.219

[19] Al Laham NA. Prevalence of bacterial contamination in general operating theatres in selected hospitals in the Gaza Strip, Palestine. J Infect Public Health. 2012 5(1): 43-51. https://doi.org/10.1016/j.jiph.2011.10.006

[20] Srinivas A, Kaman L, Raj P, Gautam V, Dahiya D, Singh G, et al. Comparison of the efficacy of chlorhexidine gluconate versus povidone-iodine as preoperative skin preparation for the prevention of surgical site infections in clean-contaminated upper abdominal surgeries. Surg Today. 2015 45(11): 1378-1384. https://doi.org/10.1007/s00595-014-1078-y

[21] Mastrocola M, Matziolis G, Böhle S, Lindemann C, Schlattmann P, Eijer H. Meta-analysis of the efficacy of preoperative skin preparation with alcoholic chlorhexidine compared to povidone iodine in orthopedic surgery. Sci Rep. 2021 11: 18634. https://doi.org/10.1038/s41598-021-97838-8

[22] Ayoub F, Quirke M, Conroy R, Hill ADK. Chlorhexidine-alcohol versus povidone-iodine for pre-operative skin preparation: a systematic review and meta-analysis. Int J Surg Open. 2015 1: 41-46. https://doi.org/10.1016/j.ijso.2016.02.002

[23] Privitera GP, Costa AL, Brusaferro S, Chirletti P, Crosasso P, Massimetti G, Nespoli A, Petrosillo N, Pittiruti M, Scoppettuolo G, Tumietto F, Viale P. Skin antisepsis with chlorhexidine versus iodine for the prevention of surgical site infection: a systematic review and meta-analysis. Am J Infect Control. 2017 45(2): 180-189. https://doi.org/10.1016/j.ajic.2016.09.017

[24] Agarwal P, Singh M, Sharma D. Bacteriological evaluation of antiseptic solutions used to keep Cheattle's forceps. Indian J Surg. 2015 77(Suppl 3): 1027-1031. https://doi.org/10.1007/s12262-014-1116-4

[25] Chongloi N, Srivastava A. Effectiveness of individually packed sterile gauze versus drum packed gauze on the incidence of surgical site infection (SSI) in surgical ward AIIMS, New Delhi. Int J Nurs Educ. 2017 9(3): 55-57. https://doi.org/10.5958/0974-9357.2017.00071

[26] Genet C, Kibru G, Tsegaye W. Indoor air bacterial load and antibiotic susceptibility pattern of isolates in operating rooms and surgical wards at Jimma University Specialized Hospital, Southwest Ethiopia. Ethiop J Health Sci. 2011 21(1): 9-18. https://doi.org/10.4314/ejhs.v21i1.69039

[27] Matinyi S, Enoch M, Akia D, Byaruhanga V, Masereka E, Ekeu I, et al. Contamination of microbial pathogens and their antimicrobial pattern in operating theatres of peri-urban eastern Uganda: a cross-sectional study. BMC Infect Dis. 2018 18: 460. https://doi.org/10.1186/s12879-018-3374-4

[28] Anguzu JR, Olila D. Drug sensitivity patterns of bacterial isolates from septic post-operative wounds in a regional referral hospital in Uganda. Afr Health Sci. 2007 7(3): 148-154. https://doi.org/10.5555/afhs.2007.7.3.148

[29] Nthumba PM, Stepita-Poenaru E, Poenaru D, Bird P, Allegranzi B, Pittet D, et al. Cluster-randomized, crossover trial of the efficacy of plain soap and water versus alcohol-based rub for surgical hand preparation in a rural hospital in Kenya. Br J Surg. 2010 97(11): 1621-1628. https://doi.org/10.1002/bjs.7213

[30] Tavolacci MP, Pitrou I, Merle V, Haghighat S, Thillard D, Czernichow P. Surgical hand rubbing compared with surgical hand scrubbing: comparison of efficacy and costs. J Hosp Infect. 2006 63(1): 55-59. https://doi.org/10.1016/j.jhin.2005.11.012

[31] Parienti JJ, Thibon P, Heller R, Le Roux Y, von Theobald P, Bensadoun H, et al. Hand-rubbing with an aqueous alcoholic solution vs traditional surgical hand-scrubbing and 30-day surgical site infection rates: a randomized equivalence study. JAMA. 2002 288(6): 722-727. https://doi.org/10.1001/jama.288.6.722

[32] Chen CF, Han CL, Kan CP, Hung SW. Effect of surgical site infections with waterless and traditional hand scrubbing protocols on bacterial growth. Am J Infect Control. 2012 40(2): e5-e9. https://doi.org/10.1016/j.ajic.2011.09.008

[33] Ghorbani A, Shahrokhi A, Soltani Z, Molapour A, Shafikhani M. Comparison of surgical hand scrub and alcohol surgical hand rub on reducing hand microbial burden. J Perioper Pract. 2012 22(2): 67-70. https://doi.org/10.1177/175045891202200205

[34] Shen NJ, Pan SC, Sheng WH, Tien KL, Chen ML, Chang SC, et al. Comparative antimicrobial efficacy of alcohol-based hand rub and conventional surgical scrub in a medical center. J Microbiol Immunol Infect. 2015 48(3): 322-328. https://doi.org/10.1016/j.jmii.2013.08.005

[35] Wheelock SM, Lookinland S. Effect of surgical hand scrub time on subsequent bacterial growth. AORN J. 1997 65(6): 1087-1098. https://doi.org/10.1016/S0001-2092(06)62949-9

[36] Jones D. A 2 minute surgical hand scrub was associated with higher, but not clinically significant, bacteria counts compared with a 3 minute hand scrub. Evid Based Nurs. 1998 1(2): 47. https://doi.org/10.1136/ebn.1.2.47

[37] Tanner J, Dumville JC, Norman G, Fortnam M. Surgical hand antisepsis to reduce surgical site infection. Cochrane Database Syst Rev. 2016 (1): CD004288. https://doi.org/10.1002/14651858.CD004288.pub3

[38] Aksoy A, Caglayan F, Cakmak M, Apan T, Gocmen J, Cakmak A, et al. An investigation of the factors that affect surgical hand disinfection with povidone-iodine. J Hosp Infect. 2005 61(1): 15-19. https://doi.org/10.1016/j.jhin.2004.11.021

[39] Ellingson K, Haas JP, Aiello AE, Kusek L, Maragakis LL, Olmsted RN, et al. Strategies to prevent healthcare-associated infections through hand hygiene. Infect Control Hosp Epidemiol. 2014 35(8): 937-960. https://doi.org/10.1086/677145

[40] Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. 32nd ed. Malvern (PA): Clinical and Laboratory Standards Institute 2022. CLSI supplement M100. Availa: https://clsi.org/about/press-releases/clsi-publishes-m100-performance-standards-for-antimicrobial-susceptibility-testing-32nd-edition

[41] Royal College of Surgeons of England. Good surgical practice. London: Royal College of Surgeons of England 2014 https://www.rcseng.ac.uk/-/media/files/rcs/standards-and-research/gsp/gsp-2014-web.pdf