DOI: https://doi.org/10.53350/pjmhs020231712410

ORIGINAL ARTICLE

Comparison of Surgical Site Infection Rates Following Different Skin Preparation Techniques

ABBAS ALI RAZA[1], LAIBA TARIQ[2], SHABINA[3], AZAL JODAT[4], ASADULLAH AWAN[5], HAMIDULLAH[6]
[1]*Assistant Professor, Department of Surgery, MTI - Mardan Medical Complex, Mardan*
[2]*Student MBBS, Peshawar Medical College, Peshawar*
[3]*Assistant Professor, Department of Surgery, Ward 2, JPMC, Karachi*
[4]*Medical Officer, Farooq Hospital DHA, Lahore*
[5]*Assistant Professor, Department of Plastic Surgery, Dow International Medical College and Dow University of Health Science, Karachi*
[6]*Assistant Professor, Department of Medicine, Bacha Khan Medical College, Mardan*
Correspondence to: Hamidullah, Email: dr.azlan2025@gmail.com

ABSTRACT

Background: Surgical site infections (SSIs) rank among the most frequent and easily preventable surgical complications. One of the Skin antisepsis performed before an operation, colloquially termed skin prep, is fundamental in reducing the possibility of infection. However, there is still confusion as to which antiseptic agent provides the best barrier. This study aimed to evaluate the effectiveness of chlorhexidine, povidone-iodine, and alcohol based solutions in the prevention of SSIs. Assess and analyze the rate of surgical site infections resulting from varying methods of skin preparation before surgery in a forward-looking group of surgical patients.

Methods: An observational study was performed over a prospective 12 month period from January 2022 to January 2023 at the department of surgery, Mardan Medical Complex, Mardan. 79 patients undergoing various elective and emergency surgical procedures were enrolled. Participants received skin antisepsis using one of the following agents, chlorhexidine, povidone iodine, or alcohol based solution. The method of application and drying time were documented. SSIs were monitored for 30 days postoperatively and categorized as superficial, deep, or organ space infections. Infected wounds were microbiologically sampled for pathogen identification.

Results: The overall SSI rate was 26.6%, with the lowest rate observed in the chlorhexidine group. Povidone-iodine and alcohol-based preparations showed higher infection rates in comparison. Superficial infections were the most common Staphylococcus aureus was the most commonly isolated pathogen. Selection of antiseptic, and within those, the wound's grade in addition to the operation time impacted infection results.

Conclusion: Chlorhexidine-based skin preparation was associated with a lower rate of SSIs compared to povidone-iodine and alcohol-based agents. These findings support the preferential use of chlorhexidine in surgical settings to improve postoperative outcomes.

Keywords: Surgical site infection, Chlorhexidine, Povidone-iodine, Alcohol-based antiseptic, Skin preparation, Postoperative infection, Antiseptic efficacy

INTRODUCTION

Surgical site infections (SSIs) are an ever-pressing concern in the surgical field since they increase patient morbidity, prolonging their stay in the hospital while simultaneously raising healthcare expenditures. SSIs are still one of the most prevalent complications in connection with modern health care, even with the improvements made in surgical methods and the care given before and after operations. SSIs affect the results of surgery and give rise to complications that, with a rational approach based on clinical evidence and best practices, could be avoided[1,2].

Preoperative skin antisepsis is crucial to achieving the goal of reducing the likelihood of SSIs. The skin is a reservoir of microorganisms which requires adequate disinfection before surgical incisions are made. For this purpose a wide variety of antiseptic agents are used, amongst which chlorhexidine, povidone-iodine and alcohol-based solutions stand out as the most common. Each agent possesses distinct antimicrobial properties, practical concerns regarding application and drying time, and mechanisms of action[3,4].

The widespread use of chlorhexidine in many surgical settings is due to the broad spectrum of antimicrobial activity and residual effects it provides. While Povidone-iodine is still a commonly accepted antiseptic used in operating rooms, its shorter duration of action does present some controversy. Alcohol based preparations exhibit quick bactericidal activity; however, they are often used in combination with other antiseptic agents to enhance sustained efficacy[5-7].

Multiple clinical trials and comparative studies have sought to assess the relative efficacy of these antiseptics in minimizing infections after surgery. However, outcomes have differed based on the type of surgery, demographics, and hospital practices. A controversy still exists on which skin preparation method shields the patients optimally from SSIs across various surgical fields.

This study was undertaken to compare the incidence of surgical site infections associated with chlorhexidine, povidone-iodine, and alcohol-based skin preparations in a prospective clinical setting. By observing SSI rates in patients undergoing various surgical procedures, this research aims to offer practical insights into which antiseptic approach may offer superior protection and inform future infection prevention strategies.

Received on 25-03-2023
Accepted on 24-11-2023

METHODOLOGY

The design of this research was a prospective observational study spanning twelve months, January 2022 to January 2023. It was carried out at the department of surgery, Mardan Medical Complex, Mardan, an academic medical center that participates in dynamic multidisciplinary surgical oncology activities in general, orthopaedic, and gynecological surgeries. This study received approval from the Institutional Review Board of the institution. All participants provided informed consent in writing. Patient confidentiality was carefully protected throughout the research."

Through non-probability sampling, 79 patients who were assigned to undergo elective or emergency surgical procedures were recruited. All patients aged above 18 years of age and of any sex who were undergoing clean as well as clean-contaminated surgical procedures were included. Informed consent was acquired in written form before participation from all individuals involved in the study.

Inclusion Criteria:

- Adults aged 18 years and older
- Undergoing elective or emergency surgery
- Surgical wounds are classified as clean, clean-contaminated, contaminated, or dirty

- Patients willing to comply with follow-up visits for infection monitoring

Exclusion Criteria:

- Patients already receiving treatment for any active infection
- Known hypersensitivity to antiseptic solutions
- Immunocompromised individuals undergoing chemotherapy or radiotherapy
- Incomplete medical records or lost to follow-up

Upon enrolment, demographic data such as age, gender, BMI, smoking status, and relevant medical history, including diabetes, hypertension, and immunosuppressive status, were recorded using a structured proforma. Clinical details, including the type of surgery (elective/emergency), surgical specialty, wound classification, ASA score, and duration of surgery, were documented. The use of prophylactic antibiotics and surgical drains was also noted.

Each patient underwent preoperative skin antisepsis using one of three commonly used techniques: chlorhexidine, povidone-iodine, or alcohol-based solutions. The selection of skin preparation method was based on the operating team's standard practice protocols. Additional details regarding the method of application (swab, spray, or paint) and drying time allowed before incision were carefully recorded.

The primary outcome was the incidence of surgical site infections (SSIs), assessed clinically within 30 days post-operation. Follow-up was conducted through daily inpatient review and outpatient follow-ups up to one month. Infections were classified as superficial, deep, or organ-space based on CDC criteria. In cases where SSI was suspected, wound swabs were obtained for microbiological analysis to identify the causative organisms.

All collected data were entered into SPSS version 26.0 for statistical analysis. Descriptive statistics were used to summarize baseline characteristics. The Chi-square test was applied to compare SSI incidence among different skin preparation groups. A p-value of <0.05 was considered statistically significant.

RESULT

The study population comprised a balanced distribution of males and females, with the average age hovering around 45 years. Most participants fell into the overweight category, with a notable proportion also classified as obese. These weight-related findings are relevant as elevated body mass index (BMI) is known to interfere with wound healing. Roughly half of the participants reported being smokers, which could further impair tissue recovery following surgery. Additionally, chronic health conditions were commonly reported; over 40% of the participants had diabetes, and nearly half had hypertension. Furthermore, a substantial portion of individuals were identified as immunocompromised, potentially increasing their susceptibility to infections. These demographic patterns set the background for interpreting post-operative outcomes, especially the risk of developing surgical site infections.

Table 1: Demographic Characteristics of Participants (n = 79)

Variable	Categories	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	–	45.0 ± 12.3
Gender	Male	41	51.9%
	Female	38	48.1%
BMI (kg/m²)	Normal (<25)	22	27.8%
	Overweight (25–29)	38	48.1%
	Obese (≥30)	19	24.1%
Smoking Status	Smoker	39	49.4%
	Non-smoker	40	50.6%
Diabetes	Yes	34	43.0%
	No	45	57.0%
Hypertension	Yes	37	46.8%
	No	42	53.2%
Immunosuppressed	Yes	32	40.5%
	No	47	59.5%

The surgical procedures included in this study were almost evenly split between elective and emergency cases. General surgery cases were slightly more frequent than orthopedic and gynecological procedures. Nearly a third of patients had clean-contaminated wounds, while contaminated and dirty wounds accounted for a significant number of operations, highlighting the potential for infection. The majority of surgeries lasted between 60 and 120 minutes, aligning with typical surgical durations for standard cases. Preoperative assessment using ASA scores revealed that most patients had mild to moderate systemic disease. A large majority of patients received prophylactic antibiotics before incision, following infection control guidelines. About 40% of the cases involved the use of surgical drains, which can also influence the likelihood of postoperative infections. These clinical features help contextualize the variations in infection rates observed among different groups.

Table 2: Clinical and Surgical Characteristics (n = 79)

Variable	Categories	Frequency (n)	Percentage (%)
Type of Surgery	Elective	42	53.2%
	Emergency	37	46.8%
Surgical Specialty	General	28	35.4%
	Orthopedic	26	32.9%
	Gynecology	25	31.7%
Wound Classification	Clean	21	26.6%
	Clean-Contaminated	24	30.4%
	Contaminated	19	24.1%
	Dirty	15	19.0%
Duration of Surgery	<60 minutes	22	27.8%
	60–120 minutes	35	44.3%
	>120 minutes	22	27.8%
ASA Score	I	19	24.1%
	II	21	26.6%
	III	23	29.1%
	IV	16	20.2%
Prophylactic Antibiotics	Yes	67	84.8%
	No	12	15.2%
Drain Used	Yes	31	39.2%
	No	48	60.8%

Table 3: Skin Preparation Techniques and Surgical Site Infection Outcomes (n = 79)

Variable	Categories	Frequency (n)	Percentage (%)
Skin Preparation Technique	Chlorhexidine	27	34.2%
	Povidone-iodine	28	35.4%
	Alcohol-based	24	30.4%
Application Method	Swab	25	31.6%
	Spray	28	35.4%
	Paint	26	32.9%
Drying Time Allowed	<30 seconds	21	26.6%
	30–60 seconds	35	44.3%
	>60 seconds	23	29.1%
SSI Observed	Yes	21	26.6%
	No	58	73.4%
Type of SSI (if Yes)	Superficial	13	61.9% of SSI
	Deep	5	23.8% of SSI
	Organ-space	3	14.3% of SSI
Pathogen Identified	Staph aureus	10	47.6% of SSI
	E. coli	7	33.3% of SSI
	Pseudomonas	4	19.0% of SSI

When analyzing the skin antiseptic techniques, it was observed that chlorhexidine and povidone-iodine were the most frequently used agents, followed closely by alcohol-based preparations. Methods of application, such as swabbing, spraying, and painting, were distributed almost equally. Most cases allowed a drying time of 30 to 60 seconds before incision, an important factor in ensuring antiseptic effectiveness. Despite these measures, surgical site infections occurred in over a quarter of the

patients. The majority of these infections were superficial, though a notable number progressed to deeper tissue levels or involved organ spaces. Microbial culture results showed Staphylococcus aureus to be the most commonly isolated pathogen, followed by E. coli and Pseudomonas. These findings underscore the fact that while antiseptic type and application are critical, they must be considered alongside other clinical variables when evaluating infection outcomes.

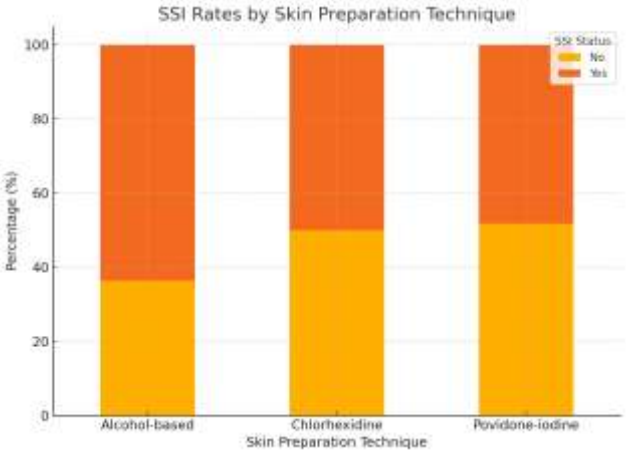

Figure 1: The graph shows the percentage of surgical site infections (SSIs) by skin preparation technique. The stacked bars represent the proportion of patients who developed SSIs (Yes) versus those who did not (No) for each antiseptic group.

DISCUSSION

Surgical site infections (SSIs) remain one of the most frequent and preventable complications following operative procedures. In this study, three commonly used skin antiseptic agents chlorhexidine, povidone-iodine, and alcohol-based solutions were compared in terms of their association with postoperative infection rates. The findings indicated a notable difference in SSI occurrence among the different skin preparation methods, supporting the growing evidence that antiseptic choice can influence surgical outcomes[8-10].

Among the participants, those prepped with chlorhexidine showed a relatively lower incidence of SSIs compared to those who received povidone-iodine or alcohol-based preparations. This observation is in agreement with studies that demonstrated significantly reduced infection rates when chlorhexidine-alcohol was used instead of povidone-iodine in clean-contaminated surgeries. The superior antimicrobial activity and sustained residual effect of chlorhexidine may account for its protective effect against microbial colonization[11-13].

Patients prepared with povidone-iodine displayed moderate infection rates, consistent with previous literature. Although povidone-iodine has a broad spectrum of antimicrobial activity, it tends to be less effective than chlorhexidine in reducing skin flora when used alone. Additionally, factors like inadequate drying time and method of application may reduce its effectiveness in clinical practice[14-16].

Interestingly, alcohol-based solutions demonstrated a higher SSI rate compared to chlorhexidine but similar to povidone-iodine. This aligns with studies indicating that while alcohol has rapid bactericidal properties, its efficacy is largely dependent on combining it with another antiseptic agent, such as chlorhexidine, to maintain prolonged microbial suppression[17-19].

Another key observation was that superficial infections were the most common type of SSI, followed by deep and organ-space infections. Most infections occurred within the first 10 days post-operation. The predominant pathogens isolated included Staphylococcus aureus, E. coli, and Pseudomonas, all of which are typical causative agents in postoperative wound infections, especially in high-risk surgical fields[20].

It is also important to consider that factors beyond skin preparation, such as obesity, diabetes, duration of surgery, wound classification, and prophylactic antibiotic use, play a crucial role in SSI development. While antiseptic choice is significant, it must be part of a broader infection control strategy.

This study adds to the body of evidence advocating for the preferential use of chlorhexidine-based preparations in surgical settings. However, larger multi-center trials with longer follow-up periods would be valuable to further validate these findings and guide institutional policy changes.

CONCLUSION

This prospective study highlights that chlorhexidine appears to be more effective in reducing surgical site infection rates compared to povidone-iodine and alcohol-based antiseptics. While all agents offer some degree of protection, the consistent performance of chlorhexidine makes it a preferable choice in both elective and emergency surgeries. Optimizing skin antisepsis through appropriate agent selection, application method, and adequate drying time should remain a critical focus in perioperative care to reduce the burden of SSIs and improve patient outcomes.

REFERENCES

1. Dockery DM, Allu S, Vishwanath N, Li T, Berns E, Glasser J, et al. Review of pre-operative skin preparation options based on surgical site in orthopedic surgery. Surgical Infections. 2021;22(10):1004-13.
2. Peel TN, Watson E, Lee SJ. Randomised controlled trials of alcohol-based surgical site skin preparation for the prevention of surgical site infections: systematic review and meta-analysis. Journal of Clinical Medicine. 2021;10(4):663.
3. Dior UP, Kathurusinghe S, Cheng C, Reddington C, Daley AJ, Ang C, et al. Effect of surgical skin antisepsis on surgical site infections in patients undergoing gynecological laparoscopic surgery: a double-blind randomized clinical trial. JAMA surgery. 2020;155(9):807-15.
4. Ruffolo AM, Sampath AJ, Colbert S, Golda N. Preoperative considerations for the prevention of surgical site infection in superficial cutaneous surgeries: a systematic review. Facial Plastic Surgery & Aesthetic Medicine. 2021;23(3):205-23.
5. Dörfel D, Maiwald M, Daeschlein G, Müller G, Hudek R, Assadian O, et al. Comparison of the antimicrobial efficacy of povidone-iodine-alcohol versus chlorhexidine-alcohol for surgical skin preparation on the aerobic and anaerobic skin flora of the shoulder region. Antimicrobial resistance & infection control. 2021;10:1-9.
6. Mehraban N, Holmes Jr GB, Lin J, Lee S, Hamid KS, Bohl DD. Skin preparation techniques for orthopedic foot and ankle surgery: a current concepts review. Foot & Ankle International. 2020;41(8):1007-16.
7. Aleem IS, Tan LA, Nassr A, Riew KD. Surgical site infection prevention following spine surgery. Global Spine Journal. 2020;10(1_suppl):92S-8S.
8. Gupta KK, Vatish D, Xavier V, Maliyil J, Manu M. Comparing surgeon adherence with World Health Organization antiseptic guidelines for surgical site preparation in the United Kingdom and India. Surgical Infections. 2020;21(7):634-8.
9. Dulong C, Brett K, Argáez C. Skin preparation for injections: A review of clinical effectiveness, cost-effectiveness and guidelines. 2020.
10. Wade RG, Burr NE, McCauley G, Bourke G, Efthimiou O. The comparative efficacy of chlorhexidine gluconate and povidone-iodine antiseptics for the prevention of infection in clean surgery: a systematic review and network meta-analysis. LWW; 2021. p. e481-e8.
11. Panos G, Mulita F, Akinosoglou K, Liolis E, Kaplanis C, Tchabashvili L, et al. Risk of surgical site infections after colorectal surgery and the most frequent pathogens isolated: a prospective single-centre observational study. Medicinski Glasnik. 2021;18(2).
12. Hoddinott KL, Weese JS, Singh A. Surgeon and patient preparation to minimize surgical site complications and infection surveillance programs. Complications in canine cranial cruciate ligament surgery. 2021:15-32.
13. Luwang AL, Saha PK, Rohilla M, Sikka P, Saha L, Gautam V. Chlorhexidine–alcohol versus povidone–iodine as preoperative skin antisepsis for prevention of surgical site infection in cesarean delivery—a pilot randomized control trial. Trials. 2021;22:1-7.
14. Ademuyiwa AO, Hardy P, Runigamugabo E, Sodonougbo P, Behanzin H, Kangni S, et al. Reducing surgical site infections in low-income and middle-income countries (FALCON): a pragmatic,

multicentre, stratified, randomised controlled trial. The Lancet. 2021;398(10312):1687-99.
15. Koumu MI, Jawhari A, Alghamdi SA, Hejazi MS, Alturaif AH, Aldaqal SM, et al. Surgical site infection post-appendectomy in a tertiary hospital, Jeddah, Saudi Arabia. Cureus. 2021;13(7).
16. Tsai H-Y, Liao W-C, Wang M, Ueng K-C, Huang C-Y, Tseng Y-C. Randomized clinical trial of preoperative skin preparation with 2% chlorhexidine versus conventional hair shaving in percutaneous coronary intervention. Medicine. 2021;100(14):e25304.
17. Chung JNC, Ali O, Hawthornthwaite E, Watkinson T, Blyth U, McKigney N, et al. Closed incision negative pressure wound therapy is associated with reduced surgical site infection after emergency laparotomy: A propensity matched–cohort analysis. Surgery. 2021;170(5):1568-73.
18. Vadhwana B, Pouzi A, Surjus Kaneta G, Reid V, Claxton D, Pyne L, et al. Preoperative oral antibiotic bowel preparation in elective resectional colorectal surgery reduces rates of surgical site infections: a single-centre experience with a cost-effectiveness analysis. The Annals of The Royal College of Surgeons of England. 2020;102(2):133-40.
19. Scholz R, Smith BA, Adams MG, Shah M, Brudner C, Datta A, et al. A multifaceted surgical site infection prevention bundle for cesarean delivery. American Journal of Perinatology. 2021;38(07):690-7.
20. Investigators TPoRTtEP-oASSiOT. Effectiveness of Iodophor vs Chlorhexidine Solutions for Surgical Site Infections and Unplanned Reoperations for Patients Who Underwent Fracture Repair: The PREP-IT Master Protocol. JAMA Network Open. 2020;3(4):e202215-e.

This article may be cited as: Raza AA, Tariq L, Shabina, Jodat A, Awan A, Hamidullah: Comparison of Surgical Site Infection Rates Following Different Skin Preparation Techniques. Pak J Med Health Sci, 2023;17(12):410-413.