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Effectiveness of Preoperative Skin Antisepsis in Reducing Infections: An Observational Study

*Russell ATM[1], Azam MA[2], Islam R[3], Mia MS[4], Islam MM[5]

Abstract

Surgical site infections (SSIs) remain a significant cause of postoperative morbidity, prolonged hospital stay, and increased healthcare costs, particularly in resource-limited settings. Effective preoperative skin antisepsis is a critical preventive strategy to reduce microbial load at the surgical site and minimize infection risk. To assess the effectiveness of preoperative skin antisepsis in reducing postoperative surgical site infections among patients undergoing surgery, this prospective cohort study was conducted from January 2025 to February 2026 at the 250 Bedded Hospital, Sadar, Magura, and Upazilla Health Complex, Sreepur, Magura, Bangladesh. A total of 287 patients undergoing elective and emergency surgical procedures were selected using purposive sampling. Data were collected using a structured questionnaire and clinical observation checklist. Patients were followed for 30 days postoperatively to identify the occurrence of SSIs. Data were analyzed using SPSS version 23.0. Among the 287 participants, the overall SSI rate was 11.5%. Patients who received standardized preoperative skin antisepsis with chlorhexidine-alcohol had a significantly lower SSI rate (7.2%) compared to those receiving povidone-iodine alone (16.8%) ($\chi^2 = 6.87$, $p = 0.009$). The relative risk of SSI was 0.43 (95% CI: 0.22–0.84) in the chlorhexidine-alcohol group. Prolonged operative time and diabetes were identified as additional significant risk factors ($p < 0.05$). Standardized preoperative skin antisepsis, particularly with chlorhexidine-alcohol, significantly reduces the incidence of surgical site infections. Strengthening antiseptic protocols may improve surgical outcomes in similar healthcare settings.

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Introduction

Surgical site infections (SSIs) are among the most frequently reported healthcare-associated infections worldwide and remain a major cause of postoperative morbidity and mortality.[1] They develop within 30 days after surgery, or within one year in procedures involving implants, and significantly increase hospital stay, readmission rates, and healthcare expenditure.[2] Despite advances in surgical techniques and infection control practices, SSIs continue to impose a substantial clinical and economic burden, particularly in low- and middle-income countries (LMICs).[3] The pooled incidence of SSIs in LMICs has been reported to exceed 10%, reflecting disparities in preventive strategies and resource availability.[4] The occurrence of SSIs is influenced by a complex interaction of patient-related and procedure-related factors.[5] Patient-related factors such asdiabetes mellitus, obesity, malnutrition, smoking, and immunosuppression increase susceptibility to postoperative infections.[6] Procedure-related determinants, including prolonged operative duration, emergency surgery, and inadequate sterilization, further elevate the risk of wound contamination.[7] Among these, microbial contamination of the surgical incision at the time of operation is considered a critical initiating event in SSI development.[5] The patient's endogenous skin flora, especially *Staphylococcus aureus*, serves as a principal

1. **Dr. Abu Taher Mohammad Russell, Junior Consultant (Surgery), Upazilla Health Complex, Sreepur, Magura, Bangladesh.*
2. *Dr. Md Ali Azam, Junior Consultant (Surgery), 250 Beeded Hospital, Sadar, Magura.*
3. *Dr. Ryhan Islam, Resident Surgeon, Department of Surgery, Jamalpur Medical College, Jamalpur, Bangladesh.*
4. *Dr. Mohammad Salauddin Mia, Medical Officer, Department of Surgery, National Gastroliver Institute & Hospital, Dhaka, Bangladesh.*
5. *Dr. Muhammad Moinul Islam, Junior Consultant, Department of Surgery, Sarkari Karmachari Hospital, Fulbaria, Dhaka, Bangladesh.*

Address of Correspondence:
Email: russelltaher@outlook.com

source of pathogens in clean and clean-contaminated surgeries.[8]. Therefore, effective reduction of microbial burden at the incision site before surgery is essential for preventing SSIs. Preoperative skin antisepsis is a cornerstone of perioperative infection prevention and is strongly recommended by international guidelines.[9] The primary objective of skin preparation is to eliminate transient microorganisms and substantially reduce resident flora without causing tissue damage or systemic toxicity.[9] Chlorhexidine gluconate (CHG) and povidone-iodine (PVI) are the most commonly used antiseptic agents in surgical practice due to their broad-spectrum antimicrobial activity.[10] Chlorhexidine acts by disrupting bacterial cell membranes and exhibits persistent residual activity by binding to the stratum corneum, thereby providing prolonged antimicrobial protection.[11] In contrast, povidone-iodine releases free iodine that rapidly penetrates microbial cells, though its efficacy may be reduced in the presence of organic material, and it lacks sustained residual action.[12] Recent evidence comparing these agents has yielded important insights. A meta-analysis published in 2020 demonstrated that chlorhexidine-alcohol was associated with a significantly lower incidence of SSIs compared to povidone-iodine in various surgical procedures.[13] Similarly, a 2021 systematic review reported improved infection prevention outcomes with alcohol-based chlorhexidine preparations.[11] However, some contemporary analyses suggest that differences in effectiveness may vary across surgical specialties and patient populations.[12] In LMIC settings, the choice of antiseptic is often influenced by cost, availability, and institutional protocols rather than solely by evidence-based superiority.[3] Given the persistent burden of SSIs and the variability in antiseptic practices, there is a need for context-specific research to evaluate the real-world effectiveness of preoperative skin antisepsis strategies. Generating local evidence is particularly important in resource-constrained healthcare facilities where standardized infection control measures may not be uniformly implemented. Therefore, this study aims to assess the effectiveness of preoperative skin antisepsis in reducing surgical site infections among patients undergoing surgery in selected hospitals in Bangladesh.

Methods

This prospective cohort study was conducted among patients undergoing surgical procedures at the 250 Bedded Hospital, Sadar, Magura, and Upazilla Health Complex, Sreepur, Magura, Bangladesh, from February 2025 to January 2026. A total of 287 patients were enrolled using purposive sampling. Both elective and emergency surgical cases from general surgery, gynecology, and other minor surgical units were considered.

Inclusion criteria: Patients aged 18 years and above who underwent clean or clean-contaminated surgical procedures during the study period were included. Participants who provided informed written consent and were available for postoperative follow-up up to 30 days were eligible for enrollment.

Exclusion criteria: Patients with pre-existing skin infections at the operative site, those undergoing contaminated or dirty surgeries, critically ill patients requiring immediate life-saving interventions, and individuals unwilling to participate or lost to follow-up were excluded from the study.

Study procedure: Participants were categorized based on the type of preoperative skin antisepsis received, namely chlorhexidine-alcohol or povidone-iodine. Standard perioperative protocols were followed in both settings. Data were collected using a structured questionnaire and clinical observation checklist, including demographic characteristics, comorbidities, operative details, and postoperative wound status. Patients were monitored during hospital stay and followed for 30 days postoperatively to identify signs of surgical site infection according to standard diagnostic criteria.

Data analysis: Collected data were coded and entered into SPSS version 23.0 for analysis. Descriptive statistics were computed, and inferential analysis using chi-square tests and relative risk estimation was performed. A p-value <0.05 was considered statistically significant.

Results

Among the 287 participants, the mean age was 41.8 ± 13.6 years, with the majority (36.6%) belonging to the 31–45 years age group. Male patients constituted 54.7% (n=157), while females accounted for 45.3% (n=130). Regarding comorbid conditions, 18.8% had diabetes mellitus, and 14.3% were hypertensive. Most procedures were elective (62.7%), and 37.3% were emergency surgeries. Clean surgeries represented 58.5% of cases, whereas 41.5% were clean-contaminated. Preoperative skin antisepsis with chlorhexidine-alcohol was used in 152 patients (53.0%), while 135 patients (47.0%) received povidone-iodine. The overall incidence of surgical site infection (SSI) within 30 days was 11.5% (n=33). A significantly lower SSI rate was observed in the chlorhexidine-alcohol group (7.2%) compared to the povidone-iodine group (16.8%) (p=0.009). Age group was not significantly associated with SSI occurrence (p=0.412). However, diabetes mellitus showed a significant association with SSI, where 22.2% of diabetic patients developed infection compared to 9.0% of non-diabetic patients (p=0.018). Emergency surgeries had a higher SSI rate (17.8%) compared to elective procedures (7.2%), demonstrating statistical significance (p=0.011). Similarly, surgeries lasting more than 90 minutes were associated with increased SSI incidence (19.4%) compared to procedures lasting ≤90 minutes (6.8%) (p=0.004). When stratified by wound class, clean-contaminated surgeries demonstrated a higher SSI rate (16.0%) than clean surgeries (8.3%), although this difference did not reach statistical significance (p=0.067). Relative risk estimation showed that patients receiving chlorhexidine-alcohol had a 57.0% reduced risk of developing SSI compared to those receiving povidone-iodine (RR=0.43; 95% CI: 0.22–0.84).

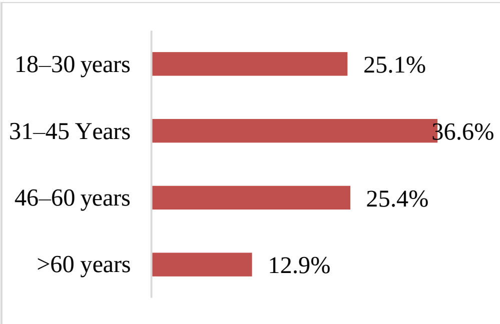

Figure 1: Age distribution of participants (N=287)

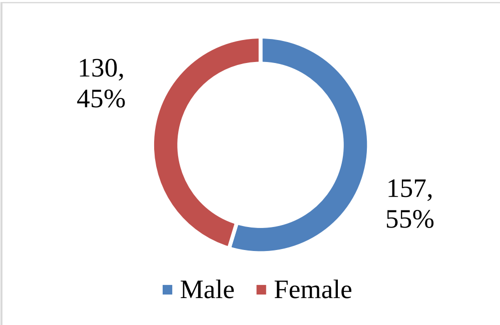

Figure 2: Gender distribution of participants

Table 1: Clinical characteristics of participants

Variable	n	%
Diabetes mellitus	54	18.8
Hypertension	41	14.3
Elective surgery	180	62.7
Emergency surgery	107	37.3
Clean surgery	168	58.5
Clean-contaminated	119	41.5

Table 2: Type of antiseptic used and SSI occurrence

Antiseptic Type	SSI	No SSI
	n (%)	n (%)
Chlorhexidine-alcohol (n=152)	11 (7.2)	141 (92.8)
Povidone-iodine (n=135)	22 (16.3)	113 (83.7)

p-value = 0.009, Chi-square test applied

Table 3: Association of diabetes with SSI

Diabetes Status	SSI	No SSI
	n (%)	n (%)
Yes (n=54)	12 (22.2)	42 (77.8)
No (n=233)	21 (9.0)	212 (91.0)

p-value = 0.018, Chi-square test applied

Table 4: Association of type of surgery with SSI

Type of Surgery	SSI	No SSI
	n (%)	n (%)
Elective (n=180)	13 (7.2)	167 (92.8)
Emergency (n=107)	19 (17.8)	88 (82.2)

p-value = 0.011, Chi-square test applied

Table 5: Association of operative duration with SSI

Duration of Surgery	SSI	No SSI
	n (%)	n (%)
≤90 minutes (n=176)	12 (6.8)	164 (93.2)
>90 minutes (n=111)	21 (18.9)	90 (81.1)

p-value = 0.004, Chi-square test applied

Discussion

The present prospective cohort study demonstrated an overall surgical site infection (SSI) rate of 11.5%, which is consistent with previously reported rates from low- and middle-income countries (LMICs).[14] This incidence remains substantially higher than figures commonly reported in high-income settings, reflecting contextual challenges such as resource constraints, variability in infection control practices, and limited adherence to standardized perioperative protocols.[15] The findings reinforce the continuing burden of SSIs in developing healthcare systems and the urgent need for strengthening preventive strategies. A key finding of this study was the significantly lower incidence of SSI among patients who received chlorhexidine-alcohol for preoperative skin antisepsis compared to those who received povidone-iodine (7.2% vs. 16.8%, p=0.009). This observation aligns with contemporary evidence suggesting the superiority of alcohol-based chlorhexidine preparations in reducing postoperative infections.[16] A meta-analysis by Privitera *et al.* demonstrated that chlorhexidine-alcohol significantly reduced SSI risk compared to povidone-iodine across multiple surgical specialties.[17] Similarly, a large-scale systematic review found that chlorhexidine-based antisepsis was associated with improved microbial suppression and lower infection rates, particularly in clean and clean-contaminated surgeries.[18] The residual antimicrobial activity of chlorhexidine, which persists on the skin after application, may explain its enhanced protective effect compared to povidone-iodine, which lacks sustained activity.[19] Diabetes mellitus emerged as a significant risk factor for SSI in this study, with diabetic patients showing a markedly higher infection rate than non-diabetic patients (22.2% vs. 9.0%, p=0.018). This finding is consistent with prior research demonstrating impaired wound healing and increased susceptibility to infection among diabetic individuals.[20] Hyperglycemia adversely affects neutrophil function and microvascular circulation, thereby compromising host defense mechanisms and tissue repair.[21] Effective perioperative glycemic control remains essential to minimizing SSI risk in this vulnerable population. Emergency surgery was also significantly associated with higher SSI incidence compared to elective procedures (17.8% vs. 7.2%, p=0.011). Similar observations have been reported in previous studies, which attribute increased infection risk in emergency settings to inadequate preoperative preparation, higher levels of contamination, and limited time for optimization of patient comorbidities.[22] The increased physiological stress and compromised sterility conditions in urgent procedures may further contribute to infection susceptibility. Operative duration greater than 90 minutes was another significant predictor of SSI in the present study ($p=0.004$). Prolonged surgeries increase tissue exposure to environmental contaminants and may reflect procedural complexity, both of which elevate infection risk.[23] Longer operative time has consistently been identified as an independent risk factor for SSI across various surgical disciplines.[24] Therefore, adherence to efficient surgical techniques and minimizing unnecessary delays during procedures are crucial components of infection prevention. Although clean-contaminated surgeries showed a higher SSI rate compared to clean procedures, the association did not reach statistical significance. Nonetheless, this trend corresponds with established evidence that higher wound contamination levels correlate with increased infection risk.[25] Overall, the findings of this study corroborate existing literature supporting the effectiveness of chlorhexidine-alcohol in reducing SSIs and highlight key modifiable risk factors such as glycemic control and operative duration. In resource-limited healthcare settings like Bangladesh, prioritizing evidence-based antiseptic protocols and strengthening perioperative infection control measures could substantially reduce postoperative complications. Future multicenter studies with larger sample sizes may further validate these findings and inform national policy recommendations.

Limitations

This study had several limitations. Purposive sampling may limit generalizability, and the findings reflect only two healthcare facilities. Potential confounding variables, such as antibiotic timing and operating room environment, were not fully controlled. Additionally, microbiological confirmation of all suspected SSIs was not performed.

Conclusion

This study concludes that preoperative skin antisepsis with chlorhexidine-alcohol significantly reduces the incidence of surgical site infections compared to povidone-iodine in a resource-limited setting. Diabetes, emergency surgery, and prolonged operative duration were important predictors of infection. Strengthening standardized antiseptic protocols and optimizing modifiable risk factors can substantially improve surgical outcomes and reduce postoperative morbidity in similar healthcare environments.

Recommendation

It is recommended that healthcare facilities adopt chlorhexidine-alcohol as the standard preoperative skin antiseptic agent. Strict perioperative glycemic control, minimizing operative duration, and strengthening infection prevention protocols should be prioritized. Further multicenter studies are advised to validate these findings nationally.

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