A Comparative Study of Chlorhexidine–Alcohol versus Povidone–Iodine for Prevention of Surgical Site Infection in Clean-Contaminated Surgeries

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ABSTRACT

OBJECTIVE:

To compare the frequency of surgical site infection in chlorhexidine alcohol versus povidone iodine among patients undergoing clean contaminated surgery.

METHODOLOGY

A randomized controlled trial was conducted at JPMC, Karachi, including 310 patients aged 18–70 years undergoing clean-contaminated surgeries. Participants were randomly assigned to receive preoperative skin preparation with either chlorhexidine-alcohol (Group A) or povidone-iodine (Group B). Surgical site infections were assessed over 30 days postoperatively based on clinical and laboratory criteria. Data were analysed using SPSS version 26 with a 95% confidence interval.

RESULTS

The mean age of participants was 33.9 ± 14.4 years. Gender distribution was comparable between groups, with males comprising 56.1% in the chlorhexidine-alcohol group and 58.1% in the povidone-iodine group. The incidence of surgical site infections was significantly lower in the chlorhexidine-alcohol group (9.0%) compared to povidone-iodine (16.8%) ($p = 0.042$). Subgroup analysis revealed greater efficacy of chlorhexidine-alcohol among females and patients aged 20–35 years.

CONCLUSION

It is to be concluded that chlorhexidine alcohol is more effective than povidone iodine in preventing surgical site infections during clean-contaminated surgeries. This highlights its potential as the preferred choice for

preoperative antiseptics to reduce infection risks.

KEYWORDS

Alcohol, Chlorhexidine, Povidone Iodine, Surgical Outcomes, Surgical Site Infection

INTRODUCTION

Surgical site infections (SSIs) defined as infections occurring at or near surgical incisions within 30 days of an operative procedure is an important source of postoperative complications, extending-length of stay and treatment costs [1–3]. These infections can be responsible for nearly a fifth of all hospital complex infections, and they represent the most frequently reported nosocomial infection of surgical patients worldwide [4,5]. Considering that most pathogens responsible for SSIs come from the skin surface, appropriate preparation of the skin before surgery is essential for SSI prevention [6]. The common antiseptic agents used for cutaneous preparation are iodophors (aqueous or alcohol based) and chlorhexidine gluconate [7,8].

Moreover, there is no absolute agreement for the best antiseptic solution for surgical preparation of skin [9].

Rates of SSIs differ widely across hospitals, individual procedures, surgical teams and — most importantly — patients [10]. Such infections usually occur due to contamination of the surgical field with microorganisms which are often derived from the patient's own flora (endogenous source) particularly when a breach of skin or of a hollow organ has occurred. The most frequently detected pathogen in SSIs is Staphylococcus aureus [11,12]. Optimising preoperative skin antisepsis can help to minimise the risk of infection. Notably used antiseptics are chlorhexidine gluconate (CHG) and povidone-iodine (PVI) which have different mechanisms of action and spectrum of activity [13].

Different antiseptic agents applied in surgery according to classification of surgery such as clean, clean-contaminated, contaminated, or dirty [14]. Povidone–iodine (PI) has traditionally been the antiseptic of choice owing to its inexpensive price, widespread availability, and proven efficacy [15]. Chlorhexidine-alcohol (CHA) has been introduced as a more recent alternative, generally as a 2% chlorhexidine gluconate plus 70% isopropyl alcohol formulation [16]. CHA is slightly more expensive than PI but has many advantages like the rapid onset of activity & long-lasting antimicrobial property with the presence of body fluids. CHA was recommended by the CDC in 2002, when used for skin preparation before catheterization in central venous and peripheral arterial placement. In addition, CHA has been shown to be superior to PI in preventing SSIs particularly after clean operations [16,17].

This study aims to assess the incidence of surgical site infections in clean-contaminated surgery patients prepped with chlorhexidine-alcohol or povidone-iodine. Though different studies have compared the efficacy of these agents on clean surgeries, specific studies relating to clean- contaminated surgeries are endemic. Povidone-iodine has been the most popular antiseptic for more than a decade for its price affordability. Still, chlorhexidine-alcohol is favoured by many surgeons these days for its increased effectiveness. Both agents are commonly used in local clinical practice for skin preparation. This study will help the surgeons to choose the best antiseptic solution that can be used to reduce the risk of surgical site infection in clean- contaminated procedures.

METHODOLOGY

This randomized controlled trial was conducted in the Department of Surgery at Jinnah Postgraduate Medical Centre (JPMC), Karachi, to compare the incidence of surgical site infections (SSIs) in patients undergoing clean-contaminated surgeries prepared with either chlorhexidine-alcohol or povidone-iodine. Patients aged 18–70 years of either sex and classified as ASA I–III were included, while those who were immunocompromised, on chronic steroid therapy, had diabetes mellitus, chronic liver disease, were receiving chemotherapy, had pre-existing contaminated wounds, were morbidly obese (BMI $\geq$ 35), or declined participation were excluded. Participants were enrolled through consecutive sampling and subsequently randomized into two groups using an opaque sealed-envelope method to ensure allocation concealment. After obtaining written informed consent, baseline demographic and clinical information—including age, sex, residence, BMI, hypertension, smoking status, and surgical indication—was recorded using a structured proforma. Group A underwent preoperative skin preparation with chlorhexidine-alcohol, whereas Group B received povidone-iodine. All surgeries were performed under general anesthesia by a consultant general surgeon with more than five years of post-fellowship experience, assisted by the primary investigator, following standardized aseptic protocols. Postoperative follow-up was carried out for 30 days to detect SSIs, defined by the presence of pain (VAS > 3), tenderness, swelling, or fever ($\geq$100°F), along with at least one of the following criteria: purulent wound discharge, leukocytosis (WBC > 12,000/mm^3), or a positive bacterial culture from wound fluid or tissue.Data were analyzed using SPSS version 26. Descriptive statistics were calculated for baseline variables, and the incidence of surgical site infections between groups was compared using the chi-square test, with a p-value < 0.05 considered statistically significant.

RESULTS

Table I presents the baseline demographic and clinical characteristics of the study participants (n=310), equally divided between the Chlorhexidine Alcohol group (n=155) and the Povidone Iodine group (n=155). The mean age of participants in the Chlorhexidine Alcohol group was 34.46 ± 15.09 years, while in the Povidone Iodine group it was 33.34 ± 13.75 years. The mean BMI was comparable between the two groups (27.45 ± 4.44 kg/m² vs. 26.94 ± 4.63 kg/m²). The average duration of procedure was slightly longer in the Chlorhexidine Alcohol group (75.81 ± 19.71 minutes) than in the Povidone Iodine group (73.59 ± 16.32 minutes). Males constituted 56.1% of the Chlorhexidine Alcohol group and 58.1% of the Povidone Iodine group, whereas females accounted for 43.9% and 41.9%, respectively. Diabetes mellitus was more prevalent among participants in the Chlorhexidine Alcohol group (66.5%) compared to the Povidone Iodine group (58.7%). Similarly, hypertension was present in 39.4% of participants in the Chlorhexidine Alcohol group and 42.6% in the Povidone Iodine group. The majority of participants in both groups resided in rural areas, with 85.8% in the Chlorhexidine Alcohol group and 87.1% in the Povidone Iodine group.

Figure 1: *Bar chart showing the comparative incidence of surgical site infections (SSIs) in patients undergoing clean-contaminated surgeries prepared with either chlorhexidine alcohol (CHA) or povidone iodine (PVI). The overall incidence of SSI was significantly lower in the CHA group (9.0%) compared to the PVI group (16.8%) (p=0.042). Stratified analysis also shows SSI rates by age group (20–35 years and >35 years) and gender (male and female), indicating significantly lower infection rates in females and younger age groups within the CHA group.*

Table III presents the comparison of surgical site infection (SSI) outcomes between Chlorhexidine Alcohol and Povidone Iodine, stratified by age and gender. Among participants aged 20–35 years, the incidence of SSI was significantly lower in the Chlorhexidine Alcohol group (7.5%) compared to the Povidone Iodine group (17.9%), with a 95% confidence interval of 0.158–0.894 and a p-value of 0.023, indicating a statistically significant difference. In participants older than 35 years, SSI occurred in 12.2% of the Chlorhexidine Alcohol group and 14.0% of the Povidone Iodine group, showing no significant difference (95% CI: 0.256–2.897, p = 0.808). When stratified by gender, male participants showed a slightly lower SSI rate in the Chlorhexidine Alcohol group (11.5%) compared to the Povidone Iodine group (16.7%), though this difference was not statistically significant (95% CI: 0.275–1.536, p = 0.323). However, among female participants, the SSI rate was significantly lower in the Chlorhexidine Alcohol group (5.9%) compared to the Povidone Iodine group

(16.9%), with a 95% confidence interval of 0.092–1.019 and a p-value of 0.040, suggesting a significant protective effect of Chlorhexidine Alcohol among females.

DISCUSSION

In this randomized controlled trial, we compared the efficacy of chlorhexidine-alcohol and povidone-iodine in preventing surgical site infections (SSIs) among patients undergoing clean-contaminated surgeries. Our findings demonstrate that chlorhexidine-alcohol was associated with a significantly lower incidence of SSIs (9.0%) compared to povidone-iodine (16.8%) ($p = 0.042$), reflecting nearly a 50% reduction in infection risk. These results align with previous literature and reinforce chlorhexidine-alcohol as an effective preoperative antiseptic.

The study population was carefully selected to minimize confounding by including patients aged 18–70 years with ASA class I–III and excluding individuals with known risk factors for SSIs such as diabetes, immunosuppression, chronic liver disease, and pre-existing wound contamination. Baseline characteristics, including age, gender distribution, BMI, and operative duration, were comparable between groups, supporting the validity of the comparative analysis.

Our findings are consistent with multiple earlier studies. Sufyan et al. reported significantly lower SSI rates with chlorhexidine-alcohol (8.6%) than with povidone-iodine (13.8%; $p = 0.016$) in clean-contaminated surgeries [7]. Similarly, John et al. observed a significant reduction in SSIs with chlorhexidine-alcohol (10%) compared with povidone-iodine (24%) ($p = 0.0084$), highlighting the superior and sustained antimicrobial activity of chlorhexidine-alcohol [8]. However, some studies have shown mixed outcomes. Bibi et al. reported no significant difference between the two agents (7.1% vs. 10.0%), suggesting that variations in microbial flora and surgical conditions may influence effectiveness [18].

Other research further explores the comparative benefits of povidone-iodine alone versus combinations or alternative antiseptics. Mareedu et al. evaluated aqueous povidone-iodine alone versus povidone-iodine combined with chlorhexidine, hypothesizing improved antimicrobial efficacy with combination therapy [19]. Gupta et al. similarly compared aqueous povidone-iodine with alcoholic chlorhexidine and found evidence supporting the superior antimicrobial properties of chlorhexidine-based preparations [20]. Collectively, these findings, along with meta-analyses and international data, support ongoing efforts to optimize preoperative antisepsis protocols to reduce SSI risk.

This study has several strengths, including its randomized design, standardized surgical techniques, and use of

detailed SSI diagnostic criteria. Additionally, the focus on clean-contaminated surgeries provides valuable insight, as most existing studies emphasize clean procedures. Nonetheless, certain limitations should be acknowledged. As a single-center study, the findings may not be generalizable to other settings due to institutional differences in microbial flora and surgical practices. The exclusion of high-risk patients, while necessary to reduce bias, may underestimate SSI rates in real-world populations. Furthermore, cost-effectiveness was not assessed, an important factor in resource-limited environments.

Despite these limitations, the results strongly support the use of chlorhexidine-alcohol over povidone-iodine as a preoperative skin antiseptic in clean-contaminated surgeries. The significant reduction in SSI rates aligns with global evidence and suggests that chlorhexidine-alcohol should be considered the preferred antiseptic in clinical practice. Future multicenter studies with broader populations and cost-effectiveness analyses are recommended to further strengthen these findings.

CONCLUSION

It is to be concluded that chlorhexidine alcohol is more effective than povidone iodine in preventing surgical site infections during clean-contaminated surgeries. This highlights its potential as the preferred choice for preoperative antiseptic to reduce infection risks.

Table I: Baseline Demographic and Clinical Characteristics of Study Participants (n=310)	
	Groups

Baseline Characteristics		**Chlorhexidine Alcohol** (n=155)	**Povidone Iodine** (n=155)
Age in years, Mean ± SD		34.46 ± 15.09	33.34 ± 13.75
BMI in kg/m², Mean ± SD		27.45 ± 4.44	26.94 ± 4.63
Duration of Procedure in mins, Mean ± SD		75.81 ± 19.71	73.59 ± 16.32
Gender	Male, *n* (%)	87 (56.1)	90 (58.1)
	Female, *n* (%)	68 (43.9)	65 (41.9)
Diabetes Mellitus	Diabetic, *n* (%)	103 (66.5)	91 (58.7)
	Non-Diabetic, *n* (%)	52 (33.5)	64 (41.3)
Hypertension	Hypertensive, *n* (%)	61 (39.4)	66 (42.6)
	Non-Hypertensive, *n* (%)	94 (60.6)	89 (57.4)
Residentials Status	Urban, *n* (%)	22 (14.2)	20 (12.9)
	Rural, *n* (%)	133 (85.8)	135 (87.1)

Table II: Comparison of Outcome between Chlorhexidine Alcohol and Povidone Iodine by Age and Gender				
Outcome	**Age Group 20---35**		**95% Confidence Interval**	**P-Value**
	Groups			
	Chlorhexidine Alcohol	**Povidone Iodine**		
Surgical Site Infection	8 (7.5)	20 (17.9)	0.158------0.894	0.023
	Age Group > 35			
	6 (12.2)	6 (14.0)	0.256------2.897	0.808
Outcome	**Gender (Male)**		**95% Confidence Interval**	**P-Value**
	Groups			
	Chlorhexidine Alcohol	**Povidone Iodine**		
Surgical Site Infection	10 (11.5)	15 (16.7)	0.275------1.536	0.323
	Gender (Female)			
	4 (5.9)	11 (16.9)	0.092------1.019	0.040

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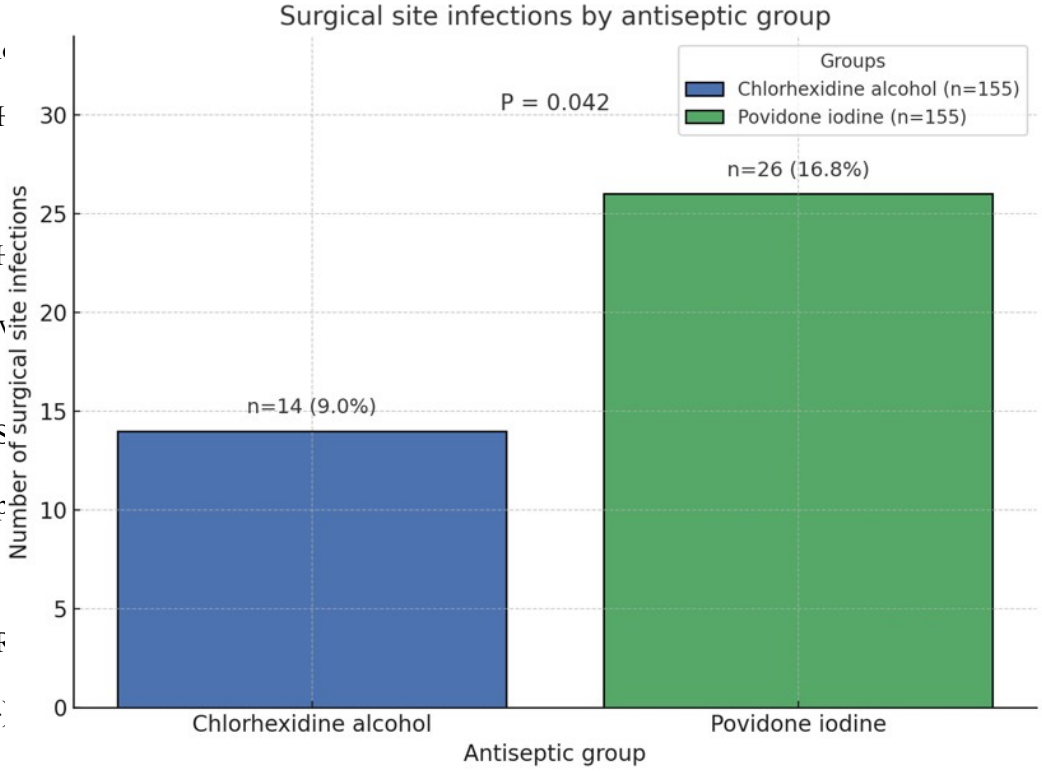

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