RESEARCH PAPER

CHLORHEXIDINE GLUCONATE VS POVIDONE-IODINE IRRIGATION FOR PREVENTING SURGICAL SITE INFECTION IN EXPLORATORY LAPAROTOMY: A PROSPECTIVE COMPARATIVE STUDY IN AN INDONESIAN TERTIARY HOSPITAL

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ABSTRACT

Introduction: Surgical site infection (SSI) remains one of the most common postoperative complications following exploratory laparotomy, contributing to increased morbidity, prolonged hospitalization, and higher healthcare costs. Intraoperative antiseptic irrigation has been used to reduce bacterial colonization of surgical wounds; however, evidence regarding the comparative effectiveness of povidone-iodine and chlorhexidine gluconate remains inconclusive. This study aimed to compare the effectiveness of 1% povidone-iodine and 0.05% chlorhexidine gluconate irrigation in reducing bacterial colonization and SSI incidence following exploratory laparotomy.

Methods: A prospective quasi-experimental comparative study was conducted among patients undergoing exploratory laparotomy at Dr. Saiful Anwar General Hospital, Malang, Indonesia. Subjects meeting the inclusion and exclusion criteria were consecutively enrolled and allocated alternately into two groups: 1% povidone-iodine irrigation (n=14) and 0.05% chlorhexidine gluconate irrigation (n=14). All patients received the same prophylactic antibiotic regimen using cefazolin. Outcomes were assessed based on postoperative subcutaneous tissue bacterial culture and SSI occurrence on postoperative day 7. Comparative statistical analyses were performed with significance set at $p<0.05$.

Result: The chlorhexidine group demonstrated a higher proportion of negative postoperative wound cultures compared with the povidone-iodine group (57.1% vs 35.7%). The incidence of SSI was also lower in the chlorhexidine group (21.4% vs 42.9%). However, these differences were not statistically significant. Risk analysis showed a trend toward increased SSI risk in the povidone-iodine group (RR=2.75; 95% CI: 0.524–14.44).

Conclusion: Although no statistically significant difference was observed, 0.05% chlorhexidine gluconate irrigation demonstrated a trend toward greater effectiveness in reducing bacterial colonization and surgical site infection following exploratory laparotomy compared with 1% povidone-iodine irrigation.

Keywords: exploratory laparotomy, surgical site infection, chlorhexidine gluconate, povidone-iodine, wound irrigation

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INTRODUCTION

Surgical site infection (SSI) remains one of the most common postoperative complications worldwide and continues to be a major concern in surgical practice due to its association with increased morbidity, prolonged hospitalization, readmission, and healthcare expenditure.[1] Patients undergoing exploratory laparotomy are particularly vulnerable to SSI because of the extensive tissue manipulation, prolonged operative duration, and increased risk of intra-abdominal contamination.[2] SSI following abdominal surgery may also contribute to delayed recovery, impaired wound healing, and increased postoperative mortality.[3]

Despite advances in perioperative management, the incidence of SSI after abdominal surgery remains relatively high, particularly in emergency laparotomy and contaminated surgical procedures.[4] Various preventive strategies have therefore been developed to reduce bacterial contamination during surgery, including prophylactic antibiotics, sterile operative techniques, wound protection devices, and intraoperative wound irrigation.[5] Among these approaches, antiseptic wound irrigation has gained increasing attention because of its potential to directly reduce microbial colonization at the surgical site before wound closure.[6]

Povidone-iodine and chlorhexidine gluconate are among the most commonly used antiseptic agents in surgical practice. Povidone-iodine exerts broad-spectrum antimicrobial activity through the release of free iodine, which disrupts microbial proteins and nucleic acids.[7] However, concerns have been raised regarding its cytotoxic effects on

fibroblasts and keratinocytes, which may impair tissue healing.[8] Chlorhexidine gluconate, on the other hand, acts by disrupting bacterial cell membranes and has demonstrated prolonged residual antimicrobial activity with relatively lower tissue toxicity.[9] Several studies have suggested that chlorhexidine may be more effective than povidone-iodine in reducing surgical wound contamination and SSI incidence.[10] Nevertheless, findings across studies remain inconsistent, particularly in abdominal surgery settings.

Current evidence comparing povidone-iodine and chlorhexidine irrigation in exploratory laparotomy remains limited, especially in Indonesian clinical settings. Furthermore, data regarding postoperative bacterial colonization following intraoperative antiseptic irrigation are still insufficient. Therefore, this study aimed to compare the effectiveness of 1% povidone-iodine and 0.05% chlorhexidine gluconate irrigation in reducing postoperative bacterial colonization and surgical site infection following exploratory laparotomy.

METHODS

Study design and participants

This prospective quasi-experimental comparative study was conducted at Dr. Saiful Anwar General Hospital, Malang, Indonesia, from April to June 2025. The study involved patients undergoing exploratory laparotomy procedures, including both elective and emergency surgeries. Subjects who fulfilled the inclusion and exclusion criteria were consecutively recruited and allocated alternately into two intervention groups.

Patients aged ≥18 years who underwent exploratory laparotomy and agreed to participate in the study were included. Patients with immunodeficiency disorders, uncontrolled diabetes mellitus, severe malnutrition, chronic corticosteroid use, pre-existing surgical site infection, or incomplete follow-up data were excluded from the study.

Intervention procedures

Eligible subjects were assigned alternately into either the 1% povidone-iodine irrigation group or the 0.05% chlorhexidine gluconate irrigation group. Before abdominal wall closure, subcutaneous tissues were irrigated using the assigned antiseptic solution according to the study protocol.

All patients received the same prophylactic antibiotic regimen consisting of intravenous cefazolin administered preoperatively according to hospital protocol. Standard sterile surgical techniques and postoperative wound care procedures were applied consistently in both groups.

Outcome assessment

The primary outcomes of this study were postoperative bacterial colonization and surgical site infection incidence. Bacterial colonization was assessed through postoperative subcutaneous tissue culture obtained from the surgical wound following irrigation and closure procedures. Culture results were categorized as positive or negative bacterial growth.

Surgical site infection was evaluated clinically on postoperative day 7 based on signs of wound infection, including purulent discharge, erythema, swelling, localized tenderness, or wound dehiscence. SSI diagnosis was determined according to clinical evaluation by the surgical team.

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) software version 25.0 (IBM Corp., Armonk, NY, USA). Numerical variables were presented as mean ± standard deviation or median (minimum–maximum), while categorical variables were expressed as frequency and percentage. Comparative analyses between groups were performed using Chi-square test or Fisher's exact test for categorical variables and independent t-test or Mann–Whitney test for continuous variables, as appropriate. Relative risk (RR) with 95% confidence interval (CI) was calculated to estimate the association between intervention groups and SSI incidence. A p-value <0.05 was considered statistically significant.

Ethical approval

Ethical approval for this study was obtained from the Health Research Ethics Committee, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia (No. 107/EC/KEPK-PPDS/04/2025). Written informed consent was obtained from all participants prior to enrollment in the study.

RESULTS

A total of 28 patients undergoing exploratory laparotomy were enrolled in this study and divided equally into the 1% povidone-iodine irrigation group (n=14) and the 0.05% chlorhexidine gluconate irrigation group (n=14). Baseline demographic and clinical characteristics of the subjects were comparable between both groups.

Table 1. Baseline characteristics of study participants

Variables	Povidone-iodine (n=14)	Chlorhexidine gluconate (n=14)	p-value
Age (years), mean ± SD	50.7 ± 12.6	47.4 ± 14.3	0.515
Sex, n (%)			0.385
Male	12 (85.7)	9 (64.3)	

Female	2 (14.3)	5 (35.7)

Note: SD = standard deviation.

Postoperative bacterial culture examination demonstrated a higher proportion of negative bacterial growth in the chlorhexidine gluconate group compared with the povidone-iodine group. Negative culture results were observed in 57.1% of patients receiving chlorhexidine gluconate irrigation and 35.7% of patients receiving povidone-iodine irrigation. However, the difference was not statistically significant.

Table 2. Comparison of postoperative bacterial culture results between groups

Bacterial culture result	Povidone-iodine (n=14)	Chlorhexidine gluconate (n=14)	p-value
Positive culture, n (%)	9 (64.3)	6 (42.9)	0.256
Negative culture, n (%)	5 (35.7)	8 (57.1)	

The incidence of surgical site infection on postoperative day 7 was lower in the chlorhexidine gluconate group compared with the povidone-iodine group. SSI occurred in 6 patients (42.9%) in the povidone-iodine group and 3 patients (21.4%) in the chlorhexidine gluconate group. Statistical analysis showed no significant difference between groups.

Table 3. Comparison of surgical site infection incidence between groups

Surgical site infection	Povidone-iodine (n=14)	Chlorhexidine gluconate (n=14)	p-value
SSI present, n (%)	6 (42.9)	3 (21.4)	0.225
SSI absent, n (%)	8 (57.1)	11 (78.6)	

Risk analysis demonstrated that patients receiving povidone-iodine irrigation had a tendency toward increased risk of surgical site infection compared with those receiving chlorhexidine gluconate irrigation (RR=2.75; 95% CI: 0.524–14.44). However, the confidence interval crossed unity, indicating the absence of statistical significance.

DISCUSSION

This study demonstrated that intraoperative irrigation using 0.05% chlorhexidine gluconate showed a trend toward lower postoperative bacterial colonization and reduced surgical site infection incidence compared with 1% povidone-iodine irrigation in patients undergoing exploratory laparotomy. Although the observed differences did not reach statistical significance, the chlorhexidine group consistently demonstrated more favorable outcomes across both microbiological and clinical parameters.

Surgical site infection remains a major postoperative complication in abdominal surgery, particularly in exploratory laparotomy procedures that involve a higher risk of contamination and extensive tissue exposure.[11] The occurrence of SSI contributes substantially to prolonged hospitalization, increased healthcare costs, delayed wound healing, and postoperative morbidity.[12] Therefore, preventive strategies aimed at reducing bacterial contamination during surgery continue to be an important area of investigation.

In the present study, the chlorhexidine gluconate group demonstrated a higher proportion of negative postoperative wound cultures compared with the povidone-iodine group. This finding suggests that chlorhexidine irrigation may provide superior bacterial suppression at the surgical site. Chlorhexidine possesses broad-spectrum antimicrobial activity against Gram-positive and Gram-negative bacteria through disruption of bacterial cell membranes and precipitation of intracellular contents.[13] In addition, chlorhexidine has residual antimicrobial activity that may persist on tissue surfaces after application, potentially contributing to prolonged antibacterial effects during the postoperative period.[14]

The incidence of surgical site infection was also lower among patients receiving chlorhexidine irrigation. Although statistical significance was not achieved, the relative risk analysis demonstrated a tendency toward increased SSI risk in the povidone-iodine group. The absence of statistical significance in this study may be related to the relatively small sample size, which limited statistical power to detect clinically meaningful differences between groups. Nevertheless, the observed trend remains clinically relevant because even modest reductions in SSI incidence may substantially improve postoperative outcomes and reduce healthcare burden.

Several previous studies have similarly reported the potential superiority of chlorhexidine compared with povidone-iodine in surgical antisepsis. Meta-analyses evaluating preoperative skin preparation and wound irrigation have shown lower SSI rates associated with chlorhexidine-based antiseptic protocols.[15] Chlorhexidine has also been reported to demonstrate lower cytotoxicity toward fibroblasts and keratinocytes compared with iodine-based antiseptics, potentially supporting better tissue recovery and wound healing.[16] In contrast, povidone-iodine may exert cytotoxic effects on

healthy tissues when used at higher concentrations, despite its broad antimicrobial spectrum.[17]

However, evidence regarding the comparative effectiveness of these antiseptic agents remains inconsistent across different surgical settings. Variations in patient characteristics, contamination level, surgical duration, antibiotic prophylaxis, and antiseptic concentration may influence postoperative infection outcomes.[18] The present study attempted to minimize these confounding factors by applying standardized prophylactic antibiotic administration and consistent surgical wound management protocols in both groups.

This study has several limitations. First, the relatively small sample size reduced the statistical power of the analysis and limited the generalizability of the findings. Second, this was a single-center study, which may not fully represent broader surgical populations. Third, postoperative follow-up was limited to postoperative day 7, potentially missing late-onset SSI cases. In addition, microbiological identification of bacterial species and antibiotic resistance patterns was not extensively analyzed.

Despite these limitations, this study provides preliminary clinical evidence regarding the use of chlorhexidine gluconate irrigation in exploratory laparotomy procedures within an Indonesian tertiary hospital setting. The findings support the potential role of chlorhexidine as an alternative intraoperative antiseptic agent for SSI prevention. Further multicenter studies with larger sample sizes and longer follow-up periods are recommended to validate these findings and establish definitive clinical recommendations.

CONCLUSION

Intraoperative irrigation using 0.05% chlorhexidine gluconate demonstrated a trend toward lower postoperative bacterial colonization and reduced surgical site infection incidence compared with 1% povidone-iodine irrigation in patients undergoing exploratory laparotomy. Although the differences were not statistically significant, chlorhexidine gluconate showed more favorable microbiological and clinical outcomes.

These findings suggest that chlorhexidine gluconate may serve as a potential alternative antiseptic irrigation agent for surgical site infection prevention in exploratory laparotomy procedures. Further studies involving larger sample sizes and multicenter designs are required to confirm the clinical effectiveness of chlorhexidine-based wound irrigation strategies.

DISCLOSURE

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The authors received no specific funding for this study.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

Author Contributions

Ibrahim Yusuf Nasution contributed to study conceptualization, data collection, data analysis, and manuscript preparation. Setyo Sugiharto contributed to study design, supervision, interpretation of findings, and critical revision of the manuscript. Solimun contributed to statistical analysis and interpretation of data. All authors reviewed and approved the final version of the manuscript.

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