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Original Research Article

Efficacy and safety of abdominal cavity cleansing with chlorhexidine for reducing surgical site infection in patients undergoing appendectomy

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ABSTRACT

Background: Surgical site infection (SSI) remains a relevant postoperative complication after appendectomy. Intraoperative abdominal cavity cleansing is used in clinical practice, but the evidence supporting antiseptic solutions remains heterogeneous.
Methods: A prospective case-control study was conducted in adults undergoing appendectomy for acute appendicitis at a tertiary hospital in Puebla, Mexico. Patients received intraoperative abdominal cavity cleansing with either chlorhexidine or saline. The primary outcome was surgical site infection within 30 days. Patients were followed at 15 and 30 days postoperatively. Demographic, clinical, microbiological, and adverse-event data were collected. Associations were analyzed using odds ratios with 95% confidence intervals and Fisher's exact test, with $p<0.05$ considered statistically significant.
Results: The median age was 37 years (IQR 26-51); 217 patients (55.5%) were women and 174 (44.5%) were men. Uncomplicated and complicated appendicitis occurred in 198 (50.6%) and 193 (49.4%) patients, respectively. Postoperative complications occurred in 97/192 (50.5%) patients in the chlorhexidine group and 58/108 (53.7%) in the saline group. Chlorhexidine showed a non-significant trend toward fewer complications (OR 0.88, 95% CI 0.55-1.41; p=0.63). Mean time to infection was 16.3±8.4 days. The most frequent positive isolate was Escherichia coli. No increase in adverse events was observed with chlorhexidine.
Conclusions: Abdominal cavity cleansing with chlorhexidine was clinically safe and showed a non-significant trend toward fewer postoperative complications compared with saline. These findings support further adequately powered randomized studies to define its role in SSI prevention after appendectomy.

Keywords: Acute appendicitis, Surgical site infection, Chlorhexidine, Abdominal cavity cleansing, Appendectomy

INTRODUCTION

Acute appendicitis is one of the most common surgical emergencies. Despite advances in diagnosis, antimicrobial therapy, and operative care, surgical site infection (SSI) remains an important source of postoperative morbidity, prolonged care, and healthcare use.[1-4] The risk of SSI is influenced by patient-related factors, wound classification, operative duration, antimicrobial prophylaxis, and the degree of intraoperative contamination.[1-3]

The Centers for Disease Control and Prevention define SSI according to the anatomic site involved and the

postoperative surveillance period. Early recognition and appropriate management are essential because SSI can lead to wound dehiscence, prolonged treatment, and reintervention.[2,5]

Appendectomy remains a standard treatment for acute appendicitis. Distinguishing uncomplicated from complicated disease is clinically relevant because perforation, purulent contamination, and more advanced local disease can increase postoperative infectious risk.[6-9] Preoperative and perioperative antimicrobial strategies are therefore central components of source-control management.[4]

Intraoperative irrigation and wound cleansing have been evaluated as additional SSI-prevention strategies, but the available evidence is heterogeneous. A Cochrane review found insufficiently consistent evidence to establish a universal benefit of intracavity lavage or wound irrigation.[10] Subsequent randomized studies and protocols have evaluated saline, antibiotic-containing solutions, polyhexanide, and other antiseptic agents with variable results.[11-17]

Chlorhexidine is a broad-spectrum antiseptic with persistent antimicrobial activity and is widely used for skin antisepsis and local wound care. Studies of antiseptic preparation have demonstrated potential reductions in SSI, although evidence from skin preparation or other surgical settings cannot be directly extrapolated to abdominal cavity cleansing during appendectomy.[18-20]

Given the continued clinical burden of SSI after appendectomy at General Hospital No. 20 "La Margarita," Mexican Social Security Institute, this study aimed to evaluate the efficacy and safety of abdominal cavity cleansing with chlorhexidine for reducing SSI in patients undergoing appendectomy, using saline cleansing as the comparator.

Therefore, the objective of this study was to evaluate the efficacy and safety of abdominal cavity cleansing with 0.05% chlorhexidine to reduce surgical site infection in patients who underwent appendectomy, comparing these results with those obtained using saline solution.

METHODS

Study design

A prospective, analytical, longitudinal case-control study was conducted to evaluate the efficacy and safety of abdominal cavity cleansing with chlorhexidine compared with saline in patients undergoing appendectomy.

Study site and period

The study was conducted in the General Surgery Department of General Hospital No. 20 "La Margarita," Mexican Social Security Institute (IMSS), Puebla, Mexico, after approval of the protocol and until the required sample size was completed.

Study population

The study population consisted of IMSS beneficiaries aged 18 years or older, of either sex, with a diagnosis of acute appendicitis who underwent appendectomy and intraoperative abdominal cavity cleansing. Patients who agreed to participate and signed written informed consent were included after approval of the protocol by the Local Health Research Committee (CLIS) and until the required total sample of 391 patients was completed.

Inclusion criteria

Patients who met the following criteria were included: age 18 years or older. Male or female sex. Diagnosis of complicated or uncomplicated appendicitis treated with appendectomy. Abdominal cavity cleansing with chlorhexidine for cases or saline for controls. Acceptance to participate and signed informed consent.

Exclusion criteria

Patients with any of the following conditions were excluded: known allergy to chlorhexidine, incomplete clinical history or loss of postoperative follow-up, absence of wound culture when required by the study protocol, death and sepsis. Any physical or mental condition preventing adherence to medical instructions in the absence of a responsible caregiver or tutor.

Incomplete data required for follow-up.

Withdrawal/elimination criteria

Procedure

All procedures were performed by attending physicians and residents of the General Surgery Department following the department's standard surgical technique.

After appendectomy and adequate source control, abdominal cavity cleansing was performed according to the study protocol. Patients exposed to chlorhexidine constituted the case group, whereas those managed with saline constituted the control group.

A sterile gauze pad held with surgical forceps was used for mechanical cleansing. In patients receiving chlorhexidine, the gauze was impregnated with 20 mL of chlorhexidine and used to cleanse the paracolic gutters, surgical site, and pelvic cavity, as described in the thesis protocol. Saline was used for cavity cleansing in the control group. Cleansing was performed mechanically over the paracolic gutters, surgical site, and pelvic cavity using instrumented gauze, as described in the study protocol.

All patients received perioperative antibiotic therapy and postoperative treatment in accordance with institutional protocols and at the discretion of the treating surgeon.

Study variables

The main exposure variable was the type of abdominal cavity cleansing performed during surgery: chlorhexidine and/or saline, as recorded in the study data collection instrument.

The primary dependent variable was the presence of a surgical site infection during the first 30 days following surgery, defined according to the criteria of the Centers for Disease Control and Prevention (CDC).

Secondary variables included: age; sex; type of appendicitis (complicated or uncomplicated); time of onset of infection; microorganisms isolated in microbiological cultures; adverse events related to abdominal cavity cleansing.

Follow-up

All patients underwent clinical follow-up 15 and 30 days after the surgical procedure. During these visits, the healing of the surgical wound was assessed, as well as the presence of clinical signs consistent with surgical site infection. When there was clinical suspicion of infection, the diagnosis was made according to CDC criteria, and, when appropriate, microbiological cultures were performed to identify the causative microorganism.

Data collection

Information was obtained using a data collection instrument designed for the study and supplemented by a review of the institutional electronic medical records. Subsequently, the data were entered into an electronic database for statistical analysis, ensuring the confidentiality of the information by removing identifying information.

Statistical analysis

Quantitative variables were assessed using the Kolmogorov-Smirnov normality test. Variables with a non-normal distribution were described using the median and interquartile range (IQR), while qualitative variables were expressed as absolute frequencies and percentages.

Results were summarized using descriptive statistics. Inferential analysis was performed using the odds ratio (OR) with a 95% confidence interval (CI) to estimate the strength of association between surgical site infection/postoperative complications and chlorhexidine exposure compared with no chlorhexidine exposure. Fisher's exact test was used for the comparison reported in the thesis, with $p<0.05$ considered statistically significant.

Ethical considerations

The study was approved by the Local Health Research Committee No. 2108 of General Zone Hospital No. 20 "La Margarita," Mexican Social Security Institute, with registration number R-2025-2108-050. The research was conducted in accordance with the Declaration of Helsinki, the Regulations of the General Health Law on Health Research, the Nuremberg Code, and the Belmont Report. All participants provided written informed consent prior to their inclusion in the study, ensuring confidentiality and the exclusive use of the information for research purposes.

RESULTS

A total of 391 patients undergoing appendectomy were included. Mean age was 40.3±16.6 years (range 18-92). Because age was not normally distributed, it was also summarized as a median of 37 years (IQR 26-51). Women accounted for 217 patients (55.5%) and men for 174 (44.5%). Uncomplicated appendicitis was documented in 198 patients (50.6%), whereas 193 (49.4%) had complicated appendicitis. All patients received preoperative antibiotic prophylaxis (100%, n=391) (Table 1).

Table 1: Demographic and clinical characteristics of the study population (n=391).

Characteristics	Value	N (%) / summary
Age (in years)	Median (IQR)	37 (26-51)
	Mean±SD; range	40.3±16.6; 18-92
Sex	Female	217 (55.5%)
	Male	174 (44.5%)
Appendicitis	Uncomplicated	198 (50.6%)
	Complicated	193 (49.4%)

Chlorhexidine abdominal cavity cleansing was documented in 192 patients (49.1%), whereas saline cleansing was documented in 108 patients (27.6%). The thesis dataset indicates that some patients received both types of cleansing; therefore, these exposure categories were not mutually exclusive.

Postoperative complications, used in the thesis as a clinical approximation to SSI and related postoperative complications, occurred in 198 patients (50.6%) overall. Among patients in the chlorhexidine group, 97/192 (50.5%) developed complications and 95/192 (49.5%) did not. In the saline group, 58/108 (53.7%) developed complications and 50/108 (46.3%) did not. The estimated odds ratio for complications with chlorhexidine compared with saline was 0.88 (95% CI 0.55-1.41; p=0.63, Fisher's exact test), indicating no statistically significant difference, although a non-significant trend toward fewer complications was observed with chlorhexidine (Figure 1).

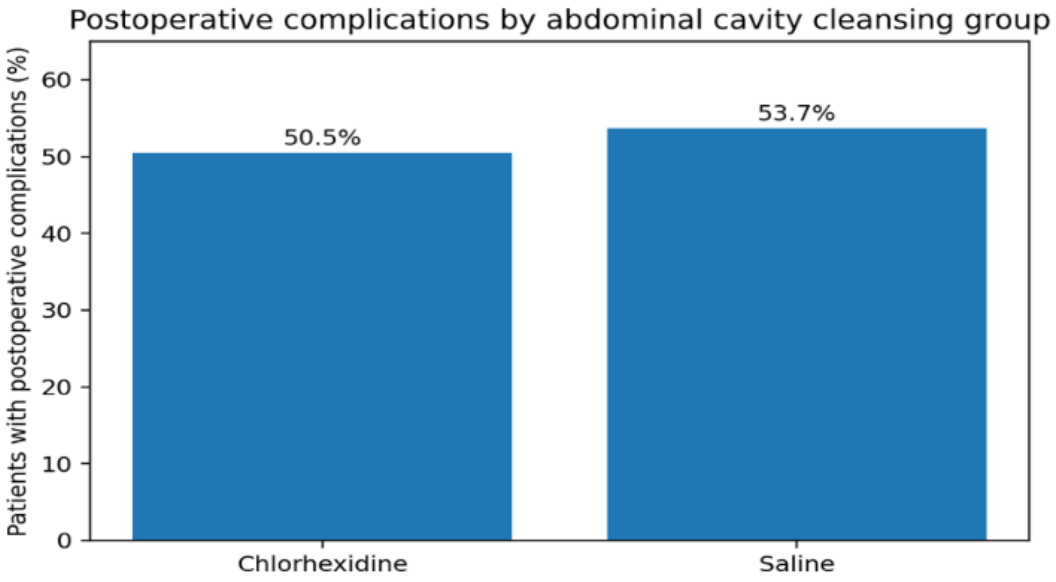

Figure 1: Frequency of postoperative complications according to abdominal cavity cleansing group.

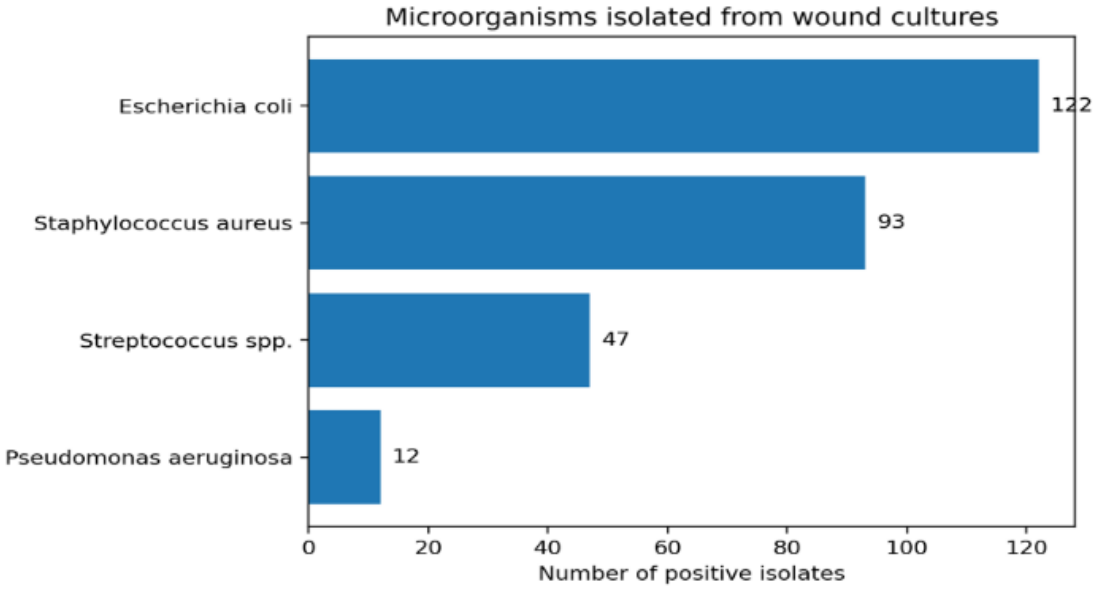

Figure 2: Microorganisms isolated from positive wound cultures.

Regarding safety, 163 patients (41.7%) in the total sample were classified as having no safety event according to the thesis safety variable. Within the chlorhexidine group, 85/192 patients (44.3%) were classified as "safe," compared with 40/108 (37.0%) in the saline group. The available data did not demonstrate an increase in adverse events associated with chlorhexidine.

Mean operative time was 68.0±27.9 minutes (range 20-120). Mean operative time was 69.3 minutes in patients receiving chlorhexidine and 66.8 minutes in those not receiving chlorhexidine; no clinically relevant difference in operative duration was identified.

The mean time to onset of infection was 16.3±8.4 days (range 1-30). Mean time to infection was 15.9 days in patients receiving chlorhexidine and 16.6 days in those without chlorhexidine, with infections occurring predominantly during the second to fourth postoperative weeks.

Wound cultures were documented in 184 patients (47.1%). Among the reported positive isolates, Escherichia coli was the most frequent (122 isolates; 44.5%), followed by Staphylococcus aureus (93; 33.9%), Streptococcus spp. (47; 17.2%), and Pseudomonas aeruginosa (12; 4.4%) (Figure 2).

The most frequent comorbidity profile was absence of comorbid disease (283 patients; 72.4%), followed by diabetes mellitus (55; 14.1%), arterial hypertension (43; 11.0%), and hypothyroidism (10; 2.6%). No marked differences in postoperative complication proportions were observed between the comorbidity categories in the thesis analysis.

DISCUSSION

This study evaluated the efficacy and safety of abdominal cavity cleansing with chlorhexidine in patients undergoing appendectomy. The principal finding was that postoperative complications occurred in 50.5% of patients exposed to chlorhexidine and 53.7% of those exposed to saline. The estimated OR was 0.88 (95% CI 0.55-1.41; p=0.63), indicating that the observed difference did not reach statistical significance. Accordingly, the present data support a possible favorable trend rather than a proven protective effect of chlorhexidine.

The study population was relatively young, with a median age of 37 years, and women represented 55.5% of the sample. Firdos et al similarly evaluated appendectomy patients in a predominantly young-adult population and demonstrated the relevance of intraoperative appendiceal morphology to postoperative SSI.[9] Age, physiologic status, and operative duration are recognized contributors to SSI risk in abdominal surgery, as described by Bhat et al, while other perioperative factors may also modify postoperative complication risk.[3,21]

Complicated and uncomplicated appendicitis were almost equally represented in the present series (49.4% and 50.6%, respectively). This distinction is clinically important because complicated disease involves perforation and/or localized abscess and is associated with a higher infectious burden.[7,8] Firdos et al reported that most SSIs in their series occurred in patients with complicated appendicitis.[9] Akash et al also addressed wound-related SSI prevention in complicated appendicitis.[6] Thus, the high proportion of complicated cases in our population may have contributed to the substantial overall frequency of postoperative complications.

All patients received preoperative antibiotic prophylaxis, consistent with the principle that antimicrobial therapy is an essential component of source control in intra-abdominal infection.[4] However, antibiotic prophylaxis does not eliminate the potential influence of residual contamination, which is the rationale for evaluating intraoperative cleansing strategies.

The absence of a statistically significant difference between chlorhexidine and saline is compatible with the heterogeneous evidence on intraoperative irrigation. Norman et al concluded that the available evidence was insufficient to establish a consistent benefit of intracavity lavage or wound irrigation for SSI prevention.[10] Mueller et al subsequently evaluated intraoperative wound irrigation after laparotomy in a randomized clinical trial, while Elfallal et al studied gentamicin-saline irrigation in open appendectomy.[11,12] Wang et al reported a benefit with high-volume saline irrigation in abdominal infection, illustrating that outcomes may depend on the surgical setting, irrigation technique, volume, and agent used.[14] Protocols by Muller et al and Mueller et al further emphasize the continuing uncertainty regarding the optimal intraoperative irrigation strategy.[13,15]

Antiseptic-specific evidence is also mixed. Obara et al reported lower SSI rates with olanexidine than with aqueous povidone-iodine in clean-contaminated surgery, whereas the randomized trial by Maemoto et al did not show superiority of aqueous povidone-iodine over saline for intraoperative wound irrigation after gastroenterological surgery; its preceding protocol illustrates the rigorous methodology required to evaluate these interventions.[16-18] Darouiche et al demonstrated lower SSI rates with chlorhexidine-alcohol than with povidone-iodine for preoperative skin antisepsis.[20] Although these studies support the antimicrobial potential of antiseptics, they involved different anatomical applications and should not be directly extrapolated to abdominal cavity cleansing with chlorhexidine.

Mean operative time was 68.0±27.9 minutes and did not differ meaningfully according to chlorhexidine exposure. This is relevant because prolonged operative duration has been associated with a higher SSI risk.[3] In the present teaching-hospital setting, operative duration may also reflect disease severity and surgeon experience, and the thesis did not model operative time as an independent predictor of SSI.

The mean time to infection was 16.3±8.4 days, with most events occurring during the second to fourth postoperative weeks. This temporal pattern supports the need for structured surveillance during the first 30 postoperative days, consistent with standard SSI evaluation and management frameworks.[2,5]

Escherichia coli was the most frequent positive wound-culture isolate (44.5%), followed by *Staphylococcus aureus* (33.9%), *Streptococcus spp*. (17.2%), and Pseudomonas aeruginosa (4.4%). The predominance of enteric organisms is biologically plausible in appendicitis because the operative field may be exposed to gastrointestinal flora, particularly in complicated disease. These microbiological findings provide locally relevant information for surveillance and postoperative therapeutic decisions.

Regarding safety, the thesis data did not show an increase in adverse events with chlorhexidine, and the proportion classified as safe was slightly higher in the chlorhexidine group than in the saline group. Chlorhexidine is widely

used as an antiseptic, including in local wound care, and prior antiseptic trials have generally reported low rates of serious treatment-related reactions.[18-20] Nevertheless, because the present safety analysis was descriptive and the exposure groups were not mutually exclusive in all patients, the safety findings should be interpreted cautiously.

This study has several strengths, including its prospective, analytical, longitudinal case-control design, a 30-day follow-up framework, inclusion of 391 appendectomy patients, and evaluation of clinical, microbiological, operative-time, and safety variables.

Overall, the present results do not establish the superiority of chlorhexidine over saline for abdominal cavity cleansing after appendectomy. They do, however, suggest that chlorhexidine can be used without an evident increase in adverse events and may warrant further evaluation. Larger multicenter randomized trials with clearly mutually exclusive treatment groups, standardized cleansing techniques, and adjusted analyses are needed to determine whether the observed trend represents a clinically meaningful reduction in SSI.

CONCLUSION

In patients undergoing appendectomy, abdominal cavity cleansing with chlorhexidine was clinically safe and showed a non-significant trend toward fewer postoperative complications compared with saline (OR 0.88, 95% CI 0.55-1.41; p=0.63). The study also characterized the timing and microbiological profile of postoperative infection, with infections occurring mainly during the second to fourth postoperative weeks and Escherichia coli being the most frequent isolate. These findings advance local understanding by providing prospective clinical and microbiological data on chlorhexidine-based abdominal cavity cleansing in a second-level teaching hospital; however, they do not establish superiority over saline and support the need for larger, multicenter randomized trials with standardized, mutually exclusive treatment groups and adjustment for confounding variables.

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REFERENCES

1. Armstrong DG, Meyr AJ. Risk factors for impaired wound healing and wound complications. UpToDate. 2023. Available at: https://www.uptodate.com/contents/risk-factors-for-impaired-wound-healing-and-wound-complications Accessed on 09 July 2026.
2. Anderson DJ. Overview of control measures for prevention of surgical site infection in adults. UpToDate. 2024. Available at: https://www.uptodate.com/contents/overview-of-control-measures-for-prevention-of-surgical-site-infection-in-adults Accessed on 09 July 2026.
3. Bhat RA, Isaac NV, Joy J, Chandran D, Suresh V, Thomas S, et al. The effect of American Society of Anesthesiologists score and operative time on surgical site infection rates in major abdominal surgeries. Cureus. 2024;16(2):e55138.
4. Membrilla-Fernández E, Gómez-Zorrilla S, González-Castillo AM, Pelegrina-Manzano A, Guzmán-Ahumada J, Prim N, et al. Scientific evidence of the duration of antibiotic treatment in intra-abdominal infections with surgical focus control. Cir Esp (Engl Ed). 2022;100:608-13.
5. Akash A, Saxena N. Superficial surgical site infection in delayed primary vs primary wound closure in complicated appendicitis. Pol Przegl Chir. 2023;96(0):123-9.
6. Norman G, Atkinson RA, Smith TA, Rowlands C, Rithalia AD, Crosbie EJ, et al. Intracavitary lavage and wound irrigation for prevention of surgical site infection. Cochrane Database Syst Rev. 2017;10:CD012234.
7. Mueller TC, Kehl V, Dimpel R, Blankenstein C, Egert-Schwender S, Strudthoff J, et al. Intraoperative wound irrigation for the prevention of surgical site infection after laparotomy: a randomized clinical trial by CHIR-Net. JAMA Surg. 2024;159(5):484-92.
8. Emile SH, Elfallal AH, Abdel-Razik MA, El-Said M, Elshobaky A. A randomized controlled trial on irrigation of open appendectomy wound with gentamicin-saline solution versus saline solution for prevention of surgical site infection. Int J Surg. 2020;81:140-6.
9. Mueller TC, Nitsche U, Kehl V, Schirren R, Schossow B, Goess R, et al. Intraoperative wound irrigation to prevent surgical site infection after laparotomy (IOWISI): study protocol for a randomized controlled trial. Trials. 2017;18(1):410.
10. Wang J, Lv W, Xu S, Yang C, Du B, Zhong Y, et al. Intraoperative incision irrigation with high-volume saline reduces surgical site infection for abdominal infections. Front Surg. 2022;9:927896.
11. Mueller TC, Dimpel R, Kehl V, Friess H, Reim D. Surgical site infection prevention in abdominal surgery: is intraoperative wound irrigation with antiseptics effective? Protocol for a systematic review and meta-analysis. BMJ Open. 2023;13(2):e066140.
12. Bom WJ, Scheijmans JCG, Salminen P, Boermeester MA. Diagnosis of uncomplicated and complicated appendicitis in adults. Scand J Surg. 2021;110(2):170-9.
13. Lai SL, Chang CH, Lee PC, Ho CM, Wu JM, Lai HS, et al. Impact of preoperative factors and waiting time on post-appendectomy complications: a retrospective study. Perioper Med (Lond). 2024;13:8.

14. Obara H, Takeuchi M, Kawakubo H, Shinoda M, Okabayashi K, Hayashi K, et al. Aqueous olanexidine versus aqueous povidone-iodine for surgical skin antisepsis on the incidence of surgical site infections after clean-contaminated surgery: a multicentre, prospective, blinded-endpoint, randomised controlled trial. Lancet Infect Dis. 2020;20(11):1281-9.
15. Evans HL. Overview of the evaluation and management of surgical site infection. UpToDate. 2024. Available at: https://www.uptodate.com/contents/overview-of-the-evaluation-and-management-of-surgical-site-infection Accessed on 09 July 2026.
16. Caballero-Alvarado J, Torres VL, Peralta KL, Zavaleta-Corvera C. Complicated acute appendicitis with compromised appendiceal base: a review of surgical strategies. Pol Przegl Chir. 2023;96(0):65-70.
17. Firdos R, Abdi IH, Laghari QA, Sahito M, Kalhoro N, Memon SM. Correlation of surgical site infection (SSI) after appendicectomy with per-operative morphological appearance of appendix. Prof Med J. 2020;27(2):251-9.
18. Tenenhaus M, Rennekampff HO. Topical agents and dressings for local burn wound care. UpToDate. 2023. Available at: https://www.uptodate.com/contents/topical-agents-and-dressings-for-local-burn-wound-care Accessed on 10 July 2026.
19. Maemoto R, Noda H, Ichida K, Tamaki S, Kanemitsu R, Machida E, et al. Superiority trial comparing intraoperative wound irrigation with aqueous 10% povidone-iodine to saline for the purpose of reducing surgical site infection after elective gastrointestinal surgery: study protocol for a randomised controlled trial. BMJ Open. 2021;11(6):e051374.
20. Maemoto R, Noda H, Ichida K, Miyakura Y, Kakizawa N, Machida E, et al. Aqueous povidone-iodine versus normal saline for intraoperative wound irrigation on the incidence of surgical site infection in clean-contaminated wounds after gastroenterological surgery: a single-institute, prospective, blinded-endpoint, randomized controlled trial. Ann Surg. 2023;277(5):727-33.
21. 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.

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