BMC Surgery

SYSTEMATIC REVIEW

Open Access

Wound irrigation and peritoneal lavage with antiseptic/antibiotic solution before wound closure during gastrointestinal surgery: a systematic review and meta-analysis

Motoi Uchino[1*], Koji Tamura[2], Shinsuke Nomura[3], Seiichi Shinji[4], Keita Kouzu[5], Hiroji Shinkawa[6], Tomohiro Ishinuki[7], Toru Mizuguchi[7], Hiroki Ohge[8], Seiji Haji[9], Junzo Shimizu[10], Yasuhiko Mohri[11], Chizuru Yamashita[12], Yuichi Kitagawa[13], Katsunori Suzuki[14], Motomu Kobayash[15], Masahiro Kobayashi[16], Yuki Hanai[17], Hiroshi Nobuhara[18], Hiroki Imaoka[19], Masahiro Yoshida[20], Toshihiko Mayumi[21], Hiroki Ikeuchi[1] and on behalf of SSI Prevention Guideline Committee in Japan Society for Surgical Infection

Abstract

Background Surgical site infections (SSIs) can affect mortality, morbidity, and medical costs. Although it has recently been reported that washing with antiseptic/antibiotic solution can prevent SSI in clean surgery, the clinical impact in gastrointestinal surgery is still uncertain. Therefore, we performed a systematic review and meta-analysis to evaluate the efficacy of antiseptic/antibiotic solution during wound irrigation or peritoneal lavage in gastroenterological surgery.

Methods The database search used PubMed, MEDLINE, and Cochrane Library. The following inclusion criteria were set for the systematic review. 1) Studies comparing with or without antiseptic/antibiotic irrigation/lavage during gastrointestinal surgery. 2) Studies that described surgical site infections and adverse events. 3) Studies conducted after 2000.

Results A total of 8 randomized controlled studies (RCTs) and 3 observational studies were included in this meta-analysis. Three RCTs of wound irrigation with povidone iodine (PVI) solution revealed no significant difference between the PVI and control groups [RR 1.41, 95% CI (0.92 to 2.17): $p=0.69$]. Three RCTs of peritoneal lavage with antibiotic solution showed no significant difference between the interventional group and control groups [RR 0.39, 95% CI (0.10 to 1.55): $p=0.18$]. Regarding other antiseptic or antibiotic solutions, the number of studies and participants were too small for evaluation.

Conclusion Wound irrigation and peritoneal lavage with antiseptic/antibiotic solution did not have enough efficacy for preventing SSI during gastroenterological surgery.

*Correspondence:
Motoi Uchino
uchino2s@hyo-med.ac.jp
Full list of author information is available at the end of the article

Keywords Gastrointestinal surgery, Morbidity, Surgical site infections, Antiseptic/antibiotic solution, Wound irrigation, Peritoneal lavage

Introduction

Surgical site infections (SSIs) are a major complication after surgery that can affect mortality and lead to prolonged hospital stays or additional medical costs [1, 2]. Therefore, the prevention of SSIs is a crucial issue not only during the pre- and postoperative periods but also during surgery. Generally, peritoneal lavage and wound irrigation before wound closure are performed to reduce the microbial burden by removing tissue debris, metabolic waste, and tissue exudate from the surgical site in gastroenterological surgery. For many years, although washing with antiseptic or antibiotic solutions has been shown to be beneficial in selected surgical disciplines and, recently, to prevent SSI in clean surgery, it has not had a universal effect in all surgeries [3, 4]. Therefore, although several randomized controlled studies (RCTs) and meta-analyses were performed previously, some guideline recommendations could not state the efficacy of these washing methods due to a lack of universal evidence [3–8].

Regarding gastroenterological surgery, some meta-analyses have evaluated the efficacy of washing with antiseptic or antibiotic solutions to prevent SSI; however, most of the included studies involved appendectomy and had been performed before 2000 [5–7]. Therefore, we performed a systematic review and meta-analysis on the efficacy of irrigation with antiseptic/antibiotic solutions during gastroenterological surgery performed after 2000.

Materials and methods

Search strategy

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [9]. Ethical approval was not necessary because this study was a meta-analysis. A comprehensive literature search of PubMed, MEDLINE, and the Cochrane Library for articles published from January 1, 2000, to April 1, 2024, was conducted. Only articles published in English were included. Studies that could be evaluated and other hand-selected papers were added manually. The search strategy is described in Supplemental Table 1.

Data extraction and quality assessment

A standard data entry form was designed for the data extraction. The extracted data included the author, publication year, study design, conflicts of interest, participants and outcomes. Four independent authors (MU, SN, TK and SS) reviewed every article's title and abstract based on the following criteria. (1) Participants: Patients who received gastroenterological surgery. (2) Intervention: Wound irrigation or peritoneal lavage with antiseptic or antibiotic solution. (3) Comparison: Outcomes in patients with washing of their surgical sites with antiseptic/antibiotic solution compared to those in patients without these agents. (4) Outcomes: Incidence of SSIs. (5) Study design: RCTs or observational studies (OBSs) were included. Any disagreement between the reviewers was resolved by all reviewers at a consensus meeting.

Each piece of evidence could be downgraded according to its risk of bias [10]. The quality of the evidence was further assessed according to the grading of recommendations assessment, development, and evaluation (GRADE) approach [11]. Some discrepancies were also resolved through discussion among all reviewers at a consensus meeting. The publication language was restricted to English, and studies had to report the incidence of SSI in order to be included. Articles with in vitro studies or animal studies and those without the proper number of events were not included.

Endpoint

The primary endpoint of this systematic review and meta-analysis was to analyze the association between washing with antiseptic/antibiotic solution during surgery and the incidence of SSI. Cases of SSI that occurred within 30 days after surgery were collected and divided into two categories: incisional (INC) SSI, including wound infection regardless of the infection depth; and organ/space (O/S) SSI, including abdominal/pelvic sepsis or abscess and anastomotic leakage [2].

Statistical analysis

We performed a random-effects meta-analysis for each outcome of interest. Outcomes were calculated using Windows Review Manager Software 5.4 (The Nordic Cochrane Center, The Collaboration, 2014, Copenhagen, Denmark) for risk ratios (RRs) and odds ratios (ORs). Secondary outcomes were incidence and kinds of adverse events. Dichotomous data were analyzed for risk ratios using a random effects model and the Mantel–Haenszel method. The RR and OR with the 95% confidence interval (CI) for the incidence of SSI were used to weight the interval in the RCTs and OBSs, respectively. A P value < 0.05 was considered to indicate statistical significance. Heterogeneity was quantified using I-squared and

tau-squared indices, testing the null hypothesis that all studies shared a common effect size.

Results

Findings

The PRISMA flow diagram for this review is shown in Fig. 1. The database search results showed that 382 studies were eligible. We excluded 353 studies because of duplication and unrelation after screening the titles and abstracts. As a result, 10 studies were reviewed in full text [8, 12–20]. Finally, 8 RCTs [8, 12–18] and 2 OBSs [19, 20] were included in the meta-analysis.

Wound irrigation

Summary and characteristics of the studies

The summary of the data in each study regarding wound irrigation is shown in Table 1.

Among the RCTs, 2 studies used wound irrigation with PVI as the intervention, 1 study used gentamycin solution, and 1 study used polyhexanide. The participants in 2 RCTs underwent gastroenterological surgery and gastric surgery.

In the 3 OBSs, the interventions were PVI, hydrogen peroxide, and chlorhexidine gluconate respectively in each study.

Result of wound irrigation with PVI solution in the RCTs

The total number of SSIs in the PVI group (47/640, 7.3%) was not significantly less than that in the control group (33/634, 5.2%), without heterogeneity (I2 = 0%). Total SSIs did not significantly differ between the groups [RR 1.41, 95% CI (0.92 to 2.17): $p = 0.69$] (Fig. 2).

Wound irrigation with PVI solution in OBSs

The incidence of SSI in an OBS of PVI irrigation was 3/23 (13.0%), which was not significantly different from that in the control group (12/33, 36.4%). The SSI incidence was not significantly different between the groups [OR 0.26, 95% CI (0.06 to 1.07)].

Result of wound irrigation with other antiseptic or antibiotic solutions

In an RCT of irrigation with gentamycin solution, the incidence of SSI after gentamycin irrigation was 2/67 (3.0%), which was not significantly different from that in the control group (3/69, 4.35%). The SSI incidence was not significantly different between the groups [RR 1.46, 95% CI (0.25 to 8.44)].

In an RCT of irrigation with polyhexanide, the incidence of SSI after polyhexanide irrigation was 39/228 (17.1%), which was significantly less than that in the control group (67/228, 29.9%). The SSI incidence was significantly different between the groups [RR 0.58, 95% CI (0.41 to 0.83)].

In an OBS of irrigation with hydrogen peroxide, the incidence of SSI in the interventional group was 17/64 (26.6%), which was not significantly different from that in the control group (12/33, 36.4%). The SSI incidence was not significantly different between the groups [OR 0.63, 95% CI (0.26 to 1.56)].

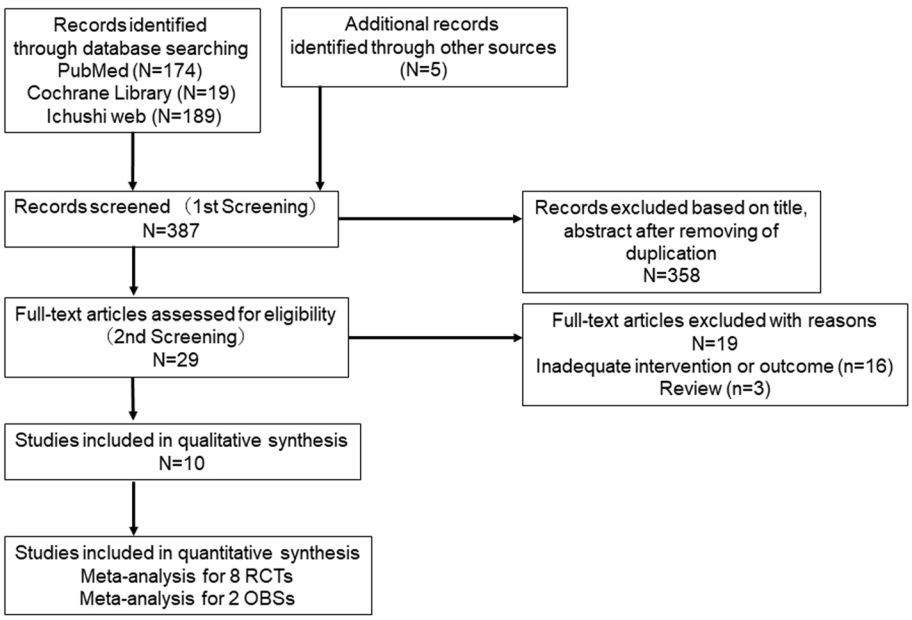

Fig. 1 Flowchart of the literature search according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)

Table 1 Characteristics of included studies for wound irrigation

Study	reference	Year	Type of study	Type of surgery	Laparoscopic surgery, n(%)		Intervention	Control	Incidences of SSI, n(%)		ratio	95%CI
					Intervention	Control			Intervention	Control		
Maemoto	16	2022	single center RCT	Gastrointestinal surgery	332/473 (70.2)	323/468 (69.0)	PVI	Saline	36/473 (7.6)	24/468 (5.1)	RR 1.48	0.90-2.45
Zhao LY	17	2023	single center RCT	Gastric cancer	no laparoscopic surgery		PVI	Saline	11/167 (6.6)	9/166 (5.4)	RR 1.21	0.52-2.85
Khan KR	20	2022	single center OBS	Gastrointestinal surgery	60/132 (45.5)		PVI	Saline	3/23 (13.0)	12/33 (36.4)	OR 0.26	0.06-1.07
Khan KR	20	2022	single center OBS	Gastrointestinal surgery			Hydrogen peroxicide	Saline	17/64 (26.6)	12/33 (36.4)	OR 0.63	0.26-1.56
Emile SH	18	2020	single center RCT	appendectomy	no laparoscopic surgery		Gentamicine	Saline	2/67 (3.0)	3/69 (4.3)	RR 1.46	0.25-8.44
Strobel	19	2020	single center RCT	Gastrointestinal surgery	76/228 (33.3)	80/228 (35.1)	Polyhexanide	Saline	39/228 (17.1)	67/228 (29.4)	RR 0.58	0.41-0.83
Goztok	21	2018	single center OBS	ileostomy closure	no laparoscopic surgery		Chlorhexidine gluconate	Saline	3/62 (4.8)	19/60 (31.7)	OR 0.11	0.03-0.40

SSI Surgical site infection, *CI* Confidence interval, *RCT* Randomized controlled study, *OBS* Observational study, *PVI* Povidion iode, *RR* Risk ratio, *OR* Odds ratio

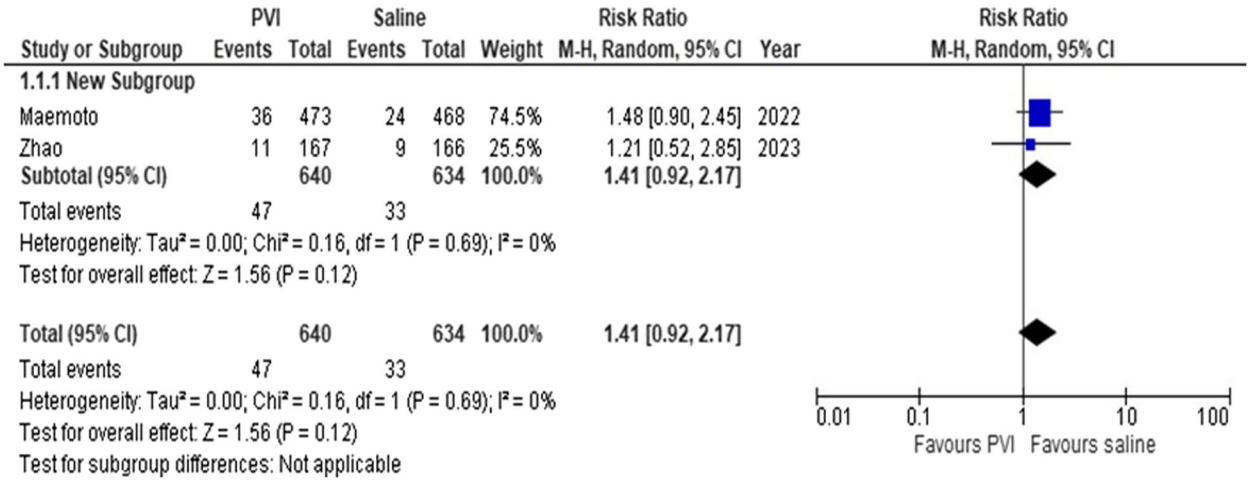

Fig. 2 Forest plot of the incidence of surgical site infection between wound irrigation groups (povidone iodine vs. saline) in randomized controlled studies

In an OBS of irrigation with chlorhexidine gluconate, the incidence of SSI in the interventional group was 3/62 (4.8%), which was significantly less than that in the control group (19/60, 31.6%). The SSI incidence was significantly different between the groups [OR 0.11, 95% CI (0.03 to 0.40)].

Result of other outcomes during wound irrigation with antiseptic or antibiotic solutions

The length of hospital stay was evaluated in four RCTs and two observational studies [8, 16–20]. None of these studies showed significant differences in hospital stay duration. Furthermore, none of the studies conducted a sufficient evaluation of adverse events or additional cost analyses.

Peritoneal lavage

Result of peritoneal lavage with antiseptic or antibiotic solution

Summary and characteristics of the studies The summary of the data in each study about peritoneal lavage is shown in Table 2.

Among the RCTs, 3 studies used lavage with antibiotic solution as the intervention, and 1 study used PVI. The antibiotic solutions were polymyxin B, imipenem, or gentamicin-clindamycin. Participants in these RCTs underwent pancreatic surgery, appendectomy, or colonic surgery.

There was no OBS conducted with antiseptic/antibiotic peritoneal lavage.

Result of peritoneal lavage with PVI solution in RCTs

The incidence of SSI in the PVI group (6/50, 12.0%) was not significantly lower than that in the control group (8/50, 16.0%). The SSI incidence was not significantly different between the groups [RR 0.75, 95% CI (0.28 to 2.00): $p = 0.57$].

Results of peritoneal lavage with antibiotic solution in RCTs

The total number of SSIs in the antibiotic group (4/141, 2.8%) was not significantly less than that in the control group (12/141, 8.5%), without high heterogeneity ($I^2 = 25\%$). Total SSIs did not significantly differ between the groups [RR 0.39, 95% CI (0.10 to 1.55): $p = 0.18$] (Fig. 3).

Result of other outcomes during peritoneal lavage with antiseptic or antibiotic solutions

The length of hospital stay was evaluated in three RCTs [12, 13]. In two of these RCTs involving PVI or antibiotic solutions, no significant differences in hospital stay duration were observed. However, a study on lavage with imipenem during appendectomy showed a beneficial effect on both costs and length of stay [13]. Overall, evaluations of adverse events and additional cost analyses were insufficient across studies of peritoneal lavage (Fig. 3).

The study quality and risk of bias

The study quality and risk of bias for each of the studies are shown in Supplemental Tables 2 and 3.

Table 2 Characteristics of included studies for peritoneal lavage

Study	reference	Year	Type of study	Type of surgery	Laparoscopic surgery	Intervention	Control	Incidences of SSI, n(%)		ratio	95%CI
								Intervention	Control		
Maatman	12	2019	single center RCT	pancreas	no laparoscopic surgery	Polyamine B	Saline	3/44	3/45	RR 1.02	0.22-4.80
Hesami	13	2014	single center RCT	appendectomy	not stated	imipenem	Saline	1/45	6/45	RR 0.17	0.02-1.33
Ruiz-Tovar	15	2012	single center RCT	colonic surgery	no laparoscopic surgery	clindamycin, gentamicin	Saline	0/52	3/51	RR 0.14	0.01-2.65
Anderson	14	2020	single center RCT	appendectomy	not stated	PVI	Saline	6/50	8/50	RR 0.75	0.28-2.00

SSI Surgical site infection, *RCT* Randomized controlled study, *CI* Confidence interval, *PVI* Povodone iodene, *RR* Risk ratio

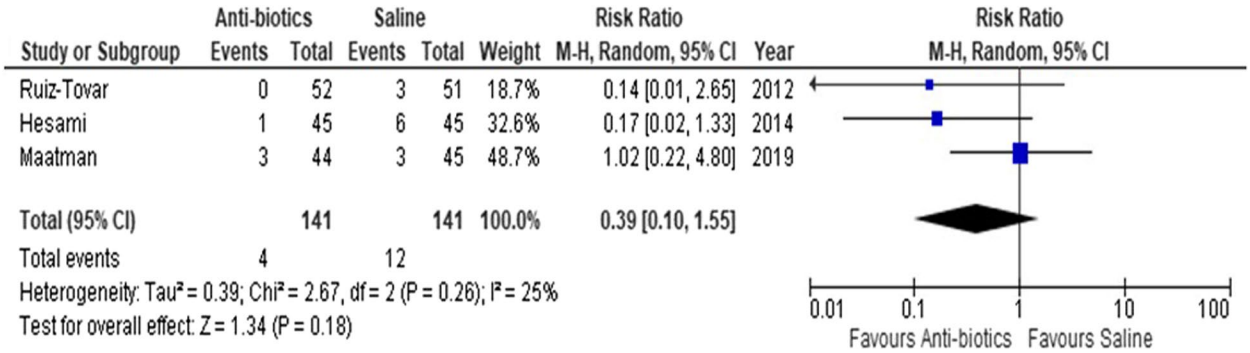

Fig. 3 Forest plot of the incidence of surgical site infection between peritoneal lavage groups (antibiotics vs. saline) in randomized controlled studies

Discussion

Surgical site infections (SSIs) are the most common surgical morbidity. To prevent SSIs, prophylactic intraoperative wound irrigation and peritoneal lavage have been advocated, although the results, conclusions and recommendations are equivocal and controversial. According to World Health Organization (WHO) SSI prevention guidelines, there is insufficient evidence to recommend saline wound irrigation for the prevention of SSI [4]. They suggested that the use of irrigation with an aqueous PVI solution before wound closure can prevent SSI, particularly in clean and clean-contaminated surgery. They also stated that antibiotic wound irrigation before closure should not be used to prevent SSI.

Some previous systematic reviews and meta-analyses have reached disparate conclusions [7, 21]. PVI solution may prevent SSI, but antibiotic solution may not. Alternatively, antibiotic solution may have preventive efficacy against SSI in supine surgery [21]. There are few studies, and heterogeneity exists; in addition, the many biases make the establishment of proper methods of wound irrigation difficult [7]. Moreover, the fact that the previous systematic review and meta-analysis, which included several surgeries (including clean and clean-contaminated surgery) and studies conducted over a decade prior, is a major problem [7, 21–23]. Currently, the surgical methods, instruments, and perioperative management are quite different and are improved. Most previous studies of wound irrigation during gastroenterological surgery involved appendectomy. Regarding peritoneal lavage, most previous studies had been performed with patients presenting appendicitis or diverticulosis [24–26]. The use of such lavage could not be recommended because of a lack of evidence. Therefore, we performed a systematic review and meta-analysis of SSI prevention in gastroenterological surgeries restricted to the recent era to make recommendations for SSI prevention guidelines.

The performed studies and related evidence on washing with antiseptic or antibiotic solutions for SSI prevention are limited. No significant efficacy was found in any meta-analysis, RCTs or OBSs in this review. Moreover, analyses for cost effectiveness or adverse events were lacking. Therefore, we could not state recommendations for using or prohibiting the use of antiseptic/antibiotic solutions for preventing SSI.

When washing with antiseptic/antibiotic solutions, we should consider these concentrations and application times. PVI solutions at 10% and 1% concentrations were applied in 2 RCTs, respectively. The application time was not stated in either study, nor was information about washing out the residual PVI solution [16, 17]. PVI itself can influence fibroblast and wound healing [27–29]. We should evaluate the proper concentration, application time, or necessity of washing out residual agents when using antiseptic/antibiotic solutions to prevent SSI in the future.

Most of the included studies involved clean-contaminated surgery. The efficacy of antiseptic/antibiotic solution for preventing SSI was not observed; however, it may be effective for contaminated or dirty/infected wound classes. Further studies on gastroenterological surgeries with higher wound classes, such as perforated panperitonitis, are needed to evaluate these efficacies.

This systematic review and meta-analysis has some limitations. Few studies have examined the use of various antiseptic or antibiotic solutions across different types of abdominal surgeries. Each study involved various disease, surgical procedures, or wound classes, often with small sample sizes. It remains unclear whether each intervention was conducted precisely to reduce bacterial contamination, and we could not detail the specific methods for each intervention. Additionally, evaluations of adverse events and cost benefits related to these interventions were insufficient.

Therefore, more evidence is needed to make a formal recommendation regarding their use.

Some studies reported significant differences between intervention and control groups, such as with polyhexanide or chlorhexidine gluconate, but the sample sizes were too small to confirm efficacy. Moreover, several studies reported high rates of SSI (over 20–30%). To minimize bias, future research should evaluate interventions in similar disease contexts, with consistent surgical backgrounds and outcome definitions.

In conclusion, wound irrigation and peritoneal lavage with antiseptic or antibiotic solutions have not demonstrated sufficient efficacy in preventing SSI. We cannot recommend the routine use of these interventions in gastroenterological surgery; however, there is no evidence to contraindicate their use. These facts, due to the lack of evidence, warrant a demand for further studies.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-025-02774-3.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Authors' contributions

Motoi U. conducted the acquisition of data, full text evaluation, interpretation of data, result discussion, and drafting of the article; Nomura S., Tamura K, Shinji S. conducted the abstract evaluation, acquisition of data, interpretation of data, bias evaluation and drafting of the article; Ikeuchi H. conducted revision of manuscript; Kobayashi Ma, Kobayashi Mo., Suzuki K., Kitagawa Y., Yamashita C., Mohri Y., Shimizu J., Suzuki K., Haji S., Kouzu K., Shinkawa H., Ishinuki T., Hanai Y., Nobuhara H., Imaoka H., Ohge H. conducted the result discussion; Yoshida M. conducted the interpretation of data and statistical analysis; Mayumi T. conducted the design of the review and result discussion; Mizuguchi T. conducted the conception of the review and result discussion.

Funding

There was no funding support for this study.

Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Gastroenterological Surgery, Division of Inflammatory Bowel Disease, Hyogo Medical University, 1-1, Mukogawacho, Nishinomiya, Hyogo, Japan. [2]Department of Surgery and Oncology Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan. [3]Department of Surgery, Hayamizu-Park Clinic, Miyazaki, Japan. [4]Department of Gastrointestinal and Hepato-Biliary-Pancreatic Surgery, Nippon Medical School, Bunkyo, Japan. [5]Department of Surgery, National Defence Medical College, Tokorozawa, Japan. [6]Department of Hepatobiliary-Pancreatic Surgery, Osaka Metropolitan University Graduate School of Medicine, Osaka, Japan. [7]Department of Nursing, Division of Surgical Science, Sapporo Medical University, Sapporo, Japan. [8]Department of Infectious Disease, Hiroshima University Hospital, Hiroshima, Japan. [9]Department of Surgery, Soseikai General Hospital, Kyoto, Japan. [10]Department of Surgery, Toyonaka Municipal Hospital, Osaka, Japan. [11]Department of Gastrointestinal Surgery, Mie Prefectural General Medical Center, Mie, Japan. [12]Department of Anesthesiology and Critical Care Medicine, Fujita Health University, Toyoake, Aichi, Japan. [13]Department of Gastrointestinal Surgery, National Center for Geriatrics and Gerontology, Obu, Aichi, Japan. [14]Department of Infection Control, Hospital of the University of Occupational and Environmental Health, Fukuoka, Japan. [15]Department of Anesthesiology, Hokushinkai Megumino Hospital, Hokkaido, Japan. [16]Department of Clinical Pharmacokinetics, Research and Education Center for Clinical Pharmacy, Kitasato University Hospital, Sagamihara, Kanagawa, Japan. [17]Department of Clinical Pharmacy, Faculty of Pharmaceutical Sciences, Toho University, Ota, Japan. [18]Department of Dentistry, Hiroshima Prefectural Hospital, Hiroshima, Japan. [19]Department of Gastrointestinal and Pediatric Surgery, Mie University Graduate School of Medicine, Mie, Japan. [20]Department of Hepato-Biliary-Pancreatic and Gastrointestinal Surgery, School of Medicine, International University of Health and Welfare, Otawara, Japan. [21]Department of Intensive Care Unit, Japan Community Healthcare Organization Chukyo Hospital, Nagoya, Japan.

Received: 16 October 2024 Accepted: 9 January 2025
Published online: 23 January 2025

References

1. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. centers for disease control and prevention (CDC) hospital infection control practices advisory committee. Am J Infect Control. 1999;27:97–132.
2. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. Infect Control Hosp Epidemiol. 1992;13:606–8.
3. National Institute for Clinical Excellence. Surgical site infection prevention and treatment of surgical site infection. Clinical Guideline. 2020. In: NICE guideline [NG125]. Available from: https://www.nice.org.uk/guidance/ng125/chapter/Recommendations. Cited 21 January 2020. Accessed 25 Oct 2023.
4. GLOBAL GUIDELINES FOR THE PREVENTION OF SURGICAL SITE INFECTION. http://apps.who.int/iris/bitstream/10665/250680/1/9789241549882-eng.pdf. Accessed 1 Oct 2023.
5. Mueller TC, Loos M, Haller B, Mihaljevic AL, Nitsche U, Wilhelm D, Friess H, Kleeff J, Bader FG. Intra-operative wound irrigation to reduce surgical site infections after abdominal surgery: a systematic review and meta-analysis. Langenbecks Arch Surg. 2015;400:167–81.
6. Norman G, Atkinson RA, Smith TA, Rowlands C, Rithalia AD, Crosbie EJ, Dumville JC. Intracavity lavage and wound irrigation for prevention of surgical site infection. Cochrane Database Syst Rev. 2017;10:CD012234.
7. Mo YW, Choi JH, Lee WJ. Prophylactic intraoperative wound irrigation with antibiotic solution for the prevention of surgical incisional wound infections: systematic literature review and meta-analysis. J Plast Reconstr Aesthet Surg. 2023;76:121–32.
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. McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS peer review of electronic search strategies: 2015 Guideline Statement. J Clin Epidemiol. 2016;75:40–6.
10. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, Savovic J, Schulz KF, Weeks L, Sterne JA, Cochrane Bias Methods Group; Cochrane Statistical Methods Group. The Cochrane collaboration's tool for assessing risk of bias in randomised trials. BMJ. 2011;343:d5928.
11. Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J, Norris S, Falck-Ytter Y, Glasziou P, DeBeer H, Jaeschke R, Rind D, Meerpohl J, Dahm P, Schünemann HJ. GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. J Clin Epidemiol. 2011;64:383–94.
12. Maatman TK, Weber DJ, Timsina LR, Qureshi B, Ceppa EP, Nakeeb A, Schmidt CM, Zyromski NJ, Koniaris LG, House MG. Antibiotic irrigation during pancreatoduodenectomy to prevent infection and pancreatic fistula: a randomized controlled clinical trial. Surgery. 2019;166:469–75.

13. Hesami MA, Alipour H, Nikoupour Daylami H, Alipour B, Bazargan-Hejazi S, Ahmadi A. Irrigation of abdomen with imipenem solution decreases surgical site infections in patients with perforated appendicitis: a randomized clinical trial. Iran Red Crescent Med J. 2014;16:e12732.
14. Anderson KT, Putnam LR, Bartz-Kurycki MA, Hamilton EC, Yafi M, Pedroza C, Austin MT, Kawaguchi AL, Kao LS, Lally KP, Tsao K. Povidone-iodine irrigation for Pediatric Perforated Appendicitis May be protective: a bayesian pilot randomized controlled trial. Ann Surg. 2020;271:827–33.
15. Ruiz-Tovar J, Santos J, Arroyo A, Llavero C, Armañanzas L, López-Delgado A, Frangi A, Alcaide MJ, Candela F, Calpena R. Effect of peritoneal lavage with clindamycin-gentamicin solution on infections after elective colorectal cancer surgery. J Am Coll Surg. 2012;214:202–7.
16. Maemoto R, Noda H, Ichida K, Miyakura Y, Kakizawa N, Machida E, Aizawa H, Kato T, Iseki M, Fukui T, Muto Y, Fukai S, Tsujinaka S, Hatsuzawa Y, Watanabe F, Nagamori M, Takahashi J, Kimura Y, Maeda S, Takayama N, Sakio R, Takahashi R, Takenami T, Matsuzawa N, Mieno M, Rikiyama T. 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. 2022;277(5):727-733. https://doi.org/10.1097/SLA.0000000000005786. Epub ahead of print.
17. Zhao LY, Zhang WH, Liu K, Chen XL, Yang K, Chen XZ, Hu JK. Comparing the efficacy of povidone-iodine and normal saline in incisional wound irrigation to prevent superficial surgical site infection: a randomized clinical trial in gastric surgery. J Hosp Infect. 2023;131:99–106.
18. Strobel RM, Leonhardt M, Krochmann A, Neumann K, Speichinger F, Hartmann L, Lee LD, Beyer K, Daum S, Kreis ME, Lauscher JC. Reduction of postoperative wound infections by Antiseptica (RECIPE)? A Randomized Controlled Trial. Ann Surg. 2020;272:55–64.
19. Khan KR, Kumari J, Haider SMW, Fawwad SBU, Kumar N, Nizar R, Kumar D, Sangam, Hasan M, Mumtaz H. The prevalence and etiology of Surgical Site infections following gastrointestinal tract surgery: a cross-sectional study from a Tertiary Care Hospital. Cureus. 2022;14:e27320.
20. Goztok M, Terzi MC, Egeli T, Arslan NC, Canda AE. Does Wound Irrigation with Clorhexidine Gluconate reduce the Surgical site infection rate in Closure of Temporary Loop Ileostomy? A prospective clinical study. Surg Infect (Larchmt). 2018;19:634–9.
21. de Jonge SW, Boldingh QJJ, Solomkin JS, Allegranzi B, Egger M, Dellinger EP, Boermeester MA. Systematic review and Meta-analysis of randomized controlled trials evaluating prophylactic intra-operative wound irrigation for the Prevention of Surgical Site infections. Surg Infect (Larchmt). 2017;18:508–19.
22. Fu C, Meng L, Ma M, Li N, Zhang J. Effect of wound irrigation on the prevention of surgical site infections: a meta-analysis. Int Wound J. 2022;19(7):1878–86. https://doi.org/10.1111/iwj.13794. Epub 2022 Mar 16.
23. Shi L, Cai L, Wan F, Jiang Y, Choudhury R, Rastogi S. Does povidone-iodine application in surgical procedures help in the prevention of surgical site infections? An updated meta-analysis. Wideochir Inne Tech Maloinwazyjne. 2022;17:261–78.
24. Burini G, Cianci MC, Coccetta M, Spizzirri A, Di Saverio S, Coletta R, Sapienza P, Mingoli A, Cirocchi R, Morabito A. Aspiration versus peritoneal lavage in appendicitis: a meta-analysis. World J Emerg Surg. 2021;16:44.
25. Bi LW, Yan BL, Yang QY, Cui HL. Peritoneal irrigation vs suction alone during pediatric appendectomy for perforated appendicitis: a meta-analysis. Med (Baltim). 2019;98:e18047.
26. Gammeri E, Petrinic T, Bond-Smith G, Gordon-Weeks A. Meta-analysis of peritoneal lavage in appendicectomy. BJS Open. 2018;3:24–30.
27. Carballo Cuello CM, Fernández-de Thomas RJ, De Jesus O, De Jesús Espinosa A, Pastrana EA. Prevention of Surgical Site infection in lumbar Instrumented Fusion using a sterile povidone-iodine solution. World Neurosurg. 2021;151:e700–6.
28. Chang FY, Chang MC, Wang ST, Yu WK, Liu CL, Chen TH. Can povidone-iodine solution be used safely in a spinal surgery? Eur Spine J. 2006;15:1005–14.
29. Niedner R. Cytotoxicity and sensitization of povidone-iodine and other frequently used anti-infective agents. Dermatology. 1997;195(Suppl 2):89–92.

Publisher's Note