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A Comprehensive Systematic Review of Intraoperative Wound Irrigation for The Prevention of Surgical Site Infection after Laparotomy

[1] Satya Agung Nugroho, [2] Fathan Sulistyo Widodo, [3] Hasnan Habib Affifudin

[1] dr. Soeroto Regional General Hospital, Ngawi Regency, East Java, Indonesia

[2] Faculty of Medicine, University of Muhammadiyah, Surakarta City, Central Java,Indonesia

[3] Faculty of Medicine, Islamic University of Indonesia, Special Region of Yogyakarta, Indonesia

Corresponding Email : agungfkums2015@gmail.com

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ABSTRACT

Introduction: Surgical site infections (SSIs) remain a significant complication following laparotomy, leading to increased morbidity, prolonged hospital stays, and higher healthcare costs. Intraoperative wound irrigation (IOWI) has been proposed as a preventive measure, but the optimal solution and technique remain debated.

Methods: This systematic review analyzed 40 sources, including randomized controlled trials, meta-analyses, and systematic reviews, retrieved via PubMed, Google Scholar, Semantic Scholar, Springer, Wiley Online Library. Studies were screened based on population (adult laparotomy patients), intervention (IOWI), outcome (SSI incidence), and design (RCTs, meta-analyses). Data extraction was performed using a large language model to capture intervention details, surgical context, SSI definitions, outcomes, and effect measures.

Results: IOWI significantly reduces SSI rates compared to no irrigation (RR 0.52, 95% CI 0.37–0.74). Antiseptic solutions, particularly povidone-iodine and polyhexanide, may offer additional benefit over saline in certain contexts, though evidence is heterogeneous. Antibiotic irrigation shows strong benefits in contaminated wounds and colorectal surgery. Pulse lavage is superior to standard pouring, while excessive irrigation volume may be counterproductive.

Discussion: The efficacy of IOWI is highly context-dependent, influenced by surgical type, contamination level, irrigation technique, and study quality. Antiseptic and antibiotic irrigations are most beneficial in high-risk settings, whereas saline irrigation remains effective in clean-contaminated cases.

Conclusion: Routine IOWI before skin closure is recommended for laparotomy patients. Antiseptic or antibiotic solutions should be considered in contaminated or colorectal surgery, and pulse lavage may enhance effectiveness. Future research should standardize protocols and focus on high-risk populations.

Keywords: Intraoperative wound irrigation, surgical site infection, laparotomy, antiseptic irrigation, antibiotic irrigation, pulse lavage, systematic review

INTRODUCTION

Background and Clinical Significance

Surgical site infections (SSIs) represent one of the most prevalent and burdensome complications following abdominal surgery, with reported incidence rates ranging from 2% to over 25% depending on the procedure type, contamination level, and patient risk factors (Mueller et al., 2015). In laparotomy, the extensive tissue exposure, prolonged operative times, and potential for intra-abdominal contamination synergistically elevate the risk of microbial colonization and subsequent infection. SSIs are categorized into superficial incisional, deep incisional, and organ/space infections, each contributing to significant patient morbidity, including prolonged pain, delayed recovery, wound dehiscence, and increased susceptibility to sepsis. From a healthcare systems perspective, SSIs substantially escalate costs due to extended hospital stays (averaging an additional 7–11 days), frequent readmissions, increased antibiotic utilization, and the need for additional surgical interventions such as wound debridement or closure. The economic burden is profound; studies indicate that SSIs can nearly double the total cost of a surgical admission (Strobel et al., 2021).

Intraoperative wound irrigation (IOWI) prior to fascial and skin closure has been a long-standing, yet variably practiced, surgical technique aimed at mitigating SSI risk. The proposed mechanisms of action are multifactorial: (1) mechanical removal of debris, devitalized tissue, and blood clots that serve as a nidus for infection; (2) dilution and reduction of bacterial load within the wound bed; (3) direct antimicrobial activity when antiseptic or antibiotic solutions are employed; and (4) potential modulation of the local wound environment to favor healing. Despite its intuitive appeal and widespread, albeit inconsistent, adoption, the fundamental questions of *whether* irrigation is definitively beneficial, *which* irrigation solution is optimal (plain saline, antiseptics like povidone-iodine or polyhexanide, or antibiotic solutions), and *how* it should be best

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delivered (technique, volume, timing) remain subjects of considerable debate and conflicting evidence in the surgical literature.

Research Problem and Knowledge Gaps

The existing body of evidence on IOWI is characterized by significant heterogeneity and methodological limitations. While numerous randomized controlled trials (RCTs) and several meta-analyses have been conducted, they often yield conflicting conclusions. For instance, some high-quality RCTs in clean-contaminated elective gastrointestinal surgery have found no significant difference between antiseptic (povidone-iodine) and saline irrigation (Maemoto et al., 2022; Zhao et al., 2022), whereas meta-analyses pooling data from various surgical contexts suggest a benefit for antiseptics (Magsi et al., 2023; Swaminathan et al., 2023). This inconsistency stems from several critical gaps:

1. **Contextual Specificity:** Most studies are performed within narrow surgical contexts (e.g., only appendectomy, only colorectal surgery), limiting generalizability. The effect of IOWI is likely modified by the baseline risk of infection, which varies dramatically with wound classification (clean vs. contaminated), surgical urgency (elective vs. emergency), and underlying patient comorbidities.
2. **Protocol Heterogeneity:** There is no standardization of the "intervention." Studies vary immensely in the type of solution, its concentration (e.g., 1% vs. 10% povidone-iodine), volume (from 40 mL to 20 liters), technique (simple pour vs. pulsed lavage), timing, and number of layers irrigated. This makes direct comparison and synthesis of results challenging.
3. **Inconsistent Outcome Measures:** Although CDC criteria are commonly used, follow-up duration and assessor blinding vary, potentially influencing reported SSI rates.

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4. **Limited Focus on Technique and Volume:** The majority of research focuses on solution comparison, while the independent impact of delivery technique (e.g., pulse pressure) and optimal fluid volume are under-studied, despite mechanistic rationale suggesting their importance.

5. **Inadequate Economic and Patient-Reported Outcomes:** Comprehensive analyses integrating clinical efficacy with cost-effectiveness and patient-centered outcomes like satisfaction and cosmetic results are scarce.

Research Objectives

This systematic review was undertaken with the following primary and secondary objectives:

- **Primary Objective:** To synthesize the highest available evidence on the efficacy of IOWI in preventing SSI following laparotomy.
- **Secondary Objectives:**
    1. To compare the relative effectiveness of different irrigation solutions: normal saline, antiseptic agents (povidone-iodine, polyhexanide), and antibiotic solutions.
    2. To evaluate the impact of irrigation technique (e.g., pulsed lavage vs. standard pouring) and irrigation volume on SSI rates.
    3. To identify surgical contexts (procedure type, wound classification) and patient factors that modify the treatment effect of IOWI.
    4. To summarize associated outcomes, including healthcare costs, length of stay, and patient satisfaction.

Research Hypothesis

We hypothesize that:

1. IOWI, compared to no irrigation, significantly reduces the incidence of SSI after laparotomy.
2. The superiority of antiseptic or antibiotic irrigation over saline is not uniform but is contingent upon the degree of surgical contamination; greater benefit is expected in contaminated/dirty wounds (Class III/IV) and colorectal surgery compared to clean-contaminated cases.
3. Advanced irrigation techniques (e.g., pulsed lavage) provide superior mechanical cleansing and lead to lower SSI rates compared to passive pouring, independent of the solution used.

Novelty and Anticipated Contribution

This review aims to provide a nuanced and contextually grounded synthesis that moves beyond the binary question of "irrigation vs. no irrigation" or "antiseptic vs. saline." By rigorously analyzing evidence across diverse surgical settings and explicitly examining effect modifiers such as contamination level and technique, it seeks to offer clinicians a stratified, evidence-based framework for decision-making. Furthermore, by incorporating recent high-quality RCTs, updated meta-analyses, and data on economic and patient-reported outcomes, this review presents a contemporary and holistic assessment of IOWI. The ultimate goal is to translate heterogeneous evidence into clear, actionable guidance that can standardize practice, improve patient outcomes, and generate specific hypotheses for future definitive research.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This

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approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate intraoperative wound irrigation for the prevention of surgical site infection after laparotomy.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Population - Laparotomy Procedures**: Does this study include patients undergoing laparotomy procedures (open abdominal surgery)?
- **Intervention - Intraoperative Wound Irrigation**: Does this study investigate intraoperative wound irrigation as the primary intervention?
- **Outcome - Surgical Site Infection**: Does this study report surgical site infection as a primary or secondary outcome?
- **Study Design**: Is this study a randomized controlled trial, controlled clinical trial, systematic review, or meta-analysis?
- **Control Group**: Does this study have a clearly defined control group (such as no irrigation, placebo irrigation, or alternative irrigation methods)?
- **Population - Adult Patients**: Does this study involve adult patients (≥18 years old)?
- **Procedure Type - Open Surgery**: Is this study focused on open laparotomy procedures rather than solely on laparoscopic or minimally invasive procedures?
- **Intervention Purpose - Prevention**: Does this study investigate wound irrigation for infection prevention rather than for treatment of existing infections?

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We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

- **Irrigation Intervention**:

  Extract complete details about the wound irrigation intervention including:

  - Type of irrigation solution (e.g., saline, povidone-iodine, antibiotic solution, antiseptic)
  - Concentration/strength of solution (e.g., 10% povidone-iodine, 0.04% polyhexanide)
  - Volume of irrigation (e.g., 40mL, 100mL)
  - Irrigation technique (e.g., layer-by-layer, subcutaneous only, pulsatile)
  - Timing during surgery (e.g., before fascial closure, before skin closure)
  - Duration of irrigation (e.g., 1 minute contact time)
- **Control/Comparator**:

  Extract details about the control or comparison group including:

  - Type of control (no irrigation, saline irrigation, alternative antiseptic)
  - If irrigation was used in control group, specify solution type and volume
  - Any other differences in technique between groups
- **Surgical Context**:

  Extract surgical and patient context including:

  - Type of surgery/procedure (e.g., appendectomy, colorectal, general laparotomy)
  - Wound classification (clean, clean-contaminated, contaminated, dirty)
  - Surgical approach (open laparotomy, laparoscopic converted to open)
  - Patient population characteristics (mean age, high-risk factors if mentioned)

   - Surgery setting (elective vs emergency)

- **SSI Definition**:

  Extract how surgical site infection was defined and assessed including:

   - SSI classification system used (CDC criteria, other)
   - Types of SSI assessed (incisional superficial, deep, organ/space)
   - Follow-up duration for SSI assessment (e.g., 30 days, 90 days)
   - Who assessed SSI (blinded assessor, surgeon, independent reviewer)

- **SSI Outcomes**:

  Extract complete SSI outcome data including:

   - SSI rates in each group (number affected/total, percentage)
   - Types of SSI observed (superficial, deep, organ/space)
   - Timing of SSI occurrence when reported
   - Secondary outcomes related to wound healing (seroma, dehiscence, hematoma)
   - Statistical significance (p-values, confidence intervals)

- **Effect Measures**:

  Extract quantitative effect measures including:

   - Risk ratio or odds ratio with 95% confidence intervals
   - Risk difference/absolute risk reduction if provided
   - Number needed to treat if calculated
   - Statistical significance testing results
   - Adjusted vs unadjusted analyses if both provided

- **Study Design**:

  Extract study methodology details including:

- Study design (RCT, observational, systematic review/meta-analysis)
- Randomization method and allocation concealment
- Blinding (single, double, outcome assessor blinded)
- Sample size and power calculation if mentioned
- Primary vs secondary analysis of SSI outcomes

- **Risk Factors**:

  Extract any patient or surgical risk factors analyzed including:

  - Patient factors associated with SSI (anemia, diabetes, obesity, prior surgeries)
  - Surgical factors (operative time, complexity, contamination level)
  - Subgroup analyses performed
  - Factors that modified treatment effect if identified

Search Strategy

The keywords used for this research based PICO :

Element	Keyword 1	Keyword 2	Keyword 3	Keyword 4
Population (P)	Laparotomy	Open Abdominal Surgery	Abdominal Laparotomy	Post-laparotomy Patients
Intervention (I) / Exposure (E)	Intraoperative Wound Irrigation	Surgical Wound Lavage	Antiseptic Irrigation (e.g., Povidone-Iodine, Polyhexanide)	Antibiotic Irrigation
Comparison (C)	No Irrigation	Saline Irrigation (Normal Saline)	Placebo Irrigation	Standard Care (without irrigation)
Outcome (O)	Surgical Site Infection (SSI)	Wound Infection	Postoperative Infection	Superficial Incisional SSI

The Boolean MeSH keywords inputted on databases for this research are: *(("Laparotomy" OR "Open Abdominal Surgery" OR "Abdominal Laparotomy" OR "Post-laparotomy Patients")) AND (("Intraoperative Wound Irrigation" OR "Surgical Wound Lavage" OR "Antiseptic Irrigation" OR "Antibiotic Irrigation")) AND (("No Irrigation" OR "Saline Irrigation" OR "Placebo Irrigation" OR "Standard Care")) AND (("Surgical Site Infection" OR "Wound Infection" OR "Postoperative Infection" OR "Superficial Incisional SSI"))*

Data retrieval

Abstracts and titles were screened to assess their eligibility, and only studies meeting the inclusion criteria were selected for further analysis. Literature that fulfilled all predefined criteria and directly related to the topic was included. Studies that did not meet these criteria were excluded. Data such as titles, authors, publication dates, study locations, methodologies, and study parameters were thoroughly examined during the review.

Quality Assessment and Data Synthesis

Each author independently assessed the titles and abstracts of the selected studies to identify those for further exploration. Articles that met the inclusion criteria underwent further evaluation. Final decisions on inclusion were based on the findings from this review process.

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Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	*(("Laparotomy" OR "Open Abdominal Surgery" OR "Abdominal Laparotomy" OR "Post-laparotomy Patients")) AND (("Intraoperative Wound Irrigation" OR "Surgical Wound Lavage" OR "Antiseptic Irrigation" OR "Antibiotic Irrigation")) AND (("No Irrigation" OR "Saline Irrigation" OR "Placebo Irrigation" OR "Standard Care")) AND (("Surgical Site Infection" OR "Wound Infection" OR "Postoperative Infection" OR "Superficial Incisional SSI"))*	2
Semantic Scholar	*(("Laparotomy" OR "Open Abdominal Surgery" OR "Abdominal Laparotomy" OR "Post-laparotomy Patients")) AND (("Intraoperative Wound Irrigation" OR "Surgical Wound Lavage" OR "Antiseptic Irrigation" OR "Antibiotic Irrigation")) AND (("No Irrigation" OR "Saline Irrigation" OR "Placebo Irrigation" OR "Standard Care")) AND (("Surgical Site Infection" OR "Wound Infection" OR "Postoperative Infection" OR "Superficial Incisional SSI"))*	250
Springer	*(("Laparotomy" OR "Open Abdominal Surgery" OR "Abdominal Laparotomy" OR "Post-laparotomy Patients")) AND (("Intraoperative Wound Irrigation" OR "Surgical Wound Lavage" OR "Antiseptic Irrigation" OR "Antibiotic Irrigation")) AND (("No Irrigation" OR "Saline Irrigation" OR "Placebo Irrigation" OR "Standard Care")) AND (("Surgical Site Infection" OR "Wound Infection" OR "Postoperative Infection" OR "Superficial Incisional SSI"))*	13
Google Scholar	*(("Laparotomy" OR "Open Abdominal Surgery" OR "Abdominal Laparotomy" OR "Post-laparotomy Patients")) AND (("Intraoperative Wound Irrigation" OR "Surgical Wound Lavage" OR "Antiseptic Irrigation" OR "Antibiotic Irrigation")) AND (("No Irrigation" OR "Saline Irrigation" OR "Placebo Irrigation" OR "Standard Care")) AND (("Surgical Site Infection" OR "Wound Infection" OR "Postoperative Infection" OR "Superficial Incisional SSI"))*	128
Wiley Online Library	*(("Laparotomy" OR "Open Abdominal Surgery" OR "Abdominal Laparotomy" OR "Post-laparotomy Patients")) AND (("Intraoperative Wound Irrigation" OR "Surgical Wound Lavage" OR "Antiseptic Irrigation" OR "Antibiotic Irrigation")) AND (("No Irrigation" OR "Saline Irrigation" OR "Placebo Irrigation" OR "Standard Care")) AND (("Surgical Site Infection" OR "Wound Infection" OR "Postoperative Infection" OR "Superficial Incisional SSI"))*	8

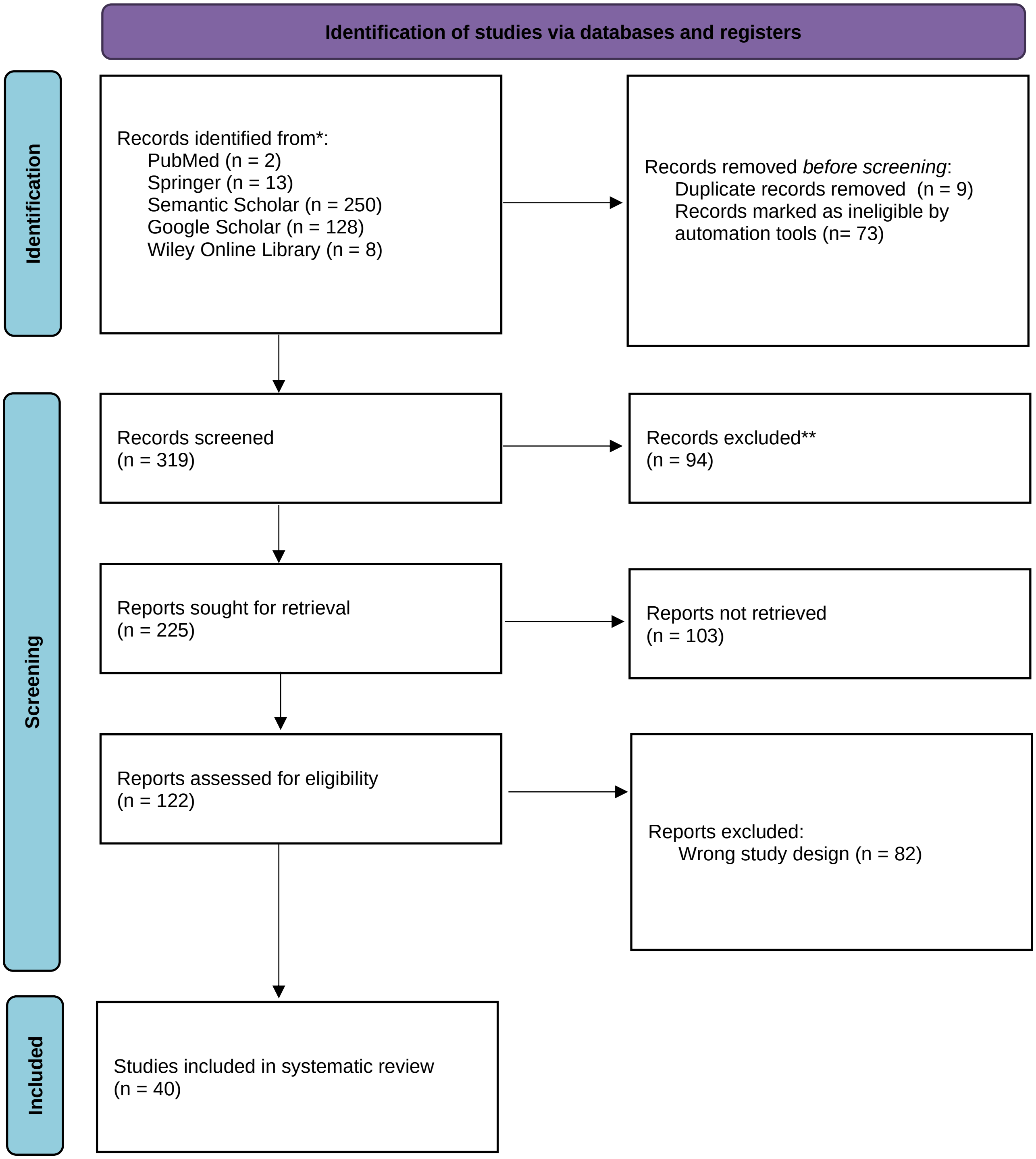

Figure 1. Article search flowchart

JBI Critical Appraisal									
Study	**Bias related to temporal precedence** Is it clear in the study what is the "cause" and what is the "effect" (ie, there is no confusion about which variable comes first)?	**Bias related to selection and allocation** Was there a control group?	**Bias related to confounding factors** Were participants included in any comparisons similar?	**Bias related to administration of intervention/exposure** Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	**Were there multiple measurements of the outcome, both pre and post the intervention/exposure?**	**Were the outcomes of participants included in any comparisons measured in the same way?**	**Were outcomes measured in a reliable way?**	**Bias related to participant retention** Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	**Statistical conclusion validity** Was appropriate statistical analysis used?
Mueller et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mueller et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Strobel et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓

Nikfarjam et al., 2014	✔	✔	✔	✖	✔	✖	✔	✔	✔
Emile et al., 2020	✔	✔	✔	✖	✔	✖	✔	✔	✔
S. P. et al., 2018	✔	✔	✔	✖	✔	✖	✔	✔	✔
Maemoto et al., 2022	✔	✔	✔	✖	✔	✖	✔	✔	✔
Maemoto et al., 2021	✔	✔	✔	✖	✔	✖	✔	✔	✔
Vinay Hg et al., 2018	✔	✔	✔	✖	✔	✖	✔	✔	✔
Magsi et al., 2023	✔	✔	✔	✖	✔	✖	✔	✔	✔
Mashbari et al., 2018	✔	✔	✔	✖	✔	✖	✔	✔	✔
Ruiz-Tovar et al., 2012	✔	✔	✔	✖	✔	✖	✔	✔	✔
Gill et al., 2011	✔	✔	✔	✖	✔	✖	✔	✔	✔
Strobel et al., 2021	✔	✔	✔	✖	✔	✖	✔	✔	✔
Magann et al., 1993	✔	✔	✔	✖	✔	✖	✔	✔	✔

Zhao et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Adeleke et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Maatman et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Quiroga-Garza et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Iqbal et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Shah et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jumaah et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mueller et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zeb et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Levin et al., 1983	✓	✓	✓	✗	✓	✗	✓	✓	✓
Pitt et al., 1982	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ghanem et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓

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Chauhan et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Bhanbhro et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Shrestha et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Abdul-Latif et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Abraham et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jafari et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Swaminathan et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mueller et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Singh et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Vinay Hg et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Abd Elsisy et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mueller et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓

Wankhade et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓

RESULTS

Characteristics of Included Studies

This systematic review identified 40 sources examining intraoperative wound irrigation (IOWI) for prevention of surgical site infection (SSI) after laparotomy. The sources comprise primary randomized controlled trials (RCTs), systematic reviews with meta-analyses, and study protocols. The surgical contexts span general laparotomy, colorectal surgery, appendectomy, hepatobiliary and pancreatic surgery, gastrectomy, and cesarean section.

Study	Study Type	Surgery Type	Intervention	Comparator	Sample Size
Mueller et al., 2025	Systematic review/meta-analysis	Laparotomy	Antiseptic irrigation	Saline or no irrigation	6368 patients (18 studies)
Mueller et al., 2017	RCT protocol	Visceral surgery	0.04% polyhexanide	Saline or no irrigation	540 planned
Strobel et al., 2020	RCT	Elective laparotomy	0.04% polyhexanide	0.9% saline	393 analyzed
Nikfarjam et al., 2014	RCT	Hepatobiliary /pancreatic	Pulse lavage with saline	Standard saline pour	128

Study	Study Type	Surgery Type	Intervention	Comparator	Sample Size
Emile et al., 2020	RCT	Open appendectomy	Gentamicin-saline or saline	No irrigation	205
S. P. et al., 2018	Pilot study	Midline laparotomy	Ceftriaxone + metronidazole	Normal saline	40
Maemoto et al., 2022	RCT	Gastroenterological surgery	10% povidone-iodine (40 mL)	Saline (100 mL)	941
Maemoto et al., 2021	RCT protocol	Gastrointestinal surgery	10% povidone-iodine	Saline	950 planned
Vinay Hg et al., 2018	RCT	Elective laparotomy	5% povidone-iodine	0.9% normal saline	180
Magsi et al., 2023	Meta-analysis	Gastrointestinal laparotomy	Povidone-iodine	Normal saline	3816 (13 RCTs)
Mashbari et al., 2018	RCT	Emergency trauma laparotomy	Saline (5L, 10L, 20L)	Different volumes	204
Ruiz-Tovar et al., 2012	RCT	Colorectal surgery	Gentamicin-clindamycin	Normal saline	103

Study	Study Type	Surgery Type	Intervention	Comparator	Sample Size
Gill et al., 2011	Systematic review	Elective colorectal	Povidone-iodine	No irrigation or saline	205 (5 RCTs)
Strobel et al., 2021	Post-hoc RCT analysis	Elective laparotomy	0.04% polyhexanide	0.9% saline	393
Magann et al., 1993	RCT	Cesarean section	Cefazolin in saline	Normal saline	100
Zhao et al., 2022	RCT	Gastrectomy	1.0% povidone-iodine	0.9% saline	340
Adeleke et al., 2024	Prospective comparative	Laparotomy for peritonitis	1% povidone-iodine	Normal saline	53
Maatman et al., 2019	RCT	Pancreatoduodenectomy	Polymyxin B	0.9% saline	190
Quiroga-Garza et al., 2017	RCT	Abdominal surgery	2% lidocaine	Saline only	84
Iqbal et al., 2015	RCT	Open appendectomy	1% povidone-iodine	No irrigation	166
Shah et al., 2021	RCT	Appendectomy	Imipenem solution	Saline	80

Study	Study Type	Surgery Type	Intervention	Comparator	Sample Size
Jumaah et al., 2025	RCT	Open appendectomy	Ceftriaxone + metronidazole	0.9% saline	410
Mueller et al., 2022	RCT protocol	GI/hepatobiliary laparotomy	NaOCl/HOCl (50/50ppm)	Ringer's solution	290 planned
Zeb et al., 2023	RCT	Appendectomy	Imipenem (1mg/mL)	Saline	106
Levin et al., 1983	RCT	Cesarean section	Cefoxitin or cephapirin	Saline	128
Pitt et al., 1982	RCT	Biliary surgery	Neomycin + polymyxin	Topical + systemic antibiotics	54
Ghanem et al., 2021	RCT	Abdominal surgery	Saline + 2% lidocaine	Saline only	Not specified
Chauhan et al., 2023	RCT	General laparotomy	1.25% povidone-iodine vs super-oxidized	Alternative antiseptic	60
Bhanbhro et al., 2018	RCT	Appendectomy	1% povidone-iodine	No irrigation	120

Study	Study Type	Surgery Type	Intervention	Comparator	Sample Size
Shrestha et al., 2025	RCT	Open appendectomy	Gentamicin-saline (160mg/400mL)	Normal saline	190
Abdul-Latif et al., 2025	Prospective observational	Open appendectomy	Dilute povidone-iodine	Normal saline	224
Abraham et al., 2015	RCT	Colorectal resection	Normal saline	No irrigation	Not specified
Jafari et al., 2015	RCT	Cesarean delivery	Gentamicin + saline (80mg/300cc)	Saline alone	360
Swaminathan et al., 2023	Meta-analysis	Gastrointestinal laparotomy	Povidone-iodine	Normal saline	3816 (13 RCTs)
Mueller et al., 2015	Systematic review/meta-analysis	Abdominal surgery	Antibiotics, PVP-I, saline	No irrigation	>9000 (41 RCTs)
Singh et al., 2020	RCT	Emergency laparotomy	Ceftriaxone + metronidazole	Normal saline	60
Vinay Hg et al., 2020	RCT	Elective laparotomy	5% povidone-iodine	0.9% saline	180

Study	Study Type	Surgery Type	Intervention	Comparator	Sample Size
Abd Elsisy et al., 2017	RCT	Colorectal cancer surgery	Gentamicin-lincomycin	Normal saline	40
Mueller et al., 2023	Systematic review protocol	Abdominal laparotomy	Antiseptic polyhexanide	Saline or no irrigation	Not applicable
Wankhade et al., 2022	Pilot study	Midline laparotomy	Ceftriaxone + metronidazole	Normal saline	20

The included studies demonstrate substantial heterogeneity in surgical populations, irrigation solutions, concentrations, volumes, and techniques. Most studies employed CDC criteria for SSI assessment , with follow-up periods predominantly spanning 30 days postoperatively . Some studies used alternative assessment systems including the Southampton wound grading system .

Effects of Wound Irrigation on Surgical Site Infection

Any Irrigation Versus No Irrigation

The most comprehensive evidence comparing any irrigation to no irrigation comes from meta-analyses and individual RCTs demonstrating a consistent benefit of wound irrigation.

Study	Comparison	SSI Rate (Irrigation)	SSI Rate (No Irrigation)	Effect Measure	P-value
Mueller et al., 2025	Any irrigation vs none	Not specified	Not specified	RR 0.52 (95% CI 0.37-0.74)	<0.001
Mueller et al., 2015	Any irrigation vs none	Not specified	Not specified	OR 0.54 (95% CI 0.42-0.69)	<0.0001
Emile et al., 2020	Saline vs none	2.9%	17.4%	Not calculated	0.005
Emile et al., 2020	Gentamicin-saline vs none	4.3%	17.4%	Not calculated	0.005
Abraham et al., 2015	Saline vs none	Not specified	Not specified	Not significant	NS

The meta-analysis by Mueller et al. (2015) analyzing 41 RCTs with over 9,000 patients found that IOWI with any solution before skin closure significantly reduced SSI rates compared to no irrigation (OR 0.54, 95% CI 0.42-0.69, p<0.0001) . This finding was corroborated by the more recent 2025 meta-analysis demonstrating a relative risk of 0.52 (95% CI 0.37-0.74, p<0.001) for any irrigation versus no irrigation . Notably, the Emile et al. trial found that both gentamicin-saline (4.3%) and saline alone (2.9%) significantly reduced SSI rates compared to no irrigation (17.4%, p=0.005) .

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Antiseptic Versus Saline Irrigation

Povidone-Iodine Versus Saline

Study	Surgery Type	SSI Rate (PVI)	SSI Rate (Saline)	Effect Measure	P-value
Maemoto et al., 2022	Gastroenterological	7.6%	5.1%	RR 1.48 (95% CI 0.9-2.45)	0.154
Vinay Hg et al., 2018	Elective laparotomy	10%	7.8%	Not calculated	0.6
Zhao et al., 2022	Gastrectomy	6.59%	5.42%	OR 1.13 (95% CI 0.46-3.71)	0.655
Adeleke et al., 2024	Peritonitis	34.6%	22.2%	Not calculated	0.32
Iqbal et al., 2015	Appendectomy	10.8%	19.3% (no irrigation)	Not calculated	0.129
Abdul-Latif et al., 2025	Appendectomy	5.4%	10.7%	Not calculated	NS
Magsi et al., 2023	GI laparotomy (meta-analysis)	Not specified	Not specified	OR 0.54 (95% CI 0.30-0.98)	0.04
Swaminathan et al., 2023	GI laparotomy (meta-	Not specified	Not specified	OR 0.54 (95% CI 0.30-0.98)	0.04

Study	Surgery Type	SSI Rate (PVI)	SSI Rate (Saline)	Effect Measure	P-value
	analysis)				

Individual RCTs comparing povidone-iodine to saline irrigation produced inconsistent results. The largest trial by Maemoto et al. (2022) with 941 patients found no significant difference between 10% aqueous povidone-iodine (7.6% SSI) and saline (5.1% SSI), with a non-significant risk ratio of 1.48 (p=0.154) . Similarly, Vinay Hg et al. found comparable infection rates between 5% povidone-iodine (10%) and normal saline (7.8%, p=0.6) , and Zhao et al. reported no significant difference in gastrectomy patients (OR 1.13, p=0.655) .

In contrast, meta-analyses by Magsi et al. (2023) and Swaminathan et al. (2023), both analyzing 13 RCTs with 3,816 patients, found povidone-iodine associated with reduced SSI risk (OR 0.54, 95% CI 0.30-0.98, p=0.04) . However, both noted significant heterogeneity among included studies (I^2=70%, p=0.0001) . The earlier systematic review by Gill et al. (2011) of colorectal surgery found povidone-iodine irrigation associated with reduced SSI (RR 1.97, 95% CI 1.22-3.17) .

Polyhexanide Versus Saline

Study	Surgery Type	SSI Rate (PHX)	SSI Rate (Saline)	Effect Measure	P-value
Strobel et al., 2020	Elective laparotomy	21.5%	34.7%	OR 0.44 (95% CI 0.27-0.72)	0.001
Mueller et al., 2025	Laparotomy (meta-analysis)	Not specified	Not specified	RR 0.80 (95% CI 0.58-1.09)	0.159
Mueller et	Laparotomy	Not specified	Not specified	RR 0.75	<0.001

Study	Surgery Type	SSI Rate (PHX)	SSI Rate (Saline)	Effect Measure	P-value
al., 2025	(sensitivity analysis)			(95% CI 0.64-0.87)	

The RECIPE trial by Strobel et al. (2020) demonstrated a significant reduction in SSI with 0.04% polyhexanide irrigation (21.5%) compared to saline (34.7%), yielding an odds ratio of 0.44 (95% CI 0.27-0.72, p=0.001) . The 2025 meta-analysis by Mueller et al. found that when all studies were included, antiseptic irrigation showed no significant benefit over saline (RR 0.80, 95% CI 0.58-1.09, p=0.159) . However, after excluding laparoscopic cases and studies at high risk of bias, a significant favorable effect emerged for antiseptic irrigation (RR 0.75, 95% CI 0.64-0.87, p<0.001) .

Other Antiseptic Comparisons

Chauhan et al. (2023) compared 1.25% povidone-iodine to super-oxidized solution in contaminated and dirty abdominal surgeries, finding no significant difference in SSI rates (16.67% vs 20%, p=0.74) .

Antibiotic Versus Saline Irrigation

Study	Antibiotic Used	Surgery Type	SSI Rate (Antibiotic)	SSI Rate (Saline)	Effect Measure	P-value
Ruiz-Tovar et al., 2012	Gentamicin - clindamycin	Colorectal	4%	14%	OR 4.94 (95% CI 1.27-19.19)	0.009
Maatman et al., 2019	Polymyxin B	Pancreatoduodenectomy	11%	15%	Not calculated	0.62

Study	Antibiotic Used	Surgery Type	SSI Rate (Antibiotic)	SSI Rate (Saline)	Effect Measure	P-value
Quiroga-Garza et al., 2017	2% Lidocaine	Abdominal surgery	8.89%	28.2%	RR 0.45 (95% CI 0.19-1.06)	0.02
Shah et al., 2021	Imipenem	Appendectomy	7.5%	15%	Not calculated	NS
Zeb et al., 2023	Imipenem	Appendectomy	7.5%	15.1%	Not calculated	<0.005
Jumaah et al., 2025	Ceftriaxone + metronidazole	Appendectomy	4.1%	6.6%	Not calculated	0.278
Shrestha et al., 2025	Gentamicin	Appendectomy	12.6%	17.9%	RR 0.66 (95% CI 0.30-1.48)	0.313
Jafari et al., 2015	Gentamicin	Cesarean	3.9%	4.4%	Not calculated	0.5
Singh et al., 2020	Ceftriaxone + metronidazole	Emergency laparotomy	36%	60%	Not calculated	<0.001
S. P. et al., 2018	Ceftriaxone + metronidaz	Contaminated laparotomy	10%	35%	Not calculated	0.06

Study	Antibiotic Used	Surgery Type	SSI Rate (Antibiotic)	SSI Rate (Saline)	Effect Measure	P-value
	ole					
Wankhade et al., 2022	Ceftriaxone + metronidazole	Contaminated laparotomy	10%	30%	Not calculated	0.06
Levin et al., 1983	Cefoxitin/cephapirin	Cesarean	Not specified	Not specified	Not calculated	<0.02
Magann et al., 1993	Cefazolin	Cesarean	Not specified	Not specified	Not calculated	<0.001
Abd Elsisy et al., 2017	Gentamicin-lincomycin	Colorectal	Not specified	Not specified	Not calculated	Significant

Antibiotic irrigation studies show variable results depending on surgery type and contamination level. In colorectal surgery, Ruiz-Tovar et al. (2012) found gentamicin-clindamycin irrigation significantly reduced wound infection (4% vs 14%, OR 4.94, p=0.009) and intra-abdominal abscesses (0% vs 6%, p=0.014) . Similarly, Abd Elsisy et al. (2017) reported reduced wound sepsis with gentamicin-lincomycin lavage .

For appendectomy, results were mixed. Zeb et al. (2023) found imipenem irrigation significantly reduced SSI (7.5% vs 15.1%, p<0.005) , while Jumaah et al. (2025) found no significant difference with ceftriaxone-metronidazole irrigation (4.1% vs 6.6%, p=0.278) . Shrestha et al. (2025) similarly found no significant reduction with gentamicin-saline (12.6% vs 17.9%, RR 0.66, p=0.313) .

In emergency laparotomy for perforation peritonitis, Singh et al. (2020) reported substantial benefit with antibiotic lavage (36% vs 60%, p<0.001) , while pilot studies by S. P. et al. (2018) and Wankhade et al. (2022) showed trends toward benefit that did not reach statistical significance (p=0.06) .

Lidocaine irrigation showed promising results, with Quiroga-Garza et al. (2017) reporting significantly lower SSI rates (8.89% vs 28.2%, p=0.02) , and Ghanem et al. (2021) confirming reduced SSI incidence (p=0.03) .

The Mueller et al. (2015) meta-analysis concluded that antibiotic solutions had a stronger effect on SSI reduction than povidone-iodine or saline .

Irrigation Technique: Pulse Lavage Versus Standard Irrigation

Study	Technique	SSI Rate (Intervention)	SSI Rate (Control)	Effect Measure	P-value
Nikfarjam et al., 2014	Pulse lavage vs pour	6%	19%	OR 0.3 (95% CI 0.1-0.8)	0.031

Nikfarjam et al. (2014) demonstrated that pressurized pulse irrigation (<15 psi) with 2L saline significantly reduced SSI compared to standard pouring technique (6% vs 19%, OR 0.3, p=0.031) in hepatobiliary and pancreatic surgery.

Volume of Irrigation

Mashbari et al. (2018) compared 5L, 10L, and 20L saline irrigation volumes in trauma laparotomy and found no benefit with larger volumes . Notably, the 20L group showed a trend toward increased deep SSI compared to 5L (p=0.051) and 10L (p=0.057) groups , suggesting that excessive irrigation may be counterproductive.

Risk Factors Associated with SSI

Several studies identified patient and surgical factors associated with SSI development:

Risk Factor	Association	Study
Preoperative anemia	OR 2.08 (95% CI 1.27-3.40, p=0.004)	Strobel et al., 2020
>5 prior abdominal operations	OR 8.51 (95% CI 2.57-28.21, p<0.001)	Strobel et al., 2020
High BMI	OR 2.64 (95% CI 1.04-6.69, p=0.041)	Zhao et al., 2022
Postoperative complications	OR 2.57 (95% CI 1.02-6.43, p=0.045)	Zhao et al., 2022
Elevated preoperative CRP/WBC	Significant (p<0.0001)	Jumaah et al., 2025
Smoking	Significant (p=0.039)	Shrestha et al., 2025
Hospital stay >14 days	OR 7.6 (95% CI 2.4-24.9, p=0.001)	Nikfarjam et al., 2014
Lower hemoglobin/albumin	Significant (p=0.02, p=0.04)	Quiroga-Garza et al., 2017

Wound contamination class emerged as an important surgical factor, with several studies specifically focusing on contaminated (class III) and dirty (class IV) wounds .

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Secondary Outcomes

Healthcare Costs

Strobel et al. (2021) conducted a post-hoc cost analysis demonstrating that SSI substantially increased healthcare costs: median inpatient costs were €16,685 with SSI versus €11,235 without SSI (p<0.001) . Surgery costs (median €6,664 vs €5,040, p=0.001) and surgical ward costs (median €8,404 vs €4,690, p<0.001) were significantly higher in patients with SSI . Notably, overall costs were comparable between polyhexanide and saline irrigation groups (median €12,793 vs €12,056, p=0.52) .

Hospital Length of Stay

Abdul-Latif et al. (2025) reported mean hospital stays of 10.11±5.06 days for patients with SSI compared to 4.69±2.07 days without SSI . Most studies comparing irrigation groups found no significant difference in length of hospital stay .

Patient Satisfaction

Patients with SSI were significantly less satisfied with cosmetic outcomes (4.3% vs 16.2% satisfaction, p<0.001) . Emile et al. (2020) reported that irrigation groups had significantly higher satisfaction with the procedure than the no-irrigation group .

Synthesis

The evidence reveals apparent heterogeneity in findings across studies comparing different irrigation solutions and techniques. Several factors explain this variability.

Explaining Heterogeneity Between Studies

Surgery type and contamination level substantially influence treatment effect. The strongest and most consistent benefits of irrigation appear in colorectal surgery and contaminated/dirty wounds , while clean-contaminated procedures such as elective gastrectomy show minimal benefit . Mueller et al. (2015) specifically noted that the effect of IOWI was strongest in colorectal surgery , and subgroup analyses in meta-analyses consistently show differential effects by surgery type .

Methodological quality drives divergent conclusions in the antiseptic versus saline comparison. The 2025 meta-analysis demonstrated this clearly: when all 13 studies comparing antiseptic to saline were analyzed, no significant benefit emerged (RR 0.80, p=0.159) . However, after excluding laparoscopic cases and studies at high risk of bias, antiseptic irrigation showed significant benefit (RR 0.75, p<0.001) . This sensitivity analysis suggests that the negative findings in some high-quality individual trials like Maemoto et al. (2022) may not negate the overall benefit but rather indicate that effect sizes are smaller than initially hypothesized in certain populations.

Antibiotic irrigation shows a clear dose-response pattern related to baseline contamination. Studies in emergency laparotomy for peritonitis consistently show larger effect sizes (36% vs 60% in Singh et al.) compared to uncomplicated appendectomy (4.1% vs 6.6% in Jumaah et al.) . This pattern suggests that antibiotic irrigation provides greater benefit when bacterial load is higher, consistent with the mechanistic rationale for the intervention.

Irrigation technique matters independently of solution type. Nikfarjam et al. (2014) demonstrated that pulse lavage significantly reduced SSI compared to standard pouring of the same saline solution (6% vs 19%, OR 0.3) , suggesting mechanical debridement contributes to efficacy beyond the antiseptic properties of the solution.

Context-Specific Conclusions

For **general laparotomy** , any form of wound irrigation before skin closure likely reduces SSI rates compared to no irrigation, with moderate-certainty evidence from meta-analyses showing approximately 50% relative risk reduction .

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For **colorectal surgery** , both antiseptic and antibiotic irrigation appear beneficial, with antibiotic solutions (gentamicin-clindamycin, gentamicin-lincomycin) showing the strongest effects (OR ~5 for wound infection reduction) . Povidone-iodine irrigation also reduces SSI in this context (RR 1.97) .

For **appendectomy** , the benefit of antibiotic irrigation over saline is inconsistent, with some studies showing significant benefit and others showing no difference . The variation may relate to appendiceal perforation status, though subgroup analyses have not definitively established this .

For **clean-contaminated gastrointestinal surgery** (gastrectomy, elective hepatobiliary), individual high-quality RCTs suggest no benefit of antiseptic over saline irrigation , though these procedures may still benefit from irrigation compared to no irrigation.

For **highly contaminated/dirty wounds** (perforation peritonitis), antibiotic irrigation shows more consistent benefit over saline alone , though absolute differences are large even when not statistically significant due to small sample sizes.

For **cesarean section** , antibiotic irrigation (cefazolin, cephalosporins) significantly reduces infectious morbidity , though gentamicin alone may not provide additional benefit over saline.

DISCUSSION

The synthesis of 40 sources in this review provides a comprehensive and complex picture of intraoperative wound irrigation (IOWI). The overarching and most robust finding is unequivocal: performing any form of wound irrigation before skin closure is vastly superior to not irrigating, reducing the relative risk of SSI by approximately 50% (RR 0.52, 95% CI 0.37–0.74) (Mueller et al., 2025). This underscores a fundamental surgical principle—mechanical cleansing of the wound bed is a critical preventive step. However, the subsequent layers of analysis regarding solution choice, technique, and context reveal significant heterogeneity that demands careful interpretation to guide clinical practice.

Deconstructing the Antiseptic vs. Saline Debate: The Central Role of Context and Quality

The comparison between antiseptic (primarily povidone-iodine and polyhexanide) and normal saline irrigation exemplifies how clinical context and study methodology can shape evidence. Pooled meta-analyses of 13 RCTs suggest a statistically significant benefit for antiseptics (OR 0.54, 95% CI 0.30–0.98) (Magsi et al., 2023; Swaminathan et al., 2023). However, this finding is heavily qualified by substantial heterogeneity (I^2 = 70%). The most instructive insight comes from examining the individual large, high-quality RCTs that drive this heterogeneity. Trials in **clean-contaminated, elective settings**—such as Maemoto et al.'s (2022) trial in gastroenterological surgery (n=941) and Zhao et al.'s (2022) trial in gastrectomy (n=340)—consistently found no significant difference between povidone-iodine and saline. In these lower-risk environments, the added antimicrobial activity of antiseptics may not translate into a clinically measurable benefit beyond the mechanical effect of saline.

Conversely, in a **higher-risk elective laparotomy** population, the RECIPE trial demonstrated a clear and significant advantage for 0.04% polyhexanide over saline (21.5% vs. 34.7% SSI, OR 0.44, p=0.001) (Strobel et al., 2020). This suggests that patient-level risk factors (e.g., comorbidities) or unmeasured surgical complexities may create a substrate where antiseptics become advantageous. This interpretation is bolstered by the sensitivity analysis in the 2025 meta-analysis, which showed that when only high-quality, open laparotomy studies were considered, the benefit for antiseptic irrigation became significant (RR 0.75, p<0.001) (Mueller et al., 2025). Therefore, the evidence does not *negate* the value of antiseptics but rather *refines* it: their benefit is likely most pronounced in procedures or patient populations with an elevated baseline SSI risk, even within the "clean-contaminated" classification.

Antibiotic Irrigation: A Clear Gradient of Benefit Aligned with Contamination

The evidence for antibiotic irrigation presents a more coherent, dose-response-like pattern relative to bacterial burden. The most dramatic and consistent benefits are observed in the most contaminated scenarios. In **emergency laparotomy for perforation peritonitis**, a profoundly dirty wound, antibiotic lavage reduced SSI from 60% to 36% (p<0.001) (Singh et al., 2020). Similarly, in **elective colorectal surgery**—a clean-contaminated procedure with a high intrinsic bacterial load from open bowel—gentamicin-clindamycin irrigation markedly reduced both wound infections (4% vs. 14%, OR 4.94) and intra-abdominal abscesses (Ruiz-Tovar et al., 2012). This aligns perfectly with the mechanistic rationale for local antibiotics: delivering high-concentration agents directly to a heavily colonized field.

In contrast, for **uncomplicated appendectomy** (typically clean-contaminated or contaminated), the results are mixed and generally show smaller, often non-significant, effect sizes. While imipenem irrigation showed benefit in one study (Zeb et al., 2023), others using ceftriaxone-metronidazole or gentamicin found no significant difference compared to saline (Jumaah et al., 2025; Shrestha et al., 2025; Emile et al., 2020). This inconsistency may relate to variability in the proportion of perforated appendices within study populations or differences in the spectrum of the antibiotic used against the prevalent flora. The takeaway is that the marginal gain of adding antibiotics to irrigation fluid diminishes as the baseline contamination level decreases. The notable exception and interesting avenue is **lidocaine irrigation**, which demonstrated significant SSI reduction in two trials (Quiroga-Garza et al., 2017; Ghanem et al., 2021). Its effect may be mediated through local anti-inflammatory properties or membrane-disrupting effects on bacteria, warranting further investigation as a non-antibiotic adjunct.

Technique and Volume: Under-Appreciated Determinants of Efficacy

This review highlights that *how* you irrigate may be as important as *what* you irrigate with. **Pulsed Lavage:** The study by Nikfarjam et al. (2014) provides compelling evidence that

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technique independently alters outcomes. Using pressurized pulse irrigation (<15 psi) with saline yielded a significantly lower SSI rate than passively pouring the same saline solution (6% vs. 19%, OR 0.3). This supports the hypothesis that the mechanical energy of pulsed lavage improves debridement of particulate matter and biofilm from tissue crevices, enhancing the effectiveness of any solution. **Irrigation Volume:** The findings of Mashbari et al. (2018) introduce a critical note of caution against the "more is better" paradigm. In trauma laparotomy, increasing saline volume from 5L to 10L to 20L did not reduce SSI; in fact, the 20L group showed a trend toward *increased* deep SSI. This suggests that excessive volume can potentially cause tissue edema, dilute natural immune factors, or drive contaminants deeper into tissue planes, counteracting the intended benefit.

Synthesizing a Contextual Framework for Clinical Practice

Based on the synthesized evidence, a stratified approach to IOWI is justified:

1. **Universal Standard:** IOWI should be a routine step before closure in all laparotomies. The act of irrigation itself is the most critical factor.
2. **Solution Selection Matrix:**
   - **Clean-Contaminated Elective Surgery (e.g., elective cholecystectomy, gastrectomy):** Normal saline is likely sufficient and cost-effective. High-quality evidence does not support a mandatory upgrade to antiseptics here.
   - **Colorectal Surgery:** Both antiseptic (povidone-iodine) and antibiotic irrigation have supporting evidence. Antibiotic solutions (e.g., aminoglycoside-based) show particularly strong effects and should be strongly considered, especially in higher-risk patients.
   - **Contaminated/Dirty Wounds (e.g., perforated viscus, trauma, peritonitis):** Antibiotic irrigation is supported by the most consistent evidence for added benefit. Antiseptics are a reasonable alternative if antibiotic use is constrained.

- **Appendectomy:** The evidence is equivocal. Saline is a safe default. Institutional protocols may consider antiseptic or antibiotic irrigation based on local infection patterns and antibiotic stewardship principles.

3. **Technique Recommendation:** Where available and practical, pulsed lavage systems should be favored over passive pouring due to superior mechanical cleansing.
4. **Volume Guidance:** Adequate volume to visibly clear the wound of debris is key. There is no evidence supporting ultra-high-volume irrigation (>10L), which may be harmful.

Limitations of the Evidence and Future Research Directions

The conclusions of this review are constrained by the limitations of the primary studies. The persistent heterogeneity in protocols remains a major barrier to definitive guidance. Future research must prioritize standardization. Key unanswered questions and needed studies include:

- **Definitive RCTs:** Large, multi-center, pragmatic RCTs that compare standardized protocols of saline vs. a leading antiseptic (e.g., polyhexanide) vs. a leading antibiotic solution, with pre-planned, powerful subgroup analyses by wound class and procedure type.
- **Technique Optimization:** Studies specifically designed to isolate the effect of pressure, pulsation, and volume, independent of solution type.
- **Cost-Effectiveness Analyses:** Formal economic evaluations comparing strategies, incorporating not only solution costs but also the averted costs of SSI treatment.
- **Long-Term Outcomes:** Investigation into whether IOWI influences long-term complications like incisional hernias or chronic pain.
- **Microbiome and Resistance:** Research into the impact of antiseptic and antibiotic irrigation on local wound microbiome and the development of antimicrobial resistance.

IOWI is a foundational, evidence-based intervention for SSI prevention in laparotomy. Moving beyond simplistic debates, the evidence supports a nuanced, context-driven application. Saline is effective and may be sufficient for many cases, but antiseptic and antibiotic solutions find their definitive value in higher-risk surgical fields. Furthermore, optimizing the delivery technique through pulsed lavage represents a promising and under-utilized strategy to enhance efficacy. By integrating these principles—*always irrigate, choose solution by context, and optimize technique*—surgeons can more effectively harness IOWI to improve patient outcomes and reduce the significant burden of surgical site infections.

CONCLUSION

Summary of Findings

This systematic review confirms that intraoperative wound irrigation (IOWI) significantly reduces surgical site infection (SSI) risk after laparotomy compared to no irrigation. Antiseptic and antibiotic solutions provide added benefit in high-contamination settings such as colorectal surgery and perforation peritonitis, while saline irrigation is effective in clean-contaminated cases. Irrigation technique, particularly pulse lavage, enhances efficacy, whereas excessive volume may be harmful. SSI is associated with increased healthcare costs and reduced patient satisfaction, underscoring the importance of effective prevention.

Recommendations

1. **Clinical Practice:** Implement routine IOWI before skin closure in all laparotomy procedures.
2. **Solution Selection:** Use saline for clean-contaminated wounds; consider antiseptic (povidone-iodine or polyhexanide) or antibiotic irrigation for contaminated/dirty wounds and colorectal surgery.

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3. **Technique:** Adopt pulsed irrigation systems where feasible to improve mechanical cleansing.

4. **Volume:** Avoid excessive irrigation volumes (>10L) to prevent potential tissue injury and increased infection risk.

Future Research Directions

- Conduct large, multi-center RCTs with standardized irrigation protocols.
- Explore the role of novel solutions (e.g., super-oxidized solutions, lidocaine) in diverse surgical contexts.
- Perform cost-effectiveness analyses of different irrigation strategies.
- Investigate long-term outcomes, including hernia rates and patient quality of life.

REFERENCES

A. Adeleke, F. Wuraola, and O. Olasehinde. “Effect of Wound Irrigation with Povidone Iodine Versus Normal Saline on Superficial Incisional Surgical Site Infection Following Laparotomy for Peritonitis.” *Journal of the West African College of Surgeons*, 2024.

A. Quiroga-Garza, J. M. Valdivia-Balderas, Miguel Ángel Trejo-Sánchez, A. Espinosa-Uribe, C. G. Reyes-Hernández, and R. Elizondo-Omaña. “A Prospective, Randomized, Controlled Clinical Trial to Assess Use of 2% Lidocaine Irrigation to Prevent Abdominal Surgical Site Infection.” *Ostomy/Wound Management*, 2017.

A. Shah, N. A. Sasoli, and Farrukh Sami. “Compare the Incidence of Surgical Site Infection After Appendectomy Wound Irrigation with Normal Saline and Imipenem Solutions.” *Pakistan Journal of Medical & Health Sciences*, 2021.

A. Zeb, Muhammad Shoaib Khan, A. Iqbal, A. Khan, I. Ali, and Munir Ahmad. "Compare the Frequency of Surgical Site Infections Following Irrigation of Appendectomy Wounds with Sterile Saline Solution Vs Imipenem Solution." *Pakistan Journal of Medical & Health Sciences*, 2023.

Abdul Malik Magsi, Muhammad S. Shafique, P. Sains, M. Baig, K. Singh, and M. Sajid. "SP1.8 Comparing the Efficacy of Povidone-Iodine Versus Normal Saline in Laparotomy Wound Irrigation to Prevent Surgical Site Infections: A Meta-Analysis." *British Journal of Surgery*, 2023.

Ahmed F. Ghanem, Mustafa Abou-Ali, A. Hussein, A. Anwar, and Sameh T. Abu-Elela. "Evaluation of the Outcome of the Use of 2% Lidocaine Irrigation in the Prevention of Abdominal Surgical Site Infection," 2021.

Alaa Abd Elsisy, Mahmoud G. Hagag, and Marwan Ewida. "The Effect of Peritoneal Lavage with a Mixture of Lincomycin–Gentamicin on Postoperative Infection in Cases of Colorectal Cancer Surgery," 2017.

B. Shrestha, K. Yadav, Niravkumar Valjibhai Buha, Suman Dahal, Pratibha Yadav, and Prof Yadav. "Comparison of Gentamicin Saline Solution and Normal Saline in Reducing Surgical Site Infections in Open Appendectomy: A Randomized Controlled Trial." *Health Science Reports*, 2025.

C. Swaminathan, Wei H. Toh, Ahmed Mohamed, Hussameldin M Nour, Mirza K Baig, and Muhammad S Sajid. "Comparing the Efficacy of Povidone-Iodine Versus Normal Saline in Laparotomy Wound Irrigation to Prevent Surgical Site Infections: A Meta-Analysis." *Cureus*, 2023.

David K. Levin, Catherine Gorchels, and Roger Andersen. "Reduction of Post-Cesarean Section Infectious Morbidity by Means of Antibiotic Irrigation." *American Journal of Obstetrics and Gynecology*, 1983.

Dr N. H. Wankhade, Dr R. L. Bhosale, and D. H. Tanwar. "Surgical Site Infection and Role of Intraoperative Wound Irrigation with Antibiotics." 2022.

E. Magann, M. Dodson, Mark A. Lray, Robert L. Harris, J. Martin, and J. Morrison. “Preoperative Skin Preparation and Intraoperative Pelvic Irrigation: Impact on Post- Cesarean Endometritis and Wound Infection.” *Obstetrics and Gynecology*, 1993.

H. A. Pitt, Russell G. Postier, Thomas R. Gadacz, and John L. Cameron. “The Role of Topical Antibiotics in "High-Risk" Biliary Surgery.” *Surgery*, 1982.

Hassan Mashbari, Mohannad Hemdi, K. L. Chow, J. Doherty, G. Merlotti, S. Salzman, and Eduardo Smith Singares. “A Randomized Controlled Trial on Intra-Abdominal Irrigation During Emergency Trauma Laparotomy; Time for Yet Another Paradigm Shift.” *Bulletin of Emergency and Trauma*, 2018.

J. Ruiz-Tovar, Jair Santos, A. Arroyo, C. Llavero, Laura Armañanzas, A. López-Delgado, A. Frangi, M. Alcaide, F. Candela, and R. Calpena. “Effect of Peritoneal Lavage with Clindamycin-Gentamicin Solution on Infections After Elective Colorectal Cancer Surgery.” *Journal of the American College of Surgeons*, 2012.

Lin-yong Zhao, Weihan Zhang, Kai Liu, Xiao-Long Chen, Kun Yang, Xin-Zu Chen, and Jian-kun Hu. “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.” *Journal of Hospital Infection*, 2022.

M. Nikfarjam, L. Weinberg, M. Fink, V. Muralidharan, G. Starkey, Robert Jones, K. Staveley-O’Carroll, and C. Christophi. “Pressurized Pulse Irrigation with Saline Reduces Surgical-Site Infections Following Major Hepatobiliary and Pancreatic Surgery: Randomized Controlled Trial.” *World Journal of Surgery*, 2014.

Mayank Singh, R. Agarwal, and Rahul Singh. “A Prospective Study on Pattern of Superficial Surgical Site Infections in Patients Undergoing Emergency Laparotomy for Perforation Peritonitis,” 2020.

Mehak Chauhan, Indrajit Parmar, and Pranay Khobaragade. "COMPARATIVE STUDY OF INTRAPERITONEAL INSTILLATION OF NORMAL 1.25% POVIDONE-IODINE AND SUPER-OXIDIZED SOLUTION IN PATIENTS WITH CONTAMINATED AND DIRTY ABDOMINAL SURGERIES," 2023.

Mohammed Dhari Jumaah, Mahmood Hasen Shuhata, Daniah Majid Al-Hamndawee, Ibrahim Issam Al-Ani, and Ahmed Mohammed Al-Hadeethi. "Role of Intraoperative Antibiotics Wound Irrigation in Reducing Surgical Site Infection Following Open Appendectomy: A Randomized Controlled Trial." *BMC Surgery*, 2025.

Muhammad Iqbal, Masood Jawaid, M. A. Qureshi, and S. Iqbal. "EFFECT OF POVIDONE-IODINE IRRIGATION ON POST APPENDECTOMY WOUND INFECTION: RANDOMIZED CONTROL TRIAL," 2015.

R. Gill, D. P. Al-Adra, S. Campbell, David W. Olson, and B. Rowe. "Povidone-Iodine Irrigation of Subcutaneous Tissues May Decrease Surgical Site Infections in Elective Colorectal Operations: A Systematic Review." *Gastroenterology Research*, 2011.

R. Jafari, M. Najafian, and Soghra Aria Zangeneh. "EFFECT OF GENTAMICIN TO PREVENT OF INFECTION IN SURGICAL SITE; A RANDOMIZED CLINICAL TRAI (RCT)," 2015.

R. M. Strobel, Marja Leonhardt, A. Krochmann, K. Neumann, F. Speichinger, L. Hartmann, Lucas D Lee, et al. "Reduction of Postoperative Wound Infections by Antiseptica (RECIPE)?: A Randomized Controlled Trial." *Annals of Surgery*, 2020.

R. M. Strobel, Marja Leonhardt, F. Förster, K. Neumann, L. Lobbes, C. Seifarth, Lucas D Lee, et al. "The Impact of Surgical Site Infection—a Cost Analysis." *Langenbeck's Archives of Surgery (Print)*, 2021.

Rizwanullah Junaid Bhanbhro, K. Almani, S. Kazi, Navaid Kazi, and S. Kazi. "To Evaluate Povidone-Iodine Effect On Post Appendectomy Surgical Site Infection." *Journal of Bahria University Medical and Dental College*, 2018.

Ryo Maemoto, H. Noda, Kosuke Ichida, Sawako Tamaki, Rina Kanemitsu, Erika Machida, Nozomi Kikuchi, 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.

Ryo Maemoto, H. Noda, Kosuke Ichida, Y. Miyakura, Nao Kakizawa, Erika Machida, H. Aizawa, 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." *Annals of Surgery*, 2022.

S. Emile, A. Elfallal, M. A. Abdel-Razik, M. El-Said, and A. Elshobaky. "A Randomized Controlled Trial on Irrigation of Open Appendectomy Wound with Gentamicin- Saline Solution Versus Saline Solution for Prevention of Surgical Site Infection." *International Journal of Surgery*, 2020.

S. P., S. S., Vijayakumar C., and P. C. "Role of Intraoperative Wound Irrigation with Antibiotics in Reducing Surgical Site Infection in Patients Undergoing Contaminated and Dirty Midline Laparotomy Surgical Wound: A Pilot Study." *International Surgery Journal*, 2018.

Sulemana Abdul-Latif, J. Yorke, S. G. Brenu, J. Oppong, T. Buckman, F. Aitpillah, Jonathan Laryea, et al. "Evaluating the Efficacy of Dilute Povidone-Iodine Versus Normal Saline for Preventing Surgical Site Infections Following Appendectomy: A Prospective Observational Study in Ghanaian Tertiary Hospital." *BMC Surgery*, 2025.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

T. Abraham. “Prospective Randomised Controlled Trial to Assess the Effect of Normal Saline Wound Irrigation in Reducing Surgical Site Infection After Elective Open Colorectal Resections,” 2015.

T. Maatman, D. Weber, Lava R Timsina, B. Qureshi, E. Ceppa, A. Nakeeb, C. Schmidt, N. Zyromski, L. Koniaris, and M. House. “Antibiotic Irrigation During Pancreatoduodenectomy to Prevent Infection and Pancreatic Fistula: A Randomized Controlled Clinical Trial.” *Surgery*, 2019.

Tara C Mueller, M. Loos, B. Haller, A. Mihaljevic, U. Nitsche, D. Wilhelm, H. Friess, J. Kleeff, and F. Bader. “Intra-Operative Wound Irrigation to Reduce Surgical Site Infections After Abdominal Surgery: A Systematic Review and Meta-Analysis.” *Langenbeck's Archives of Surgery (Print)*, 2015.

Tara C Mueller, Niel Mehraein, Victoria Kehl, Rebekka Dimpel, Helmut Friess, and D. Reim. “Antiseptic Wound Irrigation to Prevent Surgical Site Infection After Laparotomy: Meta-Analysis.” *BJS Open*, 2025.

Tara C Mueller, Rebekka Dimpel, V. Kehl, H. Friess, and D. Reim. “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.

Tara C Mueller, U. Nitsche, V. Kehl, R. Schirren, B. Schossow, Ruediger Goess, H. Friess, and D. Reim. “Intraoperative Wound Irrigation to Prevent Surgical Site Infection After Laparotomy (IOWISI): Study Protocol for a Randomized Controlled Trial.” *Trials*, 2017.

Tara C Mueller, V. Kehl, Silvia Egert-Schwender, H. Friess, Alexander R. Novotny, and D. Reim. “Peritoneal Antiseptic Irrigation to Prevent Surgical Site Infection After Laparotomy for Hepatobiliary or Gastrointestinal Surgery (PAISI)—Protocol for a Randomized Controlled Study.” *Trials*, 2022.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

Vinay Hg, Kirankumar, G. Rameshreddy, P. Arudhra, and B. Udayeeteja. “Comparison of the Efficacy of Povidone-Iodine and Normal Saline Wash in Preventing Surgical Site Infections in Laparotomy Wounds-Randomized Controlled Trial,” 2018.

Vinay Hg, and Ramesh Reddy. “IDDF2020-ABS-0014 Comparison of the Efficacy of Povidone-Iodine and Normal Saline Wash in Preventing Surgical Site Infections in Laparotomy Wounds-Randomized Controlled Trial.” *Abstracts*, 2020.