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The Role Of Healthcare Workers In Preventing Surgical Site Infections: Evidence-Based Strategies And Interventions

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Abstract

Surgical site infections (SSIs) are a significant healthcare burden, accounting for 15.7% of healthcare-associated infections. Evidence-based guidelines recommend interventions such as rational antibiotic prophylaxis, appropriate preoperative hair removal, perioperative normothermia, and glycemic control to reduce SSI incidence. However, suboptimal adherence to these measures necessitates further research to evaluate the effectiveness of care bundles and reinforce their importance in clinical practice. Recent systematic reviews and meta-analyses have identified antimicrobial sutures as a promising intervention, demonstrating significant SSI reductions across various surgical specialties. This evidence supports their inclusion in standardized care bundles. Other interventions like 2% chlorhexidine in alcohol-based skin preparation, postoperative negative pressure wound therapy, and antiseptic wound dressings show potential but require further validation. Practices such as preoperative bathing/showering, antibiotic prophylaxis for clean non-prosthetic surgeries, and perioperative oxygen supplementation remain contentious. Evidence indicates that wound guards and diathermy skin incisions do not significantly impact SSI rates. Integrating these insights into clinical practice can improve adherence to evidence-based guidelines and reduce the prevalence and impact of SSIs. Future research should focus on standardizing protocols, conducting well-powered trials, and assessing interventions in specific surgical populations to provide clearer guidance for SSI prevention.

Keywords: SSI, Surgical Site Infections, infection control, Healthcare Workers.

Introduction

Recent epidemiological studies have highlighted that the overall prevalence of healthcare-associated infections (HCAIs) stands at 6.4%, with a confidence interval (CI) of 4.7–8.7%. Among these, surgical site infections (SSIs) rank as the third most common category, accounting for 15.7% of cases. SSIs are arguably the most preventable form of HCAIs, especially when effective strategies, such as a care bundle approach, are implemented. Care bundles serve as structured groups of interventions designed to improve patient outcomes by targeting modifiable risk factors. A high-impact intervention (HII) care bundle developed under the direction of the Department of Health, is based on comprehensive guidelines for SSI prevention and management. These guidelines, published by the National Institute for Health and Clinical Excellence (NICE), integrate findings from systematic reviews, expert opinions, and other authoritative sources.

The HII care bundle emphasizes core practices, such as the rational use of antibiotic prophylaxis, appropriate preoperative hair removal, prevention of perioperative hypothermia, and strict perioperative glycemic control for patients with diabetes. Additional recommendations, albeit not supported by level IA evidence, are also incorporated. Notably, an evidence update issued by NICE has not significantly altered the original guidelines. However, despite the dissemination of these recommendations over the past five years, no formal evaluations of their adherence or effectiveness have been reported. This raises critical concerns about the implementation and practical impact of these measures.

The national SSI surveillance system has been introduced to enable healthcare institutions to benchmark their SSI rates against national averages, with the ultimate goal of improving patient care quality. Hospitals participating in the surveillance system are required to monitor at least one of 17 categories of surgical procedures. Furthermore, the Department of Health has mandated that acute NHS hospital trusts performing orthopedic surgeries conduct at least three months of annual surveillance in specified surgical categories. Nonetheless, it has been postulated that the actual prevalence of SSIs may be significantly underestimated. Variations in surgical specialties, inconsistent definitions, and gaps in postoperative surveillance contribute to this issue (Tanner et al., 2013). Rigorous post-discharge surveillance, particularly when conducted by impartial, trained, and validated observers, has revealed that SSIs may complicate 10–20% of surgical procedures, suggesting that the true incidence of SSIs is underreported across all surgical categories (Thibon et al., 2012; Williams et al., 2011).

SSIs account for over one-third of postoperative fatalities and vary in severity. They may manifest as minor wound discharges following procedures such as open hernia repairs or evolve into life-threatening conditions such as mediastinitis and sternal wound dehiscence. Intermediate cases can result in aesthetically displeasing scars, prolonged hospitalization, increased treatment costs, and psychological distress. The economic burden of SSIs is further exacerbated by indirect costs, including loss of productivity, diminished quality of life, and legal expenses. Direct treatment costs can involve extended hospital stays and additional surgical interventions, often amounting to substantial financial outlays (D. Leaper et al., 2010). For instance, sternal infections following cardiac surgeries are associated with significant morbidity and mortality. While prospective cost-benefit analyses of SSIs are scarce, retrospective analyses unequivocally demonstrate the economic toll of these infections.

Despite the comprehensive recommendations provided by the NICE guidelines, recent studies have explored novel interventions and technologies for SSI prevention. Some of these advancements hold promises for future inclusion in guidelines and HII care bundles, while others have been deemed ineffective. The NICE evidence update reflects these developments, including new data, emerging technologies, and areas where existing evidence remains unchanged. The review of the most pertinent aspects of this evolving evidence base forms the core discussion of this article.

Surgical site infections (SSIs) represent a significant proportion of healthcare-associated infections, requiring considerable healthcare resources for prevention and management. Addressing these infections necessitates adherence to established clinical guidelines, which advocate for specific interventions. These include the rational use of antibiotic prophylaxis, careful preoperative hair removal, and the maintenance of perioperative normothermia and glycemic control. Such measures are vital for reducing the incidence of preventable SSIs, which continue to burden healthcare systems.

However, compliance with care bundles remains suboptimal and is a critical factor contributing to the persistent SSI rates. This poor adherence underscores the need for further research to evaluate the effectiveness of these bundles and to emphasize their importance within clinical practice. Recent systematic reviews and meta-analyses have identified antimicrobial sutures as a promising intervention, demonstrating significant reductions in SSI rates across various surgical specialties. This evidence supports the inclusion of antimicrobial sutures in standardized care bundles to enhance their effectiveness.

Additional interventions, such as the use of 2% chlorhexidine in alcohol-based skin preparation, postoperative negative pressure wound therapy, and antiseptic wound dressings, show potential in reducing SSIs. However, further research is required to validate their clinical utility and determine their suitability for inclusion in care bundles. While practices like preoperative bathing or showering, antibiotic prophylaxis for clean, non-prosthetic surgeries, and perioperative oxygen supplementation remain contentious, evidence indicates that interventions such as wound guards and diathermy skin incisions do not significantly impact SSI rates.

By integrating these insights into clinical practice, healthcare providers can work towards achieving more consistent adherence to evidence-based guidelines, ultimately reducing the prevalence and impact of SSIs.

Preoperative Bathing and Skin Preparation

Maintaining personal hygiene for both surgical patients and the operative team on the day of surgery is universally accepted as essential; however, the role of preoperative bathing and skin preparation with antiseptic solutions in preventing surgical site infections (SSIs) remains unproven. A Cochrane review analyzed seven randomized controlled trials (RCTs) involving a total of 10,157 patients (Webster & Osborne, 2015). This review found no significant difference in SSI prevention between preoperative bathing or showering with chlorhexidine, placebo, standard soap, or no washing at all. Notably, most of these studies were conducted over two decades ago, and their findings may no longer reflect current surgical and antiseptic advancements.

Further research, including a systematic review of 10 studies encompassing 7,351 patients, examined the effects of varying numbers of antiseptic showers and different antiseptic agents. Although eight studies in the review observed that chlorhexidine could reduce skin surface bioburden, definitive conclusions regarding the optimal number of preoperative showers could not be drawn due to significant methodological limitations. Many of these trials were underpowered, and the reduction in bacterial load on the skin did not consistently correlate with a decrease in SSI risk. This disconnect highlights the need for additional well-designed studies to clarify the clinical significance of these findings.

Another comprehensive systematic review examined 20 randomized and nonrandomized studies involving 9,520 participants across various surgical disciplines, including thoracic, cardiac, plastic, orthopedic, neurological, abdominal, and pelvic surgeries. This review assessed three commonly used skin antiseptics—povidone–iodine, alcohol, and chlorhexidine—in different contexts, such as preoperative showering, surgical site skin preparation, operative team hand scrubbing, and the use of antiseptic-impregnated incise drapes. Despite the evidence that preoperative showering could reduce skin surface bacterial load, the impact on SSI rates remained inconclusive. Heterogeneity among the included studies, inconsistencies in the formulation and application of antiseptics, and variations in surgical procedures contributed to these inconclusive results.

In addition to methodological flaws, such as inconsistent randomization, inadequate sample sizes, and varying surgical protocols, the existing literature highlights the difficulty of drawing definitive conclusions about preoperative bathing practices. The variability in antiseptic formulations, their concentrations, and methods of application further complicates the interpretation of these findings. Although preoperative bathing may appear to offer some benefits, particularly in reducing surface bioburden, its overall effectiveness in preventing SSIs requires further validation through robust, large-scale clinical trials.

The uncertainty surrounding the efficacy of preoperative bathing or showering underscores the necessity for additional research to inform clinical guidelines. Only through well-powered trials with rigorous methodology can the evidence base for this intervention be strengthened.

Patient Antiseptic Skin Preparation

Preparing the patient's skin at the surgical site immediately before incision with an antiseptic agent is a widely accepted practice. Common antiseptics include povidone–iodine and chlorhexidine, which may be formulated as either aqueous or alcohol-based solutions. A Cochrane review of five trials—randomized, quasi-randomized, and cluster-randomized—analyzed the effects of preoperative skin preparation in 1,462 patients undergoing cesarean sections. The findings revealed that the application of incisional drapes did not significantly reduce SSI rates, with a reported relative risk (RR) of 1.29 (95% confidence interval [CI] 0.97–1.71, P = 0.084). In one specific trial with 79 participants, comparing alcohol scrub with povidone–iodine incise drapes against povidone–iodine scrub alone, no infections were observed in either group. However, the limited number of patients and high heterogeneity across studies precluded any definitive conclusions, aligning with the earlier systematic review's findings (Kamel et al., 2012).

Another trial included in the systematic review focused on 849 patients and compared the efficacy of 2% alcoholic chlorhexidine, delivered via a disposable applicator, with conventional aqueous povidone–iodine skin preparation. The trial demonstrated a statistically significant reduction in SSIs in the group that received chlorhexidine, but the comparison with an aqueous-based antiseptic raised concerns about methodological rigor. Despite these limitations, the use of alcoholic chlorhexidine has gained widespread acceptance in various surgical specialties, as its efficacy in reducing bacterial load appears superior to that of aqueous solutions.

The choice of antiseptic agents and their delivery methods remains an area of active investigation. Alcohol-based solutions, particularly those containing chlorhexidine, are often regarded as more effective than aqueous formulations due to their rapid bactericidal activity and residual effect on the skin. However, the variability in study designs and the lack of standardized application protocols limit the generalizability of current findings. Further studies are needed to explore the comparative effectiveness of different antiseptic agents, their concentrations, and the optimal techniques for skin preparation.

Additional challenges include the diversity of surgical settings, patient populations, and procedure types, all of which influence the effectiveness of antiseptic interventions. For instance, the use of antiseptic-impregnated incise drapes has been explored as an adjunct to traditional skin preparation. While some studies suggest potential benefits, the evidence remains inconclusive due to inconsistencies in study quality and patient outcomes. Moreover, the cost-effectiveness of such interventions warrants further analysis to guide their integration into routine practice.

Overall, while alcohol-based antiseptics like chlorhexidine show promise, the optimal choice and method of skin preparation remain uncertain. Addressing these knowledge gaps requires well-designed, large-scale trials with standardized protocols to provide clearer guidance for clinical practice.

Antibiotic Prophylaxis in Breast And Hernia Surgery

The use of antibiotic prophylaxis in breast and hernia surgeries continues to be a topic of debate. A Cochrane review evaluated 17 randomized controlled trials (RCTs), encompassing 7,843 patients, to determine the impact of antibiotic prophylaxis on surgical site infections (SSIs) in adult patients undergoing elective open inguinal or femoral hernia repair. The review found that the incidence of SSIs was significantly lower in patients who received prophylactic antibiotics compared to those who did not (3.1% versus 4.5%, respectively; odds ratio [OR] = 0.64, 95% confidence interval [CI] 0.50–0.82, P = 0.00042). However, in cases of herniorrhaphy without the use of mesh, no significant difference in infection rates was observed between the two groups, highlighting variability in the effectiveness of antibiotic prophylaxis depending on surgical techniques.

In breast cancer surgery, two studies have examined the utility of antibiotic prophylaxis in reducing SSIs. A Cochrane review involving seven RCTs with 1,945 participants compared the administration of preoperative or perioperative antibiotics to placebo or no antibiotics. The review concluded that the incidence of SSIs was significantly reduced in the group that received prophylactic antibiotics (relative risk [RR] = 0.72, 95% CI 0.53–0.97, P = 0.031). Despite these findings, a separate double-blind RCT involving 254 patients reported no significant difference in SSIs between those who received antibiotics and those given a placebo (13.4%, P = 0.719) (Cabaluna et al., 2013). This disparity in results may be attributed to methodological limitations, including variations in the antibiotics used and inconsistencies in study designs.

One of the key concerns associated with the use of antibiotic prophylaxis is the potential development of antimicrobial resistance, which presents a growing public health challenge. Additionally, the financial burden of routine antibiotic prophylaxis in clean surgical procedures must be considered. Given the contradictory findings and potential drawbacks, the role of prophylactic antibiotics in preventing SSIs during breast and hernia surgeries remains inconclusive. Further research is needed to address these uncertainties, ideally through large-scale, multicenter trials that account for surgical technique, patient comorbidities, and antibiotic regimens.

It is also important to recognize that the effectiveness of antibiotic prophylaxis may vary based on patient-specific factors, such as obesity, diabetes, and immunosuppression. These conditions are known to increase the risk of SSIs and may influence the cost-benefit ratio of prophylactic antibiotic use. Additionally, evolving surgical techniques, including laparoscopic approaches for hernia repair, may alter the necessity and effectiveness of antibiotics in preventing infections. Addressing these variables in future studies could provide a more nuanced understanding of the role of antibiotics in these types of surgeries.

Negative Pressure Wound Therapy

Negative pressure wound therapy (NPWT) has become a widely adopted modality for managing chronic wounds due to its ability to promote wound healing, enhance debridement, reduce exudate and odor, and improve overall quality of life (D. J. Leaper et al., 2012). This therapy involves the application of intermittent or continuous negative pressure (ranging from <50 to >125 mmHg) to a wound, which is sealed with an occlusive drape over a foam or gauze dressing. NPWT has demonstrated success in managing complex wounds, and emerging evidence suggests its utility in reducing SSIs in high-risk postoperative incisions (Grauhan et al., 2014). Mechanisms of action include stabilizing wound edges to reduce surgical dehiscence, improving perfusion, minimizing lateral tension, and reducing hematoma, edema, and microbial contamination at the surgical site.

Several studies have highlighted the potential benefits of NPWT in reducing SSIs. A retrospective analysis of colorectal, pancreatic, and peritoneal surface malignancy surgeries reported significantly fewer superficial incisional SSIs in patients treated with NPWT compared to standard dressings (6.7% vs. 19.5%, $P < 0.015$). Similarly, after clean-contaminated surgeries, NPWT was associated with a marked reduction in both superficial SSIs (6.0% vs. 27.4%, $P < 0.001$) and the need for postoperative wound interventions (16.0% vs. 35.5%, $P < 0.011$). These findings suggest a potential benefit; however, the retrospective nature of the study necessitates validation through well-designed, prospective RCTs.

In another prospective study involving obese patients (BMI ≥ 30) undergoing cardiac surgery via median sternotomy, NPWT was found to significantly reduce SSIs (4%) compared to standard wound dressings (16%; P = 0.027; OR = 4.57; 95% CI 1.23–16.94). Notably, infections caused by Gram-positive skin flora were identified in only one NPWT patient compared to 10 patients in the standard dressing group (P = 0.009; OR = 11.39; 95% CI 1.42–91.36). Similarly, portable NPWT devices have been used effectively to reduce groin wound infections following vascular surgery, where SSI rates were 6% with NPWT compared to 30% with conventional dressings (P = 0.0011). Furthermore, a retrospective review of patients undergoing open colectomy revealed an SSI incidence of 12.5% in patients treated with NPWT compared to 29.3% in those receiving standard wound care. In orthopedic surgery, a multicenter RCT involving 249 patients with blunt, high-energy lower limb fractures demonstrated significantly fewer infections in the NPWT group compared to the standard dressing group (23/122; 19%).

Despite these promising results, evidence on the efficacy of NPWT remains mixed. For example, a study examining ventral hernia repair found no significant difference in SSI rates between NPWT and standard wound care (25.8% vs. 20.4%, P = 0.50). Additionally, at a 12-month follow-up, there were no notable differences in late wound complications between the two groups (31.4% vs. 28.6%; P = 0.74). These findings highlight the need for further investigations to establish whether NPWT can consistently reduce SSI rates across different types of surgeries and patient populations.

The mixed outcomes from NPWT studies may be attributed to differences in patient populations, surgical techniques, and study designs. Factors such as wound contamination level, patient comorbidities, and variations in NPWT device settings could all influence the effectiveness of the therapy. Moreover, the financial implications of NPWT, especially when compared to standard wound dressings, should be considered in future studies to determine its cost-effectiveness and feasibility for widespread adoption.

Given the relatively small sample sizes and heterogeneity of available studies, further well-powered, multicenter RCTs are necessary to evaluate the true efficacy of NPWT in preventing SSIs. These trials should aim to standardize NPWT protocols, account for patient-specific risk factors, and assess both short- and long-term outcomes. Until more robust evidence becomes available, the routine use of NPWT for SSI prevention should be carefully considered on a case-by-case basis, taking into account the surgical context, patient risk factors, and available resources.

Perioperative Oxygen Supplementation

Ensuring optimal oxygenation during surgical procedures is an essential aspect of best practices in perioperative care, aiming to maintain haemoglobin saturation above 95%. A systematic review and meta-analysis encompassing seven randomized controlled trials (RCTs) with a total of 2,728 participants evaluated the effects of perioperative oxygen supplementation, specifically administering a fraction of inspired oxygen (FiO_2) of 0.8 for a duration of two hours postoperatively in the recovery room, on the incidence of surgical site infections (SSIs). The overall findings indicated no statistically significant difference in SSI rates between the group receiving supplementary oxygen and the control group, with infection rates of 15.5% and 17.5%, respectively (odds ratio [OR] = 0.85, 95% confidence interval [CI] 0.52–1.38, P = 0.51). This suggests that, based on current evidence, the routine application of high-concentration oxygen supplementation postoperatively does not confer a universal benefit in reducing SSIs.

Despite these general findings, further analysis of the data revealed two distinct subgroups in which perioperative oxygen supplementation demonstrated a significant reduction in SSIs. Firstly, when studies involving neuraxial anaesthesia were excluded, the remaining data suggested a potential benefit of increased oxygen administration in preventing SSIs. Secondly, among patients undergoing colorectal surgery, the use of supplemental oxygen was associated with a statistically significant reduction in SSIs. These subgroup findings highlight the necessity for additional research to determine whether specific surgical populations or anaesthetic techniques influence the effectiveness of perioperative oxygen supplementation in reducing postoperative infections.

One of the critical limitations of the trials included in the meta-analysis was the considerable heterogeneity in various methodological aspects, including differences in antibiotic regimens, definitions of SSIs, patient populations, and the duration of perioperative oxygen administration. These inconsistencies across studies may have contributed to the lack of a clear consensus regarding the benefits of perioperative oxygen supplementation. Future research should aim to address these limitations by standardizing definitions, controlling for confounding variables such as antibiotic prophylaxis, and conducting well-designed trials targeting patient populations and surgical procedures that may derive the greatest benefit from oxygen supplementation.

Antiseptic Surgical Dressings

The conventional practice following surgical procedures involves covering incisions with a dressing to protect the wound and promote healing. However, there remains considerable debate regarding the necessity of wound dressings and the optimal type of dressing to use. Specifically, uncertainty persists regarding whether incisions require coverage at all, or whether transparent polyurethane dressings or absorptive island dressings offer superior protection against SSIs. A Cochrane review consisting of 16 RCTs with a total of 2,578 participants examined the role of wound dressings in preventing SSIs (Dumville et al., 2016). The review concluded that there was no substantial evidence to support the notion that covering surgical wounds with a dressing reduces the incidence of SSIs. This finding challenges the conventional assumption that wound dressings provide a protective barrier against infections and calls into question their routine use in postoperative care.

Despite the comprehensive nature of the review, a critical appraisal of the included studies revealed several methodological flaws that weaken the reliability of the conclusions. Many of the trials exhibited significant heterogeneity in their study designs, patient populations, and outcome measures, making direct comparisons difficult. Additionally, the trials were generally small in scale and of poor scientific quality, with many being outdated studies that may not reflect current surgical and infection control practices. These limitations underscore the need for further high-quality research to establish clear guidelines regarding the role of wound dressings in the prevention of SSIs.

In contrast to general wound dressings, antiseptic dressings have been widely studied in the management of chronic wounds. However, the evidence supporting their role in SSI prevention remains limited. Among the various antiseptic dressings available, silver nylon dressings have shown promise in a small RCT involving 110 patients undergoing colorectal surgery. The study found a significantly lower incidence of SSIs in patients who received silver nylon dressings compared to those who had their wounds covered with standard gauze dressings. Specifically, the infection rate in the silver nylon dressing group was 13% (7 out of 55 patients), whereas the rate in the gauze dressing group was considerably higher at 33% (18 out of 54 patients, $P = 0.011$). These findings suggest a potential benefit of silver-based dressings in reducing SSIs in certain surgical populations.

Despite these promising results, it is important to acknowledge the limitations of the study, including its small sample size and potential biases in study design. Further large-scale, well-conducted RCTs are necessary to validate these findings and determine whether antiseptic dressings, particularly silver-based ones, should be routinely incorporated into surgical wound management protocols. Additionally, future research should explore the cost-effectiveness, practicality, and long-term outcomes associated with antiseptic dressings compared to conventional dressings. By addressing these gaps in evidence, clinicians can make more informed decisions regarding the most effective strategies for minimizing the risk of SSIs postoperatively.

Wound Guards

The principle of utilizing a wound barrier during surgical procedures to shield the wound margins from contamination is theoretically appealing. However, despite the potential advantages, wound guards—comprising semi-rigid plastic rings inserted into the incision with drapes attached around the circumference—have not been widely adopted as a standard component of surgical practice. A systematic review and meta-analysis evaluated the efficacy of wound guards in preventing surgical site infections (SSIs), incorporating data from 10 randomized controlled trials (RCTs) and two additional controlled trials, involving a total of 1,933 patients undergoing open abdominal surgeries, predominantly colorectal procedures. Although the studies included in the analysis varied considerably in quality, with many being outdated and exhibiting methodological flaws such as inconsistent definitions of SSIs and a high risk of bias, an exploratory meta-analysis utilizing a random effects model suggested that wound guards might provide a statistically significant protective effect against SSIs (relative risk [RR] = 0.60, 95% confidence interval [CI] 0.41–0.86, P = 0.005). These findings initially indicated the potential utility of wound edge protection devices in reducing the incidence of postoperative infections.

However, concerns regarding the methodological robustness of the included studies prompted further research to clarify the role of wound guards in surgical infection prevention. The same research group later conducted a well-designed RCT, the ROSSINI trial, which definitively assessed the effectiveness of wound edge protection devices in reducing SSIs. Unlike earlier trials, this study was methodologically rigorous, incorporating appropriate sample sizes and standardized outcome measures. The results conclusively demonstrated that wound guards did not provide a statistically significant benefit in preventing SSIs. These findings suggest that, despite the initial promise shown by exploratory analyses, wound guards may not be a reliable intervention for reducing postoperative infections.

Several factors may contribute to the lack of efficacy observed in the ROSSINI trial. One potential explanation is that the primary route of bacterial contamination in surgical wounds is not necessarily via direct exposure of wound edges but may involve other mechanisms such as airborne contamination, bacterial migration from endogenous sources, or the hands of surgical personnel. Additionally, variations in surgical techniques, patient characteristics, and the types of procedures performed could influence the effectiveness of wound guards. Future research should focus on identifying specific surgical scenarios or patient subgroups that may still derive benefit from wound barrier devices. Until then, routine use of wound guards cannot be recommended as a strategy for SSI prevention.

Scalpel Or Diathermy for Skin Incision

The use of electrosurgical diathermy as an alternative to the traditional scalpel for making surgical incisions has been proposed as a method to enhance efficiency by allowing for faster dissection and potentially reducing intraoperative blood loss. However, its impact on postoperative wound complications and SSIs remains an area of active investigation. A Cochrane review assessed the comparative effectiveness of diathermy versus scalpel incisions by analyzing data from nine RCTs involving a total of 1,901 patients. The review found no significant difference in SSI rates between patients whose abdominal incisions were performed with diathermy and those whose incisions were made using a scalpel (RR = 0.90, 95% CI 0.68–1.18, P = 0.44; seven RCTs, n = 1,559). These results suggest that diathermy, despite its potential advantages in surgical efficiency, does not inherently increase or decrease the risk of SSIs compared to conventional scalpel incisions.

One of the primary limitations of the reviewed trials was their inadequate statistical power, as many were underpowered to detect a clinically meaningful difference in infection rates. Additionally, the studies exhibited considerable heterogeneity in terms of patient populations, surgical settings, and outcome measures, which further complicates the interpretation of the findings. Variability in definitions of SSIs across studies also posed a challenge in drawing definitive conclusions. Given these limitations, the existing evidence remains inconclusive, and further high-quality, large-scale studies are required to establish whether diathermy has any measurable impact on SSI rates.

Beyond its effect on SSIs, diathermy may also influence other wound healing parameters such as postoperative pain, tissue necrosis, and overall healing time. Some studies suggest that diathermy incisions cause less tissue trauma due to reduced mechanical force, while others raise concerns about potential thermal damage to surrounding tissues. Future research should adopt a comprehensive approach, evaluating not only infection rates but also broader surgical and patient-centered outcomes. Until robust evidence becomes available, the choice between scalpel and diathermy should be guided by surgeon preference and the specific requirements of the procedure.

Antimicrobial Sutures

There is strong experimental evidence from laboratory studies demonstrating that antimicrobial sutures, which are either impregnated or coated with the broad-spectrum antiseptic triclosan, have the capacity to deliver antimicrobial agents directly into the tissues, thereby reducing the risk of bacterial colonization and infection. While early clinical trials evaluating antimicrobial sutures yielded mixed results due to methodological shortcomings such as small sample sizes and inconsistent comparator groups, more recent systematic reviews and meta-analyses have provided robust evidence supporting their effectiveness in SSI prevention. Three independently conducted systematic reviews and meta-analyses have now established high-level evidence (Level 1A) for the routine use of antimicrobial-coated sutures in surgery.

The first of these meta-analyses examined 17 RCTs, comprising a total of 3,720 patients, and utilized a fixed-effects model to assess the impact of antimicrobial sutures on SSIs (Wang et al., 2013). The results demonstrated a significant reduction in infection rates, with antimicrobial sutures decreasing the risk of SSIs by 30% (RR = 0.70, 95% CI 0.57–0.85, $P < 0.001$). Notably, subgroup analyses indicated that the beneficial effect was primarily observed in abdominal surgeries, while no statistically significant reduction was observed in SSIs following breast or cardiac procedures. These findings suggest that the effectiveness of antimicrobial sutures may vary depending on the type of surgery performed.

A second meta-analysis, which focused on higher-quality trials and included 13 RCTs with 3,568 patients, reinforced these findings by demonstrating a significant reduction in SSIs associated with antimicrobial sutures (RR = 0.73, 95% CI 0.59–0.91, $P = 0.005$). This review also incorporated an additional trial specifically examining the effect of antimicrobial sutures in colorectal surgery, further strengthening the evidence base supporting their use (Edmiston et al., 2013). Despite these promising results, some methodological limitations persisted, including inconsistencies in SSI definitions and variations in control groups, which underscore the need for continued research in this area.

The most recent and comprehensive meta-analysis identified 15 RCTs, encompassing a total of 4,800 patients, and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor. This analysis demonstrated that antimicrobial sutures significantly reduced SSIs by 33% (RR = 0.67, 95% CI 0.53–0.84, $P < 0.0005$). Importantly, this review found no evidence of publication bias, and a sensitivity analysis confirmed that the findings remained robust even when up to three trials were excluded. Furthermore, the beneficial effect of antimicrobial sutures was observed across different categories of surgical procedures, including clean, clean-contaminated, and contaminated surgeries, indicating broad applicability in various surgical contexts (Daoud et al., 2014).

These findings provide compelling evidence supporting the routine use of antimicrobial-coated sutures as an effective measure to reduce SSIs. However, future research should focus on optimizing the selection criteria for antimicrobial suture use, evaluating cost-effectiveness, and investigating potential resistance patterns associated with triclosan exposure. As the surgical field continues to evolve, incorporating antimicrobial sutures into standard practice could represent a significant advancement in reducing postoperative infections and improving overall patient outcomes.

Conclusion

Surgical site infections (SSIs) continue to pose a significant burden on healthcare systems worldwide, contributing to increased morbidity, prolonged hospital stays, and substantial financial costs. Despite extensive research and the implementation of evidence-based guidelines, SSI rates remain a challenge due to inconsistencies in adherence to preventive measures. This review has explored various interventions, including perioperative oxygen supplementation, antiseptic surgical dressings, wound guards, scalpel versus diathermy incisions, and antimicrobial sutures, highlighting their potential impact on SSI prevention.

Among the interventions examined, antimicrobial sutures have demonstrated the most compelling evidence in reducing SSIs across multiple surgical specialties. Similarly, antiseptic dressings, particularly silver-based materials, have shown promise in lowering infection rates, though further high-quality studies are needed to confirm their efficacy. Conversely, interventions such as wound guards and perioperative oxygen supplementation have yielded mixed or inconclusive results, suggesting that their routine use should be carefully reconsidered. The choice of surgical incision method, whether using a scalpel or diathermy, appears to have minimal impact on SSI risk, underscoring the need for more well-powered studies to establish definitive conclusions.

Healthcare workers play an essential role in preventing SSIs through adherence to infection control measures, proper surgical techniques, and strict compliance with best practices. However, gaps in compliance and variations in clinical practice remain a significant barrier to effective SSI prevention. Ensuring healthcare workers receive continuous education and training, along with reinforcing adherence to standardized protocols, is critical in reducing SSI rates.

Future research should focus on addressing inconsistencies in study methodologies, improving patient selection criteria, and evaluating the cost-effectiveness of various SSI prevention strategies. Additionally, ongoing surveillance and real-world data collection will be crucial in identifying trends, optimizing interventions, and enhancing patient safety. By integrating the latest evidence into clinical practice and strengthening the role of healthcare professionals in SSI prevention, healthcare systems can work toward reducing the burden of SSIs and improving overall surgical outcomes.

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