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SURGICAL SITE INFECTIONS: EPIDEMIOLOGY, RISK FACTORS, AND EVIDENCE-BASED PREVENTION STRATEGIES

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Abstract: Surgical site infections (SSIs) remain one of the most common complications following surgical procedures, leading to increased morbidity, prolonged hospital stays, and elevated healthcare costs. This article provides a comprehensive review of the epidemiology of SSIs and evidence-based strategies for prevention. Using a structured literature review methodology, studies from peer-reviewed journals published between 2010 and 2025 were analyzed to assess SSI prevalence, risk factors, common pathogens, and preventive measures. The findings highlight that SSIs are influenced by patient-related, procedure-related, and environmental factors. Effective prevention strategies include perioperative antibiotic prophylaxis, strict adherence to aseptic techniques, preoperative patient optimization, and post-operative care protocols. Continuous education and institutional infection control policies are essential for reducing SSI incidence and improving patient outcomes.

Key words: surgery, prevention, environmental factors, risk factors, methodology, complication

Introduction Surgical site infections (SSIs) are defined by the Centers for Disease Control and Prevention (CDC) as infections occurring at or near a surgical incision within 30 days of a procedure or within one year if an implant is placed. SSIs are a significant contributor to postoperative morbidity and mortality worldwide, accounting for approximately 20% of all healthcare-associated infections (Haque et al., 2018). They increase patient discomfort, length of hospital stay, and healthcare costs while posing challenges to surgical teams and hospital administrators.

Epidemiologically, SSIs occur in 2-5% of all patients undergoing surgery in high-income countries, with higher rates in low- and middle-income countries, where prevalence can reach 10-20% depending on the surgical procedure and institutional resources (Allegranzi et al., 2016). Common pathogens include *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and coagulase-negative staphylococci. Risk factors for SSIs are multifactorial and include patient-related variables (age, comorbidities, obesity, smoking), procedure-related factors (type of surgery, duration, implant use), and environmental variables (operating room sterility, surgical team practices).

Prevention of SSIs is a critical component of surgical care, encompassing preoperative, intraoperative, and postoperative measures. Despite advances in surgical techniques and aseptic protocols, SSIs remain prevalent, underscoring the need for continued research and implementation of evidence-based strategies.

Methods A structured literature review was conducted to synthesize current knowledge on SSI epidemiology and prevention. Electronic databases including PubMed, Scopus, and Web of Science were searched for peer-reviewed articles published from 2010 to 2025. Search terms

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included "surgical site infections," "epidemiology," "prevention," "risk factors," and "surgical outcomes." Inclusion criteria were: (1) studies reporting SSI incidence or prevalence, (2) studies analyzing risk factors and preventive strategies, (3) human studies, and (4) publications in English. Exclusion criteria included case reports, editorials, and studies not providing quantitative or qualitative data on SSI prevention.

Data were extracted regarding SSI incidence, identified pathogens, patient and procedural risk factors, and implemented preventive interventions. Studies were analyzed for methodological quality, sample size, and relevance to contemporary surgical practice.

Results

Epidemiology and Risk Factors

SSI prevalence varies by surgical procedure, patient population, and healthcare setting. Clean surgeries, such as elective hernia repairs, have lower SSI rates (1-2%), whereas contaminated or emergency abdominal procedures may have rates exceeding 10% (Mangram et al., 1999; de Lissovoy et al., 2009). Patient-related risk factors include advanced age, diabetes mellitus, obesity, immunosuppression, and poor nutritional status. Smoking and preexisting infections further increase susceptibility.

Procedure-related factors encompass surgical duration, intraoperative contamination, improper handling of tissues, and use of prosthetic implants. Environmental factors include operating room sterility, surgical team compliance with aseptic protocols, and sterilization practices for instruments.

Common Pathogens

Gram-positive bacteria, primarily *Staphylococcus aureus* (including MRSA), are the most frequent causative agents. Gram-negative organisms such as *Escherichia coli*, *Klebsiella spp.*, and *Pseudomonas aeruginosa* are common in gastrointestinal surgeries. Polymicrobial infections are often observed in contaminated and dirty procedures.

Prevention Strategies

1. **Preoperative Measures**: Preoperative patient optimization includes controlling blood glucose in diabetics, encouraging smoking cessation, treating existing infections, and maintaining nutritional adequacy. Skin antisepsis using chlorhexidine-alcohol solutions is preferred over povidone-iodine in most cases (Darouiche et al., 2010).
2. **Antibiotic Prophylaxis**: Administering prophylactic antibiotics within 60 minutes before incision significantly reduces SSI risk. The choice of antibiotic depends on the type of surgery and common pathogens. Redosing may be necessary for prolonged procedures.
3. **Intraoperative Techniques**: Strict adherence to sterile technique, minimizing operating room traffic, maintaining normothermia, and careful tissue handling reduce infection risk. Use of disposable surgical instruments and barrier precautions also contributes to lowering SSI incidence.

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4. **Postoperative Care**: Proper wound care, monitoring for early signs of infection, and patient education on hygiene are critical. Early mobilization and appropriate drain management are recommended.
5. **Institutional Measures**: Implementation of SSI surveillance programs, adherence to infection control protocols, and continuous training of surgical staff are essential for long-term reduction in infection rates.

Discussion The review demonstrates that SSIs are a persistent challenge despite modern surgical advances. The incidence varies by procedure type, patient characteristics, and healthcare setting, with higher rates observed in resource-limited environments. Patient optimization and perioperative interventions are highly effective when consistently applied. The integration of surveillance systems allows early detection and continuous quality improvement.

Antibiotic stewardship is crucial to prevent resistance while ensuring effective prophylaxis. Chlorhexidine-based antiseptics have consistently shown superior efficacy in skin decontamination. Advanced strategies, such as the use of antimicrobial-coated sutures and negative-pressure wound therapy, have shown promise in high-risk populations but require further large-scale studies.

Comparative studies indicate that adherence to multifaceted prevention bundles significantly reduces SSI rates. This highlights the need for a systematic approach combining patient, procedural, and institutional interventions. Future research should focus on implementing evidence-based protocols in diverse healthcare systems, monitoring long-term outcomes, and evaluating cost-effectiveness.

Conclusion Surgical site infections remain a major source of postoperative morbidity and healthcare burden. Effective prevention requires a combination of preoperative patient optimization, appropriate perioperative antibiotic use, meticulous intraoperative technique, postoperative wound care, and institutional infection control programs. Continuous education of healthcare personnel and adherence to evidence-based guidelines are essential. Further research into innovative preventive measures and implementation strategies will contribute to reducing SSI incidence globally, improving patient outcomes, and decreasing healthcare costs.

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