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Research Article

Surgical Site Infection: A Review of Epidemiology, Risk Factors, Prevention, and Management

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ABSTRACT
Surgical site infections (SSIs) remain among the most common healthcare-associated infections and a leading cause of postoperative morbidity, prolonged hospitalization, and increased healthcare costs. This paper reviews the current literature on the epidemiology, microbiology, risk factors, and prevention strategies associated with SSIs. Evidence indicates that SSIs account for a substantial proportion of hospital-acquired infections and that approximately half of these cases may be preventable through evidence-based, bundled interventions. Both modifiable and non-modifiable patient factors, along with procedural and facility-related variables, contribute to infection risk. Guidelines issued by the Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), and the Asia Pacific Society of Infection Control (APSIC) converge on core preventive measures, including appropriate perioperative antibiotic prophylaxis, glycemic control, skin antisepsis, and maintenance of normothermia. Continued surveillance and adherence to evidence-based bundles are essential to reducing SSI incidence globally.

Keywords: Surgical Site Infection (SSI), healthcare-associated infections, perioperative antibiotic prophylaxis, infection prevention and control, evidence-based surveillance

1. INTRODUCTION

A surgical site infection is an infection that develops at or near a surgical incision within a defined postoperative window, typically 30 days for most procedures and up to 90 days when implantable devices are involved. SSIs may involve the skin and subcutaneous tissue (superficial incisional), the deeper soft tissue of the incision (deep incisional), or the organs and spaces manipulated during surgery (organ/space infection). Despite decades of advances in aseptic technique, antimicrobial prophylaxis, and perioperative care, SSIs continue to represent a significant burden on patients and health systems, contributing substantially to postoperative morbidity and mortality and standing as a leading cause of hospital readmission after surgery.

2. EPIDEMIOLOGY

SSIs are reported to occur in roughly 2 to 4 percent of all inpatient surgical procedures and are considered the most common preventable complication of surgery. Collectively, they contribute to an estimated 10 to 30 percent of all hospital-acquired infections. Reported incidence varies considerably by region, surgical specialty, and surveillance methodology; for example, a review of maxillofacial and oral surgery procedures in South Africa found SSI rates ranging from 0.65 to 48 percent, a level of variability broadly consistent with figures reported elsewhere in sub-Saharan Africa. This heterogeneity underscores the influence of local infection-control infrastructure, surveillance

rigor, and patient population characteristics on observed SSI rates.

3. MICROBIOLOGY AND PATHOGENESIS

SSIs can be caused by a range of pathogenic microorganisms, most commonly skin flora such as Staphylococcus aureus, along with gram-negative organisms including Escherichia coli and anaerobic organisms such as Bacteroides fragilis. Certain aerobic and anaerobic organisms can act synergistically, increasing virulence when present together in sufficient concentration at the surgical site. Antibiotic resistance further complicates management, as colonization with resistant organisms on the skin or in the gastrointestinal tract raises the likelihood of a resistant infection. Infection risk is governed by the interaction between the degree of microbial contamination at the surgical site, the virulence of the contaminating organisms, and the adequacy of the host's local and systemic defenses.

4. WOUND CLASSIFICATION

The CDC and the Association of peri-operative Registered Nurses (AORN) classify surgical wounds into four categories that help predict infection probability and guide prophylactic decisions:

Wound Class	Description
Class I: Clean	Uninfected wound with no inflammation; closed primarily, drained if needed with a closed system.
Class II: Clean-contaminated	Controlled entry into the respiratory, GI, or genitourinary tract without unusual contamination.
Class III: Contaminated	Open, fresh, accidental wounds, or major breaks in sterile technique.
Class IV: Dirty-infected	Wounds with existing clinical infection, e.g., incision and drainage of an abscess.

5. RISK FACTORS

Risk factors for SSI are generally grouped into patient-related, procedure-related, and facility-related categories, and are further divided into modifiable and non-modifiable factors. Identifying which risk factors can be modified allows clinicians to optimize a patient's condition before surgery and set realistic expectations regarding infection risk.

Category	Examples of Risk Factors
Patient-related (non-modifiable)	Advanced age, prior skin or soft-tissue infection, recent radiotherapy.
Patient-related (modifiable)	Uncontrolled diabetes, obesity, malnutrition, smoking, immunosuppression, low preoperative albumin.
Procedure-related	Emergency or prolonged surgery, higher wound classification, open (vs. laparoscopic) technique.
Facility-related	Inadequate ventilation, excess operating-room traffic, improper instrument sterilization.
Preparation-related	Pre-existing infection, inadequate antiseptic skin preparation, poor glycemic control.

6. PREVENTION STRATEGIES

Multiple international bodies, including the CDC, WHO, and APSIC, have published evidence-based guidelines for SSI prevention. Core recommendations that appear consistently across these guidelines include:

- Administration of appropriately timed perioperative antibiotic prophylaxis, with agent selection guided by procedure type and local resistance patterns (for example, a first-generation cephalosporin for methicillin-sensitive S. aureus, or vancomycin-class agents when MRSA risk factors are present).
- Preoperative optimization of modifiable patient factors, such as glycemic control, nutritional status, and smoking cessation.
- Appropriate antiseptic skin preparation and, where indicated, decolonization protocols.
- Maintenance of perioperative normothermia and adequate tissue oxygenation, including supplemental oxygen where supported by evidence.
- Adherence to strict operating room sterilization, traffic control, and ventilation standards.

Notably, prior literature estimates that approximately half of all SSIs may be

preventable through consistent application of these evidence-based, bundled strategies, reinforcing the importance of institutional protocols and compliance monitoring.

7. MANAGEMENT

Management of an established SSI depends on its depth and severity, ranging from local wound care and drainage for superficial infections to systemic antibiotic therapy and surgical debridement for deep incisional or organ/space infections. Empiric antibiotic selection should account for the likely causative organism based on the surgical site involved and local antibiogram data, with de-escalation guided by culture results once available. Early recognition through structured postoperative surveillance is essential, since delayed diagnosis is associated with worse outcomes and increased likelihood of reoperation.

8. CONCLUSION

Surgical site infections remain a significant and largely preventable cause of postoperative morbidity, extended hospital stay, and increased healthcare expenditure. A substantial proportion of cases can be avoided through consistent application of evidence-based bundles addressing preoperative optimization, antimicrobial prophylaxis, intraoperative technique, and postoperative surveillance. Continued regional surveillance, standardized wound classification, and institutional adherence to CDC, WHO, and APSIC guidelines are essential to further reducing the global burden of SSI.

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