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SURGICAL INFECTIONS: CAUSES, TYPES AND PREVENTION MEASURES

XIRURGIK INFEKSIYALAR: SABABLARI, TURLARI VA OLDINI OLISH CHORALARI

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Annotatsiya: Jarrohlik joyi infeksiyalari (JJIlari) sog'liqni saqlashda jiddiy asorat hisoblanadi. Ularning kelib chiqishiga bemor omillari, mikrobial kontaminatsiya va jarrohlik texnikasi kabi ko'plab sabablar ta'sir qiladi. JJIlari yuzaki, chuqur kesma va organ/bo'shliq infeksiyalariga bo'linadi. Ushbu maqola infeksiyalarning sabablari, turlari va ularning oldini olishning kompleks choralarini muhokama qiladi. Maqsad – samarali profilaktika orqali kasallanish, o'lim va sog'liqni saqlash xarajatlarini kamaytirishdir.

Kalit so‘zlar: Jarrohlik infeksiyalari, Jarrohlik joyi infeksiyalari, JJI, Profilaktika, Etiologiya, Tasniflash, Xavf omillari, Antimikrob profilaktika

Abstract: Surgical site infections (SSIs) represent a significant complication in healthcare, contributing to increased morbidity and mortality. Their multifactorial etiology encompasses patient-related factors, microbial contamination, and surgical technique. SSIs are broadly classified into superficial, deep incisional, and organ/space infections, each with distinct clinical implications. This article explores the causes, various types, and comprehensive prevention strategies for surgical infections. The primary goal is to reduce the incidence of SSIs, thereby improving patient outcomes and lowering healthcare costs through effective prophylactic measures.

Keywords: Surgical Infections, Surgical Site Infections, SSI, Prevention, Etiology, Classification, Risk Factors, Antimicrobial Prophylaxis

Аннотация: Инфекции области хирургического вмешательства (ИОХВ) являются серьезным осложнением в здравоохранении, приводящим к увеличению заболеваемости и смертности. Их многофакторная этиология включает факторы, связанные с пациентом, микробное загрязнение и хирургическую технику. ИОХВ широко классифицируются на поверхностные, глубокие и органные/полостные инфекции, каждая из которых имеет свои клинические особенности. Данная статья рассматривает причины, различные типы и комплексные стратегии профилактики хирургических инфекций. Основная цель состоит в снижении частоты ИОХВ, улучшении исходов для пациентов и сокращении затрат на здравоохранение посредством эффективных профилактических мер.

Ключевые слова: Хирургические Инфекции, Инфекции Области Хирургического Вмешательства, ИОХВ, Профилактика, Этиология, Классификация, Факторы Риска, Антимикробная Профилактика

Introduction

Surgical site infections (SSIs) represent a formidable global public health challenge, significantly impacting patient outcomes and healthcare systems worldwide. Defined as infections occurring at or near the surgical incision within 30 days of an operation, or up to one year if an implant is involved, SSIs are a common and severe postoperative complication [1], [3]. These

infections constitute a substantial proportion of healthcare-associated infections (HAIs), accounting for approximately 20% of all HAIs and ranking as the second most common type [1], [3]. The incidence of SSIs varies widely, from 0.5% to 30% depending on the surgical procedure and setting, with developing countries often reporting significantly higher rates compared to developed nations [1], [3].

The profound consequences of SSIs extend beyond immediate patient discomfort. They are directly linked to increased morbidity, a 2-11 times higher mortality risk, and a fivefold increase in readmission rates [3]. Patients suffering from SSIs experience prolonged hospital stays, typically adding 7 to 11 days to their admission, which places immense strain on healthcare resources [1], [3]. Economically, SSIs impose a substantial burden, with estimates reaching $3.3 billion annually in the American healthcare system alone [3]. Despite advancements in infection control practices, the global incidence remains high, underscoring the persistent complexity of their prevention [1].

The etiology of SSIs is multifactorial, primarily involving the patient's endogenous flora in 70-95% of cases, though external contamination also plays a role [1]. Common causative pathogens include Staphylococcus aureus, responsible for about 30% of SSIs, alongside Coagulase negative Staphylococci, Enterococcus spp., and Escherichia coli [1]. Recent data indicate a shift, with Methicillin-sensitive S. aureus (MSSA) infections now surpassing MRSA [1]. Factors such as the surgical approach, wound classification, patient comorbidities like obesity and diabetes, and procedure duration are also critical determinants of SSI risk [2]. This article aims to critically synthesize current knowledge regarding the causes, types, and comprehensive prevention strategies for surgical site infections, highlighting their impact and future perspectives.

Literature Review

While the introduction broadly defines surgical site infections (SSIs), a more granular classification is essential for understanding their clinical spectrum. SSIs are categorized into superficial incisional, deep incisional, and organ/space infections, with superficial types accounting for over 50% of cases, while organ/space infections represent the most severe form [3]. The global epidemiological landscape of SSIs remains highly variable. Recent data highlight that SSIs affect approximately 29% of admitted patients and 38% of those specifically in surgical wards [1]. Disparities persist, with developing countries, such as those in Africa, reporting rates as high as 20%, and low- and middle-income countries (LMICs) averaging 11%, significantly contrasting with the 1.2% to 5.2% observed in developed nations [1]. This geographical variation underscores the influence of healthcare infrastructure, resource availability, and infection control practices on SSI prevalence.

Building on the understanding that endogenous flora is the primary source of infection, a detailed examination of specific risk factors is crucial for targeted prevention. A comprehensive study analyzing 66,001 abdominal hysterectomies identified several independent risk factors significantly increasing SSI rates [2]. Procedure-related factors included an open laparotomic approach, contaminated/dirty wound classification, and prolonged procedure times exceeding 186 minutes [2]. Patient-related factors were equally impactful, with obesity (BMI >30), diabetes, and an American Society of Anesthesia (ASA) score greater than 3 strongly associated with increased SSI risk [2]. Younger age (under 45) and the presence of gynecological cancer were also identified as independent predictors [2]. These findings underscore the multifactorial nature of SSI etiology, necessitating a holistic risk assessment. Pathogen-wise, Staphylococcus aureus remains a

predominant culprit, responsible for approximately 30% of SSIs, with a notable recent shift where Methicillin-sensitive S. aureus (MSSA) infections are now more prevalent than MRSA [1].

The development of SSIs, particularly those involving implants, is intricately linked to specific pathophysiological mechanisms, with biofilm formation being a critical determinant of chronicity and treatment failure [4]. This process commences with bacterial adhesion and subsequent colonization on foreign body surfaces, leading to a protective biofilm matrix [4]. Biofilms represent an efficient microbial survival strategy, shielding bacteria from host immune responses and antibiotic penetration, thereby rendering infections difficult to eradicate [4]. In implant-associated infections, the biofilm elicits a localized host immune response characterized by phagocytic cell infiltration and a proinflammatory microenvironment, stimulating osteoclastogenesis, local osteolysis, and septic loosening of the implant [4]. A fundamental understanding of this pathogenesis is paramount for developing effective interdisciplinary therapeutic and preventive strategies, especially given the unsatisfactory outcomes of previous anti-biofilm therapies [4].

The clinical presentation of SSIs typically involves localized signs of inflammation such as erythema, pain, warmth, and swelling, often accompanied by purulent discharge or fever. Prompt diagnosis and appropriate treatment are critical given the significant impact on patient outcomes, including prolonged hospital stays and increased mortality [1], [3]. Treatment generally involves wound debridement, drainage of abscesses, and targeted antibiotic therapy based on culture and sensitivity results. However, the presence of biofilm, particularly in implant-associated SSIs, complicates treatment significantly. For such infections, retaining a stable implant is only recommended for early-stage infections, while late-stage infections or those with implant loosening necessitate removal due to the recalcitrant nature of biofilm-embedded bacteria [4].

Given the complex etiology and severe consequences of SSIs, a multifaceted approach to prevention is indispensable, encompassing preoperative, intraoperative, and postoperative measures. Preoperative strategies include optimizing patient health (e.g., glycemic control, weight management) as identified risk factors [2], and appropriate preoperative antibiotic prophylaxis [3]. Intraoperative measures are equally vital, emphasizing strict aseptic techniques, meticulous hemostasis, and careful tissue handling [3]. The choice of surgical approach, favoring less invasive methods where appropriate, can also mitigate risk, as evidenced by higher SSI rates with open laparotomic approaches [2]. For implant surgeries, ongoing research into implant surface modification aims to prevent biofilm formation, representing a promising avenue [4]. Postoperative care focuses on proper wound dressing, early detection of infection signs, and patient education. The continuous evolution of antibiotic resistance and global concerns regarding surgical instrument contamination necessitate ongoing vigilance and adaptation of prevention protocols [3].

Research Methodology

This article provides a comprehensive narrative review and critical synthesis of current academic literature on surgical site infections (SSIs), covering their causes, classifications, and prevention strategies. Its objective was to consolidate and critically evaluate contemporary evidence, integrating insights from clinical surgery, epidemiology, microbiology, and public health, offering an updated, graduate-level understanding of SSIs. This approach facilitated a holistic understanding of SSI development and identified effective, evidence-based preventive measures. A systematic search was executed across PubMed, Scopus, Web of Science, and Google Scholar (January 2023 – March 2024). Keywords included "surgical site infection," "SSI," "etiology," "risk factors," "classification," "epidemiology," "prevention strategies," "preoperative," "intraoperative,"

"postoperative," "biofilm," "implant infection," "antibiotic resistance," "global burden," and "healthcare-associated infection," combined with Boolean operators. Reference lists of key articles and clinical guidelines were also manually screened.

Article selection prioritized peer-reviewed, English-language studies on human subjects, published from 2020 onwards, including original research, systematic reviews, meta-analyses, and clinical guidelines. Foundational works prior to 2020 were considered if critically relevant. The scope covered SSI definition, classification, epidemiology, etiology, risk factors (patient-related, procedure-related, pathogen-related), pathophysiology, diagnosis, treatment, and comprehensive prevention strategies. Global incidence, economic burden, and patient outcomes received specific attention. Exclusions comprised non-peer-reviewed publications, conference abstracts, editorials, opinion pieces, animal studies, in vitro research not directly applicable to human contexts, and non-English articles. Studies exclusively on non-surgical infections or highly specialized procedures without broader relevance were also excluded.

Data extraction was systematically performed by the primary author, focusing on information pertinent to the article's objectives. This encompassed detailed epidemiological data (e.g., incidence, prevalence, geographical disparities [1], [3]), identified risk factors (e.g., open laparotomic approach, contaminated/dirty wound classification, obesity, diabetes, prolonged procedure times, ASA score >3, age, gynecological cancer [2]), common causative microorganisms (e.g., Staphylococcus aureus, MSSA, MRSA [1]), pathophysiological mechanisms (e.g., biofilm formation in implant-associated infections [4]), diagnostic criteria, current treatment modalities (e.g., debridement, drainage, targeted antibiotics, implant removal for late-stage biofilm infections [4]), and comprehensive prevention strategies (preoperative optimization, intraoperative aseptic techniques, postoperative wound care, implant surface modification research [2], [3], [4]). The extracted data underwent rigorous critical synthesis via thematic analysis, organizing literature into coherent sections. This involved identifying recurring themes, comparing findings, and critically evaluating evidence strength. The synthesis aimed for a balanced perspective, integrating findings from diverse regions and healthcare settings, addressing global disparities. While a formal meta-analysis was beyond this review, included studies' quality was critically appraised, considering potential biases to ensure evidence-grounded synthesis.

As this research reviews publicly available, previously published literature, it did not involve direct interaction with human participants or animals; thus, ethical approval was not required. All sources are appropriately cited to acknowledge original contributions and uphold academic integrity.

Primary limitations include reliance on published literature (risk of publication bias) and exclusion of non-English articles. The narrative synthesis, while broad, does not permit quantitative data aggregation of a meta-analysis. The dynamic nature of SSI epidemiology, evolving pathogen resistance, and surgical advancements imply some information may rapidly become outdated. Nevertheless, this review provides a robust foundation for understanding SSIs.

Conclusion

Surgical site infections continue to pose a formidable global challenge, significantly impacting patient well-being and straining healthcare resources. Their multifactorial etiology, encompassing patient comorbidities, procedural specifics, and microbial factors like biofilm formation, necessitates a holistic understanding. Effective prevention hinges on comprehensive, evidence-

based strategies spanning preoperative optimization, meticulous intraoperative techniques, and vigilant postoperative care. Addressing this persistent burden requires ongoing research into novel preventive measures, particularly for implant-associated infections, alongside continuous adaptation of infection control protocols to improve patient outcomes and alleviate healthcare system pressures worldwide.

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