

Wound Infection after Surgery

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Received: January 03, 2020; Published: January 22, 2020

Abstract

Introduction: Surgical site infections (SSIs) are described as infections taking place up to 30 days after surgery (or up to 365 days after surgery in individuals that received implants) and involving either the incision or deep tissue at the operation site. In spite of advancements in prevention, SSIs remain a major clinical challenge as they are associated with significant mortality and morbidity and enforce severe demands on healthcare resources.

Aim The of Work: The study aimed to explain wound infection after surgery, its etiopathogenesis, risk factors, preventive measures, and treatment plan.

Methodology: The review is a comprehensive research of PUBMED from the year 1977 to 2016.

Conclusion: Surgical site infections can happen to any given case resulting in increased morbidity and mortality of surgical patients. Although certain surgical site infections are unavoidable, the majority can be controlled by strictly following the asepsis guidelines and proper patients' education.

Keywords: Surgical Site Infection; Surgical Wounds; Surgical Infection

Introduction

Healthcare services consider Healthcare-Associated Infections (HAIs), a matter of great concern. Surgical Site Infection (SSI) is presently one of the most critical among the HAIs and directly involved with the surgical procedures [2]. Surgical site infections (SSIs) occur in up to 15% of elective surgeries and roughly 30% of surgeries that were classed as contaminated or "dirty" [3]. Increased treatment costs and length of hospital stay are SSI's severe consequences. The possibility of death in patients with SSI is increased when compared

to those who did not develop an infection [4].

Methodology

A systematic search was done for wound infection after surgery using the PubMed search engine and Google Scholar search engine: All relevant studies were retrieved and discussed. Only full articles were included.

The terms used in the search were: Surgical Site Infection, surgical wounds, prevention of surgical infection.

Types

The definition of surgical site infections (SSIs) are infections of the skin and/or underlying soft tissues at the site of surgery, which occurs within 30 days after an operative procedure in which an incision was closed primarily [5]. CDC classifies SSIs in three groups, including superficial incisional, deep incisional, and organ/space SSI [5].

Superficial incisional SSI Infection arises within 30 days after any operative procedure where the incision entails only skin, and subcutaneous tissue and patient has at least one of the following:

1. Purulent drainage is seen in the superficial incision.
2. Organisms isolated aseptically via culture of fluid or tissue obtained from incisional drainage.
3. At least one of the signs or symptoms of infection: pain, localized edema, rubor, and dolor.
4. A surgeon or attending physician must establish the diagnosis of superficial incisional SSI.

Deep incisional SSI

National Healthcare Safety Network (NHSN) operative procedure where incision includes deep soft tissues (fascial and muscle layers) where Infection occurs within a month to three months and the patient has at least one of the following:

1. Purulent drainage is seen on deep incisions but not from the organ/space component of the surgical site.
2. A deep incision suddenly dehisces or is intentionally opened by a surgeon and is culture-positive or not cultured and when the patient has at least one of the given signs or symptoms: fever ($> 38^{\circ}\text{C}$), localized pain except when the site is culture-negative.
3. Evidence of infection such as an abscess comprising the deep incision is discovered on clinical examination, during the second surgery, or by radiological and histopathologic examination.
4. A surgeon or attending physician must establish the diagnosis of deep incisional SSI.

Organ/space SSI infection

Occurs within a month to 3 months after the NHSN surgery, and infection entails any part of the anatomy (organs or spaces), other than the skin incision, fascia or muscle layers that are opened or manipulated during surgery and at least one of the following:

1. Drain from the organ/space shows purulent drainage.
2. Organisms can be isolated from an aseptically obtained culture of fluid or tissue in the organ/space,
3. Any evidence of infection or an abscess involving the organ/space that is seen on direct examination, while reoperating, or by histopathologic or radiologic examination.
4. A surgeon or attending physician must diagnose an organ/space SSI.

Wound classification

Operative wound classification was developed by the US National Research Council group in 1964 [7]:

1. **Clean wounds:** When no inflammation is present, and the respiratory, gastrointestinal, genital, and urinary tract is not entered [1]. Less than 2% of clean operated wounds are affected by SSI.

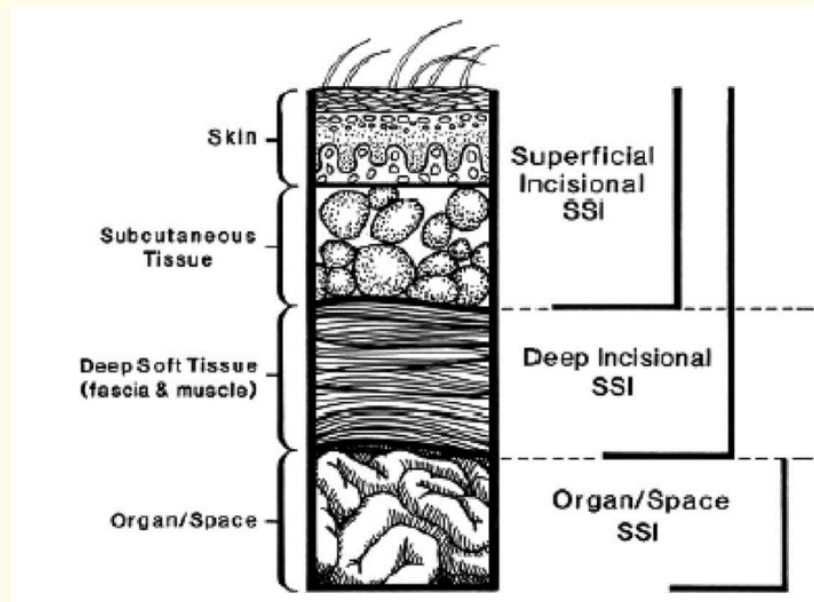


Figure 1: Schematic illustration of the anatomical classification of surgical site infections [6].

2. **Clean-contaminated wounds:** When the surgical procedure penetrates a colonized viscus or cavity of the body, but under elective and controlled conditions with minimum spillage [1]. 3% to 11% rate of SSI is seen as clean-contaminated wounds.
3. **Contaminated wounds:** Surgeries with major breaks in sterile technique (e.g. open cardiac massage) or gross spillage from the gastrointestinal tract [1]. Even with preventive antibiotics, the rate of infection is more than 10%.
4. **Dirty wounds:** Operative procedures performed when active infection is already present are considered dirty wounds [1]. The rate of SSI can surpass 20% in dirty wounds.

Patient related risk factors

Certain conditions which lessen the effectiveness of the immune response and delays wound healing such as [8]:

- Diabetes,
- Malnutrition,
- Smoking,
- Obesity,
- Alcoholism,
- Extremes of age,
- Steroid therapy,
- Chemotherapy, radiotherapy,
- Peripheral vascular disease, skin disease at the operation site, pre-existing infection, chronic inflammatory conditions.

Pathogenesis

SSI causing pathogens can enter either endogenously from the patient's flora present on the skin or open cavity or exogenously from contact with operative room personnel or the environment. Prolonged surgeries increase the risk of exogenous contamination [9]. *Staph-*

Staphylococcus aureus (MRSA) is the prevalent pathogen triggering SSI in clean surgeries that do not explore the abdomen or genital tract such as cardiothoracic surgeries, neurosurgeries, orthopedic, ophthalmic, and breast surgeries [1]. Gram-negative bacilli such as *Escherichia coli*, *Klebsiella*, *Enterobacter*, *Proteus* species, and gram-positive organisms like *Enterococcus*, and anaerobes may enter exposed tissues during surgeries that enter into hollow viscera like appendectomy, colorectal, gastroduodenal, biliary tract and urologic operations. In the head and neck surgeries, organisms inhabiting the oropharyngeal region as commensal and therefore gain access to the surgical site easily. *Peptostreptococcus*, *Propionibacterium*, *Prevotella*, *Veillonella*, *Bacteroides* and *Clostridium* species are anaerobes that primarily cause SSIs in the head and neck region [9].

Microbiology

Pathogens commonly associated with different surgical procedures	
Type of surgery	Common pathogens
Placement of graft, prosthesis or implant	<i>Staphylococcus aureus</i> ; CoNS
Cardiac	<i>S. aureus</i> ; CoNS
Neurosurgery	<i>S. aureus</i> ; CoNS
Breast	<i>S. aureus</i> ; CoNS
Ophthalmic	<i>S. aureus</i> ; CoNS; <i>streptococci</i> ; Gram-negative <i>bacilli</i>
Orthopedic	<i>S. aureus</i> ; CoNS; Gram-negative <i>bacilli</i>
Non-cardiothoracic	<i>S. aureus</i> ; CoNS; <i>Streptococcus pneumoniae</i> ; Gram-negative <i>bacilli</i>
Vascular	<i>S. aureus</i> ; CoNS
Appendectomy	Gram-negative <i>bacilli</i> ; anaerobes
Biliary tract	Gram-negative <i>bacilli</i> ; anaerobes
Colorectal	Gram-negative <i>bacilli</i> ; anaerobes
Gastroduodenal	Gram-negative <i>bacilli</i> ; <i>streptococci</i> ; oropharyngeal anaerobes (e.g. <i>peptostreptococci</i>)
Head and neck	<i>S. aureus</i> ; <i>streptococci</i> ; oropharyngeal anaerobes (e.g. <i>peptostreptococci</i>)
Obstetric and gynaecological	Gram-negative <i>bacilli</i> ; <i>enterococci</i> ; Group B <i>streptococci</i> ; anaerobes
Urological	Gram-negative <i>bacilli</i> ;

Table 1: CoNS, coagulase-negative staphylococci. (adapted from Mangram., et al. [10].)

Development of SSI depends on the interplay of four factors:

- **Inoculum of bacteria:** Surgeries involving the areas which are heavily colonized with bacteria such as bowel (10^3 - 10^4 bacteria/ml of distal small bowel contents, 10^5 - 10^6 bacteria/ml in right colon, 10^{10} - 10^{12} bacteria/gm of stool in rectosigmoid colon), female genital tract (10^6 - 10^7 bacteria/ml) are at a greater risk of getting SSI as large amounts of bacteria lodge into wound during the procedure [11].
- **Virulence of bacteria:** The more virulent the bacterial contaminant, the greater the possibility of infection. A very small inoculum of *Streptococcus pyogenes*, *Staphylococcus aureus*, *Clostridium perfringens*, are required to cause severe necrotizing disease at the surgical site. *Bacteroides fragilis* and other *Bacteroides* species act as solitary pathogens because of their negligible virulence, but when blended with other oxygen-consuming microorganisms, microbial synergism occurs and causes considerable infection following surgeries of female genital tract or colon [11].
- **Microenvironment around the surgical site:** The probability of infection increases in the presence of necrotic tissue, dead space, foreign bodies at the surgical site [11].

- **Innate and acquired host defenses:** Human inflammatory response is activated when a surgical incision is made through the skin and subcutaneous tissues. Normally, acute surgical wounds heal through an orderly and well-timed process of repair resulting in the restoration of anatomy and function. An acute wound can become a chronic wound if it does not heal within six weeks. Inflammation of the first 24 hours starts with hemostasis through the constriction of blood vessels, thrombin formation, and aggregation of platelets. Platelets release cytokines and many growth factors such as platelet-derived growth factor (PDGF), transforming growth factor (TGF- β), fibroblast growth factor (FGF), keratinocyte growth factor (KGF), epidermal growth factor (EGF) and insulin-like growth factor (IGF-1). Neutrophils, fibroblasts, and monocytes travel via chemotaxis from these platelet factors, and they move towards the area of the wound, stimulate proliferation and migration of epithelial cells like keratinocytes, stimulate angiogenesis, and promote extracellular matrix synthesis [12].

Preventive management

- **Preoperative phase:** Preoperatively, strong attention should be given to improve the patient's health by ensuring optimum glycaemic control in people with diabetes, stopping smoking, improving nutritional state, and correcting anemia. Night before or the day of operation, all patients should take a bath with soap on [13].
- **Hair removal:** According to CDC recommendations, hair should not be removed unless it interferes with the operation, and if the hair is to be removed, it is done immediately before the surgery with an electric clipper rather than shaving with a razor. Razor shaving causes microscopic cuts and abrasions that disrupt the skin's barrier defense against microorganism colonization and increases the risk of postoperative SSI [14].
- **Antibiotic prophylaxis:** Patients who are undergoing clean surgery, which require prosthesis implantation, clean-contaminated surgery, and contaminated surgery, need preoperative antibiotic prophylaxis [15].
- **Patient theatre wears:** Theatric wear should be specific for the patient so that the operative site, as well as other regions for placement of intravenous cannulas, catheters, and epidurals, etc., are easily accessible [15].
- **Intraoperative phase:** Patient skin should be prepared in the operating room using skin antiseptics that reduce the number of resident microflora around the incision on the skin [15].
- **Perioperative blood glucose control:** There is an increased susceptibility to SSI with elevated blood glucose levels. Pro-inflammatory cytokines are released due to high blood glucose levels, and it weakens the immune system [16].
- **Hand decontamination:** The entire operating team must wash their hands using an aqueous antiseptic surgical solution before any surgical procedure first in the list. They should use a single-use brush or pick for the nails and confirm that hands and nails are visibly clean. Hands must be washed using either an alcoholic hand rub or an antiseptic surgical solution for subsequent surgical procedures [15].
- **Wound closure and wound dressings:** The dressing material of the wound should ensure that the wound remains moist, free from devitalized tissue, toxic chemicals, or particles released from the dressing material [15].
- **Postoperative phase:** It is necessary to clean the wound, and timely change the wound dressing as it helps in the removal of excess wound exudates, foreign bodies, and wound crusts [15].

Treatment

- **Superficial Incisional SSI:** Drainage and local wound care are usually acceptable treatment. Antibiotics can be used in severe cases or immunocompromised patients [10].
- **Deep Incisional SSI:** Deep incisional SSI necessitates more definitive drainage or debridement. It may also involve implant removal in cases where it is present. Systemic antibiotics are also necessary for the successful eradication of infection [10].
- **Organ/Space SSI:** In cases of laparoscopic-related organ/space SSI, the ideal treatment typically requires laparoscopic, open, or percutaneous drainage and the use of systemic antibiotics [10].

Conclusion

SSIs impose a significant burden of mortality and morbidity, which in turn imposes heavy demands on healthcare resources due to prolonged hospitalizations. It is essential to recognize that much of this burden of morbidity and mortality associated with SSIs are preventable. With proper preoperative patient assessment and by sticking strictly to infection control guidelines, most of these surgical infections can be avoided. Therefore, it's the duty of the healthcare staff to take the utmost care with surgical patients.

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Volume 16 Issue 2 February 2020

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