A. Overview

In the United States alone, approximately 27 million surgical procedures are performed each year.¹ The Centers for Disease Control and Prevention’s (CDC’s) National Nosocomial Infections Surveillance system, which monitors and reports trends in nosocomial infections in US acute care hospitals, has found that surgical site infections (SSIs) are the third most frequently reported nosocomial infection among hospitalized patients.² SSIs increase the length of hospital stay by an average of 7.3 days and, in 1992, added approximately $3152 to the hospital bill.³,⁴,⁵,⁶ Thus, it is important to develop an understanding of the causes of SSIs and develop effective interventions to prevent them.

B. Classification of Surgical Site Infections

In 1988, the CDC published a definition of surgical wound infection that divided wound infections into either incisional surgical wound infections or deep surgical wound infection.⁷ This was revised in 1992, changing the name surgical wound infection to surgical site infection to emphasize the importance of specifying the anatomical location involved in deep surgical wound infections. The modifications made in 1992 have become the standard for classifying surgical site infections. This classification scheme describes SSIs on the basis of three anatomically distinct categories. These are superficial incisional SSI, deep incisional SSI, and organ/space SSI.³ In this scheme, infections are SSIs if they occur within 30 days of the operative procedure if no implant, and within 1 year if an implant is left in place.⁴ (See also Appendix 91-A for detailed surveillance definitions).⁹

1. Superficial incisional SSIs
   a) Involve only the skin or subcutaneous tissue of the incision.
   b) Involve as least one of the following:
      (1) Purulent drainage from the superficial incision.
      (2) Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision.

(3) At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness or heat, and the superficial incision is deliberately opened by a surgeon, unless culture of the incision is negative.
(4) Diagnosis of a superficial incisional SSI by a surgeon or attending physician.

2. Deep incisional SSIs
   a) Infection involves deep soft tissues of the incision.
   b) Involves at least one of the following:
      (1) Purulent drainage from the deep incision but not from the organ/space component of the surgical site.
      (2) A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: fever (over 38°C), localized pain or tenderness, unless culture of the incision is negative.
      (3) An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.
      (4) Diagnosis of a deep incisional SSI by a surgeon or attending physician.

3. Organ/space SSI
   a) Involves any part of the anatomy other than the incision, opened, or manipulated during the operative procedure.
   b) Specific sites are assigned in order to identify the location of the infection (i.e., intraabdominal, joint, bursa, etc.).
   c) Involves at least one of the following:
      (1) Purulent drainage from a drain placed through a stab wound into an organ/space.
      (2) Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space.
      (3) Abscess or other evidence of infection involving the organ/space on direct examination, during reoperation, or by histopathologic or radiologic examination.
      (4) Diagnosis of an organ/space SSI by a surgeon or attending physician.
C. Classification of Surgical Wounds

Surgical wounds are classified on the basis of the extent of contamination and increased risk of infection according to the scheme developed by the National Academy of Sciences and National Research Council.  

1. Clean wounds
   a) Elective, primarily closed and undrained.
   b) Nontraumatic, noninfected, including blunt, nonpenetrating trauma.
   c) No inflammation encountered.
   d) No break in aseptic technique.
   e) Respiratory, alimentary, genitourinary, or oropharyngeal tracts not entered.

2. Clean-contaminated
   a) Alimentary, respiratory, or genitourinary tracts entered under controlled conditions and with no unusual contamination.
   b) Genitourinary tract entered in absence of culture-positive urine.
   c) Biliary tract entered in absence of infected bile.
   d) Minor break in technique.

3. Contaminated
   a) Open, fresh traumatic wounds.
   b) Gross spillage from gastrointestinal tract.
   c) Entrance into genitourinary or biliary tracts in the presence of infected urine or bile.
   d) Major break in surgical technique.
   e) Incisions in which acute nonpurulent inflammation is present.

4. Dirty and infected
   a) Traumatic wound with retained devitalized tissue, foreign bodies, fecal contamination, or delayed treatment, or from a dirty source.
   b) Perforated viscus encountered.
   c) Acute bacterial inflammation with pus encountered during operation.

D. Risk Factors for Postoperative Wound Infection

1. Microbe-related risk factors
   a) Load of bacteria introduced into the wound.
      (1) Contamination with >10^5 microorganisms per gram of tissue markedly increases the risk of SSI while less contamination generally does not produce infection.  
         The presence of foreign material markedly decreases the number of microorganisms required to cause an infection.  
   b) Virulence of the bacteria contaminating the wound.
   c) Elaboration of endotoxins.
   d) Ability to resist host defenses.
   e) Ability to adhere to wound surfaces/prosthetic devices (i.e., slime producing coagulase-negative Staphylococcus).

2. Host-related risk factors
   a) Define relation to wound infection.
      (1) Morbid obesity
      (2) Extremes of age
      (3) Prolonged preoperative stay
      (4) Infection at other sites
      (5) American Society of Anesthesiologists (ASA) class
      (6) Disease severity index (e.g., ASA score)
   b) Likely relation to wound infection.
      (1) Low albumin
      (2) Malnutrition
      (3) Nicotine use
   c) Possible relation to wound infection.
      (1) Cancer
      (2) Diabetes mellitus
      (3) Immunosuppressive therapy

E. SSI Risk Stratification

Through the years, various schemes for SSI risk stratification have been developed.

1. In 1964, the National Academy of Sciences/National Research Council cooperative study proposed a scheme for SSI surveillance which was modified by the CDC in 1982 and included the following:
   a) At the end of the operation, a member of the surgical team classified the patient's wound as either clean, clean-contaminated, contaminated, or dirty and infected as defined above in Section C.
   b) This strategy has several shortcomings. Studies have shown that there is great variability in the risk of SSI even within the same incision category.  
   c) This SSI risk stratification scheme is no longer used as the sole determinant of SSI risk.

2. In 1985, a new model was developed to stratify SSI risk.  
   This was based on a logistic regression of 10 variables collected in the Study of the Efficacy of Nosocomial Infection Control (SENIC) project and showed that four variables are independently associated with SSI risk.
a) Abdominal operation.
b) Operation lasting more than 2 hours.
c) Surgical site with a wound classification of either contaminated or dirty/infected.
d) Patient with three or more discharge diagnoses.
e) This model weighs these variables equally and assigns a point value of one for each variable present. Thus, the risk index values range from 0 (low risk) to 4 (high risk). This scheme was found to be limited in that the number of discharge diagnoses could not be determined until the time of discharge; therefore, this did not allow for prospective inpatient stratification.

3. The currently accepted method for SSI risk stratification is the National Nosocomial Infections Surveillance risk index. This index differs from those described above in that it is operation specific and can be applied to prospectively collected data. The risk index weights each of the following variables equally.

a) Surgical site wound classification of contaminated or dirty/infected.
b) ASA score as rated by an anesthesiologist prior to operation of 3 or greater.
c) Procedure time over T hours, where T is the 75th percentile of the duration of surgery for the specific procedure being performed.
d) A patient scores one point for each variable present. Thus, the index can range from 0 to 3 with higher scores representing greater risk.

G. Treatment of Surgical Site Infections

1. Superficial wound infections
   a) Cellulitis/erythema at wound margin and no pus expressible.
      (1) Usually caused by *staphylococci* and *streptococci* and treated with an appropriate antibiotic.
      (2) Frequently is a sign of fluid collection in the wound; consider aspirations of the wound.

2. Wound infection – pus or infected fluid leaks from wound, failure to heal, or spontaneous dehiscence
   a) Wound should be reopened.
   b) Consider surgical reexploration.
   c) Debridement of necrotic tissue indicated.
   d) Irrigation of wound using physiologic solutions and packing with fine mesh sterile gauze.

3. Deep wound infections (infection of the fascia)
   a) Signs: wound dehiscence, fever, elevated white blood count, superficial wound infection, organ/space infections with pus draining between fascial sutures.
   b) Treatment
      (1) Remove fascial sutures.
      (2) Ensure no fascial necrosis present.
      (3) If fascial tension present and concern exists regarding intestinal herniation, the fascial defect may be allowed to persist and repaired after infection resolved.

4. Antibiotic therapy is directed by Gram stain and culture of purulent material and/or empirical selection based on likely pathogens.
H. Microbiology of Surgical Site Infections

The patient’s endogenous flora is the primary reservoir for organisms causing SSIs. However, the operating room environment, hospital personnel, or seeding of the operative site from a distant focus of infection also play a role.

1. Skin
   a) Gram-positive organisms: *staphylococci* and *streptococci* primarily.

2. Gastrointestinal system
   a) Mixed flora including enteric, gram-negative bacilli, anaerobes, and gram-positive organisms (including enterococci).

3. Genitourinary system
   a) Gram-negative organisms primarily (*Escherichia coli*, *Klebsiella spp.*, and *Pseudomonas*) but also some gram-positive organisms (enterococci).

4. Female genital tract
   a) Enteric, gram-negative bacilli, enterococci, group B streptococci, and anaerobes as well as gram-positive organisms such as staphylococcus and streptococcus.

5. Fungal infections as part of SSIs
   a) Factors that increase the risk of fungal infections in surgical patients include the following:
      (1) Exposure to broad-spectrum antimicrobial agents.
      (2) Use of agents that decrease gastric acidity and thereby promote growth of microorganisms including yeast.
      (3) Disruption of the gastrointestinal mucosal barrier.

References


