

SURGICAL SITE INFECTIONS

SSIs are the most common and costly of all hospital-acquired infections, accounting for 20% of all hospital infections. It is associated with increased length of stay and a twofold to eleven fold increase in the risk of mortality. In the United States, there are more than 40 million surgical operations performed and 2% to 5% are complicated by SSIs. There is an estimated annual incidence ranging from 160,000 to 300,000, with an annual cost of SSIs in the United States estimated at \$3.5 billion to \$10 billion. The increased cost is due to prolonged hospitalization, increase in emergency room visits, readmission, antibiotic costs, and additional procedural costs. About 60% of SSIs are preventable with evidence-based guidelines; as a result, SSI is one of the quality metrics frequently used to assess quality of surgical care, which is then linked to performance ranking, reimbursement, and patient satisfaction.

Classification of Surgical Site Infection

The most commonly used definition of SSI is that of the Centers for Disease Control and Prevention (CDC). The SSI must occur within 30 days after the operative procedure if no implant is left in place, or within 1 year if implant is in place, and the infection appears to be related to the operative procedure. SSIs are classified based on the depth and tissue layers involved as superficial incisional, deep incisional, and organ/space (Table 1). Standardization of reporting plays an important role in ensuring accurate data collection for research, quality improvement, and public reporting.

TABLE 1 CDC/NHSN classification of surgical site infection.	
CLASSIFICATION	DEFINITION
Superficial incisional SSI (SIS)	Infection occurs within 30 days after the operative procedure and involves only skin and subcutaneous tissue of the incision and had at least one of the following: <ol style="list-style-type: none"> a. Purulent drainage from the superficial incision. b. Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision. c. At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, and superficial incision is deliberately opened by surgeon and is culture positive or not cultured. A culture-negative finding does not meet this criterion. d. Diagnosis of superficial incisional SSI by the surgeon or attending physician.
Deep incisional SSI (DIS)	Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure and involves deep soft tissues (e.g., fascial and muscle layers) of the incision and patient has at least one of the following: <ol style="list-style-type: none"> a. Purulent drainage from the deep incision but not from organ/space component of the surgical site. b. Deep incision spontaneously dehisces or is deliberately opened by a surgeon and is culture-positive or not cultured when the patient has at least one of the following signs or symptoms: fever (>38°C) or localized

Organ/space SSI	<p>pain or tenderness. A culture-negative finding does not meet this criterion.</p> <p>c. An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.</p> <p>d. Diagnosis of a deep incisional SSI by a surgeon or attending physician. Wound that has both superficial and deep incisional infection is classified as DIS.</p> <p>Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure and infection involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure and patient has at least one of the following:</p> <p>a. Purulent drainage from a drain that is placed through a stab wound into the organ/space.</p> <p>b. Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space.</p> <p>c. An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination.</p> <p>d. Diagnosis of an organ/space SSI by a surgeon or attending physician.</p>
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CDC, Centers for Disease Control and Prevention; NHSN, National Healthcare Safety Network; SSI, surgical site infection.

Risk Factors for Surgical Site Infection

The CDC classifies wound into four groups: clean, clean-contaminated, contaminated, and dirty-infected (Table 2), with progressively increasing risk of SSIs. In addition, patient, environmental, and treatment factors can increase the risk of subsequent development of SSIs (Box 1). Of particular interest are risk factors amenable to preoperative optimization such as smoking cessation, protein-calorie malnutrition, and obesity. In general, laparoscopic surgical approaches carry a lower risk of SSIs compared with open techniques for the same procedure.

CLASSIFICATION	DESCRIPTION
I—Clean	An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow no penetrating (blunt) trauma should be included in this category if they meet the criteria.
II—Clean-contaminated	An operative wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.
III—Contaminated	Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g., open cardiac massage) or gross spillage from the gastrointestinal tract and incisions in which acute, no purulent inflammation is encountered are included in this category.
IV—Dirty-infected	Old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.

CDC, Centers for Disease Control and Prevention.

BOX 1 Risk factors for the development of surgical site infection.

Patient Factors

- Alcoholism
- Ascites
- Age
- Chronic inflammation
- Diabetes
- History of skin or soft tissue infection
- Hyperbilirubinemia >1 mg/dL
- Hypercholesterolemia
- Hypoalbuminemia
- Hypoxemia
- Immunosuppression
- Malignancies
- Malnutrition
- Obesity
- Peripheral vascular disease
- Postoperative anemia
- Preexisting infection
- Recent radiotherapy
- Smoking
- Steroid therapy

Environmental Factors

- Contamination
- Inadequate antisepsis
- Inadequate disinfection
- Inadequate ventilation
- Increased operating room traffic

Treatment Factors

- Blood transfusion
- Contamination: poor scrubbing technique, breach in asepsis, poor gloving, etc.
- Drains
- Emergency surgery
- High wound classification
- Hypothermia
- Hypoxemia
- Inadequate or inappropriate antibiotic prophylaxis
- Poor glycemic control
- Prolonged operation

Surgical Site Infection Prevention

Numerous interventions have been proposed to reduce the risk of SSI. In 2002, the CDC and Center for Medicare and Medicaid Services initiated the Surgical Infection Prevention Project to reduce SSIs, and in 2006, this became the expanded Surgical Care Improvement Program. The U.S. Congress authored the Deficit Reduction Act of 2005, which mandates hospital reporting process and outcome and quality improvement measures to be made available to the public and Center for Medicare and Medicaid Services. The act also allows payment adjustment downward for health care–associated infections that could have been prevented through application of evidence-based strategies. These interventions can be broadly divided into three stages: preoperative, intraoperative, and postoperative strategies.

The CDC provided a new and updated evidence-based recommendation for the prevention of SSIs. Preventive measures for SSI include a full-body bath or shower with soap (antimicrobial or nonantimicrobial) or an antiseptic agent the night before or the morning of the operation, appropriate antimicrobial prophylaxis before incision, and skin

preparation with an alcohol-based agent unless contraindicated. In clean and clean-contaminated procedures, additional prophylactic antimicrobial agents should not be administered even in the presence of a drain nor should topical antimicrobials be applied to the surgical incision. Maintenance of normothermia, glycemic control with targets less than 200 mg/ dL, and the provision of supplemental oxygen are other adjunct measures proposed to reduce SSI in the perioperative bundle.

In addition to the 2017 CDC guideline for the prevention of SSI, a randomized study showed that prophylactic use of negative pressure dressings for closed laparotomy wounds significantly reduces the incidence of SSI at 30 days postoperatively, concomitantly decreasing length of stay (6.1 vs. 14.7 days; $P = 0.01$).

Treatment of Surgical Site Infection

There are five steps in the treatment of SSI (Box 2). Once SSI is diagnosed, it is paramount to obtain a high-quality specimen for Gram stain and culture to identify the causative pathogens. With the increasing prevalence of multidrug resistant organisms associated with wound infection, identification of the causative pathogen and its antimicrobial susceptibility helps guide appropriate antibiotic therapy as well as facilitate rapid de-escalation, which is important in preventing unnecessary antibiotic use that facilitates further development of resistant organisms.

BOX 2 Treatment strategies for surgical site infection.

1. Pathogen identification.
2. Source control by opening the incision in superficial or deep surgical site infections (SSIs) or by image-guided percutaneous drainage, laparoscopic, or open drainage if indicated in organ space SSIs.
3. Immediate empiric antibiotic coverage.
4. Timely antibiotic de-escalation.
5. Local wound care

Source control in superficial and deep SSI usually requires opening of the incision site and irrigation, drainage, and debridement of devitalized or infected tissue as needed. Organ space infections often can be controlled by image-guided drainage using computed tomography (CT) scan or ultrasound (US) if localized and well contained. However, where there are multiple sites or widespread infection—interloop abscesses between loops of small intestine, for example, surgical drainage is necessary and can be performed either by laparoscopic or open approach.