Surgical site infection (SSI)

see also Surgical site infection in spine surgery

see also Surgical site infection in cranioplasty.

A surgical site infection is an infection that occurs after surgery in the part of the body where the surgery took place.

Surgical site infections pose a significant problem in the treatment of neurosurgical procedures, regardless of the application of perioperative prophylaxis with systemic antibiotics. The infection rate in these procedures ranges from less than 1% to above 15%.

Neurosurgical wound infections are the most common and serious complications resulting in increased rates of morbidity and mortality ¹.

Active outpatient follow-up is not necessary and monitoring of inpatients and readmissions is enough for a cranial neurosurgical SSI programme ².

**Epidemiology**

Several studies had been reported lower incidence of neurosurgical wound infection ³ ⁴.

The neurosurgical wound infection rate is usually low even in developing countries and remains within the accepted rate ⁵.

Predictors of SSI and hospital readmission differ in the US, Denmark and Japan, suggesting that risk stratification models may need to be population specific or adjusted. Some differences in measured parameters exist in the 3 databases analyzed, however, patient and procedure selection also appear to differ and may limit the ability to directly pool data from different regions. Therefore, risk stratification models developed in one country may not be directly applicable to other countries ⁶.

**Classification**

SSIs are classified into incisional SSIs, which can be superficial or deep, and organ/space SSIs, which affect the rest of the body other than the body wall layers.

These classifications are defined as follows:

Superficial incisional SSI - Infection involves only skin and subcutaneous tissue of incision

Deep incisional SSI - Infection involves deep tissues, such as fascial and muscle layers; this also includes infection involving both superficial and deep incision sites and organ/space SSI draining through incision.

see Deep wound infection

Organ/space SSI - Infection involves any part of the anatomy in organs and spaces other than the incision, which was opened or manipulated during operation.
Etiology

Surgical site infections (SSIs) are potential complications occurring after surgery. Despite the availability of prophylactic antibiotics and aseptic technique, they remain a cause for concern. 

Microorganisms

The most common microorganisms isolated from SSI were Staphylococcus aureus (23%), Enterobacteriaceae (21%), and Propionibacterium acnes (12%).

Risk factors

see Surgical site infection risk factors.

Diagnosis

A wound infection can manifest itself by local symptoms, for example, by suppuration, or by general symptoms, for example, by fever, weakness, or posttraumatic sepsis.

Diagnosis of surgical site infection appears to rely primarily on clinical factors and laboratory values, such as C-Reactive Protein, are not universally sensitive. Similarly, novel methods of perioperative infection prophylaxis such as local antibiotic administration appear to be modestly effective.

SSI and bone flap resorption are the most frequent complications associated with the reimplantation of autologous cryopreserved bone after decompressive craniectomy. Prolonged procedural time and cardiovascular comorbidity tend to increase the risk of SSI.

Complications

Sepsis and tetanus are severe forms of general wound infection. Causative agents include staphylococci, Pseudomonas aeruginosa, and colon bacillus. Associations of these microorganisms are frequently observed. The causative agents of anaerobic infection are less commonly observed. Microorganisms always penetrate a wound, although infection rarely develops if the body and injured tissues are adequately resistant and primary surgical treatment is prompt.

Prevention

Surgical site infection prevention.

Case series

2016

An observational, prospective study was conducted of the rates of surgical wound infection among patients admitted for more than 48 h to the Neurosurgery Department of Ramon y Cajal University Hospital, Madrid, Spain (a tertiary-level university hospital) between July 2011 and December 2014.

The study surveyed a total of 536 surgical procedures performed in 521 patients. The rate of diagnosed surgical site infection (SSI) was 4.85% (26 infections), below the established acceptable threshold of 5%. Of these, 65.38% were organ-space infections, 30.77% deep infections, and 7.69% superficial infections. Infection rates for each type of surgical procedure were 4.35% for spinal fusion, 0.00% for refusion of spine, 2.08% for laminectomy, 5.95% for ventricular shunt, and 5.14% for...
craniotomy. **Antibiotic prophylaxis** was evaluated as suitable in 80.22% of surgical procedures.

Infection rates were lower when the surgery was elective, clean, the patient had a lower ASA, and when suitable antimicrobial prophylaxis was administered. The rate of suitable antimicrobial prophylaxis shows that there is room for improvement. In order to minimize the risk of surgical wound infection, all professionals involved in patient care need to know and apply current recommendations, especially those relating to proper hand hygiene and suitable **antibiotic prophylaxis**\(^{11}\).

One thousand thirty (N=1,030) patients were included in the study. All subjects underwent primary lumbar single- or two-level decompression, microdiscectomy, or instrumented fusion. **OUTCOME MEASURES:** Occurrence of an SSI defined according to the current Centers for Disease Control and Prevention guidelines that required surgical or nonsurgical therapy. **METHODS:** The effect of preoperative patient characteristics, comorbidities, disease history, and invasiveness of the elective surgery on the risk of SSI was determined in uni- and multivariate logistic regression models in the test cohort (N=723). The performance of the final multivariable regression model was assessed by measuring its discriminative ability (c-index) in receiver operating characteristic analysis. Performance of the multivariable risk estimation model was tested on the validation (N=307) cohort. **RESULTS:** The prevalence of SSI was 3.5% and 3.9% in the test and in the validation cohorts, respectively. The final multivariable regression model predictive (p=.003) for SSI contained the patient's age, body mass index (BMI), and the presence of 5 comorbidities, such as diabetes, ischemic heart disease, arrhythmia, chronic liver disease, and autoimmune disease as risk factors. The c-index of the model was 0.71, showing good discriminative ability, and it was confirmed by the data of the independent validation cohort (c=0.72).

Predisposing factors for SSI were older age, higher BMI, and the presence of certain comorbidities in the present study. The cumulative number of risk factors significantly associated with the increasing risk for an SSI (p<.0001). Our model needs further validation but it may be used for individual risk assessment and reduction in the future\(^{12}\).

The full set of prospectively gathered Medicare insurance data (2005-2012) was retrospectively reviewed. Patients who underwent primary **lumbar discectomy** for lumbar disc herniations from 2009 to quarter 3 of 2012 were selected. This cohort (n=41,655) was then divided into two subgroups: those who were diagnosed with incidental durotomy on the day of surgery (n=2,052) and those who were not (control population). To select a more effective control population, patients of a similar age, gender, smoking status, diabetes mellitus status, chronic pulmonary disease status, and body-mass-index were chosen at random from the control population to create a control cohort. In-hospital costs, length of stay, and rates of 30-day readmission, 90-day wound complications, and 90-day serious adverse effects were compared.

An incidental durotomy rate of 4.9% was observed. Higher rates of **wound infection** (2.4 vs 1.3%; OR 1.88; 95% CI: 1.31 - 2.70; p<0.001), wound dehiscence (0.9 vs 0.4%; OR 2.39; 95% CI: 1.31 - 4.37; p=0.004), and serious adverse events related to incidental durotomy (0.9 vs 0.2%; OR 4.10; 95% CI: 2.05 - 8.19; p<0.0001) were observed in incidental durotomy patients. In-hospital costs were increased by over $4,000 in patients with incidental durotomy (p<0.0001).

Incidental durotomies occur in almost one in every twenty elderly patients treated with primary lumbar discectomy. Given the increased hospital costs and complication rates, this complication must be viewed as anything but benign\(^{13}\).
From 152 patients with **spinal metastases**. Overall **surgical site infection** SSI rate was 11.2 per 100 patients (9.7 per 100 procedures). An increase in the risk of SSI was observed when surgery involved a greater number of vertebral levels (odds ratio 1.26, p=0.019) when controlling for primary spinal region. Controlling for the number of spinal levels, the odds of SSI increased by a factor of 5.6 (p=0.103) when the primary surgical region was thoracic, as opposed to cervical or lumbar.

In conclusion, surgery associated with multiple vertebral levels for treatment of spinal metastases, particularly of the thoracic spine, is associated with increased risk of SSI.  

2015

Selby et al., track surgical site infections (SSIs) with two systems; our in-house surgical secondary events (SSE) database and the National Surgical Quality Improvement Project (NSQIP). The SSE database, a modification of the Clavien-Dindo classification, categorizes SSIs by their anatomic site, whereas NSQIP categorizes by their level. Our aim was to directly compare these different definitions.

NSQIP and the SSE database entries for all surgeries performed in 2011 and 2012 were compared. To match NSQIP definitions, and while blinded to NSQIP results, entries in the SSE database were categorized as either incisional (superficial or deep) or organ space infections. These categorizations were compared with NSQIP records; agreement was assessed with Cohen kappa.

The 5028 patients in our cohort had a 6.5% SSI in the SSE database and a 4% rate in NSQIP, with an overall agreement of 95% (kappa = 0.48, P < 0.0001). The rates of categorized infections were similarly well matched; incisional rates of 4.1% and 2.7% for the SSE database and NSQIP and organ space rates of 2.6% and 1.5%. Overall agreements were 96% (kappa = 0.36, P < 0.0001) and 98% (kappa = 0.55, P < 0.0001), respectively. Over 80% of cases recorded by the SSE database but not NSQIP did not meet NSQIP criteria.

The SSE database is an accurate, real-time record of postoperative SSIs. Institutional databases that capture all surgical cases can be used in conjunction with NSQIP with excellent concordance.

2012

Scalp wound infections following craniocerebral trauma caused by the Wenchuan earthquake.

A total of 82 patients suffered from scalp trauma in this study, including 52.4% cases (43/82) with wound infections, mostly accompanied by severe **foreign body** contamination, for which the time of first debridement was significantly delayed. There were 59 strains of infectious pathogenic bacteria. Gram-positive bacteria were the most common organisms found (64.4%), including strains of Staphylococcus aureus (26/59, 44.1%) and strains of Staphylococcus epidermidis (12/59, 20.3%). Gram-negative bacteria accounted for 35.6% of samples: 22.0% (13/59) were strains of Enterobacter cloaceae; 5.1% (3/59) were strains of Klebsiella pneumoniae; and 8.5% (5/59) were strains of Serratia rubidaea.

The rate of scalp wound infections following earthquake-induced craniocerebral trauma, which was dominated by Grampositive Staphylococcus aureus infection, has been markedly elevated in recent years. Early debridement and suturing, nutritional support and application of sensitive antibiotics can augment the therapeutic effect.

1) Lietard C, Thébaud V, Besson G, Lejeune B: Risk factors for neurosurgical site infections: An 18 month
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