Surgical Site Infection

Juan David Vega Padilla1,2, José Daniel Sierra Reyes2, Diego Rodríguez Pineda2, Edwin Alejandro Barón Muñoz2, Fabián Andrés Orozco Rodríguez3, Rosana María Babilonia Yepes5, Dennis Ximena Murcia Acero1, Edgar Yovany Cerinza García2, Ligia Fernanda Sossa Bonilla1, Daniel Eduardo Gutiérrez Muñoz2 and Jouline Stephanie Joya Pineda1

INTRODUCTION

Surgical site infection is one of the most studied complications in the world. There are many studies that describe its frequency and also prevent its appearance, however; it continues to be a frequent cause of morbidity and mortality [1]. In 2006, approximately 80 million surgical procedures were performed in the United States [2]. Surgical site infection (SSI) is the second most common type of health care–associated infection and increases hospital morbidity and mortality. It is defined as the infection that affects the surgical incision area or its deep tissue in the first 30 days after surgery and when a prosthesis or implant is used, this time extends up to one year [6].

EPIDEMIOLOGY

The epidemiology of the SSI is heterogeneous because it varies according to the hospital, the surgeon, the type of surgery and the patient [7]. SSI is one of the most common nosocomial infections and causes increase in morbidity, mortality, economic costs, days of hospitalization, use of antibiotics and in the number of surgical procedures [8,9]. SSI complicates 1.9% of surgeries [10] but it may be superior when open surgery is compared to laparoscopic surgery or depending on the type of surgery [6]. The economic costs attributed to the SSI vary from 10,000 to 43,000 dollars per patient and depend on the type of surgery and the causative agent [11,12].

CLASSIFICATION

CDC classification of surgical site infection

The surgical site infection is classified according to the depth in: superficial, deep and organ or space [13]. In the superficial infection only the skin or the subcutaneous cellular tissue is affected and must have at least one of the following criteria: purulent drainage of the incision, organism isolated in culture, pain, edema, erythema or local heat, diagnosis made by surgeon. In deep infection, the fascia or muscle is affected and must have at least one of the following criteria: purulent drainage of the deep incision, dehiscence of the wound with positive culture, without culture but with fever greater than 38 degrees or localized pain, evidence of infection involving the deep incision, diagnosis made by surgeon. In the organ or space infection, there is purulent drainage of an organ or space, positive culture, any clinical evidence of organ or space infection or diagnosis made by a surgeon [14].

Classification of operative wounds

Clean: Elective, not emergency, non-traumatic and primarily closed; no acute inflammation; no break in technique; respiratory, gastrointestinal, biliary, and genitourinary tracts not entered.

Clean-contaminated: Urgent or emergency case that is otherwise clean; elective opening of respiratory, gastrointestinal, biliary, or genitourinary tract with minimal spillage not encountering infected urine or bile; minor technique break.

Contaminated: Non-purulent inflammation; gross spillage from gastrointestinal tract; entry into biliary or genitourinary tract in the presence of infected bile or urine; major break in technique; penetrating trauma ≤4 h old; chronic open wounds to be grafted or covered.

Dirty: Purulent inflammation; preoperative perforation of respiratory, gastrointestinal, biliary, or genitourinary tract; penetrating trauma >4 h old [15].

PATHOGENESIS AND RISK FACTORS

Surgical infections have characteristics that include the primed systemic inflammatory response by surgical insult, immediate postoperative immune suppression, various invasive interventions and anesthetic. All these previous factors together cause that the course of surgical infections is more complex [16]. SSI arises from an interaction of several factors that include the type and number of contaminating bacteria, the virulence and the resistance of the patient involved. Bacteria involved may originate from the host patient or arise from other sources as the surgical personnel, equipment, and the operating room environment [17,18]. Patient-related risk factors for the development of SSI can be categorized as either unmodifiable or modifiable. The unmodifiable risk factor is the age (increasing age predicted an increased risk of SSI until age 65 years). Modifiable patient-related risk factors include poorly controlled diabetes mellitus, obesity, tobacco use, use of immunosuppressive medications, and length of...
preoperative hospitalization. Perioperative risk factors include wound class, length of surgery, and shaving of hair, hypoxia and hypothermia [19]. The most common pathogen in surgical site infections is *Staphylococcus aureus* (Table 1).

**Table 1**

**Pathogens in surgical site infections [13]**

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Percentage of Infections</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>20%</td>
</tr>
<tr>
<td>Coagulase-negative <em>Staphylococci</em></td>
<td>14%</td>
</tr>
<tr>
<td>Enterococci</td>
<td>12%</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>8%</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>8%</td>
</tr>
<tr>
<td><em>Enterobacter species</em></td>
<td>7%</td>
</tr>
</tbody>
</table>

**PREVENTION**

**Pre-hospital interventions**

**MRSA screening:** It is recommended screening and nasal mupinocin decolonization for *S. aureus*-colonized patients before total joint replacement and cardiac procedures. Decolonization protocols should be completed close to the date of surgery to be effective. Vancomycin should not be administered [20,21].

**Smoking cessation:** Smoking cessation is recommended for all current smokers, especially those undergoing procedures with implanted materials. Smoking cessation 4 to 6 weeks before surgery reduces SSI [22].

**Antibiotic prophylaxis:** Preoperative prophylaxis with appropriately selected procedure-specific antibiotics administered 1 hour before skin incision is a mainstay of SSI prevention [27] (2 h for vancomycin and fluoroquinolones) [28]. Choice of prophylactic antibiotic should be dictated by the procedure and pathogens most likely to cause SSI [29]. There is no evidence that improved Hgb A1C decreases SSI risk [30].

**Skin preparation:** There is no evidence that improved Hgb A1C decreases SSI risk. However, optimal blood glucose control should be encouraged for all diabetic patients [21,24].

**Hospital interventions**

**Skin preparation:** Alcohol-containing preparation should be used unless contraindication exists. If alcohol cannot be included in the preparation, chlorhexidine should be used instead of iodine unless contraindications exist [25].

**Surgical hand scrub:** Use of a waterless chlorhexidine scrub is as effective as traditional water scrub and requires less time [26].

**Antibiotic prophylaxis:** Preoperative prophylaxis with appropriately selected procedure-specific antibiotics administered 1 hour before skin incision is a mainstay of SSI prevention [27] (2 h for vancomycin and fluoroquinolones) [28]. Choice of prophylactic antibiotic should be dictated by the procedure and pathogens most likely to cause SSI [29]. There is no evidence that prophylactic antibiotic administration after incision closure decreases SSI risk [30].

**Normoglycemia:** It is recommend confirming perioperative glucose levels <200 mg/dL in diabetic and non-diabetic patients or an immediate postoperative control in all surgeries 180 mg/dL [13,31].

**Oxygenation:** It is recommended optimizing tissue oxygenation during surgery, administering a higher inspired oxygen fraction in the operative and immediate postoperative phases and maintaining haemoglobin saturation >95% [31].

**CONCLUSION**

Its prevention depends on hospital and pre-hospital interventions (MRSA screening, smoking cessation, bowel preparations, glucose control, skin preparation, antibiotic prophylaxis, among others). The prevention of surgical site infection is an important objective in health care.