Prevention of surgical site infections

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Abstract

Surgical site infections (SSI) are a major healthcare burden throughout the world and prevention is paramount in reducing the impact of this common category of healthcare associated infection. SSI may be classified as superficial incisional, deep incisional or organ/space and are caused by both patient and procedural factors. UK guidelines on prevention were published in 2008 and the World Health Organization has recently published guidelines in 2016 which are summarized here.

Keywords Hospital acquired infection; prevention; surgical site infection; wound sepsis

Definition

Surgical site infection (SSI) is defined as an infection occurring within 30 days of surgery (90 if a prosthesis is involved) and can be divided into three categories by location; superficial incisional, deep incisional, and, organ/space SSI.[1]

A superficial incisional SSI only involves the skin and subcutaneous tissue of the incision and has at least one of the following:

- purulent drainage from the superficial incision
- organisms identified through microbiological testing from an aseptically-obtained specimen from the incision
- superficial incision that has been deliberately opened by a surgeon or designee when the patient has at least one of the following signs or symptoms: pain or tenderness; localized swelling; erythema or heat
- diagnosis of a superficial incisional SSI by the surgeon or designee.[1]

A deep incisional SSI involves the deep soft tissues of the incision (e.g. fascial and muscle layers) and the patient has at least one of the following:

- purulent drainage from the deep incision
- a deep incision that spontaneously dehisces or is deliberately opened or aspirated by a surgeon or designee
  - and organisms are identified through microbiological testing
  - and the patient has at least one of the following signs or symptoms: fever >38°C, localized pain or tenderness
- an abscess or other evidence of infection involving the deep incision that is detected clinically or radiologically.[1]

An organ/space SSI involves any part of the body deeper than the fascial or muscle layers that is opened or manipulated during the operative procedure (specific sites listed by the Centers for Disease Control and Prevention[1]) and the patient has at least one of the following:

- purulent drainage from a drain that is placed into the organ/space
- organisms are identified from an aseptically-obtained fluid or tissue in the organ/space by microbiological testing
- an abscess or other evidence of infection involving the organ/space that is detected clinically or radiologically.[1]

Incidence

The World Health Organization (WHO) has found that up to one-third of patients undergoing a surgical procedure in low and middle income countries are affected by SSI.[2] In the UK the cumulative incidence of SSI varies according to the type of surgery. Between April 2011 and March 2016 147 NHS trusts submitted data on 611,700 procedures and the highest incidence of SSI was observed in colorectal surgery (9.8%) and the lowest incidence in hip and knee prosthesis surgery (0.6%).[3]

Pathology and pathogenesis

The creation of a wound triggers an inflammatory response to begin the healing process. This response includes pre-emptive mobilization of host defences (phagocytes) into the wound to tackle ensuing bacterial contamination. The following four factors are at play to determine whether there will be a continuation of the normal healing process or the development of an SSI:

- number of bacteria present (infective load)
- ability of the bacteria to produce an infection (virulence)
- wound environment

Wound classification[4]

Class	Type	Definition	Example
I	Clean	No entry into viscus or tract	Joint replacement, breast, hernia
II	Clean-contaminated	Hollow viscus opened but with minimal contaminated spillage	Cholecystectomy, elective colorectal resection, uncomplicated appendicectomy
III	Contaminated	Viscus or tract opened with major contaminated spillage or inflammatory process	Inadvertent enterotomy
IV	Dirty	An active infection is already present; i.e. gross contamination secondary to pus or perforation, incision through an abscess	Perforated diverticular disease

Table 1

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Risk factors for surgical site infections (SSI)[2,5]

	Non-modifiable	Modifiable
Infective load	Infective organism	Surgical antibiotic prophylaxis MRSA eradication treatment
Virulence	Infective organism	Surgical antibiotic prophylaxis
Wound environment	Mechanism of wound Anatomical site operated upon (wound type)	High volume centre Procedure sterility Technique Use/type of prosthesis Duration of procedure Wound haematoma
Patient factors	American Society of Anaesthesia grade (ASA) ≥3 Age Immunosuppression Malnutrition Obesity Diabetes Ascites Renal failure Jaundice	Hyperglycaemia Hypothermia Hypoxia Anaemia Blood transfusion Smoker Nutritional state

Table 2

- ability of the patient to fight infection (patient factors).

Viable tissue surrounding an infected wound will display the classic signs of inflammation (rubor, calor, tumour and dolor) due to increased local blood supply, accumulation of tissue oedema and the stimulation of pain receptors.[4]

Risk factors

Wounds are defined as being clean, clean-contaminated, contaminated or dirty based on the site and degree of contamination. Greater contamination within the wound leads to a greater the risk of developing SSI (Table 1). Other risk factors for development of SSI can be divided into non-modifiable and modifiable risk factors (Table 2). Causative organisms are related to the site of surgery (Table 3). The most frequent causative organisms in SSI in the UK have changed over the past 10 years with a steady reduction in *Staphylococcus aureus* infections since 2006 and increase in SSI caused by Gram negative bacteria. Gram negative bacterial SSI now account for 28% of infections.[3]

Diagnosis and investigations

Clinical examination in combination with blood and microbiological testing are the mainstays of diagnosis and investigation. Deep/organ infections may present more insidiously with non-specific symptoms, failure to progress or postoperative ileus. Radiological imaging maybe required. In the assessment of sepsis appropriate microbiological cultures including blood cultures should be taken prior to starting antibiotics as sterilization of cultures can occur within a short time frame of starting antibiotics, therefore making tailoring antibiotic therapy difficult. The Surviving Sepsis campaign recommends that hospitals screen for sepsis in acutely unwell patients and adhere to performance improving programs (i.e. surviving sepsis campaign care bundles).[6] Surveillance can reduce SSI rates from between three and 57%.[2]

Prevention

The WHO developed guidelines published in November 2016 encompassing their recommendations for the prevention of SSI in the perioperative period and these are summarized in Table 4.[2] Recommendations are made with respect to their effect on SSI prevention and therefore should not be extrapolated further than

Surgical site and likely infective wound pathogens[3,5]

Surgical site	*Staphylococcus aureus*	Coagulase-negative staphylococci	Gram-negative bacilli	Streptococci	Anaerobes	Others
Cardiac	✔	✔	✔			
Neurosurgery	✔	✔	✔			
Breast	✔	✔				
Ophthalmic	✔	✔	✔	✔		
Orthopaedic	✔	✔	✔			
Vascular	✔	✔				
Gastroduodenal			✔	✔		Oropharyngeal anaerobes
Biliary			✔		✔	
Colorectal			✔		✔	
Head and neck	✔			✔		Oropharyngeal anaerobes
Obstetric and gynaecological			✔		✔	Enterococci, group B streptococci
Urological						
Foreign material	✔	✔	✔			

Table 3