

# PREVENTING SURGICAL SITE INFECTIONS

Surgical site infections (SSIs) are costly for the NHS and the patient — increasing the length of hospital stay and the need for further treatment. This article examines the different types of SSI, how they can be detected and how symptoms can be differentiated from normal wound healing. It also identifies the main risk factors and explains how the healthcare professional should help prevent their occurrence.

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Surgical site infections (SSIs) are a significant burden on the patient in terms of pain, suffering, mortality and morbidity. They also place a financial burden on the healthcare system by extending the patient's length of stay in hospital.

There are many recognised risk factors associated with the development of a SSI and the practitioner has an obligation as part of their duty of care to minimise these.

This paper will describe the epidemiology of SSIs and provide guidance on how to recognise the signs of an infection. It will list the most common risk factors and provide an overview of some of the preventive strategies that should be used.

## Epidemiology

A national prevalence study of infections in hospitals in 1996 showed that SSIs constituted 9% of the total number of infections (Emmerson et al, 1996). The third national prevalence study of healthcare-associated infections was conducted in England in 2006 and showed



*Figure 1. Cellulitis following a hernia repair.*

that 8.2% of patients nationally were developing healthcare-associated infections while in hospital. Of all those patients that had undergone a surgical procedure, 4.65% had developed an SSI (Hospital Infection Society and Tissue Viability Nurses Association, 2007). American statistics also suggest that SSIs are a significant burden to its healthcare system. It has been estimated that 38% of all healthcare-associated infections in American patients who have had surgery are SSIs, and that 2–5% of all patients who undergo an operation will develop an SSI. In addition, they have estimated that an SSI increases length of stay in hospital by an average of seven days (Institute

of Healthcare Improvement, 1992). In comparison, one European study reported the mean length of extended stay in hospital caused by an SSI to be 9.8 days (DiPiro et al, 1998). Plowman et al (2000) found that of 3,980 NHS patients, 7.8% of them developed a healthcare-associated infection during their hospital stay. They also identified that SSIs alone increased hospital-incurred costs for each patient by £1,618 and increased length of stay in hospital by an average of seven days. Infected patients also visited their GP and the hospital more frequently post discharge, spent more on drugs and dressings and took longer to return to normal activities of daily living and paid employment.

**Table 1**

Clinical signs of wound infection (Cutting and Harding, 1994; White et al, 2002)

- » Abscess
- » Cellulitis
- » Discharge
- » Delayed healing
- » Discolouration
- » Friable, bleeding, granulation tissue
- » Unexpected or increasing pain or tenderness
- » Pocketing/bridging at the base of the wound
- » Bridging of the epithelium or soft tissue
- » Abnormal smell
- » Wound breakdown

### Definition

There are many definitions of infection (*Table 1*), however, a practitioner must be aware that in the case of surgical wounds there has been concern raised that infection is often overdiagnosed. Practitioners frequently mistake the normal erythema and exudate associated with normal wound inflammation as signs of infection (Melling et al, 2005). In contrast, deep surgical infections can go undiagnosed for some time because initially there are no visible external signs but the patient will become systemically unwell. A raised white cell count, pain and pyrexia will often indicate infection.

Another definition for SSIs advocated by the Health Protection Agency (2004) identifies the differences between superficial incisional infection, deep incisional infection, and organ or space infection (*Table 2*).

### Risk factors and risk reduction strategies

There are many risk factors associated with surgical

**Table 2**

What is a surgical site infection? (Health Protection Agency, 2004)

#### Superficial incisional infection

This is defined as a surgical site infection that occurs within 30 days of surgery and involves only the skin or subcutaneous tissue of the incision, and meets at least one of the following criteria:

Criterion 1: purulent discharge from the superficial incision.

Criterion 2: the superficial incision yields organisms from the culture of aseptically aspirated fluid, tissue, or from a swab, and pus cells are present.

Criterion 3: at least two of the following symptoms and signs:

- » Pain or tenderness
- » Localised swelling
- » Redness
- » Heat

**And;** a) the superficial incision is deliberately opened by a surgeon to manage the infection, unless the incision is culture negative

**Or b)** the clinician diagnoses a superficial incisional infection.

#### Deep incisional infection

This is defined as a surgical site infection involving the deep tissues (i.e. fascial and muscle layers) that occurs within 30 days of surgery if no implant is in place, or within a year if an implant is in place and the infection appears to be related to the surgical procedure, and meets at least one of the following criteria:

Criterion 1: purulent drainage from the deep incision but not from the organ/space component of the surgical site.

Criterion 2: the deep incision yields organisms from the culture of aseptically aspirated fluid or tissue or from a swab and pus cells are present.

Criterion 3: a deep incision that spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following symptoms or signs:

- » Fever (>38 degrees C)
  - » Localised pain or tenderness,
- unless the incision is culture negative.

Criterion 4: an abscess or other evidence of infection involving the deep incision that is found by direct examination during re-operation, or histopathological or radiological examination.

Criterion 5: diagnosis of a deep incisional surgical site infection by an attending clinician.

#### Organ/space infection

This is defined as a surgical site infection involving any part of the anatomy (i.e. organ/space), other than the incision, opened or manipulated during the surgical procedure, that occurs within 30 days of surgery if no implant is in place, or within one year if an implant is in place and the infection appears to be related to the surgical procedure, and meets at least one of the following criteria:

Criterion 1: Purulent drainage from a drain that is placed through a stab wound into the organ/space.

Criterion 2: The organ/space yields organisms from the culture of aseptically aspirated fluid, tissue or from a swab, and pus cells are present.

Criterion 3: An abscess or other evidence of infection involving the organ/space that is found by direct examination during re-operation, or histopathological or radiological examination.

Criterion 4: Diagnosis of an organ/space infection by an attending clinician.

site infections, but the most important of these is how dirty or contaminated the wound is preoperatively (Gottrup et al, 2005). In 1964 the US National Research Council developed a classification

system that describes the level of contamination in a surgical wound (*Table 3*). This is still widely recognised today as a means of predicting the likelihood of infection and therefore the need for prophylactic antibiotics. The

**Table 3**

Classification of operative wounds based on degree of microbial contamination (cited in Gottrup, Melling and Hollander, 2005 and adapted from Berard and Gandon, 1964)

Classification	Criteria
<b>Clean</b>	Elective, not emergency, non-traumatic, primarily closed; no acute inflammation; no break in aseptic technique, respiratory, gastrointestinal, biliary and genitourinary tracts not entered
<b>Clean-contaminated</b>	Urgent or emergency case that is otherwise clean; elective opening of respiratory, gastrointestinal, biliary or genitourinary tract with minimal spillage (e.g. appendectomy) not encountering infected urine or bile; minor break in aseptic technique
<b>Contaminated</b>	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 aseptic technique; penetrating trauma <4 hours old; chronic open wounds to be grafted or covered
<b>Dirty</b>	Purulent inflammation (e.g. abscess); preoperative perforation of respiratory, gastrointestinal, biliary or genitourinary tract; penetrating trauma >4 hours old

Health Protection Agency has included 'the likelihood of micro-organisms being present in the wound at the time of surgery (the wound class)' as one of only three risk factors in a risk index, which they use to predict the risk of developing a SSI (Nosocomial Infection National Surveillance Service, 2002).

### Prophylactic antibiotics

The prescription and administration of systemic prophylactic antibiotics is justified in those wounds that are considered to be most at risk of developing infection. The purpose of prophylactic antibiotics given before or during surgery is to reduce the impact of microbial contamination during surgery and to minimise the risk of infection developing. However, the antibiotic prophylaxis must be aimed at the bacteria most likely to infect the wound and be given at the most appropriate time (Griffin, 2005). In most cases it is recommended that prophylactic antibiotics are given

before the first incision but no more than 60 minutes before (Consumers Association, 2001, 2003; 2004a,b). If the surgery is longer than 4–5 hours in duration then subsequent doses are recommended (Consumers Association, 2004). Subsequent doses of prophylactic antibiotics beyond 24 hours after surgery is not recommended and can be detrimental because of the association between overuse of antibiotics and the emergence of resistant strains of bacteria (Consumers Association 2001, 2003; 2004a).

### Patient factors

The ability of the patient to defend against bacterial infection is a significant risk factor and any patient that has a suppressed immune system must be recognised as a high risk. This includes patients who are taking chemotherapy or other immunosuppressant drugs and those with illnesses that have suppressed the immune system (Collier, 2004).

Another patient factor is their risk of or actual contamination with methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA screening and subsequent preoperative decontamination has been advocated as a means of reducing the likelihood of MRSA surgical site infection (Consumers Association, 2003; 2004a). The most at-risk groups of patients are those undergoing complex surgery such as cardiac, neuro-, orthopaedic and vascular surgery and those having surgery to insert an implant (DoH, 2006). However, it has also been suggested that screening should be undertaken on patients that have previously been known to be MRSA positive, those that have frequent contact with healthcare settings, patients admitted to intensive care units, inpatients undergoing chemotherapy and patients admitted from high-risk settings such as care homes (DoH, 2006). In fact, it is thought that the most proactive approach would be that all elective and emergency patients admitted to hospital should be screened for MRSA and isolated until results are known, although financial and organisational constraints often prevent this (DoH, 2006). This type of legislation has been criticised recently as being unnecessary, potentially harmful to the patients and detrimental because it might reduce the autonomy of healthcare practitioners to risk assess their patients and develop flexible and more broad ranging infection control measures (Weber et al, 2007). In the author's experience, NHS organisations have recently been considering the implementation or actually implementing surveillance

protocols that indicate the need to screen those patients that are recognised as being at high risk of being colonised or infected and those that are being admitted for high-risk procedures. Decontamination procedures appear to differ between hospitals, some decontaminate only when the patient is identified as being colonised or infected whereas others start decontamination on admission for those patients deemed to be at high risk. The author would suggest that these differences have developed because of the lack of legislation on this subject and the current economic burden on the NHS.

### Preventing infection

The Department of Health *Saving Lives* document (2005) includes a number of high impact interventions that NHS organisations are recommended to implement to reduce the risk of harm to patients. It covers the prevention of SSI and includes guidance on how to reduce the risk to patients. It also incorporates an audit tool that can be used by the organisation or individual department as a means of identifying local practices and deficits.

The intervention includes the following areas.

### Pre- and intra-operative risks

#### Hair removal

Shaving before surgery is not recommended and removal should only be performed if the hair will interfere with the operation and then it should be removed using clippers (DoH, 2005; Tanner et al, 2006).

Shaving can cause microscopic cuts and abrasions to the skin that can then become colonised with bacteria and increase the risk of infection. If hair removal is necessary this should be performed as close to the time of surgery as possible (Gottrup, et al, 2005). Staff and patients should be educated about these risks in order to eliminate the unnecessary use of razors (Griffin, 2005).

#### Normothermia

The control of a patient's temperature and the prevention of hypothermia before and during a surgical procedure have been shown to reduce the risk of SSIs (Melling et al, 2001). An induced hypothermia is necessary for some operations such as some cardiac procedures, but during many others the patient will often become cold unnecessarily, particularly during prolonged procedures, and this can increase their likelihood of developing a postoperative wound infection. It is thought that this is caused by the hypothermia triggering thermoregulatory vasoconstriction, which decreases subcutaneous oxygen tension and therefore prolongs wound healing (Kurz et al, 1996). Patients should be prevented from developing hypothermia before and during all operations unless this is contraindicated. This can be achieved by the use of warming blankets, warmed intravenous fluids or raising the operating room's temperature (Griffin, 2005). The practitioner should ensure that patients' temperatures are recorded preoperatively and periodically during the operation and

implement warming measures as necessary (Odom-Forren, 2006).

#### Blood glucose control

Patients who suffer from diabetes and whose blood glucose is not effectively controlled postoperatively are at greater risk of developing an infection (Gannon, 2007). The Department of Health suggests that blood glucose levels should be maintained below 11mmol/l (DoH, 2005). A practitioner should ensure that blood glucose is closely monitored and controlled, particularly in the first two days after the operation, to reduce a patient's risk of SSI (Odom-Forren, 2006).

#### Principles of asepsis

One of the most significant factors resulting in SSI is a lack of asepsis either during or after the operation, which leads to a surgical wound becoming contaminated. The Health Protection Agency (2007) identify that there are three main risk factors associated with developing a surgical site infection. These are:

- ▶▶ The state of health of the patient before surgery
- ▶▶ The type of operation and how long it took
- ▶▶ The likelihood of micro-organisms being present in the wound at the time of surgery (the wound class).

These three risk factors are associated with the patient's ability to fight invading micro-organisms, the risk of micro-organisms contaminating the wound during surgery and the risk of micro-organisms already being present in the wound. This suggests that inappropriate



postoperative management is not a significant risk. However, the author believes that this does not mean there is no risk of a patient developing an infection caused by inappropriate wound care, although the wound infection is more likely to be a superficial one.

Wound contamination can result from direct transfer of micro-organisms from equipment or the hands of carers, from airborne micro-organisms being deposited into the wound while it is left uncovered, or from micro-organisms migrating from the patient's skin or gastrointestinal tract into the wound (Collier, 2004). Practitioners must ensure that surgical incisions are kept covered for the first 24–48 hours. Infection control procedures must be adhered to tightly and patients should be educated about not touching their wound and ensuring that they wash their hands after using the toilet.

### Organisational strategies

Other interventions that can lessen a patient's risk of developing an SSI include reducing the length of hospital stay so the risk of contamination of their skin or their wound in hospital is reduced. This can be achieved by facilitating patients' admission to hospital on the day of surgery. Staff and patient education programmes are also thought to be useful so that staff understand how to prevent infection and patients understand what they can do to avoid SSIs and recognise when they need to ask for help (DoH, 2006).

### Conclusion

There are many aspects of the management of surgical patients that can predispose them to, or reduce their risk of, developing a SSI. It is part of the healthcare professional's duty of care to recognise these risks and reduce them to the best of their ability. This will depend on the involvement of the whole healthcare team and should include the education of the patient. **WE**

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### Key Points

- ▶ Surgical site infections can be divided into three categories: superficial incisional infection, deep incisional infection and organ/space infection.
- ▶ The most important risk factor is if the wound is contaminated preoperatively.
- ▶ Other risk factors include the patient's immune status and their risk of contamination with MRSA.
- ▶ Healthcare professionals should take appropriate action to help prevent SSIs from occurring.

## MYTH BUSTER: YELLOW SLOUGH

**Q** Does yellow slough always indicate infection?

**A** When assessing wounds we often hear staff say that a wound swab has already been taken and sent off as routine when there is yellow slough present. The presence of slough indicates that the wound has dead tissue present which requires removal (debridement) to encourage healing (Figure 1). However, not all yellow sloughy wounds are infected.

**Q** When is a yellow sloughy wound infected?

**A** The factors that indicate the presence of infection are (Figure 2):

- ▶ Pain — usually increased pain from the wound and surrounding tissue
- ▶ Erythema — the wound edges and surrounding tissue becomes red and inflamed
- ▶ Oedema — increased swelling around the wound



No erythema to wound edges

No oedema and minimal exudate

Figure 1. Pressure ulcer to the sacrum. There is 100% yellow slough present in the wound bed and no symptoms of infection. The wound does not require a wound swab. The aim of treatment should be debridement of slough.

▶ Heat — the wound and surrounding tissue is hot to touch

▶ Purulence — exudate from the wound is thick and yellow/green in colour (Baronski and Ayello, 2004).

**Q** How should an infected wound be treated?

**A** Treat according to assessment:

- ▶ A swab should be taken
- ▶ Antibiotics should be given due to the presence of cellulitis
- ▶ Wound dressings should be based on application of a topical antimicrobial to reduce the recurrence of bacteria and a dressing with exudate handling capability to reduce maceration of surrounding tissue and effects of oedema.

Baronski S, Ayello E (2004) *Wound Care Essentials, Practice and Principles*. Lippincott Williams and Wilkins, Springhouse, PA



Redness moving up the limb (cellulitis)

Oedema present

High exudate, maceration of surrounding tissue.

Increased pain.

Figure 2. An infected yellow, sloughy wound illustrating the factors that indicate infection.