Factors associated with increased risk of surgical site complications and wound infection

All surgical wounds are at risk of developing complications, such as surgical wound dehiscence (SWD), seroma, haematoma, delayed healing, poor quality or abnormal scar formation, incisional hernia and SSI. Surgical wounds can be divided into four different classifications, which can determine their risk of post-operative SSI:

- **Clean**: an incision in which no inflammation is encountered in a surgical procedure, without a break in sterile technique, and during which the respiratory, alimentary or genitourinary tracts are not entered (e.g. surgical wound following primary closure – hernia, varicose veins)
- **Clean–contaminated**: an incision through which the respiratory, alimentary, or genitourinary tract is entered under controlled conditions but with no contamination encountered (e.g. surgical wound at risk of infection due to location – elective cholecystectomy)
- **Contaminated**: an incision undertaken during an operation in which there is a major break in sterile technique or gross spillage from the gastrointestinal tract, or an incision in which acute, non-purulent inflammation is encountered (e.g. surgical wound – elective colorectal). Open traumatic wounds that are more than 12 to 24 hours old also fall into this category
- **Dirty or infected**: an incision undertaken during an operation in which the viscera are perforated or when acute inflammation with pus is encountered (e.g. emergency surgery for faecal peritonitis), and for traumatic wounds if treatment is delayed, there is faecal contamination, or devitalised tissue is present (e.g. burns, diabetic foot ulcers – drainage of abscess, faecal peritonitis).

An SSI is a post-surgical infection that can affect either the incision or deep tissue at the operation site (Center for Disease Control, 2016; PHE, 2019). There are three types: superficial incisional, deep/open incisional and organ/space incisional.

- **Superficial incisional infection:** Infection occurring in the skin and subcutaneous tissue within 30 days of a procedure, or up to 1 year for patients receiving an implant. Clinical signs and symptoms for superficial incisional infection are listed in Table 1 (Stryja et al, 2020).
- **Deep/open incisional infection:** Infection within 30 or 90 days of procedure involving the fascial and muscle layers. Clinical signs and symptoms for deep/open incisional infection are listed in Table 1 (Stryja et al, 2020).
- **Organ/space incisional infection**: Infection within 30 or 90 days of procedure involving any part of the anatomy, other than the incision, that is opened or manipulated during the surgical procedure; for example, a joint or the peritoneum. Clinical signs and symptoms for organ/ space incisional infection are listed in Table 1 (Stryja et al, 2020).

Signs and symptoms of superficial, deep/open and organ/space incisional infection (adapted from Stryja et al, 2020):

- <u>Superficial incisional infection</u>
    - Increased pain and tenderness at the surgical site
    - Localised swelling and induration
    - Localised heat and redness
    - Purulent drainage
    - Cellulitis limited to the wound and adjacent soft tissues
    - Evident superficial wound abscess
- <u>Deep/open incisional infection</u>
    - Increased pain at the surgical site

Reference: Wounds UK (2020) Best Practice Statement: Post-operative wound care – reducing the risk of surgical site infection. Wounds UK, London. International Wound Infection Institute (IWII) Wound Infection in Clinical Practice. Wounds International. 2022.

    - Spreading induration and swelling
    - Erythema and heat at the surgical site
    - Purulent drainage from the incision
    - Spreading cellulitis at the surgical site
    - Evident deep wound abscess or fasciitis
    - Separation of the edges of incision, exposing the deeper tissues
    - Unexpected post-operative fever accompanied by increasing wound pain and/or wound dehiscence Pathological blood test findings (elevated C-reactive protein, white blood counts, erythrocyte sedimentation rates, pro-calcitonin)
- Organ/space incisional infection
    - Purulent drainage from a drain placed through the skin into the organ or body space
    - Organ or body space abscess diagnosed by radiological or histopathological examination
    - Evidence of infection involving the organ or body space seen on direct examination during surgery Post-operative fever
    - Positive result of blood cultures, deep tissue biopsies, surgical sampling or pathological blood test findings (as in deep SSI)

Risk factors for Surgical site infections are:

- **Obesity**: Morbidly obese patients (BMI ≥40 kg/m2) have a significantly longer mean operative time and higher mean intra□operative blood loss, which may contribute to high risk of SSI (Jibodh et al, 2004). Surgery often requires larger incisions for better access, and can be complicated by increased fat, which is poorly vascularised. This can result in reduced oxygen and nutrients to the healing tissues, which can be compounded by the patient's nutritional status. Increasing BMI is also linked to changes in skin microbiota (Rood et al, 2018).
- **Diabetes mellitus**: Abnormal glycaemia has a multifactorial negative effect on the cells involved in wound healing (Wukich et al, 2011). Hyperglycaemia as a result of diabetes can also weaken the patient's immune system. Resultant neuropathy and reduced blood flow to the extremities can increase infection risk and also reduce the tensile strength of the wound.
- **Current or recent smoking**: Smoking compromises the immune system and increases susceptibility to infections; smoking can also lead to an iron imbalance, and bacteria thrive on iron. Reduced oxygenation to tissues inhibits the cell activity required for wound healing processes, increasing the risk of complications (Kong et al, 2017).
- **Emergency surgery**: For emergency surgery, complete pre- and peri-operative infection prevention strategies or risk factor management may not be possible due to time constraints. These patients are often very physiologically unwell (i.e. acidosis, hypoxia), which interrupts the normal immune cell response post-surgery (Wingert et al, 2016).
- **Age >65 years**: Older age can increase SSI risk due to an increase in comorbidities and a decrease in immune activity with increasing frailty (Wingert et al, 2016).
- **Extended duration of surgery**: Longer operative times are associated with higher risk factors and more complex surgeries. Longer exposure of the internal cavity to air-borne microbes increases the risk of contamination. It should be noted that the natural ingress, or settling, of bacteria during surgery does not trigger the same inflammatory response as acute, gross contamination (Berbari et al, 2012).
- **Inadequate surgical closure**: This means the wound is left open and exposed to air-borne microbes that may cause contamination. Gaps in surgical closure may lead to inappropriate wound tension, which can reduce perfusion. Poor use of wound closure material can provide a focus for bacteria (Blencowe et al, 2019). Inadequate closure of dead space allows collection of seroma or haematoma within the wound.
- **Peri-operative hypothermia**: This reduces the body's homeostasis and is linked with prolonged recovery from anaesthesia and a longer length of hospital stay (PHE, 2019). Hypothermic patients have reduced blood supply to the wound site due to peripheral vasoconstriction, which inhibits wound healing processes.
- **Surgery type**: Colorectal surgery is associated with a high rate of SSI due to frequency of bowel flora; vascular surgery is associated with a high rate of SSI due to frailty and multiple comorbidities of the patient group (PHE, 2019). For gynaecological and obstetric-related

surgery, the extent of SSIs and surgical complications may be underestimated. Under-reporting may be due to patients being managed in the community, as they often do not return to obstetrics if complications occur. This group is at high risk of infection due to the location of the wound, the activity of the mother and the potential misconception that caesarean and other obstetric-related wounds are minor. NICE (2019) recommend that sutures rather than staples should be considered to close the skin after caesarean section to reduce the risk of superficial wound dehiscence.

Wound infection can lead to protracted wound healing, multiple health service visits and increased hospital admission duration. This comes at significant economic cost and negatively impacts quality of life outcomes for the patient with a wound and their family. Accurate and timely identification of the signs and symptoms of wound infection is critical to achieving effective management of wound infection. The risk factors:

- Poorly controlled diabetes
- Peripheral neuropathy (sensory, motor, and autonomic)
- Neuroarthropathy
- Radiation therapy or chemotherapy
- Conditions associated with hypoxia and/or poor tissue perfusion (e.g. anaemia, cardiac disease, respiratory disease, peripheral arterial disease, renal impairment or rheumatoid arthritis)
- Immune system disorders (e.g. acquired immune deficiency syndrome)
- Connective tissue disorders (e.g. Ehlers-Danlos syndrome)
- Corticosteroid use
- Malnutrition or obesity
- Alcohol, smoking or illicit drug use
- Poor compliance with treatment plan
- Contaminated or dirty wounds
- Traumatic injuries
- Operation is classified as contaminated or dirty
- Inappropriate hair removal
- Operative factors (e.g. prolonged surgery, blood transfusion or hypothermia)
- Duration of wound
- Large wounds
- Anatomically located near a site of potential contamination (e.g. perineum or sacrum)
- Foreign body presence (e.g. drains, sutures or wound dressing fragments)
- Haematoma
- Necrotic or sloughy wound tissue
- Impaired tissue perfusion
- Increased exudate and oedema that is not adequately managed
- Wounds over bony prominences or probing to bone
- Involvement of tissue deeper than skin and subcutaneous tissues (e.g. tendon, muscle, joint or bone)
- Unhygienic environment (e.g. dust, unclean surfaces, or presence of mould/mildew)
- Hospitalisation (due to increased risk of exposure to antibiotic resistant microorganisms)
- Inadequate hand hygiene and aseptic technique
- Inadequate management of moisture (e.g. due to exudate, incontinence or perspiration)
- Interface pressure that is inadequately off-loaded

Reference: Wounds UK (2020) Best Practice Statement: Post-operative wound care – reducing the risk of surgical site infection. Wounds UK, London. International Wound Infection Institute (IWII) Wound Infection in Clinical Practice. Wounds International. 2022.