

Chapter 12 Surgical Site Infection Prevention

This chapter offers an overview of the key principles for preventing surgical site infections (SSIs). It does not address procedure-specific requirements, as these can vary widely between different types of surgeries. For detailed guidance on specific procedures, please refer to local protocols or guidelines.

As part of surgical management, it is expected that facilities have procedures and guidelines for best practice management of patients before, during and after surgery, in particular for high-risk patients as infection prevention is just one aspect of safe surgical care. This chapter focuses on those aspects of care that are particularly important for the prevention of surgical site infections.

12.1 Background

Surgical site infections are infections of incision sites or an organ space following a surgical procedure (Chaker et al., 2024). SSIs are associated with significant morbidity and mortality, prolonged hospital stays, and increased risk of readmission. SSIs also lead to a substantial strain on healthcare systems, contribute to the spread of antibiotic resistance and threaten the lives of millions of patients each year ([Global Guidelines for the Prevention of Surgical Site Infection WHO 2018](#)). Many factors influence surgical wound healing and the potential for infection. These include patient-related (endogenous) and process/procedural-related (exogenous) variables that affect a patient's risk of developing an SSI. Some of the factors are the health of the patient's immune system, presence of foreign material, degree of bacterial wound contamination, and use of antibiotic prophylaxis (Seidelman et al., 2023).

Some common patient-specific risk factors include advanced age, obesity and malnutrition, diabetes, immunosuppressive therapy, concurrent infection at another site, and smoking. In paediatrics, premature infants are also at higher risk, especially those undergoing gastrointestinal surgery early in life. Some of these risks can be reduced such as nutritional status, tobacco use, correct use of antibiotics and intraoperative techniques such as adequate surgical scrub, the antiseptic preparation of the skin and duration of surgery (Calderwood et al., 2023, World Health Organization, 2018).

12.2 Environmental controls in operating theatres

The rate of surgical wound infections can be influenced by operating theatre air quality, environmental cleanliness, health worker behaviour, theatre clothing, communication and health worker knowledge.

12.2.1 SSI prevention strategies

SSIs can largely be prevented if appropriate strategies are implemented. The most common strategy has been through the development and implementation of care bundles. A care bundle is a collection of evidence-based practices that can be applied when managing a certain condition (Chaker et al., 2024). For SSI prevention they are usually divided into three areas as follows, noting this is not a comprehensive list:

- preoperative measures
 - patient screening and modifying risk factors as appropriate including optimising glycaemic control in diabetes
 - antibiotic prophylaxis
 - appropriate skin preparation
- intraoperative measures

- maintaining normothermia while in the operating room
- aseptic technique
- minimising traffic in the operating room
- cleaning of theatre environment
- airflow-clean, non-circulated air or HEPA filtration
- postoperative measures
 - best practice wound care
 - patient education on how to manage wounds
 - timely removal of catheters and drains.

Ventilation

The management of airflow, clean air (minimising recirculation of potentially contaminated room air) and the creation of a turbulence-free environment are essential to reduce bacteria in the air, which may lead to post-operative wound infection. Air flow into the operating theatre should be by means of a distribution system that provides a flow of clean supply of air over the operating area first then away. For more information refer to [NSW Health Engineering Services Guide \(2022\)](#).

Routine use of laminar air flow is not required to reduce the risk of SSIs for patients undergoing total arthroplasty surgery, and laminar air flow is not required in new operating rooms (Ling et al., 2019, Ouyang et al., 2023, World Health Organization, 2018).

Environmental cleaning

A regular and audited cleaning schedule is required for operating theatres. This includes cleaning of frequently touched surfaces between each patient, cleaning and disinfection after contaminated or dirty procedures and/or any areas contaminated by blood or body fluids. Shared equipment must be cleaned and disinfected after each patient, including anaesthetic machines, and before the next patient arrives in the operating room.

Where possible clean beds with fresh, clean linen to be brought into operating theatre complex directly from clinical areas.

Bacterial and dust counts in operating theatre air are associated with the number of door openings and traffic in and out of the operating theatre. This can be reduced by minimising non-essential staff movement and door openings during surgical procedures.

Organisational and behavioural characteristics

It is expected that health workers will comply with the best practice while in the operating theatre area. Some of the key practices are:

- hand hygiene must be performed for all stages of patient care within the perioperative area
- correct surgical attire must be worn
- health workers who are scrubbed are not to wear forearm, wrist or hand jewellery
- operating room staff are not to wear artificial or polished nails in the operating theatre
- health workers in the operating room are to wear a head covering and a face mask in accordance with local procedures
- no food or drink is to be consumed in the operating room
- avoid bringing any personal items into the operating room

- if staff need to leave the operating room area temporarily and they are wearing scrubs they either need to change into their usual clothes including their shoes or cover their operating theatre attire with an over gown and change their footwear.

There is no need to place patients with suspected or confirmed multi-drug resistant infection/colonisation at the end of an operating list as long as the operating room is cleaned and disinfected to standard between patients, and the theatre ventilation is running without interruption.

12.2.2 Pre-operative measures

Best practice for the prevention of surgical site infections requires attention to a number of pre-operative areas.

Length of stay

An extended period of hospitalisation prior to surgery is a known risk factor for SSIs as this increases patient risk of colonisation with some pathogens ([VICNISS 2020](#)). If possible, shorten patient's pre-operative hospital stay to admission on day of surgery (Sulzgruber et al., 2020, Yang et al., 2023).

Pre-operative bathing

Preoperative bathing on the day of, and/or the day before surgery is commonly recommended ([APSIC 2019](#)). This can either be with soap, chlorhexidine 2% or chlorhexidine impregnated cloths. However systematic review of the evidence for preoperative bathing or showering does not show an impact on SSI rates.

Nasal decolonisation for *Staphylococcus aureus*

Staphylococcus aureus (*S. aureus*) carriage increases the risk of post-operative SSIs. However, decolonisation has only been shown to be of benefit in patients undergoing cardiac and joint replacement surgery and is not recommended for patients having other surgical procedures. Patients having cardiac or joint replacement surgery should be screened pre-operatively for *S. aureus* carriage by swabbing the nares and groins or perineum.

If swabs show *S. aureus* carriage, advice should be given to commence decolonisation the week before their planned procedure ([VICNISS 2020](#)). Routine administration of intranasal mupirocin in the absence of testing for *S. aureus* carriage is not recommended as there is increasing evidence of mupirocin resistance (Abdulgader et al., 2020, Dadashi et al., 2020, Prakash et al., 2023).

For more information refer to Chapter 7 Management of MROs.

Hair removal

If hair needs to be removed, moderate-certainty evidence suggests using clippers or depilatory cream probably results in fewer SSIs and other complications compared with shaving using a razor. There may be a small reduction in SSIs when hair is removed on the day of, rather than the day before surgery (Tanner and Melen, 2021). Therefore:

1. hair removal should be avoided unless hair interferes with the operative procedure
2. if hair removal is necessary, use electric clippers as close to surgery as possible. Do not use razors for hair removal.

Antimicrobial prophylaxis

Correct timing, dose and antimicrobial selection for surgical prophylaxis reduces surgical site infection. Administer antimicrobial prophylaxis according to evidence-based standards and guidelines including [Therapeutic Guidelines: Antibiotic](#). Some key principles include:

- use surgical antibiotic prophylaxis only where there is a clear indication for use (Ling et al., 2019)
- antibiotic choice needs to consider the presence of current infection, any recent antimicrobial use, colonisation with multi-drug resistant bacteria, prolonged hospitalisation or the presence of prostheses
- a single preoperative (before skin incision) dose of antibiotic(s) given as per *Therapeutic Guidelines: Antibiotic* is sufficient for the majority of procedures. In specific circumstances, a repeat intraoperative dose may also be necessary. Note: most antibiotic prophylaxis should be given within 60 minutes of the procedure starting
- for a minority of procedures, it is unclear if a single dose is as effective as 24 hours of prophylaxis. For these procedures, postoperative doses can be considered but should be ceased after 24 hours
- re-dosing should be considered to maintain adequate tissue levels based on agent half-life and or the amount of blood loss
- urinary catheterisation or the presence of a surgical drain are not indications for prolonged antibiotic prophylaxis.

Nutrition

Malnutrition is associated with an increased risk for SSIs and may occur in both underweight and overweight patients. Underweight patients undergoing major surgical procedures, especially oncology and cardiovascular operations, may benefit from the administration of oral or enteral multiple nutrient-enhanced nutritional formulas for the purpose of preventing SSI (Ling et al., 2019).

12.2.3 Intra-operative measures

Surgical hand antisepsis

Surgical hand antisepsis is performed to substantially reduce the number of resident and transient microorganisms on the hands prior to performing any aseptic or surgical procedure. A surgical scrub with either antimicrobial soap or surgical alcohol/chlorhexidine-based hand rub with persistent antimicrobial activity must be performed prior to donning sterile gloves. Scrub brushes may damage skin and should not be used. Surgical hand antisepsis is required prior to performing any surgical procedure that enters a sterile site ([SA Health Hand hygiene clinical Guidelines 2020](#)).

Operating team members should not wear wrist or hand jewellery, nail polish or artificial nails. If hands are visibly soiled, perform hand hygiene with liquid soap prior to scrubbing. Remove debris from underneath fingernails using a nail cleaner, preferably under running water. Prepare hands for surgery by scrubbing, using the correct technique with a TGA approved suitable antimicrobial soap and water OR surgical alcohol-based hand rub (before donning sterile gloves).

Glycemic control

One of the commonest surgical complications in patients with pre-existing diabetes mellitus and hyperglycaemia is infection, with superficial SSIs, deep wound infections, surgical space abscesses, urinary tract infections and pneumonia accounting for a large percentage of infectious complications (Ling et al., 2019). Implement perioperative glycemic control during and in the post-operative period and use blood glucose target levels less than 10mmol/L in patients with and without diabetes (Duggan et al., 2017), ([VICNISS 2020](#)).

Detailed management of glycaemic control is out of scope for this document and more information can be found in comprehensive guidelines from the [Australian Diabetes Society](#).

Normothermia

Exposure of large surfaces of skin to cold temperatures in the operating room can cause hypothermia and vasoconstriction and is a risk factor for SSIs (Kurz et al., 1996, Pu et al., 2014).

Maintain perioperative normothermia. This may include use of a warmed blanket or intravenous fluid warming devices. For procedures not requiring hypothermia, maintain normothermia (temperature > 35.5°C) during the perioperative period ([VICNISS 2020](#)).

Normovolemia

Hypovolemia and reduced cardiac output theoretically trigger musculocutaneous and splanchnic vasoconstriction, causing hypoperfusion and tissue hypoxia. Strategies need to be in place to avoid prolonged fasting as part of pre-operative preparation. Hemodynamic goal-directed therapy is recommended to reduce SSI (World Health Organization, 2018).

Maintenance of asepsis

Surgical aseptic technique refers to work practices that result in prevention or minimisation of microorganisms entering sterile body areas. Aseptic technique involves applying the correct protocols before, during and after a procedure, along with establishing and maintaining an aseptic field.

Movements in and out of the operating area should be kept to a minimum. Use sterile disposable non-woven drapes, or sterile reusable woven drapes. Ensure all surgical equipment is sterile and maintain asepsis throughout surgery ([VICNISS 2020](#)).

Skin preparation and wound management

Use alcohol-based solution preferably containing an antiseptic, for example, chlorhexidine gluconate for skin preparation unless contraindicated, for example, patient sensitivity/allergy, mucous membranes. Ensure processes are in place to mitigate risk of fire if using alcohol-based skin preparation.

Antimicrobial sealants should not be used after surgical site skin preparation for the purpose of reducing SSI.

Irrigation

As per the (World Health Organization, 2018) and NICE guidelines (Ling et al., 2019):

- there is insufficient evidence to recommend for or against irrigating incisional wounds with saline before closure for the purpose of preventing SSI
- antimicrobial agents must not be used to irrigate the incisional wounds before closure to reduce the risk of SSI
- povidone iodine irrigation – consider the use of irrigation of the incisional wound with an sterile aqueous povidone iodine solution before closure for the purpose of preventing SSI, particularly in clean and clean-contaminated wounds (World Health Organization, 2018)
- other topical antimicrobial agents (for example, ointments, solutions, and powders) applied to the surgical incision may cause hypersensitivity reactions and have not been shown to reduce risk of SSI ([VICNISS 2020](#)).

Antimicrobial impregnated sutures

Several international reviews and guidelines have been reviewed to synthesis the evidence for antimicrobial/antiseptic impregnated sutures and there is only weak evidence to support their routine use as a strategy to reduce SSI. It is important to note this evidence only applies to wound closure

systems (including muscle) in clean/clean contaminated operations with limited animal or human studies of their efficacy and safety in anastomosis or non-closure systems.

Individual facilities may consider them as an additional strategy if SSI are not controlled by optimising other measures. Such decisions must consider the evidence base for individual procedures, the added costs, and the risk of resistance and cross resistance to antibiotics (Elsolh et al., 2017, Yang et al., 2024).

12.2.4 Post operative period

Wound drain

The wound drain should be removed when clinically indicated. The optimal timing for wound drain removal for the purpose of preventing SSIs is unknown. Perioperative surgical antibiotic prophylaxis should not be continued due to the presence of a wound drain for the purpose of preventing SSI (World Health Organization, 2018).

Negative pressure wound therapy (NPWT)

Prophylactic negative pressure wound therapy may be used when there has been primary closure of surgical incisions in high-risk wounds and, taking resources into account, for the purpose of preventing SSI. Benefits of NPWT vary according to type of surgery and patient risk factors (Norman et al., 2022, Zwanenburg et al., 2020), ([WHO 2018](#), [VICNISS 2020](#)).

Glycaemic control

Maintenance of normoglycaemia in the post-operative period will support better wound healing (Wang et al., 2018).

Antibiotic prophylaxis

For almost all clean and clean-contaminated procedures, prophylactic antibiotics are not required after the surgical incision is closed, even if there is a surgical drain or a urinary catheter in place.

If post-operative dosing of antibiotics is required, it should be ceased within 24 hours of the procedure. Prolonged duration of antibiotic prophylaxis increases the patient's risk of subsequent infections with resistant pathogens and *Clostridioides difficile* ([VICNISS 2020](#)).

Wound management

Advanced dressing of any type should not be used over standard dressing on primarily closed surgical wounds for the purpose of preventing SSI. Aseptic technique should be used when undertaking wound dressings and wound management. Evaluate and manage wound appropriately using aseptic technique, including cleansing, dressing and care (World Health Organization, 2018).

12.3 SSI surveillance

The surveillance of healthcare associated infections (HAIs) is one of the core components of an effective infection prevention and control program. Surveillance of SSI with feedback of appropriate data to surgeons, as well as all staff involved in caring for the patients in the perioperative journey has been shown to be an important component of strategies to reduce the risk of SSIs ([APSIC guidelines for the prevention of surgical site infections 2019](#)).

A successful surveillance program includes the use of standardised SSI definitions and surveillance methods, stratification of SSI rates according to risk factors associated with SSI development and timely feedback of data.

For more information on SSI surveillance refer to [CEC HAI Clinical Indicator Manual](#).

12.4 SSI from contaminated heater cooler device

Some heater-cooler units used in cardiac surgery were contaminated with a rare bacterium called *Mycobacterium chimaera* (or *M. chimaera*), and there is a small risk that exposure to these units in the operating theatre may lead to infections in exposed patients that can appear months to years after surgery.

For more information refer to NSW Health [Mycobacterium chimaera and open-heart cardiac surgery](#), Australian Commission in Safety and Quality in Health Care National [Infection Control Guidance Non-tuberculous Mycobacterium infections associated with heater-cooler devices](#), Therapeutic Goods Administration [Infections associated with heater-cooler devices](#).