

Evidence-Based Principles and Practices for Preventing Surgical Site Infections



CHAPTER 1

Infection Prevention in the Operating Theater and Surgical Services: **The Preoperative Phase**

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Overview

Background

Approximately 187 to 281 million surgical procedures are performed worldwide each year—almost one surgical procedure for every 25 persons.¹ Most of these procedures result in good outcomes and improved health for the patients, but some do not. Surgical site infections (SSIs) are one of the undesirable and potentially very serious outcomes from surgery. The study cited above showed that in developed countries, 3% to 16% of surgeries resulted in major morbidity, and 0.4% to 0.8% in death.^{1,2} A report from the World Health Organization (WHO) in 2011 noted that in developing countries, the leading health care-associated infection, and the most frequently studied, is SSI. The WHO survey found that in low- and middle-income countries, the incidence rates of SSI ranged from 1.2 to 23.6 per 100 surgical procedures. This contrasted with rates between 1.2% and 5.2% in countries with more resources.³ Therefore, SSIs are a significant part of the historical, and current global public health issue of health care-associated infections (HAIs).

Brief History

The idea of preventing HAIs is reflected in the well-known admonition to physicians to “First, do no harm,” which is a cornerstone of the Hippocratic Oath.⁴ Infections that occur in association with care provided in hospitals and surgical clinics are challenging, because the patient did not have an infection upon entering the hospital or clinic but acquired it during or after a surgical procedure performed in these settings.

Historically, physicians did not understand why SSIs occurred and were not aware of the route of transmission of infection to man. They often attributed the cause of disease to “bad air,” “effluvia,” or “miasmas.” British surgeon Joseph Lister (1827-1912), a pioneer of antiseptic surgery, dramatically reduced HAIs in surgical patients. He believed that microbes might be responsible for infections and that by killing organisms in wounds he could prevent surgical infections and death. In his practice he used carbolic acid to “sterilize” dressings packed into the wounds of patients with compound fractures. He even soaked his fingers in carbolic acid, and sprayed the operating theater with the acid to kill germs in the air.⁵ Lister published his findings in 1867, and

the clear evidence of decreased infections in his surgical population was so compelling that his techniques gained acceptance over the next decades and his surgical asepsis principles remain foundational today in the operating theater.

Formerly, surgeons did not use personal protective equipment, such as gowns and gloves, when operating. This allowed transmission of organisms from staff to patient or vice versa. However, by 1910, sterile instruments, gowns, and gloves and masks were standard in many large teaching hospitals. The original use of rubber gloves was to protect the hands of the surgical team from carbolic acid, but the role of gloves in protecting patients from microorganisms on the hands of health care workers was eventually recognized, and gloves became standard garb where available. Eventually sterilizers were introduced, and they were fundamental to preparing sterile instruments and devices to help protect patients from surgical infections. In some clinics, staff silence during surgery was also required to limit bacterial contamination thought to be spread by talking. Some physicians began to keep records of infections and use active surveillance systems to track surgical infection trends.⁶

Today’s more sophisticated strategies for preventing wound infections take into account the host characteristics and risks, the technique of procedure, protective garb for staff, preparation of the patient, wound closure methods, the operating theater environment, and the disinfection and sterilization of the surgical instruments and supplies.

Overview

Although significant progress has been made in preventing and controlling infections, one of the limiting factors in preventing SSI is that different countries have unevenly implemented recommended prevention practices because of dramatic differences in their human and material resources, politics, and regulations. As a result, in addition to understanding and teaching best practices to prevent SSI, infection prevention and control professionals and health care epidemiologists have become more adept in understanding human behavior as to why proven practices are or are not adopted, the critical need for leadership and resources, and the effectiveness of teams in providing safer surgical care. They have also learned to use performance improvement and patient safety methods to enhance infection prevention practices that will reduce SSI.

Many current initiatives have endeavored to engage care providers in preventing SSI and will be discussed in this toolkit. For example, the WHO Safe Surgery Saves Lives challenge has helped reduce SSIs around the world.⁷ One of the WHO SSI prevention guidelines is the Surgical Safety Checklist to help reduce surgery-related infections and death. The checklist applies to the global population of patients in all phases of the perioperative experience. Newer guidelines from a variety of organizations have updated the science and evidence that should be used to make decisions about care. Many of these will be presented in this toolkit.

The Toolkit

This toolkit has four chapters. The three phases of the perioperative experience—preoperative, intraoperative and postoperative—form the majority of the content, and a chapter on patient safety and performance improvement strategies for surgical services completes the information. Each chapter presents the theory, science, and rationale for proven practices and practical tools to implement evidence-based best practices.

Chapters 1-3 focus on host characteristics and risks, processes and procedures, and education and safety of staff, patients, and families in each of the perioperative phases. Chapter 4 discusses patient safety principles and performance improvement methods and techniques and is supported by case studies and other practical examples.

References and resources are provided in each chapter. Current recommendations from groups such as WHO, the Centers for Disease Control and Prevention (CDC), Society for Healthcare Epidemiology of America (SHEA), American College of Surgeons (ACS), Surgical Infection Society (SIS), and others are referenced quite liberally throughout the toolkit.

The author and sponsors hope you find the toolkit valuable for your practice and your continuing efforts to reduce and eliminate SSIs for your patients and personnel.

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Introduction

Surgical site infections (SSIs) are prevalent around the world, are a serious and undesirable outcome of surgery, and are the most frequently reported healthcare-associated infections (HAIs) from health care facilities in low- and middle-income countries¹² Superficial infections may cause minimal disruption in recovery, while deep tissue infection can hinder healing, can prolong lengths of stay in the hospital; and may result in loss of mobility, lack of full recovery to presurgical status, and even death. Efforts to decrease SSIs should start early in the surgical process, preferably when surgery is scheduled, and continue through the preoperative, intraoperative, and postoperative phases.

Implementing measures to prevent SSIs and other potential functional or negative clinical outcomes is one of the principal efforts of the surgical team. Many factors can create potential infection risks for surgical patients:

- Interruptions in skin integrity
- Burns from surgical equipment
- Hemorrhage during or after surgery
- Fractures
- Preexisting or postoperative urinary tract infections
- Lower respiratory tract infections
- Chronic diseases
- Contaminated environment
- Surgical instruments and equipment
- Contaminated air
- Breaks in aseptic technique
- Hair, dandruff, and skin squames laden with bacteria from perioperative team

This chapter addresses these risk issues, as well as concepts and processes for risk prevention, using targeted solutions and evidence-based infection prevention strategies. Surgical staff can implement these best clinical practices to successfully prepare the patient for surgery and to prevent SSIs during the preoperative phase of the surgical experience and beyond.

The preoperative phase is defined as the time from when the patient is notified of or decides to move forward with the surgery until the time the patient is moved to the operating theater bed.³ As a patient moves through the preoperative phase, surgical personnel have an opportunity and responsibility to assess the patient's surgical infection risk factors, initiate interventions to mitigate modifiable infection risk factors, and implement best practices to prepare the patient for a safe operative procedure. These practices focus on assessing modifiable infection risk factors and identifying methods to support patients to reduce their infection risk. The assessment includes evaluating innate or acquired host conditions, such as chronic disease or acute infection, and preparing the patient for the surgical procedure by using such methods as removing hair, administering prophylactic antibiotics, checking blood glucose levels, assessing for hypertension, screening for and ceasing smoking, and decolonizing multidrug-resistant organisms (MDROs). Patients and their families or caregivers are also educated about expectations and prepared for the surgical procedure and the postoperative phase.

Learning Objectives

After reviewing this chapter, the reader will be able to do the following:

1. Describe the process for assessing the surgical patient for infection risk(s) during the preoperative phase
2. Identify key strategies implemented in the preoperative phase to reduce risk of SSIs
3. Discuss preparation of the patient and the personnel for safe surgery
4. Discuss preoperative patient and family education for preventing SSIs
5. Describe the care of the preoperative patient with a communicable disease
6. Summarize the responsibilities of the preoperative leadership team to implement surgical care strategies, reduce risk, and maintain an optimal surgical environment

Assessing Patient Risks During the Preoperative Phase

SSIs are the result of a dynamic interrelationship among factors that are internal and external to the patient. Internal factors that may affect surgical outcomes include host resistance, or the patient's immune status, which is affected by conditions such as diabetes mellitus, age, nutritional status, obesity, malignancies, and the presence of infections at remote sites at the time of surgery. Extended hospital stays prior to surgery may result in patient colonization with potentially pathogenic microorganisms. (See Table 1-1 below.) Other host characteristics that contribute to infection risk include a history of smoking, previous irradiation of the surgical site, diminished respiratory status, and immunosuppression.^{1,4,5} Any of these host conditions can impair the body's defense mechanisms to mount a successful response against pathogenic microorganisms that may cause SSIs. Prevention and control efforts in the preoperative surgical phase are directed toward managing the influence of these innate conditions and mitigating external risks. The surgeon, anesthesiologist, and nurse who evaluate the patient prior to surgery should each perform a risk assessment of host status and communicate results to each other. External or extrinsic risk factors are also important to consider in preoperative patients. These are discussed briefly below. Other factors that may influence the development of an SSI are discussed in Chapter 2, which examines the intraoperative phase of surgery. Table 1-1, below, briefly reviews some of the more challenging host (intrinsic) characteristics in surgical patients.

TABLE 1-1. Host (Intrinsic or Internal) Characteristics in Surgical Patients

Host Characteristic	Issue(s)	Possible Intervention
Age	Older age is a risk factor for developing SSI; possible defects or waning of host defenses; diminished immunologic status; comorbid conditions. ^{6,7}	Ensuring that all possible host defenses are intact; no infections; chronic conditions under control.
Obesity	Researchers have found that when the fatty tissue is prominent, the infection rate is higher than when it is less thick. Older and newer studies have identified obesity as an SSI risk. Healing may be more difficult because of decreased blood supply. ^{8,9,10,11}	Some clinicians suggest delaying surgery to attempt weight loss, if the surgery is not urgent, or may suggest a comprehensive medical history and physical exam with diagnostic tests to determine other related risks. Some surgeons give additional antibiotics based on the patient's weight.

TABLE 1-1. Host Characteristics in Surgical Patients (cont.)

Host Characteristic	Issue(s)	Possible Intervention
Malnutrition	Studies linking malnutrition to SSI have been in conflict. It is often difficult to separate malnutrition from other factors such as older age or underlying disease. ^{6,10,12,13,14}	Strategies may include nutritional supplements for 1-2 weeks prior to surgery if severely malnourished, and total parenteral nutrition. Consultation with a nutritionist may be considered.
Smoking	Smoking is associated with vasoconstriction, which impairs revascularization of the wound and can delay wound healing. This places the patient at risk for colonization with organisms that may be pathogenic or multi-resistant. Wound rates in smokers have been shown to be higher in many surgeries. ^{15,16,17,18,19}	The preferred strategy is for the patient to stop smoking for as long a period as possible before the surgery. This is difficult for heavy smokers and may not be feasible.
Cancer or Immunotherapy	Cancer has been identified as an SSI risk factor because defects in immunity that often accompany the diseases and treatment for the malignancy may lead to immunosuppression. Other conditions such as rheumatoid arthritis or post-organ transplantation often require immunosuppressive therapy. ^{20,21,22}	In spite of possible decreased immune competence, WHO does not recommend routinely stopping immunosuppressive therapy to decrease risk of SSI. The decision to stop this therapy should be made by the prescribing physician, the patient, and the surgeon.
Extended Duration of Preoperative Hospitalization	An extended period of hospitalization prior to surgery is a known risk factor for SSI. Patients can become colonized with pathogens that predispose them to infections with resistant organisms. ⁶	The most obvious intervention is to limit the time patients spend in the hospital before surgery. Many healthy patients undergoing elective surgeries can arrive at the hospital a few hours prior to their procedures for preoperative preparation, reducing the opportunity for colonization with hospital pathogens.

WHO, World Health Organization.

Modifiable and Non-Modifiable Host Risk Factors

Some host risk factors can be modified before surgery and others cannot. Boxes 1-1 and 1-2, below, identify those host factors that are not modifiable before surgery and those risk factors that are modifiable and addressed during the preoperative phase. Modifiable factors are discussed in greater detail in the following sections.

BOX 1-1. Non-Modifiable and Possibly Modifiable Host Risk Factors

Non-Modifiable Host Risk Factors	Possibly Modifiable Host Risk Factors
<ul style="list-style-type: none">• Older age• Recent radiotherapy• History of skin or soft tissue infections• Specific diseases (for example, cancer)	<ul style="list-style-type: none">• Diabetes and glucose levels• Obesity• Alcoholism• Smoker (current)• Preoperative albumin < 3.5 mg/dL• Total bilirubin > 1.0 mg /dL• Immunosuppression• Extended duration of preoperative hospitalization

Source: Adapted from Ban KA. American College of Surgeons and Surgical Infection Society: Surgical site infection guidelines, 2016 update. 2017 Jan;224(1):59-74.

BOX 1-2. Modifiable Risk Factors Specific to the Preoperative Phase

<ul style="list-style-type: none">• Preexisting infection: Treatment• Procedure with high risk of SSI: Surgical antibiotic prophylaxis• Hypothermia: Warm blankets or warming device preoperatively to ensure normothermia• Blood sugar: Glycemic control• Low circulating vascular volume: Normovolemia• Bacteria-laden hair at incision site: Hair removal before entering operating theater; clipped hair• Resident and transient skin flora: Preoperative antiseptic bathing and skin preparation at surgery prior to incision• Nasal colonization: Use of nasal antiseptic solution or antibiotic ointment preoperatively

Source: Adapted from Ban KA. American College of Surgeons and Surgical Infection Society: Surgical site infection guidelines, 2016 update. 2017 Jan;224(1):59-74.

Extrinsic or External Risk Factors

During the preoperative phase, extrinsic risk factors may contribute to patient risk of infections. For example, the patient should be admitted to a clean and safe environment. The preoperative area must be thoroughly cleaned on a regular basis using hospital approved cleaning agents and disinfectants and correct cleaning techniques. This includes surfaces, floors, beds, bedside tables and other equipment. Cleaning should be monitored. To reduce potential transmission of organisms from staff to patient, all staff should be meticulous about performing hand hygiene. If the patient has an infection that is transmissible the staff should use the appropriate personal protection equipment (PPE) and an isolation room to prevent spread of infection. In addition, if an intravenous line or a urinary catheter is inserted, staff must use strict aseptic technique according to the hospital's or surgery center's policy and procedure. Often these or other devices are not inserted until the patient is in the operating theater, but they may be placed in the perioperative area. Staff who may be ill should not care for the preoperative patient. Other extrinsic risk factors are discussed in more detail later in this chapter and in the next phases of the perioperative experience.

The Preoperative Patient Risk Assessment

Performing the preoperative risk assessment, both in the preclinical setting (for example, office or clinic) and when the patient arrives at the hospital, is critical for identifying and potentially modifying or eliminating risk factors to prepare the patient for a safer surgery. The patient-focused risk assessment must be performed by the operating theater staff to evaluate and prioritize current risks. General risk assessment directions are provided below in Table 1-2 that can be used to ensure that the most common steps in the preoperative process are reviewed and addressed. Organizations may wish to adapt these directions to their own policies and processes.

Table 1-2. Tool for Assessing Assessment Steps in the Preoperative Care Process

Action	Date/Time Initiated	Comments	Patient Status
Educate patient and family about the planned surgical procedure.		Ongoing; may relieve stress and anxiety.	
Assess patient for allergies, comorbidities, smoking, medication use, blood glucose levels, and remote sites of infection.		Maximize wellness, treat remote sites of infection, and schedule procedure based on communicable disease, if any. Monitor blood glucose levels.	
Provide instructions and product for patient to perform antiseptic (chlorhexidine) bath/shower the night before and morning of surgery. ¹		CHG cloths or liquid can be used. Best compliance if product is provided free of charge to patient and a reminder is sent.	
Perform nasal decolonization for patients scheduled for procedure at high risk of SSI (for example, cardiac, orthopedics, spine). ²		Nasal antiseptic products and nasal antibiotic ointment have been reported to be effective. Antiseptics do not contribute to antibiotic resistance and can be applied 1 hour preoperatively.	
Remove hair from the surgical site only if necessary, using clippers or a depilatory. No razors; consider clipper vacuum device if hair must be removed in the operating theater. ³		Day of surgery in the holding area.	
Administer antibiotic prophylaxis as ordered by the surgeon within 30 minutes to 1 hour before the incision (2 hours if vancomycin is used). ⁴		Evidence-based procedure that reduces the risk of infection; select right antibiotic for the procedure and the patient.	
Maintain normothermia in the holding area by using warm blankets or forced-air warming devices. Covering the head may be helpful (particularly in neonates and children).		Evidence-based procedure that reduces the risk of infection.	

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CHG, chlorhexidine gluconate

Identify Key Strategies to Minimize Risk of SSIs

By a careful review of the literature and scientific studies, specific strategies have been demonstrated either to be effective or not useful. Several strategies are discussed below.

Identification and Management of Preexisting Remote Infections

Preexisting infections at sites remote from the surgical area (for example, urinary tract infection or respiratory viral disease) should be treated and resolved before surgery when possible.¹³ Research strongly indicates that patients who have infections at the time of surgery have increased risk for postoperative SSIs.^{6,23} The increased risk may be related to (1) significant numbers of bacteria that gain access to the wound from the remote infection site or (2) bacteria that inoculate the surgical wound through the bloodstream from bacteremia. One investigator, Edwards, observed that among 383 patients who had cultures taken from SSIs and remote sites, 55% of the wound infections were preceded by urinary tract or lower respiratory tract infections with the same microorganisms found in the surgical site and causing the SSI.²⁴

If an infection is identified during the preoperative phase, the surgery may be postponed until the infection has resolved. If the surgery must proceed, as in an emergency, the surgeon should carefully consider the patient's infection and make accommodations with, for example, antimicrobial agents. The preoperative nurse and the surgeon should inquire about current infections during the patient risk assessment and communicate that information to the team so a decision can be made about how to best manage the patient and the infection.

Bathing for Skin Decolonization

Preoperative bathing is considered a good clinical process to clean and reduce the bacterial load on the skin (skin decolonization). Preoperative bathing is generally recommended for patients, usually with an antimicrobial soap such as chlorhexidine gluconate (CHG 4% combined with a detergent) if affordable and available. Other options are a triclosan preparation and—if no other options are available—regular soap.¹ Even though most surgical services now use an antiseptic, there is no clear evidence that the use of an antiseptic agent over soap and water reduces SSIs.²⁵ In spite of this finding, other studies have concluded that preoperative antiseptic bathing reduces the risk of SSI,²⁶ and it has become an accepted practice to use an antiseptic rather than just soap and water in most surgery programs. When preoperative bathing is implemented, patients should bathe at least once before the surgical procedure. Repeating the application of chlorhexidine during two preoperative baths/showers increases the residual efficacy of the antiseptic, which is why the patient should optimally be advised to bathe twice with the prescribed agent (for example, the night before surgery and the morning of surgery).^{1,27,28}

Note: Patients should receive careful instruction about how to perform a preoperative antiseptic bath (see Table 1-3 on page 12) and be given the appropriate agent or instructed about how to obtain it (some may have to purchase at a pharmacy). The protocol used to perform the preoperative antiseptic bath or shower is important to ensure adequate skin concentrations of the antiseptic. See Box 1-3, on page 12, for one example of a protocol that can be taught to patients and their families for preoperative bathing.

Preoperative Bathing Protocol Example

Box 1-3. Preoperative Bathing Protocol Example

In a recent study, the protocol recommended for liquid chlorhexidine gluconate (CHG) is showering with 118 mL of aqueous CHG, 4%, per shower; a minimum of two sequential showers; and a one-minute pause before rinsing.

The same study recommends the use of six CHG cloths applied gently to the entire body from the neck down, one hour after a shower with regular soap and water the night before, and repeated the morning of surgery (no regular shower needed the morning of surgery).

If the technology is available, an electronic reminder has been shown by the same researcher to improve patient compliance with preoperative antiseptic bathing.

Source: Adapted from Edmiston CE Jr, et al. Evidence for a standardized preadmission showering regimen to achieve maximal antiseptic skin surface concentrations of chlorhexidine gluconate, 4%, in surgical patients. *JAMA Surg.* 2015 Nov;150(11):1027-1033.

In some situations, the patient may come to the hospital and will be bathed there preoperatively, in which case staff must be trained about the agent to use, how to properly apply the agent, how long to leave it on the skin, what body parts to avoid (for example, above the neck), and other procedures. The surgeon's office, hospital, or clinic should also have written instructions to give to the patient and family. Table 1-3, below, is an example of instructions for preoperative showers.

Table 1-3. Instructions for Preoperative Showers for Patients

Action	When	Comments
Take your first shower or bath.	The evening before you are scheduled for surgery	
Take your second shower or bath.	The morning of the day you are scheduled for surgery	
Apply the antibacterial soap recommended by your nurse or surgeon using a washcloth or sponge.	The evening before and the morning of your surgery	Regular soap can be used if antibacterial soap is not available.
Apply the antibacterial soap only from the neck down, paying special attention to the neck, arms, breast, groin, feet, and skin folds.	The evening before and the morning of your surgery	Antibacterial soap may irritate eyes.
Do not shave the surgical area or apply creams, lotions, or powder during and after the shower or bath.	The evening before and the morning of your surgery	Shaving can cause nicks and cuts and increase the risk for SSL.

Hair Removal

Hair should **not** be removed from around the incision area unless its presence interferes with the surgical procedure.²⁹ Shaving has been associated with increased risk of SSIs.^{1,4-6} If hair removal is absolutely necessary, a razor should *not* be used as it can cause microscopic trauma to the skin.¹¹³ Razors are preferred for preoperative hair removal on only two body sites, the scalp and male genitalia, as clippers have been shown to cause more skin damage in these areas.^{30,31} On all other body sites, if it is necessary to remove hair prior to a surgical procedure, personnel should consider clipping the hair.^{4-6,13} Clipping has become the recommended alternative to shaving in virtually all guidelines and recommendations. Depilatory agents can be used; however, they can cause an inflammatory/allergic reaction. Clippers are preferred.

When clipping occurs, it should be performed on the day of surgery, close to the procedure time, in an area outside the operating theater to minimize the presence of loose hair in the operating theater and to avoid contaminating the incision and the sterile field. Clipper heads should be disposable or must be cleaned and disinfected between patient uses. Clipper handles must always be cleaned and disinfected or sterilized between patient uses. See Sidebar 1-1, right.

Sidebar 1-1. Instructions for Hair Removal

- Hair should not be removed unless it will interfere with the surgical procedure.
- Hair should not be removed in the room set up for the procedure because of the contamination risk to the sterile setup.
- If hair must be removed in the operating theater (for example, an emergency case), containment is essential to prevent dispersal of bacteria-laden clipped hair, ideally with a clipper vacuum combination device.
- Razors should not be used except for scalp and male genitalia.
- Hair should not be removed the day or evening before surgery because microorganisms would have an opportunity to collect in tiny nicks in the skin.
- Clippers should have disposable or cleanable heads, and the clipper handles must be cleaned and disinfected or sterilized between use on patients.

Surgical Antibiotic Prophylaxis

Surgical antibiotic prophylaxis should be administered according to published evidence-based recommendations during the preoperative phase. The antibiotics are generally between 30 minutes and 1 hour before incision, or 2 hours if using vancomycin or fluoroquinolones.^{5,13,28,32} It is important to allow at least 30 minutes between start of antibiotic and incision in order to ensure adequate tissue levels of the antibiotic, but no more than 60 minutes. For the most commonly used antibiotics, it has been considered optimal to administer the drug intravenously 30 minutes before skin incision,^{33,34} and it has been documented that administration more than 60 minutes preoperatively is associated with higher risk of surgical infection,³⁵ with the exception of a few specific drugs.¹

The objective of surgical antibiotic prophylaxis is to achieve a sufficient tissue level of the antibiotic before tissues are manipulated. Antibiotic levels should be maintained through the entire procedure. Re-dosing during surgery and continuing antibiotics following surgery are also critical and will be discussed in Chapters 2 and 3.

The antibiotic is selected based on the procedure being performed and the most likely pathogens that will be encountered during this surgery. The amount of antibiotic administered should be determined according to the patient's weight.^{4,32} It is important to monitor compliance with administering the prophylactic antibiotic during the appropriate time frame as determined by the organization's policy and procedure. The time of administration, the antibiotic selected, and the dose should be documented and followed as a process measure (see Chapter 4, "Measuring and Improving Care," for sample process measures for the preoperative phase). The formula in Box 1-4, on page 14, may be helpful to clinicians and the infection control team to monitor these processes. See also Chapter 4 for additional formulas. Box 1-5, on page 14, is an example of a quick assessment tool to check whether the surgical antibiotic prophylaxis process is effective. This can be incorporated into a checklist.

Box 1-4. Formula for Monitoring the Process of Administering the Antibiotic within 1 Hour Prior to Incision

$$\text{Number of Patients Receiving Antibiotic Within 1 Hour Prior to Incision} \div \text{Number of Patients Eligible for the Preoperative Antibiotic} \times 100 = \% \text{ of Patients Receiving Surgical Antibiotic Prophylaxis in Approved Time Frame}$$

EXAMPLE:

$$62 \text{ Patients on January 24 received surgical antibiotic prophylaxis within 1 hour of incision} \div 66 \text{ Patients were eligible for the preoperative antibiotic} \times 100 = 94\% \text{ of Patients Received Surgical Antibiotic Prophylaxis in the Approved Time Frame}$$

Box 1-5. Antibiotic Administration Process Measures

<input type="checkbox"/>	Prophylactic antibiotic is ordered.	YES	NO
<input type="checkbox"/>	Antibiotic selection is accurate as per protocol.	YES	NO
<input type="checkbox"/>	Antibiotic dose is accurate as per protocol.	YES	NO
<input type="checkbox"/>	Antibiotic prophylaxis is given within 60 minutes of incision.	YES	NO
<input type="checkbox"/>	Antibiotic is discontinued within 24 hours of surgery.	YES	NO
<input type="checkbox"/>	Antibiotic is discontinued at the time the incision is closed.	YES	NO
<input type="checkbox"/>	Times of administration and discontinuation are documented in the medical record administration.	YES	NO

Glycemic Control

Studies have shown that hyperglycemia, particularly from stress, has been associated with a higher risk of SSI.³⁶⁻³⁸ Various targets have been proposed for blood glucose level in the perioperative phase. For all patients, both diabetic and nondiabetic, the Centers for Disease Control and Prevention (CDC) recommends blood glucose levels less than 200 mg/dL.⁵ Others have recommended the target blood glucose in the perioperative phase should be between 110 and 150 mg/dL.⁴ For cardiac patients the target is < 180 mg/dL or lower.^{4,13}

The patient's blood glucose level should be checked during the preoperative phase when decisions can be made about establishing and maintaining the desired glycemic levels. It is important for preoperative personnel to be aware of blood glucose levels and communicate any information to the surgical team about levels out of the preferred range. This function should be part of the checklist prior to surgery and in the role of the preoperative staff.

Normothermia

Surgical procedures tend to create hypothermia in patients. This may occur from a cold operating theater, cool fluids that are administered, sedatives, or anesthesia.¹ Hypothermia is defined as a core temperature below 35°C and has been associated with an increased risk of SSI. It is common for patients to become hypothermic during and after major surgical procedures that last more than two hours. In contrast, maintaining normothermia has been associated with decreased risk of SSI.^{39,40}

Research indicates that warming patients *before* clean surgeries aids in preventing postoperative wound infection.⁴¹ Patients should receive preoperative warming with blankets or forced-air devices as needed to achieve or maintain normal body temperature. Many warming devices are available on the market. Techniques and equipment to maintain normal body temperature include those listed in Sidebar 1-2, right.

The organization should select the preferred warming device and train staff on using it in the preoperative phase.

Sidebar 1-2. Techniques to Maintain Normal Body Temperature (Normothermia)

- Forced-air warming
- Circulating water garments
- Energy transfer pads
- Warmed blankets
- Warmed intravenous fluids and irrigation fluids
- Warmed gases for inspiration
- Increased room temperatures

Note: Temperatures of warmed solutions should be monitored to prevent burn injuries. Core body temperatures should be monitored during and immediately after the surgical procedure for all patients.

Supplemental Oxygen

The data on the benefits of supplemental oxygen used in the perioperative phase are not conclusive, and guidelines do not always agree. However, in general, supplemental oxygenation to achieve 80% FiO₂ is recommended during surgery as needed and postoperatively for 2-6 hours for patients undergoing surgery with general anesthesia.¹⁴ Supplemental O₂ may be started just prior to the incision or earlier in the preoperative phase for some patients. Checking the patients' oxygen level should be a routine part of the preoperative assessment. Acceptable levels should be predetermined and written into policy.

Nasal Decolonization

Nasal decolonization of patients prior to surgery and treatment with mupirocin have been reported in multiple studies to be effective in reducing SSI risk, particularly for orthopedic, spine, and cardiac procedures. Typically, nasal decolonization has been studied as a paired intervention with skin decolonization performed via chlorhexidine bathing. Until recently, the single agent available for nasal decolonization was mupirocin antibiotic ointment. There are now several nasal antiseptics available for which preliminary data are positive in reducing SSI risk. These products are either iodine or alcohol based. They are inexpensive, not associated with development of antibiotic resistance, and designed to be applied by staff within one hour of the surgical procedure.⁴²

The World Health Organization (WHO) has recommended that patients undergoing cardiothoracic surgery and who are known to be colonized with *Staphylococcus aureus* should be treated with 2% mupirocin ointment, regardless of whether they have had a preoperative CHG body wash.¹ Other groups have supported this recommendation. Also, the Society for Healthcare Epidemiology of America and the Infectious Diseases Society of America (SHEA/IDSA) have included total joint replacement procedures surgical patients as candidates for screening for MSSA and MRSA¹³, and the Institute for Healthcare Improvement) has made other more extensive decolonization recommendations.²⁸

The practice of screening surgical patients preoperatively, and decolonizing only those who are positive for MSSA or MRSA, is targeted decolonization. Universal decolonization is the practice of performing skin and nasal decolonization for *all* patients undergoing a certain category of surgical procedure. There are studies supporting the efficacy of both of these approaches in reducing surgical infection risk.

Evidence suggests that the decolonization process should take place close to the time of surgery to be most effective,⁴³ and decolonization as part of an MDRO prevention bundle has been shown to be effective if all elements of the bundle are followed.^{44,45} Each organization must determine its own policy and procedure after reviewing the scientific data and recommendations from various agencies and societies. If targeted decolonization is used, the organization should establish a procedure that includes which patients will be targeted, the time period for obtaining nasal and body swab cultures, what sites will be cultured, who will process the specimens, how results will be communicated, and standardized plans for decolonization.

Extrinsic Risk Factors

During the patient's perioperative experience, many extrinsic risk factors or factors external to the patient can present risk to the patient. The list includes the following:

- Type, length and complexity of procedure
- Amount of tissue trauma and microenvironment of the wound
- Degree of microbial contamination in the wound
- Pathogenicity of the microorganisms in the wound
- Blood transfusions
- Breaks in asepsis or sterility
- Lack of appropriate preoperative antibiotics and re-dosing
- Inadequate surgical site skin preparation
- Poor personnel hand scrub or surgical attire
- Personnel communicable illness
- Lack of isolation for patients with communicable diseases
- Incorrect environmental controls (e.g., ventilation, humidity, temperature)
- Disinfection and sterilization of instruments

These and other extrinsic risks are discussed throughout the toolkit in the various chapters. Surgical and central sterile supply staff should identify and monitor the key extrinsic risks for their organization. Process monitors with appropriate analysis to identify those risks that can be minimized or eliminated will assist in providing safer care to patients and a reduced opportunity for developing an SSI.

Key Strategies

This discussion has covered some key strategies to prepare patients for safe surgery. Additional patient preoperative preparation information, such as mechanical bowel preparation and screening for extended-spectrum beta-lactamase colonization, is also important and should be reviewed.¹ Some organizations have moved to bundled interventions of evidence-based practices to reduce risk of SSI. Patients who have been targeted include those undergoing cardiac, hip, and knee surgeries. Bundles of interventions appear to be successful in reducing SSI.⁴⁵ For more information on SSI bundles go to www.IHI.org/HowtoGuidePreventSSIHipKneeArthroplasty.pdf

Preparing for Surgery: Educating the Patient and Family

As soon as a decision about a surgical intervention is made, patient and family education preparing for safe surgery should begin. Some education may occur in the surgeon's office, but much is left to the operating theater staff. Providing education early in the surgical experience gives patients and families time to think about issues, ask questions, and express concerns. There is little conclusive evidence indicating that preoperative education directly affects SSIs.⁴⁶ However, such education has been shown to help prepare patients and families for surgery, improve their knowledge about the surgical process and what to expect, and help them understand their role in reducing complications and risks throughout the preoperative, intraoperative, and postoperative phases. Education can minimize unneeded suffering and anxiety by providing information and contacts for questions in the postoperative phase about unexpected pain, unusual fatigue, self-care, and other issues.⁴⁷

Education begins with an explanation that the patient is *a participant* in rather than simply *a recipient* of surgery, indicating that the patient has an active role in his or her surgical experience. Education should be presented in a way that will help increase understanding and improve the patient's ability to ask questions about the procedure. Language abilities, capability of understanding the information, the most effective method(s) of learning, and other factors must be considered when preparing and presenting information.

Education should address what staff members will be doing before, during, and after surgery to help prevent SSIs. Through education, patients and families have the opportunity to do the following:

- Hear information from expert caregivers
- Ask questions for clarity and understanding
- Express concerns about the procedure and the effect on personal health
- Optimize their readiness for surgery and the full surgical experience

Understanding what is going to happen during the various phases of surgery can help decrease fear and anxiety in many people. Operating theater personnel may use the tools in Tables 1-4 below, and 1-5 on page 19, to ensure that patient and family education materials are developed and readily available.

Table 1-4. Ideas for Staff Preparing Education for Surgical Patients

Task	Done		Date Completed
Assemble a team of caregivers, including—when possible—patients who had surgery, to develop a surgical patient education plan for a specific surgical procedure.	YES	NO	
Collect and review surgery patient education materials from different groups where available.	YES	NO	
Review surgery patient educational materials already available in the organization.	YES	NO	
Identify key family members who should receive education about the procedure.	YES	NO	
Review and identify methods for providing education, including pamphlets, flyers, videos, and coloring books. Consider learning styles of the patient and family members.	YES	NO	

Table 1-5. Patient Education: Questions Patients May Ask Preoperatively

Topics Discussed with Patient and Family: PREOPERATIVELY	YES	NO
When should I stop smoking?		
Do I need antibiotics before surgery?		
What about allergies?		
May I shave before surgery?		
When do I shower before surgery?		
How will my diabetes affect the surgery?		
How long will the surgery take?		
What type of anesthesia will I receive?		
What are my risks for infection?		

Designing Educational Materials and Methods

Educational materials should be tailored to address different learning styles. Some people are primarily visual learners, and others learn by hearing information. Incorporating technology can be effective for delivering education, if available.

For both adults and children, it is vital to validate that the intended message was received. For adults, one-on-one conversations (face-to-face), videotapes, the Internet, brochures, stories, and other media can be effective in conveying information.

It is important to note that children learn differently from adults based on their abilities to understand words or phrases through their limited life experience. It can be helpful to present information in a context with which children are familiar, for example, childhood characters or games with which they are familiar. Parents and/or other family members should be present when their child receives information, as they may need to later reinforce or reframe the information based on the child's background and learning skills.^{48,49}

When surgery is emergent, presenting education before the procedure may be a challenge. Often, the patient may not be able to assimilate information or is not in a situation that facilitates learning. In these cases, teaching the patient's family or support person may be the only education that can be provided. Additional education can be provided after the procedure.

Many organizations have developed their own tools for patient education before surgery. See Table 1-6, on page 20, for one example that can be used to educate the patient and family. This teaching tool addresses common patient questions. Sidebar 1-3 lists questions patients may ask regarding infections and surgery.

(cont.)

Table 1-6. Patient Education Tool with Patient Questions and Potential Responses

Questions	Possible Responses	Notes
How can I decrease my risk for getting an infection after surgery?	<ol style="list-style-type: none"> 1. Clean your hands by rubbing them together using soap and water. 2. Make sure health care providers clean their hands before and after examining you. 3. Make sure that your vaccinations are current. 4. Follow the preoperative shower regimen given to you by the nurse or surgeon. 	<p>Wash for at least 20 seconds before eating, after using the bathroom, and whenever your hands are visibly soiled.</p> <p>Ask them to wash their hands or use a waterless alcohol-based product before they examine you.</p> <p>Check with your doctor or nurse about shots you may need.</p> <p>Preoperative showering protocol and instructions.</p>
What can I eat or drink before the procedure?	As a general rule, you should not eat or drink anything after midnight before your surgery.	Follow the directions provided to you. Your anesthesiologist may give you permission to drink clear liquids up to a few hours before your anesthesia.
Can I smoke?	The sooner you quit smoking before surgery the better; 6-8 weeks prior would be preferable.	Smoking can impair wound healing.
Should I take my regular medications before surgery?	It depends on the medication.	Discuss with the surgeon or anesthesiologist.
What should I expect to happen on the day of surgery?	<ol style="list-style-type: none"> 1. You will be admitted to surgery and transported to the operating theater holding area. 2. A nurse in the operating theater holding area will check your identification and interview you. 3. The nurse may start an intravenous line or remove hair from the operative site. 4. The anesthesia care provider will interview you and perform an assessment. 5. The surgeon will mark the operative site. 6. You will be transported to the room where the surgery will be performed and transferred and secured onto the operating table. 7. The surgical team will perform the surgery and then transfer you to the post-anesthesia recovery unit. 	<p>A relative may be allowed to accompany you to the operating theater holding area.</p> <p>The nurse may ask for your name and date of birth.</p> <p>The intravenous line may also be inserted by the anesthesia care provider.</p> <p>The type of anesthesia will be discussed. You can ask questions.</p> <p>You should ask any additional questions.</p> <p>Anesthesia will be administered.</p> <p>The nurses and anesthesiologist will monitor you until you are ready to return to your room.</p>
Will I have pain after the surgery?	Pain medication will be administered as ordered by the surgeon and anesthesia team in the postanesthesia recovery unit.	The staff will monitor your pain and administer pain medication as required.
Who will notify my family about the surgery?	The surgeon will speak with your family members.	The surgeon may talk with your family right after surgery or later when you are awake.

Figure 1-1, below, presents another tool highlighting patient questions. It is available free to download from the CDC at http://www.cdc.gov/hai/pdfs/ssi/ssi_tagged.pdf and may be adapted for any health care organization.⁵⁰

Figure 1-1. Surgical Site Infections FAQs

FAQs

(frequently asked questions)

about
"Surgical Site Infections"

What is a Surgical Site Infection (SSI)?

A surgical site infection is an infection that occurs after surgery in the part of the body where the surgery took place. Most patients who have surgery do not develop an infection. However, infections develop in about 1 to 3 out of every 100 patients who have surgery.

Some of the common symptoms of a surgical site infection are:

- Redness and pain around the area where you had surgery
- Drainage of cloudy fluid from your surgical wound
- Fever

Can SSIs be treated?

Yes. Most surgical site infections can be treated with antibiotics. The antibiotic given to you depends on the bacteria (germs) causing the infection. Sometimes patients with SSIs also need another surgery to treat the infection.

What are some of the things that hospitals are doing to prevent SSIs?

To prevent SSIs, doctors, nurses, and other healthcare providers:

- Clean their hands and arms up to their elbows with an antiseptic agent just before the surgery.
- Clean their hands with soap and water or an alcohol-based hand rub before and after caring for each patient.
- May remove some of your hair immediately before your surgery using electric clippers if the hair is in the same area where the procedure will occur. They should not shave you with a razor.
- Wear special hair covers, masks, gowns, and gloves during surgery to keep the surgery area clean.
- Give you antibiotics before your surgery starts. In most cases, you should get antibiotics within 60 minutes before the surgery starts and the antibiotics should be stopped within 24 hours after surgery.
- Clean the skin at the site of your surgery with a special soap that kills germs.

What can I do to help prevent SSIs?

Before your surgery:

- Tell your doctor about other medical problems you may have. Health problems such as allergies, diabetes, and obesity could affect your surgery and your treatment.

- Quit smoking. Patients who smoke get more infections. Talk to your doctor about how you can quit before your surgery.
- Do not shave near where you will have surgery. Shaving with a razor can irritate your skin and make it easier to develop an infection.

At the time of your surgery:

- Speak up if someone tries to shave you with a razor before surgery. Ask why you need to be shaved and talk with your surgeon if you have any concerns.
- Ask if you will get antibiotics before surgery.

After your surgery:

- Make sure that your healthcare providers clean their hands before examining you, either with soap and water or an alcohol-based hand rub.

If you do not see your providers clean their hands, please ask them to do so.



- Family and friends who visit you should not touch the surgical wound or dressings.
- Family and friends should clean their hands with soap and water or an alcohol-based hand rub before and after visiting you. If you do not see them clean their hands, ask them to clean their hands.


What do I need to do when I go home from the hospital?

- Before you go home, your doctor or nurse should explain everything you need to know about taking care of your wound. Make sure you understand how to care for your wound before you leave the hospital.
- Always clean your hands before and after caring for your wound.
- Before you go home, make sure you know who to contact if you have questions or problems after you get home.
- If you have any symptoms of an infection, such as redness and pain at the surgery site, drainage, or fever, call your doctor immediately.

If you have additional questions, please ask your doctor or nurse.

Co-sponsored by:




Source: Centers for Disease Control and Prevention. FAQs About "Surgical Site Infections." Accessed Aug 9, 2017. http://www.cdc.gov/hai/pdfs/ssi/ssi_tagged.pdf.

Sidebar 1-3. Questions Patients May Ask Regarding Infections and Other Risks Related to Surgery

- What will happen to me before surgery that might give me an infection?
- If I have an infection at surgery time, should I tell the surgeon?
- How long will the surgical procedure last?
- What are the risks of the surgical procedure?
- Will the anesthetic make me sick?
- Am I at risk for getting an infection from this surgery?
- How many patients have acquired an infection from this surgery?
- How many people die from this surgery?
- Are you going to shave my hair? Will it grow back?
- Why do I need to take a shower with that medication before I go to surgery?
- How do I take care of my incision after surgery?
- How long will it take for my wound to heal?
- How will I know if I am developing an infection?
- What signs and symptoms of infection should I look for?
- What are the criteria for contacting my health care provider?

Preparing for Surgery: Personnel Attire and Scrub Technique

Personnel Attire

The Association of periOperative Registered Nurses (AORN) states: “Surgical attire and personal protective equipment (PPE) are worn to provide a high level of cleanliness and hygiene within the perioperative environment and to promote patient and worker safety.”⁵¹ AORN also notes that the primary source of bacteria dispersed into the air in the operating theater comes from health care providers’ skin.⁵¹ One study reported that humans disseminate more than 107 skin particles every day, and about 10% of those disseminated skin squames can carry viable microorganisms with potential threat of SSI to perioperative patients.⁵² Reducing the patient’s exposure to microorganisms that are shed from the skin and hair of perioperative personnel may reduce the patient’s risk for surgical site infection (SSI).⁵¹

The operating theater should have clearly written policies and procedures for personnel attire and should monitor to ensure that staff follow hospital-approved policies. All operating theater staff should be appropriately attired for the semi-restricted and restricted areas, including the preoperative admitting area, and areas closest to the surgical procedure, generally the hallways directly outside the surgical suite. Each facility determines its own policy for personnel attire for the physicians, nurses, assistants, technologists who work in the operating theater and other support staff who enter for specific purposes such as bringing or removing supplies, laundry, instruments, and wastes. AORN provides three main recommendations regarding surgical staff attire⁵¹:

1. Clean surgical attire should be worn in the semi-restricted and restricted areas of the perioperative setting.
2. All individuals who enter the semi-restricted and restricted areas should wear scrub attire that has been laundered at a health care-accredited laundry facility or disposable scrub attire provided by the facility and intended for use within the perioperative setting.
3. Personnel entering the semi-restricted and restricted areas should cover the head, hair, ears, and facial hair.

Table 1-7, below, describes the surgical attire that should be worn in each area or zone within the operating theater suite.

Table 1-7. Operating Theater Zones: What to Wear

Zone or Area	What to Wear
Restricted zone—includes the operating theater rooms and scrub areas.	Freshly laundered surgical scrub attire: Tops must be snugly fitting or tucked into pants when worn, hair and facial hair covered, and mask worn when surgical supplies are opened or scrubbed personnel present. Attire should be laundered by the hospital.
Semi-restricted zone—includes corridors or hallways, supply rooms, offices, scrub areas, and equipment-processing areas.	Freshly laundered surgical attire, head and facial hair covered. Jumpsuits may be worn as surgical attire. Attire should be laundered by the hospital.
Unrestricted zone—includes areas where the surgical suite may interface with other parts of the facility, such as areas for delivery of supplies and equipment, and areas for personnel and patients.	Street clothes

Staff should wear clean, freshly laundered scrubs. Scrub clothing includes pants and tops for women (recommended) or dresses, and pants and tops for men.⁵¹ Staff should wear long-sleeved warming jackets in the restricted areas.^{4,51} These jackets should not be made of any linting material, such as fleece. Scrubs should be laundered by the hospital to ensure correct water and drying temperatures and management of clean linen. Fluid-resistant or impervious gowns or aprons can be used to reduce the risk for strikethrough of patients' body fluids to scrubs.

Head and Hair Coverings

Hair coverings are often worn in the preoperative care unit, which is considered a semi-restricted area of the operating theater. Staff should wear head coverings over all hair. Fabric head coverings should be laundered at least daily and after contaminated cases. Frequently, bouffant coverings made of disposable material are used to ensure that all hair is enclosed. If surgeons or assistants have beards or other facial hair, this hair must be covered. Previously the AORN recommended that all bouffant head or hair coverings and facial hair coverings should be disposed of before leaving the operating theater area.⁵¹ In an updated recommendation, the AORN recommends that bouffant hair coverings be left on until the end of the shift, unless contaminated.

Masks

A mask is required when staff members are in the operating theater to set up for the surgical procedure and during the procedure. Other PPE, such as a mask with face shield or a mask with goggles, should be used when splashing to the face is anticipated.

Shoe Coverings

Shoe coverings in the preoperative care areas are not indicated unless the personnel will enter the semi-restricted or restricted areas of the operating theater. Fluid-resistant shoe covers are worn to protect health care workers from exposure to blood and body fluids,⁵³⁻⁵⁵ and they will be discussed further in Chapter 2.

See Sidebar 1-4, right, for other recommendations for surgical attire from the AORN Guideline for Surgical Attire.⁵¹

Sidebar 1-4. Surgical Attire Recommendations from AORN

Other selected AORN recommendations related to surgical attire include the following:

- When in the restricted areas, all non-scrubbed personnel should completely cover their arms with a long-sleeved scrub top or jacket. Cover arms when performing skin antisepsis.
- Wear dedicated shoes that remain in the perioperative areas; wear shoe covers or boots to protect from gross contamination.
- Wear clean operating theater scrub attire daily.
- If briefcases, backpacks, and other personal items are brought into the semi-restricted or restricted areas of the operating theater, they should be cleaned with a low-level disinfectant and should not be placed on the floor.
- Laboratory coats or cover gowns are not needed to be worn over scrub attire for infection prevention purposes when leaving the Operating Theater while staff are still in the hospital.

Source: Adapted from Association of periOperative Registered Nurses. Guidelines for Perioperative Practice: Guideline for Surgical Attire. Published Online Jan 2018. Accessed February 14, 2018. <http://www.aornstandards.org/content/1/SEC6.body>.

Personnel Hand Hygiene and Scrub Technique

Hand hygiene is a critical infection prevention function in all phases of care for the surgical patient. Personnel should follow their hospital's policy for hand hygiene at all times. Hand hygiene is discussed in detail in Chapter 3, the postoperative phase of care.

As personnel are preparing to move into the surgical suite, they should perform their hand scrub process according to the established facility policies and procedures. Institutions use different scrub products, each with distinct manufacturer's directions for scrubbing technique and times. Some institutions have implemented brushless, waterless scrubbing techniques using waterless alcohol-based products. These products require the user to first wash his or her hands with soap and water, use a nail pick to clean under the fingernails, dry the hands, then use the alcohol-based product. Detailed steps for the surgical scrub technique and monitoring are described in Chapter 2.

Preparing for Surgery: The Surgical Patient with a Communicable Disease

Assessing the patient for the presence of an infection and/or communicable disease is a critical step in maintaining the safety and health of the patient, other patients, and staff in the perioperative setting.

Patients may have infections that are unlikely to be transmitted to others but can affect the outcome of the surgery (for example, urinary tract infection). Patients with communicable infections can potentially transmit the infection to staff or other patients via airborne or contact routes. These patients may need additional precautions prior to, during, and after the surgical procedure.⁵⁶⁻⁵⁸ Table 1-8, below, highlights isolation requirements for communicable infections. The tool can be used as a guide when developing infection prevention and control policies for communicable diseases. Staff should review guidelines and recommendations periodically to maintain current policies.

Table 1-8. Infection Control Risk Assessment for Communicable Diseases

	Isolation/Precautions Indicated	Items/Equipment Needed	Comments
Pulmonary tuberculosis	Airborne	Negative pressure operating theater Operating theater with anteroom Air cleaning devices with high-efficiency particulate filter (HEPA) N95 respirator mask	Schedule at the time of least activity in the operating theater. Allow sufficient time for airborne contamination to dissipate before staff enters to clean room. Terminally clean room at end of procedure.
Varicella (chickenpox)	Airborne and contact	Negative pressure operating theater Operating theater with anteroom Air cleaning devices with high-efficiency particulate filter (HEPA) N95 respirator mask Isolation gowns	Schedule at the time of least activity in the operating theater. Terminally clean room at end of procedure.
Multidrug-resistant organisms (MDROs), including MRSA, vancomycin-resistant Enterococci (VRE), extended-spectrum beta-lactamase (ESBL)-producing pathogens, and <i>Clostridium difficile</i>	Contact	Isolation gowns, gloves	Schedule at the time of least activity in the operating theater. Terminally clean room at end of procedure.
Creutzfeldt-Jakob disease (CJD)	Contact	Isolation gowns, gloves Disposable instruments and supplies whenever available Nonpowered drills and saws	Have available 1N (normal) sodium hydroxide (NaOH) for soaking instruments before sterilization.

MRSA, methicillin-resistant *Staphylococcus aureus*.

The Isolation Room

During the preoperative phase, a patient with a communicable infectious disease should be placed in a regular isolation room to receive care. The operating theater staff should ensure that the environment in the operating theater suite is arranged to reduce risk of infection transmission to staff. Different room configurations and ventilation parameters are required for patients presenting with some form of airborne communicable diseases such as tuberculosis (TB) or measles. During the intraoperative and postoperative phases, there will be special arrangements in the operating theater for isolation to protect staff and other patients from the infection. These will be discussed in Chapters 2 and 3.

Respiratory Protection for Staff

Airborne infection isolation (AII) precautions must be implemented in the operating theater when caring for patients suspected of or confirmed with TB or other communicable airborne infections, such as varicella. This is a major safety imperative for operating theater personnel. It is best for operating theater personnel who are immune to varicella to care for these patients. However, if that is not possible, strict respiratory protective devices (such as the N95 respirator type mask) must be used.

The organization should develop and implement a respiratory program that includes the N95 type respirator mask for use when caring for patients with airborne infectious diseases, including TB and varicella. The “N95” designation means that when subjected to careful testing, the respirator blocks at least 95% of very small test particles and, therefore, provides added protection from airborne microorganisms to staff members. If properly fitted, the filtration capabilities of N95 respirators exceed those of face masks. N95 respirators are not designed for people with facial hair because a proper fit cannot be achieved.

People with chronic respiratory, cardiac, or other medical conditions that make it hard to breathe should check with their health care provider before using an N95 respirator because the device can require more effort to breathe. A medical assessment program to assess and document fitness to wear the respirator should be developed. Personnel must be fit tested and receive certification for wearing the N95 respirator mask. In addition, personnel should be trained to perform a fit check every time the respirator is donned to ensure proper fit. Table 1-9, below, provides information on when staff should wear different types of masks.

Table 1-9. Protective Masks

Type of Mask	When to Wear	Comments
N95 or P2	Open/active pulmonary TB, pneumonic plague, SARS	Ideally recommended, but single-use, cost, and continuous availability may restrict use. In such situations, standard surgical masks may be worn.
N100 or P3	During invasive procedures, collection of respiratory secretions, laboratory work, and work in an environment where organisms in concentrated form may be encountered.	Ideally recommended; but the fact that filters need to be kept continuously available and can be used only once may mean that cost restricts use. In such situations, standard surgical masks may be worn.
Standard surgical splash-proof masks (not gauze mask)	Mainly when dealing with droplet infections; use for airborne infections when N95 masks are not available.	Change mask when wet, soiled, or contaminated. Do not reuse. Discard according to health care facility protocol.

TB, tuberculosis; SARS, severe acute respiratory syndrome.

The Communicable Disease Assessment

During the scheduling process and just before surgery, a designated staff member should complete and communicate results of a communicable disease assessment to the other personnel who will be involved in the care of the patient. This information will help ensure that the timing of the infected patient's surgical procedure will be set to minimize his or her interactions with other patients and minimize exposure of staff. For example, a patient with pulmonary TB or varicella or a patient on contact precautions for an MDRO may be scheduled at the end of the day to reduce exposure to other patients, or certain isolation procedures may be carried out in the operating theater.⁵⁸

Patients with TB, Varicella, or Other Airborne Communicable Infections

Preventing the transmission of TB or other airborne infections when an infected patient needs surgery requires a high level of coordination. The surgical team must forge relationships with the entire health care delivery team. Communication with nurses, physicians, environmental services staff, engineering staff, and others is key to successfully and safely caring for the patient. When the need for AII is established, the operating theater team can implement the requisite administrative, environmental, and respiratory protection controls before, during, and after surgery.

Administrative Controls for Patients with Communicable Disease

Administrative controls are leadership imperatives that include scheduling the infected patient for the surgical procedure when a minimum number of health care workers and patients are present. Patients with airborne infections should be scheduled as the final case of the day to minimize disruptions in the daily schedule. Special considerations may be required (for example, additional time for cleaning the room), as it takes time for staff to don the appropriate PPE. The environmental services manager should support this extra time in cooperation with the operating theater manager. It is also critical to ensure that the air balance in the designated operating theater room is negative in relation to the corridor and that the correct number of air changes occurs (at least 15-25 ACH [air changes per hour])⁵⁹ to ensure that any potentially airborne agent is evacuated rather than spread outward. This requires coordination with the engineers. These and many other procedures are implemented to protect other patients and staff members.

Remember this:

Situations When Surgical Procedures Should Be Performed at the End of the Day

- Patient diagnosed or suspected with an airborne infectious disease/condition requiring *airborne infection isolation* (AII) precautions (for example, varicella [chicken pox], tuberculosis)
- Patient diagnosed or suspected with an MDRO requiring *contact isolation* precautions (for example, MRSA, vancomycin-resistant Enterococci (VRE), extended-spectrum beta-lactamase (ESBL)-producing pathogens, and *C. difficile*).

Administrative controls also involve having the infected patient bypass the holding area when the diagnosis requires AII. This process should be established before admission. The patient should go directly from his or her room or from admitting into the room where the surgical procedure will be performed. In addition, at the end of surgery, the patient should ideally be recovered in the surgical procedure room in the operating theater and then transferred directly to the isolation room on the inpatient care area. A written procedure should be part of the operating theater policies and procedures.

AORN-recommended practices note that administrative controls should be established to reduce the risk of exposure to airborne infections such as TB and should include the following⁵⁸:

- Implementing work practices for managing patients with suspected or confirmed airborne infection such as TB.
- Ensuring that potentially contaminated equipment is properly cleaned and sterilized or disinfected (for example, endoscopes).
- Providing training and education for health care workers about TB.
- Establishing a TB screening program.
- Implementing a respiratory protection program for personnel involving fit testing and certification for N95 respirator mask use, which is recommended when caring for patients with TB.

Staff Safety in the Operating Theater

Safety of staff in the operating theater is of utmost importance and requires special attire when caring for a patient with an infectious disease, whether in the preoperative, intraoperative, or postoperative phases of surgery. Table 1-10 and Table 1-11, below, present tools that can be used to assess, evaluate, and implement a respiratory protection program for staff in the operating theater when caring for a patient with an airborne infectious disease.

Table 1-10. Respiratory Protection Program Elements

Elements	In Place		Action
Program administrator	YES	NO	
Selection of an appropriate respirator for staff	YES	NO	
Medical evaluation of the respirator users	YES	NO	
Fit testing of tight-fitting respirators	YES	NO	
Use of respirators in routine and foreseeable emergency situations	YES	NO	
Procedures and schedules for respirator disposal, cleaning, disinfecting, storing, inspecting, and repairing	YES	NO	
Training employees in respiratory hazards and appropriate respirator use	YES	NO	
Evaluation of respiratory protection program annually	YES	NO	

Reviewed by:

Date:

Table 1-11. Respiratory Protection Checklist

Elements	In Place		Action
Are the available respirators appropriate for the hazard expected?	YES	NO	
Have all personnel received medical clearance to wear the respirators?	YES	NO	
Have all personnel been fit tested and certified to wear the respirators?	YES	NO	
Are disposable respirators being disposed of in the appropriate containers (wet/soiled)?	YES	NO	
Are reusable respirators cleaned, disinfected, and appropriately stored after each use?	YES	NO	
Is there a written respiratory protection plan/policy/procedure?	YES	NO	
Is the plan/policy/procedure readily available to all personnel?	YES	NO	
Are personnel fit tested annually?	YES	NO	

Reviewed by:

Date:

Leadership during the Preoperative Phase

Leadership support should be apparent during the entire perioperative experience, and it begins in the preoperative phase. The role of leadership during the preoperative phase is to ensure that policies are followed for the best practice interventions known to reduce SSI risk for patients and staff. Staff must be educated and competent to accurately assess patients, communicate information, educate patients and families, and in general advocate for the patient. Leaders in the operating theater should provide the education and the time to learn for all staff, coach and mentor them in their professional development, ensure competency, and maintain a culture of strong support for staff and patients.⁶⁰ Leadership should take the form of teams that work together for the benefit of the patient.⁶¹ This will include clear goals, a results-driven structure, competent team members, unified commitment to the patients, and a collaborative climate. The team and each individual should strive for standards of excellence, as well as support and recognition. To achieve this, principled leaders—who set the tone for the team—are a critical component.⁶¹

It is also imperative that the leaders support staff in ensuring access to content experts who can share information regarding the constantly evolving SSI prevention best practices. The preoperative staff should develop policies and procedure for the care of the patient, and leadership should approve them, enforce them, and support the staff in implementing them.

Summary

Infection prevention in the operating theater is a critical safety imperative for both patients and personnel. Optimizing positive outcomes and minimizing negative outcomes—including the development of surgical site infection—translates to reduced length of hospital stay prior to surgery, minimal patient morbidity, tremendous cost savings, and huge patient and family satisfaction results.

For personnel working in the preoperative setting, reducing the transmission of infection can be accomplished by adherence to such safety measures as universal and or standard precautions or isolation precautions, careful assessment of the patient and family, and aseptic technique. Other specific strategies discussed in this chapter apply and are important for implementation and careful monitoring (see Chapter 4). Educating patients and families before the surgical procedure can reduce anxiety and lead to a more positive surgical experience.

Throughout all phases of the surgical experience, a culture of patient safety and continuous performance improvement will benefit patients, staff, and the entire organization. See Chapter 4 for performance improvement tools and case studies.

Discussion Questions for the Surgical Preoperative Team

- What processes are in place in the preoperative care setting to ensure that each patient is thoroughly assessed for host risk factors that may contribute to surgical site infections?
- How are findings from the assessment communicated to the rest of the surgical team?
- What is the process if the patient is found to have a remote infection prior to surgery?
- How consistent are the policies for administering preoperative antibiotics according to evidence-based research and organizational policy?
- Do you monitor compliance?
- What are the organization's compliance rates for hand hygiene?
- How is the surgical scrub process among surgical staff monitored?
- What methods are used to provide preoperative education to surgical patients, and how are the patients' unique learning styles addressed?
- Are there policies and procedures to help patients maintain normothermia before surgery?
What about care of a patient with an airborne communicable disease?

A risk assessment tool and instructions for surgical services and the operating theater are provided in Chapter 4 under Additional Tools. This tool applies to all phases of the perioperative experience, preoperative, intraoperative and postoperative and also addresses the use of central intravenous lines and bundles.

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Evidence-Based Principles and Practices for Preventing Surgical Site Infections



CHAPTER 2

Infection Prevention in the Operating Theater and Surgical Services: **The Intraoperative Phase**

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Overview

Background

Approximately 187 to 281 million surgical procedures are performed worldwide each year—almost one surgical procedure for every 25 persons.¹ Most of these procedures result in good outcomes and improved health for the patients, but some do not. Surgical site infections (SSIs) are one of the undesirable and potentially very serious outcomes from surgery. The study cited above showed that in developed countries, 3% to 16% of surgeries resulted in major morbidity, and 0.4% to 0.8% in death.^{1,2} A report from the World Health Organization (WHO) in 2011 noted that in developing countries, the leading health care-associated infection, and the most frequently studied, is SSI. The WHO survey found that in low- and middle-income countries, the incidence rates of SSI ranged from 1.2 to 23.6 per 100 surgical procedures. This contrasted with rates between 1.2% and 5.2% in countries with more resources.³ Therefore, SSIs are a significant part of the historical, and current global public health issue of health care-associated infections (HAIs).

Brief History

The idea of preventing HAIs is reflected in the well-known admonition to physicians to “First, do no harm,” which is a cornerstone of the Hippocratic Oath.⁴ Infections that occur in association with care provided in hospitals and surgical clinics are challenging, because the patient did not have an infection upon entering the hospital or clinic but acquired it during or after a surgical procedure performed in these settings.

Historically, physicians did not understand why SSIs occurred and were not aware of the route of transmission of infection to man. They often attributed the cause of disease to “bad air,” “effluvia,” or “miasmas.” British surgeon Joseph Lister (1827-1912), a pioneer of antiseptic surgery, dramatically reduced HAIs in surgical patients. He believed that microbes might be responsible for infections and that by killing organisms in wounds he could prevent surgical infections and death. In his practice he used carbolic acid to “sterilize” dressings packed into the wounds of patients with compound fractures. He even soaked his fingers in carbolic acid, and sprayed the operating theater with the acid to kill germs in the air.⁵ Lister published his findings in 1867, and

the clear evidence of decreased infections in his surgical population was so compelling that his techniques gained acceptance over the next decades and his surgical asepsis principles remain foundational today in the operating theater.

Formerly, surgeons did not use personal protective equipment, such as gowns and gloves, when operating. This allowed transmission of organisms from staff to patient or vice versa. However, by 1910, sterile instruments, gowns, and gloves and masks were standard in many large teaching hospitals. The original use of rubber gloves was to protect the hands of the surgical team from carbolic acid, but the role of gloves in protecting patients from microorganisms on the hands of health care workers was eventually recognized, and gloves became standard garb where available. Eventually sterilizers were introduced, and they were fundamental to preparing sterile instruments and devices to help protect patients from surgical infections. In some clinics, staff silence during surgery was also required to limit bacterial contamination thought to be spread by talking. Some physicians began to keep records of infections and use active surveillance systems to track surgical infection trends.⁶

Today’s more sophisticated strategies for preventing wound infections take into account the host characteristics and risks, the technique of procedure, protective garb for staff, preparation of the patient, wound closure methods, the operating theater environment, and the disinfection and sterilization of the surgical instruments and supplies.

Overview

Although significant progress has been made in preventing and controlling infections, one of the limiting factors in preventing SSI is that different countries have unevenly implemented recommended prevention practices because of dramatic differences in their human and material resources, politics, and regulations. As a result, in addition to understanding and teaching best practices to prevent SSI, infection prevention and control professionals and health care epidemiologists have become more adept in understanding human behavior as to why proven practices are or are not adopted, the critical need for leadership and resources, and the effectiveness of teams in providing safer surgical care. They have also learned to use performance improvement and patient safety methods to enhance infection prevention practices that will reduce SSI.

Many current initiatives have endeavored to engage care providers in preventing SSI and will be discussed in this toolkit. For example, the WHO Safe Surgery Saves Lives challenge has helped reduce SSIs around the world.⁷ One of the WHO SSI prevention guidelines is the Surgical Safety Checklist to help reduce surgery-related infections and death. The checklist applies to the global population of patients in all phases of the perioperative experience. Newer guidelines from a variety of organizations have updated the science and evidence that should be used to make decisions about care. Many of these will be presented in this toolkit.

The Toolkit

This toolkit has four chapters. The three phases of the perioperative experience—preoperative, intraoperative and postoperative—form the majority of the content, and a chapter on patient safety and performance improvement strategies for surgical services completes the information. Each chapter presents the theory, science, and rationale for proven practices and practical tools to implement evidence-based best practices.

Chapters 1-3 focus on host characteristics and risks, processes and procedures, and education and safety of staff, patients, and families in each of the perioperative phases. Chapter 4 discusses patient safety principles and performance improvement methods and techniques and is supported by case studies and other practical examples.

References and resources are provided in each chapter. Current recommendations from groups such as WHO, the Centers for Disease Control and Prevention (CDC), Society for Healthcare Epidemiology of America (SHEA), American College of Surgeons (ACS), Surgical Infection Society (SIS), and others are referenced quite liberally throughout the toolkit.

The author and sponsors hope you find the toolkit valuable for your practice and your continuing efforts to reduce and eliminate SSIs for your patients and personnel.

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Introduction

In Chapter 1, we described the importance of careful patient assessments to identify and modify, where possible, those factors that place the patient at risk during the preoperative phase of the surgical process. During the intraoperative phase, there are both similar and additional considerations that may influence the risk of an SSI. Some of these risks can be modified by the clinical staff, and others cannot but must be managed. This chapter focuses on selected patient and staff risks that are common during the intraoperative phase and proposes strategies to eliminate or minimize them. The intraoperative phase encompasses the time from when the patient enters the surgical suite, throughout the surgical procedure, and until the surgery is complete and the patient moves to the postanesthesia care unit (PACU) for recovery.

The following are the main goals of SSI prevention in the intraoperative phase for the patient:

- Maximize host defenses.
- Minimize contamination of surgical wound by the following:
 - Environment
 - Patient
 - Perioperative team
 - Instruments/equipment
- Neutralize or decrease the pathogenicity of microorganisms.
- Perform a safe surgical procedure for patients and personnel.
- Provide an optimal microenvironment for tissue repair and healing.
- Maintain a safe physical environment for the surgical procedure.

Learning Objectives

After reviewing this chapter, the reader will be able to do the following:

1. State host factors and conditions that influence infection risk during the intraoperative phase of surgery.
2. Describe strategies to reduce patients' exposure to microorganism from personnel or the operating theater environment.
3. Discuss personnel preparation for surgery.
4. State methods to prevent contamination of the surgical field.
5. Discuss the relationship of surgical technique and wound closure to SSI.
6. Describe an approach to staff safety in the operating theater.
7. Discuss leadership's role in preventing SSI.
8. Discuss the meaning of the "surgical conscience" for surgical staff.

Host Risk Factors and SSI in the Intraoperative Phase of Surgery

The host's resistance to infection is critical to the surgical outcome and can be affected by many patient characteristics. Risk factors for SSIs are specific to each surgical patient and should be integrated into the patient's plan of care starting in the preoperative phase and carrying forward throughout the intraoperative and postoperative phases. As these risks are addressed, the team determines which interventions to use to reduce the patient's risk. Box 2-1, below, lists some of the host characteristics that may place the patient at increased peril for an SSI. Some of these host factors, such as preexisting infections, blood glucose levels, and duration of stay before surgery, are amenable to modification through careful planning and clinical care.

Box 2-1. Host Factors Related to Risk of SSI

- Diabetes mellitus, hyperglycemia
- Extremes in age
- Malnutrition
- Malignancies
- Presence of preexisting infections at remote sites
- Extended duration of hospital stay prior to surgery
- Smoking
- Immune status/immunosuppressive drugs

Promoting Host Conditions That Reduce Infection Risk during the Intraoperative Phase of Surgery

Many of the host factors that influence the patient's risk of infection are discussed in Chapter 1 (the preoperative phase of surgical care). Key processes to support the host during the intraoperative phase include re-dosing of prophylactic antibiotics for prolonged cases, controlling blood-glucose levels, maintaining normothermia, providing supplemental oxygenation, maintaining normovolemia, and preventing blood loss. Each is discussed below.

Surgical Antimicrobial Prophylaxis and Re-dosing during the Intraoperative Phase

In the intraoperative phase, prior to the incision, the surgical antibiotic prophylaxis is administered to provide a concentration of the drug in serum and tissues that is at a bactericidal level when the incision is made. The amount of drug administered is based on the patient's weight and expected pathogens. Some guidelines recommend that the antibiotic be re-administered or re-dosed during the surgical procedure.¹ The purpose of re-dosing is to maintain adequate tissue levels when the surgical procedure is prolonged. The antibiotic should be re-dosed periodically based on length of the procedure and two half-lives of the drug or for every 1,500 mL of blood loss during surgery.^{2,3} During longer surgeries the antibiotic may be administered several times. The surgeon will make the decision about re-dosing. The issue of when to discontinue the prophylactic antibiotic is discussed in Chapter 3 (the postoperative phase).

Blood Glucose Management

Managing the surgical patient's blood glucose levels and addressing hyperglycemia during surgery appear to help reduce risks of SSI.^{2,4} In studies, the HbA1C level was not found to be related to risk of SSI, but hyperglycemia was.^{5,6} Strict blood glucose level targets are beneficial in reducing SSI rates when compared to more conventional protocols.⁷ Some researchers have focused on the correlation of lower blood glucose with lower SSIs in general surgery patients and those having vascular procedures.^{2,8,9} The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) suggest the use of protocols for intensive perioperative blood glucose.^{7,10}

Targets for glucose control vary. The CDC recommends a target of < 200 mg/dL in patients with and without diabetes.¹⁰ In diabetic patients undergoing open heart surgery, the accepted glucose level is maintained preferably below < 180 mg/dL.² The consensus in the 2016 SSI prevention guidelines from the American College of Surgeons and the Surgical Infection Society (ACS/SIS) is that a perioperative glucose level between < 110 and < 150 mg/dL is important for all patients, to help achieve a lower SSI risk.² Increasingly, recommendations encourage maintaining glucose control for up to a day after the surgery.¹

Each organization should develop its own policy and procedure for following the most current evidence-based recommendations and educate staff as to their responsibilities in the monitoring, recording, and reporting of glucose rates in the three phases of surgery. This is an essential function of the surgical team and a benefit to the patient. Glucose levels should be carefully monitored during surgery and adjusted when necessary. Each organization should have written policies to guide clinicians regarding blood glucose levels and processes of care. Continual communication among the surgical team about the blood glucose level will help focus attention on managing this important patient risk.

Maintaining Normothermia

Mild perioperative hypothermia, which is common during major surgeries, may increase the risk for SSIs.^{11,12} Hypothermia occurs by triggering vasoconstriction leading to reduced levels of oxygen in the tissues, which impairs the ability of neutrophils to kill organisms and therefore decreases the wound's ability to heal. Loss of body heat occurs after induction of anesthesia and continues throughout the surgical procedure. Studies have shown a decreased risk of SSIs in patients undergoing colon surgery when body temperature is maintained at or above 36.5°C.^{13,14} One research team has written that, in longer cases, warming the patient both preoperatively and during the procedure is recommended.¹⁵

Research should continue to further explore the relationship between normothermia and decreased risk of infection; however, many guidelines now recommend efforts to maintain normothermia throughout the entire surgical experience. Sidebar 2-1, right, lists equipment and techniques to maintain normal body temperature. Sidebar 2-1 is also found in Chapter 1. Box 2-2, below, shows various body sites for monitoring temperature and medical devices that can be used for this purpose.

Sidebar 2-1. Techniques to Maintain Normal Body Temperature (Normothermia)

- Forced-air warming
- Circulating water garments
- Energy transfer pads
- Warmed blankets
- Warmed intravenous fluids and irrigation fluids
- Warmed gases for inspiration
- Increased room temperatures

Note: Temperatures of warmed solutions should be monitored to prevent burn injuries. Core body temperatures should be monitored during and immediately after the surgical procedure for all patients.

Box 2-2. Body Sites and Medical Devices to Monitor Body Temperature

- A probe placed in the lower portion of the esophagus can be used to monitor intraoperative temperature.
- Tympanic membrane temperatures can be measured by using a thermocouple.
- A thermistor probe inserted through the nares into the nasopharynx can be used to monitor temperature. Note that nasopharynx temperature readings may be influenced by the temperature of the inspired gases and may be lower than readings obtained at other sites, such as the pulmonary artery site.
- The pulmonary artery provides the most accurate body temperature monitoring; however, this is an invasive form of monitoring.
- Other sites to monitor core body temperatures include the oral, rectal, bladder, axillary, skin, and temporal artery. These sites are less reliable for estimating core body temperature.

References:

- Hooper VD, Andrews JO. Accuracy of noninvasive core temperature measurement in acutely ill adults: The state of the science. *Biol Res Nurs*. 2001 Jul;8(1):24-34.
- Ilsley AH, Rutten AJ, Runciman WB. An evaluation of body temperature measurement. *Anaesth Intensive Care*. 1983 Feb;11(1):31-39.
- Holtzclaw BJ. Monitoring body temperature. *AACN Clin Issues Crit Care Nurs*. 1993 Feb;4(1):44-55.
- Erickson RS, Kirklín SK. Comparison of ear-based, bladder, oral, and axillary methods for core temperature measurement. *Crit Care Med*. 1993 Oct;21(10):1528-1534.

Refer to the formula below in Box 2-3. This simple formula can be used by health care workers to measure adherence to maintaining normothermia in surgical patients.

Box 2-3. Formula for Measuring Adherence to Maintaining Normothermia

Number of patients undergoing colorectal surgery, with normothermia maintained

Number of patients undergoing colorectal surgery

EXAMPLE:

Number of patients undergoing colorectal surgery and normothermia maintained

46 Patients

÷

Number of patients undergoing colorectal surgery

48 Patients

x 100 =

96%

or 95.83 of patients with normothermia maintained

Supplemental Perioperative Oxygenation

WHO recommends that adult patients who are having anesthesia with endotracheal intubation should receive an 80% fraction of inspired oxygen (FIO₂) both intraoperatively and in the immediate postoperative phase for 2–6 hours to reduce the risk of SSI. The 80% FIO₂ is associated with a decrease in SSI compared to an FIO₂ of 30%–35%.⁷ Other groups, including professional societies or national authorities, recommend a hemoglobin saturation above 95% or greater if there is underlying respiratory insufficiency.^{16–18} Careful monitoring of the oxygen level is part of the overall strategies to reduce risk of infection beginning in the preoperative phase and continuing in the intraoperative and postoperative phases.

Maintaining Normovolemia

Perioperative fluid therapy can prevent tissue hypoxia by improving arterial oxygenation and maximizing cardiac output during surgery.⁷ Although the optimal fluid strategy is not clear from the research and there is large variability, WHO and others recommend the use of a “goal directed fluid therapy” protocol intraoperatively versus standard fluid management.^{7,16} Personnel must be careful not to create fluid overload or hypovolemia when determining the volume of fluid to introduce, as both have led to increases in morbidity or mortality.⁷ Markers to help the clinician determine volume include pulse pressure, blood pressure, and arterial catheter measurements when an arterial line is used.

Blood Loss Prevention

Blood transfusion has been shown to increase the risk of surgical infection, due to immunosuppressive effects. It is consequently important to take the following measures to reduce the risk for blood transfusion^{19–23}.

- Correct the preoperative anemia.
- Control local bleeding (which can lead to increase in dead space and development of seroma and/or abscess) via the following:
 - Intracapsular injection, postoperative total knee—ensure that it is prepared under hood in the pharmacy and delivered to the operating theater in a sterile syringe.
 - Tranexamic acid infusion—ensure that it is prepared under hood in the pharmacy and delivered to the operating theater in a sterile syringe.
 - Fibrin sealant prior to wound closure, total knee

Additional Potential Risk-Reduction Strategies

Other strategies proposed for reducing the risk of SSI during the intraoperative phase are found in Table 2-1, below, along with recommendations from the 2016 WHO SSI prevention guidelines.

Table 2-1. Conditional Recommendations from the World Health Organization

Strategy	Recommendation
Adhesive incise drapes	<ul style="list-style-type: none"> Plastic adhesive incise drapes with or without antimicrobial properties should not be used. Access may be low, costs may be high, and training is needed.
Wound protector devices	<ul style="list-style-type: none"> Consider use in clean-contaminated, contaminated, and dirty abdominal surgical procedures to reduce surgical site infection.
Drapes and Gowns	<ul style="list-style-type: none"> Either sterile disposable non-woven or sterile reusable woven drapes and surgical gowns can be used during surgical operations. Consider safety, comfort, financial costs, ecological effects when selecting drapes and gowns.
Incisional wound irrigation	<ul style="list-style-type: none"> Insufficient evidence to recommend for or against saline irrigation of incisional wounds before closure to prevent SSI Consider end-of-case irrigation of the incisional wound with an antiseptic instead of antibiotic solution. Aqueous povidone-iodine (diluted) is used by some to irrigate wounds. Antibiotic incisional wound irrigation before closure has been reported to be ineffective and can contribute to antibiotic resistance pressure.
Laminar airflow ventilation systems	<ul style="list-style-type: none"> Should not be used for patients undergoing total arthroplasty surgery to reduce risk of SSI

Source: Adapted from World Health Organization (WHO). *Global Guidelines for the Prevention of Surgical Site Infection*. Geneva: WHO, 2016. Accessed Aug 11, 2017. <http://apps.who.int/iris/bitstream/10665/250680/1/9789241549882-eng.pdf?ua=1>

Strategies to Minimize Contamination of Surgical Wound by Environment, Patient, Perioperative Team, Instruments, and Equipment

Microorganisms that could potentially contaminate the surgical wound come from two sources: (1) endogenous or intrinsic, which are present on the patient's skin, hair, nose, or mucous membranes, or are present in body tissues, such as bowel flora; and (2) microorganisms from exogenous or extrinsic sources that can be acquired from exposure to operating theater personnel, inadequate preparation of the patient for surgery, or contact with contaminated equipment or the environment.

The potential microorganisms that patients may encounter can be virulent; that is, they have the ability to produce cellular and tissue damage through the following methods:

- The presence of endotoxins
- Polysaccharide capsules that inhibit phagocytosis
- Disruption of cell membranes through the presence of exotoxins
- Slime production (biofilm) that shields the microorganisms

Given the potential pathogenicity or virulence of microorganisms that may be encountered, it is incumbent on the surgical team to follow evidence-based best practices consistently when preparing themselves or the patient for the surgical procedure. Many of the extrinsic risk factors for SSI are listed in Box 2-4, below. These Extrinsic Risk Factors are also discussed in Chapter 1. A selected few will be discussed in further detail in the chapter.

Box 2-4. Selected Extrinsic Risk Factors for SSI

- Type, length and complexity of procedure
- Amount of tissue trauma and microenvironment of the wound
- Degree of microbial contamination in the wound
- Pathogenicity of the microorganisms in the wound
- Blood transfusions
- Breaks in asepsis or sterility
- Lack of appropriate preoperative antibiotics and re-dosing
- Inadequate surgical site skin preparation
- Poor personnel hand scrub or surgical attire
- Personnel communicable illness
- Lack of isolation for patients with communicable diseases
- Incorrect environmental controls (e.g., ventilation, humidity, temperature)
- Disinfection and sterilization of instruments

Preparing Personnel for Surgery

Personnel Attire

Surgical attire, such as scrub clothing, is worn to reduce the shedding of skin squames, dandruff, and hair (which can contain microorganisms) into the environment; to reduce transmission of organisms to patients; and to maintain a sterile field. Traditionally, surgical staff have worn special clothing, although there is a lack of evidence that strongly aligns surgical attire with the development of SSI. However, the wearing of special attire reflects the belief that it can reduce the patient's risk of exposure to microorganisms from staff, and this practice is integral to all surgical programs.

Each surgical staff member should wear clean, freshly laundered scrubs.²⁴ Surgical attire may include gloves, gowns, head coverings, masks and respirators, eyewear, and foot coverings, depending on the situation. Scrub clothing (pants, tops, gowns, or dresses) should be put on when entering the restricted areas of the operating theater. Staff should wear long sleeves in the restricted areas.²⁴ Clothing should not have any linting material, such as fleece. Cover or warming jackets worn in the operating theater have not been associated with reduced incidence of SSI.² They do provide warmth for staff and may help to contain and prevent skin squames reaching the patient or the sterile field. The operating team should cover all hair and wear sterile gowns and sterile gloves during the operation. When surgical personnel leave the health care organization, they should not wear scrub clothing. In general, cover jackets/cover gowns or lab coats can be worn over scrub clothes when personnel leave the surgery department/unit; the cover jacket should then be removed when personnel return to semi-restricted or restricted areas.²⁴ However, the AORN guidelines now state that cover gowns or jackets do not need to be worn when leaving the operating theater if personnel are remaining within the hospital or clinic.²⁴ The evidence does not support wearing cover apparel to protect scrub attire from becoming contaminated. In fact, some evidence even shows that laboratory coats worn as cover apparel when leaving the operating theater have the potential to become contaminated with large numbers of pathogenic microorganisms.

Traffic zones are established in the operating theater and help ensure that staff wear the appropriate clothing depending on their location in the various areas of the operating theater. Table 2-2, below, describes appropriate personnel attire for each area. This information is also found in Chapter 1.

Table 2-2. Traffic Zones: What to Wear

Area	What to Wear
Restricted zone—includes the operating theater rooms and scrub areas.	Freshly laundered surgical scrub attire: Tops must be snugly fitting or tucked into bottom when worn, hair and facial hair covered, and mask worn when surgical supplies are opened or scrubbed personnel present. Attire should be laundered by the hospital.
Semi-restricted zone—includes corridors or hallways, supply rooms, offices, scrub areas, and equipment processing areas.	Freshly laundered surgical attire, head and facial hair covered. Jumpsuits may be worn as surgical attire. Attire should be laundered by the hospital.
Unrestricted zone—includes areas where the surgical suite may interface with other parts of the facility, such as areas for delivery of supplies and equipment, and areas for personnel and patients.	Street clothes or scrub suits

AORN recommends that clean surgical attire should be worn in the semi-restricted and restricted areas of the perioperative setting; personnel entering the semi-restricted and restricted areas should cover the head, hair, ears, and facial hair; and scrubs should be laundered by the organization to ensure correct water and drying temperatures and management of clean linen.²⁴ No definitive studies exist that show an increase in SSI with home laundering of scrubs,² but laundering scrub clothing at home may not provide the necessary water temperature, sufficient number of water changes, controlled concentrations of bleach, or drying temperature for the safe reduction of microorganisms. In addition, there is a risk of debris—including bacteria-laden pet hair—adhering to home-laundered scrubs in the home or in transit.²⁴ AORN recommends that surgical attire be laundered at the organization. Fluid-resistant or impervious gowns or aprons can be used to reduce the risk for strikethrough of patients' body fluids to scrubs. It is recommended that clean and appropriate professional clothing be worn during patient encounters outside the operating theater and that scrubs not be worn outside the hospital at any time. All surgical garb should be changed when visibly soiled or between contaminated cases, and staff should change or cover scrubs before seeing the patient and family following surgery.^{2,24}

Gloves

The use of sterile gloves is normal and best practice during any surgical procedure. Gloves should be selected based on the glove materials, tensile strength, length of use, and material stress, which will influence the gloves' integrity. Holes and tears compromise the integrity of the gloves, the sterility of the procedure, and the safety of the health care worker. Various studies demonstrate significant tears in gloves with orthopedic, obstetric, endoprosthesis, and other surgeries.^{25,26} When a health care worker recognizes that a hole or tear has occurred, the gloves should immediately be removed, the hands should be washed or sanitized, and the gloves should be replaced.

The Society for Healthcare Epidemiology of America and the Infectious Diseases Society of America (SHEA/IDSA)¹ and AORN²⁴ recommend double gloving for all procedures. Some studies have shown differences in hand contamination when double or single gloves are worn.²⁷ WHO and others reported that in many studies there were no differences in SSI outcomes when comparing double gloving versus a single pair of gloves or when a glove was torn during surgery or was intact.^{7,28,29} However adding a second pair of surgical gloves can significantly reduce perforations to the innermost gloves. One study demonstrated an association between double gloving and SSI, with a 50% reduction in postoperative shunt infections.³⁰ Using double gloves is also thought to provide added protection from bloodborne pathogens from sharps injuries. Some surgeons prefer to change the outer glove during a long surgical procedure. There continues to be significant variability in the use of gloves during the intraoperative phase. When reviewing triple gloving, knitted outer gloves, and glove liners, it was also evident that these gloves significantly reduce perforations to the innermost glove.²⁸

Recommendations from WHO regarding gloves used during surgery include the following⁷:

- Use sterile gloves.
- Do not perform glove decontamination with alcohol or other products.
- Do not reuse sterile surgical or medical exam gloves.

WHO did not present a recommendation on double gloving or changing of gloves during the operation or using specific types of gloves as more effective to reduce SSI risk.⁷

Both AORN²⁴ and SHEA/IDSA¹ recommend that sterile gloves should be changed when damaged and/or changed every 90 to 150 minutes during a case. The 2016 ACS/SIS and 2017 Wisconsin Division of Public Health SSI prevention guidelines recommend that surgeons should change sterile gloves at the end of the procedure, prior to closing the wound.^{2,31}

Each organization and surgical team should review the current science and develop a policy and procedure for glove use that is acceptable to staff.

Gowns

Personnel who participate in surgical procedures should wear sterile gowns over scrub apparel. Gowns should be made of material that creates minimal amounts of lint, have adequate tensile strength to reduce tears and holes, and be resistant to liquids in order to minimize personnel exposure to blood and body fluids.²⁴ Gowns may be reusable or single use (disposable); gowns with toxic ingredients or allergens should not be used. There are many gowns available with varying levels of barrier protection, and for any particular procedure a gown should be selected according to the anticipated use and degree of exposure to blood or other potentially infectious organisms. (See Table 2-3 below.) For example, in complex, lengthy surgical procedures, such as cardiovascular surgery, personnel may select gowns with greater barrier capacity that will minimize passage of potential contaminants. If it is anticipated that a surgical gown will not provide a sufficient barrier to fluids, a plastic apron may be worn under the sterile gown.

Table 2-3. Classification Level of Protection for Gowns and Drapes by Type of Procedure

Level of Protection	Exposure Risk	Type of Procedure
1	Little fluid or pressure	Ophthalmology; simple ear, nose, and throat surgeries
2	Increased amount of fluid and pressure	Hernias, orthopedic procedures with tourniquets, and tonsillectomies/adenoidectomies
3	Increased amount of fluid and greater pressure	Mastectomies, arthroscopies, and general surgery operations
4	Requires highest level of protection, such as impervious gowns	Large abdominal cases, orthopedic procedures without tourniquets, and surgeries involving trauma, cesarean sections, or cardiovascular procedures

Sources: Adapted from:

- US Department of Labor, Occupational Safety and Health Administration. Occupational exposure to bloodborne pathogens: Final rule. 29 CFR Part 1910.1030. *Fed Regist.* 1991 Dec 6;56(235):64174-64182.
- Association for the Advancement of Medical Instrumentation (AAMI). *Liquid Barrier Performance and Classification of Protective Apparel and Drapes Intended for Use in Health Care Facilities*, ANSI/AAMI PB70:2012. Arlington, VA: AAMI, 2012.

Head Coverings

Staff members should wear head coverings over all hair.²⁴ Head coverings should create minimal amounts of lint and cover the hair so dandruff and hair do not fall into the sterile field, onto the surgical incision site, or into the operating theater (OT) environment. Hoods should be used to cover facial hair. Both disposable and fabric head coverings are employed in the OT. When fabric head coverings are used, they should be laundered frequently and changed between dirty or contaminated cases and prior to subsequent cases even if not visibly soiled.³² Often bouffant coverings made of disposable material are used to ensure that all hair is enclosed. All bouffant head or hair coverings should be discarded at the end of the shift or when contaminated before leaving the OT area.

AORN recommends that only hair cover or hood that contains all hair should be used by staff.²⁴ However, the American College of Surgeons Statement on Operating Room Attire states that a “skullcap can be worn when close to the totality of hair is covered by it and only a limited amount of hair on the nape of the neck or modest sideburns remains uncovered.”³² At this point there are no data that compare cloth versus disposable scrub hat material and no comparisons of the effect of skull caps versus bouffant head coverings as specifically related to SSI; more studies need to be completed.² In any event, net caps should not be used, as hair and dandruff can fall into the sterile field. Given the variability of recommendations, each organization should determine its policy for head coverings in the context of the published guidelines.

Masks

Surgical masks are universally worn in operating theaters to protect the patient from microorganisms carried in the health care workers' nose and upper respiratory tract that may potentially be shed onto the surgical site. Masks also protect staff from exposure to the patient's blood and body fluids. A mask is required when staff members are in the operating theater to set up for the surgical procedure, when sterile items or supplies are opened, and during the procedure. Other personal protective equipment (PPE), such as mask with face shield or mask with goggles, should be used when splashing to the face is anticipated. Sidebar 2-2, right, offers guidance for the wearing of a surgical mask.

Eyewear

Eyewear should be worn to prevent the health care worker from exposure to blood splatter and splashes in the eyes. Regular glasses are not sufficient for adequate protection—workers should wear glasses with side shields, goggles, or face shields for optimum protection. Reusable eyewear should be decontaminated after use, and disposable eyewear should be discarded.²⁴

Shoe Coverings

Fluid-resistant shoe covers are worn to protect health care workers from exposure to blood and body fluids, particularly in procedures that result in a high volume of fluids or blood, such as traumas, orthopedic procedures, and procedures that use irrigating liquids. Shoe covers have been historically worn to protect the employee's shoes and not the patient, as floors have not been considered a risk factor for health care-associated infections, including surgical infections.^{33,34} Over a nearly 50-year period, studies have not found an association between air dispersion from the floor and contamination of the surgical wound or an effect on the SSI rate.³⁵ However, there has been more focus on the association of floors with infection in recent years, and a theoretical risk posed regarding contaminated surfaces (including floors) in high-risk environments such as operating theaters, where air currents can disrupt particles on any surface and potentially move them within the operating theater.³⁶ In summary, it is generally believed that shoe coverings are primarily needed to protect staff from blood and body fluids from the procedure. Surgical personnel should continue to review new research and wear shoes that are easy to clean and dedicated for use in the operating theater.

Hand Hygiene and Gloves

Hand hygiene with soap and water or alcohol-based waterless sanitizer should be practiced at all times and in all situations. Hand hygiene is a cornerstone of infection prevention. In the preoperative phase, hands are scrubbed for the surgical procedure and gloved. However, it is still imperative to perform hand hygiene when hands are not enclosed in gloves.

Sidebar 2-2. Wearing a Surgical Mask

The surgical mask should . . .

- cover the mouth and nose.
- be secured to prevent venting at the sides of the mask.
- be a fresh surgical mask that is donned before the health care worker performs or assists with each new procedure.
- be replaced and discarded whenever it becomes wet or soiled or has been taken down.
- not be worn under the nose or hanging around the neck.
- be handled in a manner so as not to contaminate the staff member's hands when removed; that is, touch only the ties or band to avoid contact contamination with nasopharyngeal organisms.
- be discarded after use, if disposable.
- not be stored in pockets or bags, left hanging on the neck, or placed on hair coverings for later reuse.

When the patient has an airborne infection, such as pulmonary tuberculosis, health care workers should wear particulate respirators (N95) or powered air purifying respirators (PAPR).

Source: Adapted from Association of periOperative Registered Nurses. Guidelines for Perioperative Practice: Guideline for Surgical Attire. Published online Jan 2018. Accessed March 10, 2018. <http://www.aornstandards.org/content/1/SEC6.body>.

Summary: Personnel Attire

Personnel attire is worn to protect the patient's surgical wound from contamination with microorganisms and to protect the health care worker from exposure to blood and other potentially infectious agents.

- All clothing should be clean and preferably laundered by the facility.
- All clothing should be removed and replaced when visibly soiled, contaminated, or wet.
- Gloves should be worn whenever contact with blood or body fluids is expected.
- Hand hygiene must be practiced when removing gloves.
- Shoes should be cleaned, and blood or body fluids should be removed.
- Other surgical attire is worn based on organizational policy.

Personnel Surgical Hand Scrub

The surgical team members perform surgical hand scrub (antiseptis) before every surgical procedure. Surgical hand antiseptis cleans health care workers' skin and removes debris and transient microorganisms present on the nails, hands, and forearms. It also reduces the resident flora and slows the regrowth of microorganisms. Personnel should perform their scrub process according to the established facility policies and procedures. Institutions use different scrub products, each with distinct manufacturer directions for scrubbing technique and times. Some organizations use medicated hand scrub products, and others have implemented brushless, waterless scrubbing techniques using waterless alcohol-based products. General considerations for selecting an agent for the scrub procedure are listed in Box 2-5, below.

Box 2-5. Criteria for Selecting a Surgical Hand Scrub Product

- The surgical team should use an agent with rapid, broad-spectrum antimicrobial activity.
- The scrub can be performed with an alcohol-based hand rub with persistent activity or an antimicrobial soap/product.^{1,2}
- The selected agent should be effective against a wide variety of organisms, including gram-negative and gram-positive bacteria.
- The agent should provide protection during surgical procedures and have a residual effect to provide persistent antimicrobial activity that protects the patient in the event of tears or holes in the gloves.
- The goal is for the surgical hand scrub product to eliminate transient microorganisms, reduce resident microorganisms, and maintain the resident organisms at reduced levels until the end of the surgical procedure.
- The agent should be nonirritating, acceptable for sensitive skin, and accepted by the staff who will use it.

References:

1. Larson EL, et al. Alcohol for surgical scrubbing? *Infect Control Hosp Epidemiol*. 1990 Mar;11(3):139-143.
2. Mulberry G, et al. Evaluation of a waterless, scrubless chlorhexidine gluconate/ethanol surgical scrub for antimicrobial efficacy. *Am J Infect Control*. 2001 Dec;29(6):377-382.

Alcohol-Based Brushless Surgical Hand Scrub Products

Products with high concentrations of alcohol approved for use as a surgical hand scrub may be selected in lieu of antimicrobial/medicated surgical scrub soap solutions and water. The high concentration of alcohol, along with other components, provides rapid reduction of resident skin flora and slows regrowth of bacteria and sustained antimicrobial effect. Because they save time, have fewer side effects, and have less risk for recontamination of hands during the rinsing process,^{37,38} alcohol-based brushless surgical hand scrub products have been well accepted by personnel. The exposure times vary by product. Personnel should follow the manufacturer's recommended directions for use.

Antimicrobial or Medicated Surgical Hand Scrub Soap and Water

Surgical hand scrubs using an antimicrobial/medicated soap should follow manufacturer's recommendations for process and duration of scrub, which is usually 2 to 6 minutes. Longer scrub times (10 minutes or longer) are not necessary.³⁹

As personnel are preparing to move into the surgical suite, they should perform their hand scrub process according to the established facility policies and procedures. Institutions use different scrub products, each with distinct manufacturer's directions for scrubbing technique and times. Some institutions have implemented brushless, waterless scrubbing techniques using waterless alcohol-based products. These products require the user to first wash his or her hands with soap and water, use a nail pick to clean under the fingernails, dry the hands, then use the alcohol-based product. Box 2-6 below lists steps in the surgical scrub process for traditional methods and using waterless agents.

Box 2-6. Hand Scrub Procedures Using Traditional and Waterless Methods

Traditional	Waterless
Follow the specific product recommendations for use.	Follow the specific product recommendations for use.
Remove all jewelry, rings, watches, bracelets.	Remove all jewelry, rings, watches, bracelets.
Turn on faucet and clean subungual areas with a nail file under running water.	Turn on faucet and clean subungual areas with a nail file under running water.
Scrub each side of the finger, between the fingers, and the back and front of the hand for two minutes.	Wash hands up to the elbow with soap, and rinse under running water.
Proceed to scrub the arms, keeping the hand higher than the arm at all times.	Dispense antiseptic into cupped hand.
Wash each side of the arm to 3 inches above the elbow for 1 minute.	Dip fingertips of your opposite hand into the antiseptic, work under the nails and spread on the hand and lower two thirds of the forearm.
Repeat the process on the other hand and arm, keeping hands above elbow at all times.	Repeat with the other hand and forearm.
Rinse the hands and arms by passing them through the water in one direction only. Start at the fingertips and progress to the elbow. Do not move the arm back and forth through the water.	Dispense additional antiseptic and apply to all surfaces of the hands up to wrist. Rub hands until dry.
Proceed to the OT holding the hands above the elbows.	Proceed to the OT.
Using aseptic technique, dry the hands and arms using a sterile towel.	Allow hands to air dry.
Don gown and sterile gloves.	Don gown and sterile gloves.

Source: George Allen. Used with permission.
OT, operating theater

Additional Considerations for the Personnel Surgical Hand Scrub

Sidebar 2-3, right, provides tips for personnel on how to manage their jewelry and nails in the operating theater and for the surgical scrub procedure.

Monitoring the Surgical Hand Scrub

As part of the quality of care and patient safety efforts, it is the responsibility of the leaders and key staff in the operating theater to monitor that all personnel are competent and are following the organization's policy for the surgical scrub. The tool in Table 2-4, below, can be used to monitor the surgical scrub, and Table 2-5, on page 25, provides a checklist to monitor the scrub steps.

Table 2-4. Monitoring Steps for the Surgical Scrub

Action	Performed	
Rings, watches, and/or bracelets are removed.	YES	NO
Nails are short.	YES	NO
Artificial nails are removed.	YES	NO
Clock is visible (for the timed scrub).	YES	NO
Approved antimicrobial soap is provided.	YES	NO
Approved alcohol-based waterless product is provided (for brushless scrub).	YES	NO
Approved non-medicated soap is provided (for use with the alcohol-based product).	YES	NO
Approved brushes are provided (for brush scrub).	YES	NO
Hands and forearms are thoroughly moistened and washed using an approved scrub agent and rinsed.	YES	NO
Water is at a comfortable temperature and steady flow.	YES	NO
Hands are held higher than the elbow.	YES	NO
Rinsing is performed from fingertips to elbows.	YES	NO
Fingers, hands, and arms are visualized as having four sides, and each side scrubbed.	YES	NO
Used brushes or sponges are discarded into the waste container.	YES	NO

Sidebar 2-3. Tips for Jewelry and Nails in the Operating Theater¹

- Personnel should remove jewelry before beginning the surgical hand scrub procedure, as these items can harbor microorganisms.
- Rings should not be worn during surgical procedures, and watches, bracelets, necklaces, and earrings should either be removed or contained within the scrub attire.
- Nails should be kept short, and fingernails should be cleaned under running water during the scrub procedure.
- Special attention should be paid to the area under the fingernails.
- Long fingernails increase the potential for glove tears and the potential for exposing patients to microorganisms and surgical personnel to patients' blood.
- Fingernails that do not extend beyond the fingertips are less likely to tear gloves.
- Artificial nails should NOT be worn in the operating theater, because a greater number of gram-negative organisms and fungi are harbored under them, which increases hand carriage of microorganisms.²⁻⁴

References

1. Association of periOperative Registered Nurses. Guidelines for Perioperative Practice: Guideline for Surgical Attire. Published online Jan 2018. Accessed February 11, 2018. <http://www.aornstandards.org/content/1/SEC6.body>.
2. Porteous J. Artificial nails . . . very real risks. *Can Oper Room Nurs J*. 2002 Sep;20(3):16-17, 20-21.
3. Toles A. Artificial nails: Are they putting patients at risk? A review of the research. *J Pediatr Oncol Nurs*. 2002 Sep-Oct;19(5):164-171.
4. Pottinger J, Burns S, Manske C. Bacterial carriage by artificial versus natural nails. *Am J Infect Control*. 1989 Dec;17(6):340-344.

Each facility should have written policies and procedures to guide perioperative personnel in the specific techniques used for scrubbing and to comply with specific manufacturer's instructions for use. Figure 2-1, below, is an example of a policy and procedure that can be tailored for any institution. It outlines the requirements for the surgical scrub.

Figure 2-1. Surgical Hand Scrub Policy and Procedure

Purpose

To provide guidelines for operating theater personnel to perform the surgical skin preparation, to outline procedures to effectively complete the cleaning of hands and forearms before sterile attire can be donned, and to minimize the risk for surgical site infection by reducing the microbial skin count to a minimum, while leaving a long-acting antimicrobial residue.

Policy

All members of the surgical team must perform a surgical hand scrub before donning sterile gowns and gloves for a surgical procedure.

(continued on pages 22 and 23)

Figure 2-1. Surgical Hand Scrub Policy and Procedure (cont.)

Antiseptic Agents

- Antiseptic agents for the surgical hand scrub should be approved by the Infection Control Committee. Products may include the following:

Brushless:

- Chlorhexidine gluconate 1% solution plus ethyl alcohol 61%
- Ethanol 70% plus isopropanol 5%

Scrub with Water:

- PVP iodophors scrub solution
- CHG (Chlorhexidine gluconate) scrub solution

Methods of the Surgical Hand Scrub

Anatomic Timed Scrub:

- The scrub may be for 5 minutes or 10 minutes.
- The 5-minute scrub provides a 2½-minute scrub per arm.
- The 10-minute scrub provides a 5-minute scrub per arm.

Counted Stroke Scrub:

- The scrub person counts the number of strokes for each area, 15 strokes per area.
- The person should consider each anatomic part—arms, fingers, and hands—to have four sides.
- This method assigns a number of strokes (15) with the scrub brush for each of these surfaces.

Brushless (Hand Rub) Scrub:

1. Wash hands and forearms with soap and running water immediately before starting the surgical hand antisepsis procedure.
2. Clean the subungual areas of fingers under running water using a nail cleaner.
3. Rinse hands and forearms under running water.
4. Dry hands thoroughly with a paper towel.
5. Dispense the manufacturer-recommended amount of the surgical hand rub product.
6. Apply the product to the hands and forearms, following manufacturer's written instructions. Some manufacturers may require the use of water as part of the process.
7. Rub thoroughly until dry.
8. Repeat the product application process if indicated in the manufacturer's written instructions.

General Procedure for the Surgical Hand Scrub

Preparation:

1. Remove jewelry, including watches, bracelets, and rings, as they may harbor microorganisms.
2. Wear appropriate surgical attire, including head covering that covers hair (including sideburns and neckline), a mask that covers the nose and mouth, protective eyewear or face shield, shoes that provide protection.
3. Fingernails should be short, clean, and healthy. Artificial nails are not permitted for any health care personnel having direct contact with patients.
4. Cuticles, hands, and forearm are free of open lesions and breaks in the skin.

Figure 2-1. Surgical Hand Scrub Policy and Procedure (cont.)

5. An effective antimicrobial surgical hand scrub agent approved by the Infection Control Committee is used for the surgical hand scrub.
6. The surgical hand scrub procedure is standardized—anatomical timed scrub, counted stroke scrub, or the brushless hand rub/scrub.

Procedure:

1. Roll sleeves of scrub top to at least 3 inches above the elbow, and tuck scrub shirt into scrub pants.
2. Open the sterile scrub brush package and position it for easy access.
3. Adjust the water to a comfortable temperature and flow to prevent spraying scrub attire. Water is controlled with knee panel on sink.
4. Wet hands and forearms.
5. Lather hands and forearms 2 inches above the elbows, using an antimicrobial soap. This loosens the surface debris and removes cross-contamination.
6. Rinse hands and arms while keeping fingers pointed upward so water drips at the elbows away from the scrub attire.
7. Dry hands and arms thoroughly with paper towels.
8. Remove nail cleaner from package; clean under nails of both hands using nail cleaner while holding hands under running water. Discard nail cleaner.
9. Rinse hands.
10. Remove scrub brush and squeeze it under water to dispense soap (if brush contains soap), or apply soap from dispenser.
11. Avoid contact with faucet or sides of sink. If contact occurs, the scrub procedure must be started again using a new brush.
12. Using either the anatomic timed scrub or the counted stroke method, hold the brush perpendicular to the fingertips and scrub the nails, scrub the fingers using a back and forth motion on all four sides of each finger, pay attention to the webbed spaces of each hand, bend the fingers to flatten the creases or knuckles while scrubbing. A clock should be visible when the timed scrub method is used.
13. Scrub the palm and the back of the same hand to the wrist using a circular motion.
14. Maintain the lather and ensure that friction is used on all skin surfaces and that the skin is sufficiently exposed to the antimicrobial agent.
15. Move to the arm: Scrub by mentally dividing the arms into thirds, each third having four planes. The first third is the wrist, the second third is the middle area, and the last third is the proximal third, which is about 2 inches above the elbow. Scrub for 15 strokes for each plane or 2 minutes.
16. Transfer the scrub brush to the other hand and repeat steps for scrubbing from fingertips to 2 inches above elbow.
17. Discard the brush into the waste container, dropping it in, keeping hands up and away from body.
18. Rinse hands and arms under running water, starting at fingertips and working toward elbow, keeping the hand upright and elbow in a downward position.

More information on the surgical hand scrub can be found in the AORN Standards for Surgical Attire.²⁴

Preparing the Surgical Site to Minimize Patient Exposure to Microorganisms

Hair Removal

Studies have demonstrated that preoperative shaving compared with clipping and use of depilatory cream can increase the risk of surgical site infection.^{12,710} Hair has been left in place for neurosurgery procedures without any increase in the risk of SSI. The patient should be directed not to shave or use a depilatory on the surgical site for one week prior to surgery. Shaving hair at the surgical site can abrade the skin surface and facilitate microbial invasion. In addition, depilatory creams may cause skin reactions in some individuals, which could result in cancellation of surgery. Alternatives to hair removal for head and neck surgery include braiding the hair or using a nonflammable gel to keep the hair away from the incision. If the hair will interfere with the surgical procedure, the following precautions should be taken:

- Hair removal should be performed the day of surgery, in a location outside of the operating or procedure room.
- Only hair that will interfere with the surgical procedure should be removed.
- Hair should be clipped using a single-use electric or battery-operated clipper, or a clipper with a reusable head that can be disinfected between patients.

Clipping the hair outside the operating theater minimizes the dispersal of loose hair and therefore the potential for contamination of the sterile field and/or the surgical wound. If it is necessary to remove hair in the operating theater, hair should be contained, such as via a combined clipper/vacuum device.⁴⁰ During use, the clipper handle and head can become contaminated with the patient's skin flora. Therefore, the clipper head should be disposable, and the clipper handle disinfected between patients.⁴⁰

Surgical Site Skin Antisepsis

Antiseptics for skin preparation are important to reduce debris and transient and resident flora. The preparation of the patient's skin is usually performed just after the initiation of anesthesia and clipping of any hair, and before the patient is covered with sterile drapes. Although there is not universal agreement on the most effective skin antiseptic to use to prevent SSIs,^{2,41-45} it is generally agreed that the most effective surgical skin preparation solutions are dual agent, containing alcohol plus another antiseptic such as chlorhexidine or iodine, which provides rapid, persistent, and cumulative antimicrobial action.¹⁴⁵ (When alcohol is not available, chlorhexidine may be the agent of choice.) The most current CDC SSI prevention guidelines support this as a strong recommendation, stating: "Perform intraoperative skin preparation with an alcohol-based antiseptic agent unless contraindicated."¹⁰ The WHO panel also recommends strongly the use of an alcohol antiseptic solution based on CHG (chlorhexidine gluconate) surgical site skin preparation for patients undergoing surgery.⁷

All patients should be evaluated for skin sensitivities or allergies before applying skin antiseptic agents. This can be covered in the preoperative assessment. All products used should meet applicable government agency standards or requirements and should always be used per manufacturer's directions. Research from current standards from government agencies, recommendations from professional organizations, manufacturers' recommendations, and guidance from the facility's infection prevention and control committee should be incorporated into discussions and decisions about the organization's selection of skin antiseptics for surgical site skin preparation. When selecting a skin antiseptic agent, consider the following qualities, which the agent should have:

- Nonirritating
- Broad-spectrum activity
- Ability to act rapidly
- Persistent effect
- Resistance to being washed away or inactivated by blood and/or saline

Table 2-5, below, lists antiseptic agents and their mechanism of action, rapidity, and other characteristics. Table 2-6 on page 26 offers additional information about commonly used antiseptic agents, including advantages and disadvantages of each. These two tools should provide guidance to personnel selecting the antiseptic agent(s).

Table 2-5. Mechanism and Spectrum of Activity of Antiseptic Agents Commonly Used for Perioperative Skin Preparation and Surgical Scrubs

Agent	Mechanism of Action	Gram-Positive Bacteria	Gram-Negative Bacteria	Mtb	Fungl	Virus	Rapidity of Action	Residual Activity	Toxicity	Uses
Alcohol	Denature proteins	E	E	G	G	G	Most rapid	None	Drying, volatile	SP,SS
Chlorhexidine	Disrupt cell membrane	E	G	P	F	G	Intermediate	E	Ototoxicity, keratitis	SP,SS
Iodine/Iodophors	Oxidation/substitution by free iodine	E	G	G	G	G	Intermediate	Minimal	Absorption from skin with possible toxicity, skin irritation	SP,SS
PCMX	Disrupt cell wall	G	F*	F	F	F	Intermediate	G	More data needed	SS
Triclosan	Disrupt cell wall	G	G	G	P	U	Intermediate	E	More data needed	SS

Abbreviations: E, excellent; F, fair; G, good; Mtb, *Mycobacterium tuberculosis*; P, poor; PCMX, para-chloro-meta-xyleneol; SP, skin preparation; SS, surgical scrubs; U, unknown

Source: Mangram AJ, et al. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol*.1999 Apr;20(4):250-278.Used with permission

Table 2-6. Skin Preparation (Antisepsis) Product Characteristics

Antiseptic	Mechanism of action	Onset	Advantages	Disadvantages
Aqueous iodophor	Free iodine–protein, DNA damage	Intermediate	Excellent gram + activity, good gram - virus activity, broad spectrum	Minimal persistent and residual activity. Decreased effectiveness in the presence of blood and organic material. Two step application—scrub and paint.
	Denatures protein, free iodine–protein, DNA damage	Rapid	Excellent gram + activity, excellent gram - activity, broad spectrum	Highly flammable. Must completely dry before drapes are placed.
Aqueous chlorhexidine-gluconate (CHG)	Disrupts membranes	Intermediate	Excellent activity for gram + good for gram - and virus	Inactivated in the presence of saline. Contraindicated for use on eyes, ears, brain, spinal tissue, genitalia, and mucous membranes
Alcohol-CHG	Denatures protein, disrupts membranes	Rapid	Good gram - and fungal activity	Highly flammable. Must completely dry before drapes are placed.
Parachoro-xyleneol (PCMX)		Moderate	Good gram - and gram activity - activity, broad spectrum. Remains effective in the presence of blood, organic materials, and saline.	Less effective than CHG and iodophors. Available data are insufficient to classify as safe and effective for surgical skin preparation.

Considerations when preparing to apply skin antiseptic to the incision site include the following:

- Before performing antisepsis, the patient's skin should be inspected to assess its condition.⁴⁵ The skin should be free of soil, debris, emollients, cosmetics, and alcohol-based products. Jewelry at or near the incision area should be removed before antisepsis is performed.
- Areas of greater contamination (for example, the umbilicus, foreskin, under nails, intestinal or urinary stoma) in the surgical field should be cleansed before preoperative patient skin antisepsis is performed.
- The correct operative site should be confirmed to avoid preparing the wrong skin site and contributing to wrong-site surgery.
- The surgical site should be marked with an alcohol-based marker and should not be washed off during skin preparation so that the mark remains visible after the preoperative skin preparation.

An example of a procedure for applying the skin antisepsis is described in Sidebar 2-4, right.

Remember This: Perform all skin antisepsis carefully. (For patients with skin ulcerations or delicate skin, the skin antisepsis procedure should be performed particularly gently to minimize additional skin trauma.) See Box 2-7, below.

Box 2-7. Recommendations for the Perioperative Team Member Applying Skin Antisepsis⁴⁵

The perioperative team member should do the following:

- Perform hand hygiene before applying the preoperative patient skin antiseptic.
- Wear sterile gloves when performing preoperative patient skin antisepsis. Nonsterile gloves may be worn if the antiseptic applicator is of sufficient length to prevent contact of the gloved hand with the antiseptic solution and the patient's skin.
- Wear surgical attire that covers his or her arms while performing preoperative patient skin antisepsis.
- Use sterile supplies to apply preoperative patient skin antiseptics.
- Ensure that items that touch the patient's skin after preoperative skin antisepsis are sterile.
- Staff applying skin antisepsis should follow manufacturer's recommendations for application technique, timing and any other directions based on the agent being used.

Note: Some of these recommendations may not be supported by scientific studies, and additional research is needed.

Reference

1. Association of periOperative Registered Nurses. Guidelines for Perioperative Practice: Guideline for Surgical Attire. Published online Jan 2018. Accessed February 13, 2018. <http://www.aornstandards.org/content/1/SEC6.body>.

Sidebar 2-4. Process for Applying the Antiseptic Agent to the Incision Site

- An effective process for preparing the skin involves applying the antiseptic agent properly.
- Begin at the incision site, and move outward to the periphery, using a single-application applicator or sponge.
- Use a new applicator or sponge for each application of the agent.
- Prepare the size of an area that is larger than the opening (fenestration) of the surgical drape and any anticipated shifting of the drape during the procedure.
- Include in the preparation zone or region an area surrounding the incision site that may be used for drains and additional incisions.
- Prepare body areas with high counts of microorganisms last.
- Cover and isolate the incision site with a sterile drape any highly contaminated site(s), such as a colostomy, which is not part of the surgical procedure.
- In cases where the incision site is more contaminated than the surrounding skin, the skin-preparation solution should be applied from the least-contaminated area (surrounding skin) to the most-contaminated area (incision site).
- Personnel performing skin preparation should follow manufacturer's instructions regarding the correct procedure to apply the agent and the amount of time required for drying.
- Use the appropriate skin exposure and drying time for maximum effectiveness of all antiseptic agents.

Note: Skin preparation agents have the potential to cause harm to the patient. Measures should be taken to avoid chemical burns, irritation, or trauma on the skin and to avoid fires that result from pooling of the skin preparation solution and prolonged contact with the skin.

Although CHG solutions with high concentrations of alcohol are contraindicated for surgical preparation of the vagina, solutions with low concentrations of alcohol (for example, 4%) are both safe and effective for off-label use as vaginal surgical preparations and may be used as an alternative to iodine-based preparations in cases of allergy or when preferred by the surgeon!¹

Reference

1. American College of Obstetricians and Gynecologists, Committee on Gynecologic Practice. Committee Opinion No. 571: Solutions for Surgical Preparation of the Vagina. Sep 2013. (Reaffirmed: 2015.) Accessed Aug 11, 2017. <https://www.acog.org/-/media/Committee-Opinions/Committee-on-Gynecologic-Practice/co571.pdf?dmc=1&ts=20170629T0138418639>.

Maintaining the Sterile Field

When the surgical staff have completed the surgical scrub procedures, they will don their surgical attire in an area removed from the instrument table to avoid any contamination.

The following areas of the gown are considered sterile:

- Front of the gown from the chest down to the level of the sterile field
- Two inches above the elbows down to the cuff

All other areas of the gown, such as the back, neckline, shoulders, underarms, and sleeve cuffs, are considered nonsterile.

Inspecting Trays and Opening Sterile Instruments

As the scrub nurse prepares to set up the “back” table(s) and other surfaces such as Mayo stands, the trays of sterile instruments should be inspected to verify that the appropriate sterilization has occurred. External and internal indicators should be carefully reviewed to determine if they reflect that the instruments are sterile and that the sterilization process has been effective. The nurse should also look for any tears, unusual stains, or other indications of damage to the tray coverings or the prepackaged instruments. If defects are found, these packages should be returned to the Central Sterile Supply Department (CSSD) for replacement.

Patterns of Movement around the Sterile Field

When the staff have donned their sterile garb, they should remain close to the sterile field and move carefully around the sterile field to protect and to maintain it. There are prescribed movements used in the operating theater to minimize the risk of contaminating the sterile field. These include the following:

- Moving back to back or front to front when passing or going by another scrubbed person
- Keeping arms and hands above the level of the waist and in front of the body
- Personnel who have not completed the appropriate surgical hand scrub should refrain from walking between scrubbed personnel and the sterile field.⁴⁶

Sterile Drapes

After the skin is prepped, the sterile drapes are placed on the patient. The drapes are used to create a barrier between the sterile and nonsterile areas during the procedure. Drapes can be made of various materials, some with reinforced areas and others with adhesive qualities to try to reduce gaps and shifting of the drape during the procedure. WHO recommends that either sterile disposable nonwoven drapes, or sterile reusable woven drapes be used to prevent SSI and recommends against using plastic adhesive incise drapes with or without antimicrobial properties to prevent SSI. Studies have shown neither benefit nor harm for the patient when adhesive drapes are compared to non-adhesive drapes.⁷ Box 2-8, below, outlines some of the characteristics of drapes that the surgical team should consider.

Box 2-8. Drapes

Drapes should be resistant to penetration by blood and other body fluids; resistant to tears, punctures, and abrasions; able to maintain their integrity; and be consistent with accepted flammability standards. They should also be durable, flexible, and low linting, and have limited memory.

WHO Surgical Safety Checklist

The operating theater staff must ensure the safety of all patients. Implementing a safety checklist can help accomplish this critical requirement. Figure 2-2, below, features the WHO Surgical Safety Checklist that can be used in any operating theater. It has been shown to be effective in reducing errors in surgical care, including SSI.⁴⁷⁻⁴⁹

Figure 2-2. WHO Surgical Safety Checklist

Surgical Safety Checklist

World Health Organization
A World Alliance for Safer Health Care

Patient Safety
A World Alliance for Safer Health Care

Before induction of anaesthesia
(with at least nurse and anaesthetist)

Before skin incision
(with nurse, anaesthetist and surgeon)

Before patient leaves operating room
(with nurse, anaesthetist and surgeon)

Has the patient confirmed his/her identity, site, procedure, and consent?

 Yes

Is the site marked?

 Yes
 Not applicable

Is the anaesthesia machine and medication check complete?

 Yes

Is the pulse oximeter on the patient and functioning?

 Yes

Does the patient have a:

Known allergy?

 No
 Yes

Difficult airway or aspiration risk?

 No
 Yes, and equipment/assistance available

Risk of >500ml blood loss (7ml/kg in children)?

 No
 Yes, and two IVs/central access and fluids planned

Confirm all team members have introduced themselves by name and role.

Confirm the patient's name, procedure, and where the incision will be made.

Has antibiotic prophylaxis been given within the last 60 minutes?

 Yes
 Not applicable

Anticipated Critical Events

To Surgeon:

 What are the critical or non-routine steps?
 How long will the case take?
 What is the anticipated blood loss?

To Anaesthetist:

 Are there any patient-specific concerns?

To Nursing Team:

 Has sterility (including indicator results) been confirmed?
 Are there equipment issues or any concerns?

Is essential imaging displayed?

 Yes
 Not applicable

Nurse Verbally Confirms:

 The name of the procedure
 Completion of instrument, sponge and needle counts
 Specimen labelling (read specimen labels aloud, including patient name)
 Whether there are any equipment problems to be addressed

To Surgeon, Anaesthetist and Nurse:

 What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.

Revised 1 / 2009

© WHO, 2009

Source: World Health Organization. WHO Surgical Safety Checklist. 2009. Accessed Aug 11, 2017. <http://www.who.int/patientsafety/safesurgery/checklist/en/>. Used with permission.

Completing the Surgical Procedure

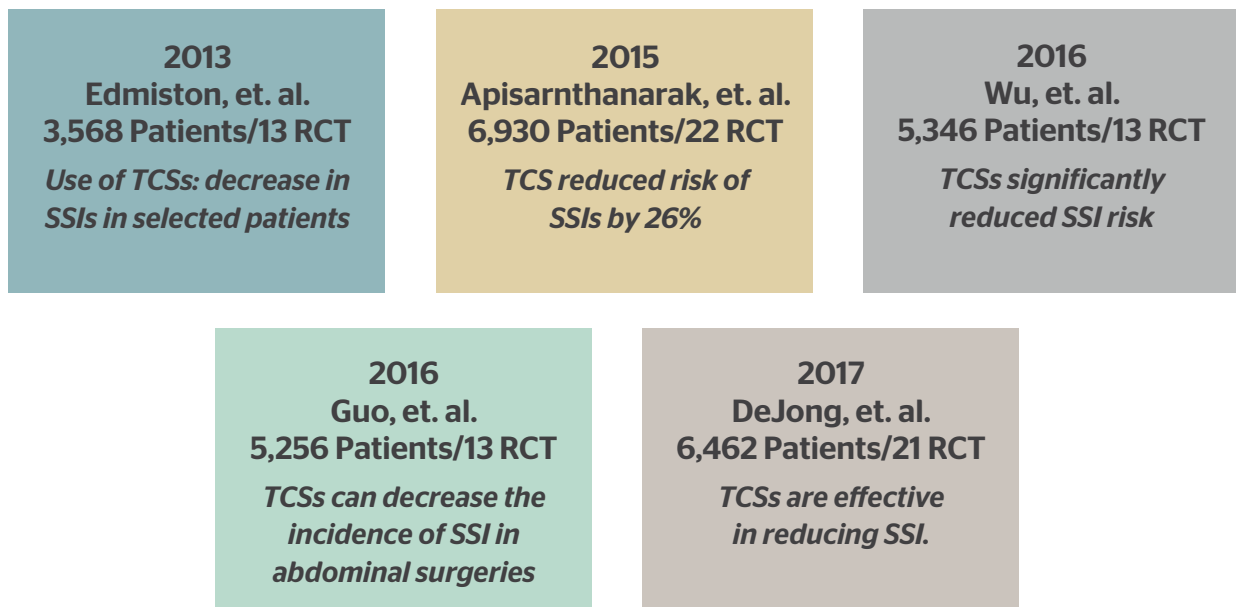
Changing Gloves and Using Separate Sterile Closure Trays

During the development of the 2016 WHO *Global Guidelines for the Prevention of Surgical Site Infection*, WHO reviewed and performed meta-analyses and randomized controlled trials (RCTs) to determine if changing gloves during surgery or changing surgical instruments before closure affected SSI. Although these are both common practices in some settings, WHO found that there was no strong evidence that they influenced SSI. Despite that finding, the two procedures seem logical, particularly in situations of contaminated wound surgeries such as colorectal surgery or peritonitis.⁷

Antimicrobial-Coated Sutures

One variable that may influence the incidence of SSIs is the type of suture used to close the wound. Sutures are important because bacteria can adhere to the suture material, which then becomes a nidus for bacterial growth and possible infection postsurgery. The development of sutures coated with the antiseptic triclosan has resulted in extensive testing during the past few years. Researchers wanted to determine if triclosan-coated sutures (TCS) were effective in reducing patient risk for SSI. The triclosan coating inhibits colonization of bacteria found on the surface of the sutures. In evaluating TCS, many meta-analyses have demonstrated a decrease in SSI in both adult and pediatric patients when antimicrobial-coated sutures were used, regardless of the type of suture (for example, braided or monofilament) and in some studies regardless of the type of surgery being performed.⁵⁰⁻⁵³ Figure 2-3, below, shows the results of selected meta-analyses from 2013 to 2017 analyzing the effect of TCS on risk of SSI.

Figure 2-3. Selected Meta-Analyses of Randomized Controlled Studies (RCT) on Triclosan-Coated Sutures (TCS) and Study Conclusions for Reducing Risk of Surgical Site Infection 2013-2017



References:

- Edmiston CE Jr, Daoud FC, Leaper D. Is there an evidence-based argument for embracing an antimicrobial (triclosan)-coated suture technology to reduce the risk for surgical-site infections? A meta-analysis. *Surgery*. 2013 Jul;154(1):89-100.
- Apisarnthanarak A, et al. Triclosan-coated sutures reduce the risk of surgical site infections: A systematic review and meta-analysis. *Infect Control Hosp Epidemiol*. 2015 Feb;36(2):169-179.
- Wu X, et al. Antimicrobial-coated sutures to decrease surgical site infections: A systematic review and meta-analysis. *Eur J Clin Microbiol Infect Dis*. 2017 Jan;36(1):19-32.
- Guo J, et al. Efficacy of triclosan-coated sutures for reducing risk of surgical site infection in adults: A meta-analysis of randomized clinical trials. *J Surg Res*. 2016 Mar;201(1):105-117.
- de Jonge SW, et al. Meta-analysis and trial sequential analysis of triclosan-coated sutures for the prevention of surgical-site infection. *Br J Surg*. 2017 Jan;104(2):e118-e133.

As a result of these scientific studies, the SSI prevention guidelines from the ASC/SSI, WHO, the CDC, and the Wisconsin Division of Public Health now all recommend considering the use of the coated sutures.^{2,7,10,31} The specific recommendations are found in Sidebar 2-5, right.

Concerns about the use of the antiseptic triclosan for possible toxicity have been addressed based on a comparison with the amount of antiseptic used for consumer products, such as for hand hygiene products. General consumer personal care products use nearly 10 times the amount of triclosan as do the sutures. In addition, the sutures are generally a short-term exposure, while consumer personal care products are often used for years. Triclosan has not been shown to promote bacterial resistance or allergic reactions.⁵⁴

The cost of the antimicrobial sutures is a consideration for some low-to middle-income countries. However, the cost may be offset by reducing SSIs and the associated costs of caring for patients who get these infections. In one study comparing patients with and without the coated sutures, there was a decrease in infection rate from 9.3% in the control group to 4.3% in the study group using coated sutures, and a decrease in cost for care of more than \$40,000 in the study group.⁵⁵

Edmiston et al. have suggested that the antimicrobial-coated sutures be used as one component of a multifaceted SSI prevention bundle.⁵⁶ Each surgical service and team of surgeons should review the current evidence-based literature and determine how they might use these new sutures to reduce SSI.

Wound Closure

Wound contamination occurs from (1) the ability of microorganisms to cause an infection, (2) host factors, and (3) the contamination of the wound with bacteria that enter the wound during or after the surgical procedure. In clean procedures, the wound is irrigated and then closed at the conclusion of surgery to limit the bacteria that could enter the surgical incision from the patient's endogenous skin flora. This is healing by primary intention. In healthy patients, a closed wound seals very quickly. Wounds expected to heal by primary intention are covered with sterile dressings generally for at least 24 to 48 hours. Incisional adhesives may be used to close wounds.

Note: Adhesive skin closures may be used in clean-contaminated and contaminated wounds to decrease the closure time, decrease erythema and edema, and provide greater comfort for the patient; give increased tensile strength to the wound; may result in less scarring results from puncture marks or cross-hatching produced by sutures or staples; and may reduce tissue trauma and increase patient comfort.^{57,58}

Sidebar 2-5. Recommendations from Organizations and Societies for the Use of Antimicrobial Coated Sutures

- American College of Surgeons / Surgical Infections Society, 2016 (published January 2017): *“Triclosan antibacterial suture use is recommended for wound closure in clean and clean-contaminated abdominal cases when available.”*²
- World Health Organization, 2016: *“The panel suggests the use of triclosan-coated sutures for the purpose of reducing the risk of SSI, independent of the type of surgery.”*⁷
- Centers for Disease Control and Prevention, 2017: *“Consider the use of triclosan-coated sutures for the prevention of SSI.”*¹⁰
- Wisconsin Division of Public Health: *“Use triclosan-coated antimicrobial sutures to close surgical wounds.”*³¹

(cont.)

When an incision is left open at the level of the skin for a few days after the surgical procedure, it is considered either delayed primary closure (DPC) or open wound management. These patients are likely to have a condition that would prevent closure, such as edema at the site or a “dirty” wound. In this situation, a sterile dressing may be packed into the incision, and wound healing occurs by secondary intention. However, DPC or open wound management places the patient at higher risk for SSI; many have highly contaminated wounds at the time of closure.² WHO suggests the use of prophylactic negative-pressure wound therapy in adult patients with high-risk wounds and primarily closed surgical incisions to address poor tissue perfusion, decreased blood flow, intraoperative contamination, and other events.⁷

Care of the wound after surgery, including drains, drainage, wound care, and dressing changes, is addressed in Chapter 3.

Managing the Surgical Patient with an Infection

Preparing the Patient and the Operating Theater Suite

Assessing the patient for the presence of infections and/or communicable diseases is an essential step in maintaining the patient's safety and health, as well as the health and safety of other patients and staff in the perioperative setting. Patients may enter the operating theater suite with infected draining wounds, an airborne infection, or an infection with a multidrug-resistant organism (MDRO). Table 2-7, below, highlights isolation requirements for patients with transmissible and communicable conditions.

Table 2-7. Risk Assessment and Isolation Requirements for Patients with Communicable Diseases

Suspected Disease/Condition	Isolation/Precautions Indicated	Items/Equipment Needed	Comments
Pulmonary tuberculosis	Airborne	Negative pressure operating theater Operating theater with anteroom Air cleaning devices with high-efficiency particulate filter (HEPA) N95 respirator mask	Schedule at the time of least activity in the operating theater. Allow sufficient time for airborne contamination to dissipate before staff enters to clean room. Terminally clean room at end of procedure.
Varicella (chickenpox)	Airborne and contact	Negative pressure operating theater Operating theater with anteroom Air cleaning devices with high-efficiency particulate filter (HEPA) N95 respirator mask Isolation gowns	Schedule at the time of least activity in the operating theater. Terminally clean room at end of procedure.
Multidrug-resistant organisms (MDROs), including MRSA, vancomycin-resistant Enterococci (VRE), extended-spectrum beta-lactamase (ESBL)-producing pathogens, and <i>Clostridium difficile</i>	Contact	Isolation gowns, gloves	Schedule at the time of least activity in the operating theater. Terminally clean room at end of procedure.
Creutzfeldt-Jakob disease (CJD)	Contact	Isolation gowns, gloves Disposable instruments and supplies whenever available Nonpowered drills and saws	Have available 1N (normal) sodium hydroxide (NaOH) for soaking instruments before sterilization.

MRSA, methicillin-resistant *Staphylococcus aureus*.

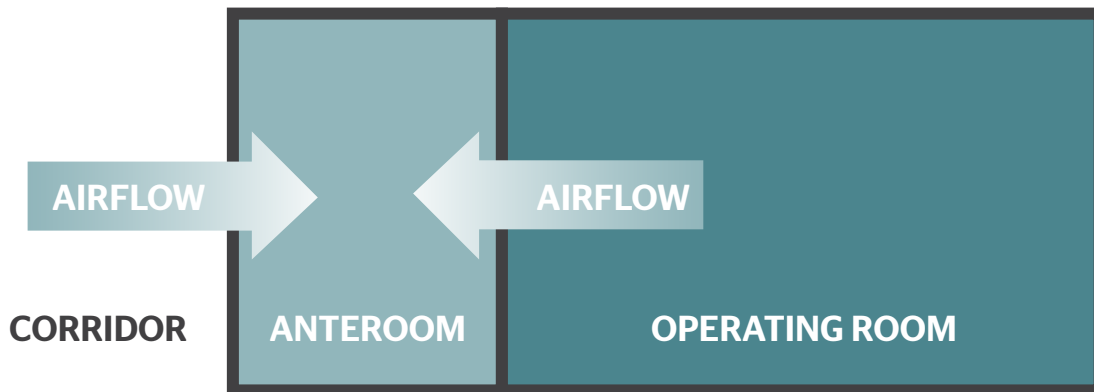
(cont.)

When procedures are performed on patients with airborne infections, such as pulmonary tuberculosis (TB), health care workers should wear particulate respirators (N95). Masks made of cotton, wool, gauze, or paper are ineffective against airborne infectious agents. The type of mask that should be worn varies according to the purpose for which it is being used and the situation in which it is used.

Different room configurations and ventilation parameters are required for patients presenting with some forms of airborne communicable diseases (such as TB or varicella). During the scheduling process and just before surgery in the preoperative phase, an assessment for communicable diseases should be completed and communicated to the surgical team. (Refer to Chapter 1.) This information will help ensure that the timing of the infected patient's surgical procedure is set to minimize his or her interactions with other patients and minimize exposure of staff. For example, a patient with pulmonary TB or a patient on contact precautions for an MDRO may be scheduled at the end of the day to reduce exposure to other patients, or certain isolation procedures may be carried out in the operating theater.⁵⁹

Environmental controls specific to caring for a patient requiring airborne isolation precautions include performing the procedure in an operating theater with an anteroom, if available. The anteroom can be used as a buffer zone in this positive-pressure setting. Some operating theater suites are built specifically to house surgical patients with airborne diseases. These suites may have anterooms that are situated with a positive airflow operating theater suite, but are negative to the hallway and have direct exhaust to the outside. This arrangement provides additional barriers to movement of contaminated air and provides staff with an area for preparation and care activities. If an anteroom is not available, using a room that meets the requirements for airborne isolation may be available in other parts of the organization. Figure 2-4, below, illustrates one configuration of an isolation room in an operating theater.

Figure 2-4. Configuration of an Isolation Room



Technologies capable of cleaning the air of TB bacteria (for example, high-efficiency particulate air [HEPA] filters) can be employed when available. However, caution must be used to ensure that devices are appropriately placed to achieve maximum effectiveness.

Predetermined institutional guidelines, and policies and procedures, allow the operating theater staff to efficiently and effectively implement the appropriate isolation procedures for addressing the condition of concern. Arrangements can range from implementing contact isolation precautions to addressing MDROs⁶⁰ or implementing airborne precautions to address a patient presenting with *Mycobacterium tuberculosis*.⁶¹ Box 2-9, below, provides guidance for staff on the management of surgical patients with tuberculosis, varicella, or other airborne communicable infections.

Box 2-9. Patients with TB, Varicella, or Other Airborne Communicable Infections

- Preventing the transmission of TB or other airborne infections when an infected patient needs surgery requires a high level of coordination that the surgical team must forge with the entire health care delivery team.
- Pulmonary and laryngeal TB require airborne isolation. A diagnosis of extrapulmonary TB in a patient who requires surgery does not call for isolation because the infection site is not in the pulmonary system.
- Additional safeguards should be implemented if extrapulmonary TB (such as skin abscess) is subjected to pulse irrigation during the surgical procedure.
- Aerosols are likely to be generated during pulse irrigation, bringing the potential for the spread of the TB bacteria.
- If pulse irrigation is planned for an extrapulmonary TB lesion, airborne isolation precautions should be instituted.
- Communication with nurses, physicians, environmental services staff, engineering staff, and others is key to successfully and safely caring for the patient.
- When the need for implementation of airborne isolation is established, the operating theater team can implement the requisite administrative, environmental, and respiratory protection controls before, during, and after surgery.

Administrative Controls for the Infected Surgical Patient

Administrative controls are leadership imperatives that encompass scheduling the infected patient when a minimum number of health care workers and patients are present.

- Patients with TB or other airborne infections should be scheduled as the final case of the day to minimize additional disruptions in the daily schedule (see Box 2-10, below).
- Increased time may be needed for cleaning the room, as it takes time for the staff to don the appropriate personal protective wear.
- It is critical to ensure that the correct number of air changes occur in the isolation surgical room to ensure that any potentially airborne agent is evacuated.
- These precautions should be applied whenever it is determined that additional procedures must be implemented to protect both other patients and staff from the transmission of infection.

Box 2-10. Situations When Surgical Procedures Should Be Performed at the End of the Day

- Patient diagnosed or suspected with an airborne-spread disease/condition requiring *airborne isolation* precautions (for example, varicella [chicken pox], tuberculosis)
- Patient diagnosed or suspected with an MDRO requiring *contact isolation* precautions (for example, MRSA, vancomycin-resistant Enterococci (VRE), extended-spectrum beta-lactamase (ESBL)-producing pathogens, and *C. difficile*).

Administrative controls also involve having the patient bypass the holding area when the diagnosis requires airborne isolation precautions. This process should be established before or at admission. The patient should go directly from his or her room or from the admitting area into the operating theater suite where the procedure will be performed. In addition, at the end of surgery, the patient should be recovered in the surgical procedure room in the operating theater and then transferred directly to either an appropriate isolation room, a designated area in the postanesthesia care unit/recovery room, or directly to the isolation room on the inpatient care area.

Respiratory Protection for Staff

For staff safety during care of a patient with a communicable disease: Each operating theater should have in place a written respiratory protection program for staff. The necessary supplies and equipment should be made available by leadership. Table 2-8 and Table 2-9, below, can be used to assess, evaluate, and implement a respiratory protection program for the operating theater. These tables are also found in Chapter 1.

Table 2-8. Respiratory Protection Program

Elements	In Place		Action
	YES	NO	
Program administrator	YES	NO	
Selection of an appropriate respirator for staff	YES	NO	
Medical evaluation of the respirator users	YES	NO	
Fit testing of tight-fitting respirators	YES	NO	
Use of respirators in routine and foreseeable emergency situations	YES	NO	
Procedures and schedules for respirator disposal, cleaning, disinfecting, storing, inspecting, and repairing	YES	NO	
Training employees in respiratory hazards and appropriate respirator use	YES	NO	
Evaluation of respiratory protection program annually	YES	NO	

Reviewed by:

Date:

Table 2-9. Respiratory Protection Checklist

Elements	In Place		Date Expected
	YES	NO	
Are the available respirators appropriate for the hazard expected?	YES	NO	
Have all personnel received medical clearance to wear the respirators?	YES	NO	
Have all personnel been fit tested and certified to wear the respirators?	YES	NO	
Are disposable respirators being disposed of in the appropriate containers (wet/soiled)?	YES	NO	
Are reusable respirators cleaned, disinfected, and appropriately stored after each use?	YES	NO	
Is there a written respiratory protection plan/policy/procedure?	YES	NO	
Is the plan/policy/procedure readily available to all personnel?	YES	NO	
Are personnel fit tested annually?	YES	NO	

Reviewed by:

Date:

For patients with airborne communicable diseases, a disposable bacterial filter should be placed between the anesthesia circuit and the patient's airway while in the surgical suite. Also, the door to the operating theater in which the procedure is in progress should remain closed. If pulse irrigation is anticipated in patients with extrapulmonary TB, staff members must also wear the appropriate respiratory protective equipment (N95 respirator).

Airborne isolation precautions must be implemented in the operating theater when caring for patients suspected of or confirmed with TB or other communicable airborne infections. For example, it is best for operating theater personnel who are immune to varicella to care for these patients. However, if that is not possible, strict respiratory protective devices (such as the N95 respirator type mask) must be used. The institution should develop and implement a respiratory program that includes the N95 type respirator mask for use when caring for patients with TB. The "N95" designation means that the respirator blocks at least 95% of very small test particles, providing added protection from airborne microorganisms to staff members. If properly fitted, the filtration capabilities of N95 respirators exceed those of face masks. N95 respirators are not designed for people with facial hair because a proper fit cannot be achieved. A powered air purifying respirator (PAPR) is an acceptable alternative for staffers with facial hair. Both N95 masks and PAPRs come in various sizes and should be fitted to the individual's facial size.

People with chronic respiratory, cardiac, or other medical conditions that make it hard to breathe should check with their health care provider before using an N95 respirator because the device can require more effort to breathe. A medical assessment program to assess and document fitness to wear the respirator should be developed. Personnel must be fit tested and receive certification for wearing the N95 respirator mask. In addition, personnel should be trained to perform a fit check every time the respirator is donned to ensure proper placement. Table 2-10, below, provides information on when to wear different types of masks.

Table 2-10. Protective Masks

Type of Mask	When to Wear	Comments
N95 or P2	Open/active pulmonary TB, pneumonic plague, SARS	Ideally recommended, but single-use, cost, and continuous availability may restrict use. In such situations, standard surgical masks may be worn.
N100 or P3	During invasive procedures, collection of respiratory secretions, laboratory work, and work in an environment where organisms in concentrated form may be encountered.	Ideally recommended; but the fact that filters need to be kept continuously available and can be used only once may mean that cost restricts use. In such situations, standard surgical masks may be worn.
Standard surgical splash-proof masks (not gauze mask)	Mainly when dealing with droplet infections; use for airborne infections when N95 masks are not available.	Change mask when wet, soiled, or contaminated. Do not reuse. Discard according to health care facility protocol.

TB, tuberculosis; SARS, severe acute respiratory syndrome.

Environmental Controls in the Operating Theater

Each surgical patient should be provided with a clean and safe environment. To that end, at the start of the day all horizontal surfaces, including the tables, surgical lights, and equipment in the room, should be damp-dusted with a clean, lint-free cloth. Also, after the patient is transferred from the surgical area, a clean environment should be reestablished to prepare for the next patient.

Environmental Cleaning in the Operating Theater

The operating theater should be cleaned with an approved, hospital-grade disinfectant.⁶² AORN states, All reusable noncritical, nonporous surfaces (e.g., mattress covers, pneumatic tourniquet cuffs, blood pressure cuffs, other patient equipment) should be cleaned after each individual patient use and according to the manufacturers' recommendations. High-touch areas, including control panels, switches, knobs, work areas, and handles, should be cleaned, and the floor and walls of ORs and procedure rooms should be cleaned and disinfected after each surgical or invasive procedure if soiled or potentially soiled as evidenced by the presence of splash, splatter, or spray during the procedure. Between-case cleaning is essential to provide each surgical patient with a clean environment. Terminal cleaning at the end of the day is addressed in Chapter 3.

It is important that only clean supplies be used in the operating theater. Mop heads, cleaning cloths, and other cleaning materials should not be reused between operating theater rooms. Some facilities have begun using microfiber cloths and mops for environmental cleaning. Microfibers are densely constructed, polyester and polyamide (nylon) fibers that are = a fraction of the width of a human hair. The density of the material enables it to hold six times its weight in water, making it more absorbent than a conventional mop. The positively charged microfibers attract dust, and the tiny fibers are able to penetrate the microscopic surface pores of most flooring materials. These characteristics make microfiber an effective cleaning material.⁶³ Note the precautions that must be followed when using microfiber cloths. See Sidebar 2-6, below.

Sidebar 2-6. Reusable Microfiber

Reusable microfiber must be used with care. Laundering reusable microfiber must follow the prescribed protocol from the manufacturer. For instance, if rinsing is not sufficient, cloths will remain contaminated. In addition, lint from the washing machine and other fabrics can plug microfiber channels, reducing their cleaning efficacy. And maximum dryer temperature must not exceed 140°F (60°C). For these reasons, disposable microfiber cloths and mops may be safer in a critical environment such as the operating theater. In low- and middle-income countries, health care organizations may not have the resources to use disposable microfiber cloths or mops, in which case directions for care of the materials should be followed carefully.

If microfiber cloths are not available, acceptable substitutions are lint-free cotton or polyester cloths that can be laundered. The figure below shows microfiber material and microfiber mop bucket.

Traffic Patterns and Flow Zones

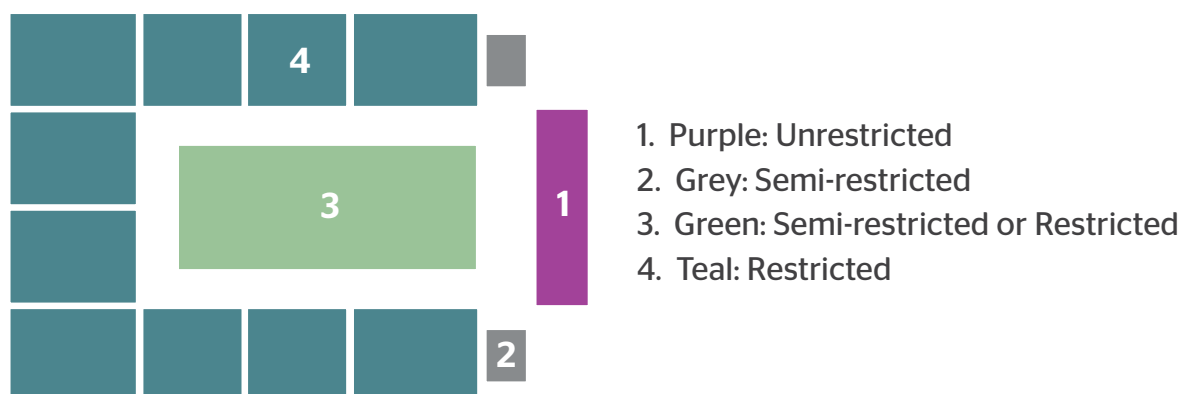
Another environmental control is the traffic patterns and traffic flow in the operating theater. This was also discussed earlier in the chapter in relation to the clothing worn by staff. When the surgery has begun, managing traffic flow is important to reduce air turbulence, which can disrupt and resettle any particulates on horizontal surfaces, which may then become laden with microorganisms. Traffic flow is managed by limiting the number of personnel who enter and exit the operating theater. Managing traffic is particularly critical when performing surgery on patients who require isolation precautions; are having a device implanted, such as a total joint replacement; or are having a long spinal procedures.

Key points for managing traffic flow in the operating theater include the following:

- The door to the surgical room should be kept closed.
- The number of people entering and exiting should be kept to a minimum.
- Opening and closing the door can disrupt the air-pressure balance, which can increase dust particles and microorganisms in the air.
- Ensure that all anticipated supplies, equipment, and personnel are in the room when the procedure starts.
- Less traffic reduces the risk for accidental contamination of sterile supplies.

Each facility should have a policy to address these special situations and should monitor compliance. Figure 2-5 below shows one example of traffic zones in an operating theater. Traffic zones may vary depend on how the operating theater is organized but most have the 3 zones shown in the figure. The appropriate behaviors and attire for each zone should be written in policy. The attire for each zone is discussed in Table 2 -10 on page 38. Attire for each zone is discussed in Chapter 1.

Figure 2-5. Traffic Patterns in the Operating Theater



Ventilation and Humidity in the Operating Theater

Ventilation and humidity are key factors in reducing risk of infection in the operating theater. Surgical procedure rooms should be kept at positive pressure in relation to the hallways outside the room to avoid having potentially contaminated air enter the surgical suite. There should also be a minimum of 15 air exchanges per hour as best practice in the surgical suite. Humidity must be kept at a certain level to prevent the growth of molds and fungi. The Facility Guidelines Institute (FGI) recommends the operating theater should be maintained at 68°F to 75°F (20°C to 24°C) temperature and at 20% to 60% humidity with positive pressure to adjacent areas, as well as a minimum of 20 changes of filtered air per hour, with 4 of the changes consisting of outdoor air.⁶⁴ (See Table 2-11, below.)

Table 2-11. Risks from Equipment in the Operating Theater

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ACH	Minimum Total ACH	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
SURGERY AND CRITICAL CARE							
Operating theater (Class Band C) (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Operating/surgical cystoscopy rooms, (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Delivery room (Caesarean) (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Substerile service area	NR	2	6	NR	No	NR	NR
Recovery room	NR	2	6	NR	No	20-60	70-75/21-24

Source: Adapted from Facility Guidelines Institute. *Guidelines for Design and Construction of Health Care Facilities*, 2010 ed. Chicago: American Society for Healthcare Engineering, 2010. ACH, air exchange per hour; NR, no requirement.

Notes explaining the letters are found in additional tools at the end of the chapter.

Equipment Risks in the Operating Theater

Equipment and supplies in the OT must continually be evaluated as potential risk points for infection. A recent example illustrates this point. Outbreaks have occurred in both Europe and the US from heater-cooler devices used during cardiac surgery to maintain optimal body temperature during and following the procedure. Water is pumped through the machine to cool or warm the patient. The water creates droplets that when exposed to the atmosphere create a bio-aerosol and are disseminated throughout the OT by means of exhaust and cooling fans. A number of patients became infected after cardiac surgery when the heater-cooler machines were used. In these events, the infected patients were theoretically contaminated from the aerosols from the machine. Some subsequently developed infections from *Mycobacterium chimaera* and other species of non-tuberculous *Mycobacterium*. These infections emphasize the need to use all equipment according to the manufacturer's instructions, identify which piece of equipment is used on which patient, have a checklist for cleaning and when using water, ensure it is filtered using a 0.2 micron filter.⁶⁴ At all times, perform careful SSI surveillance.

Staff Safety in the Operating Theater

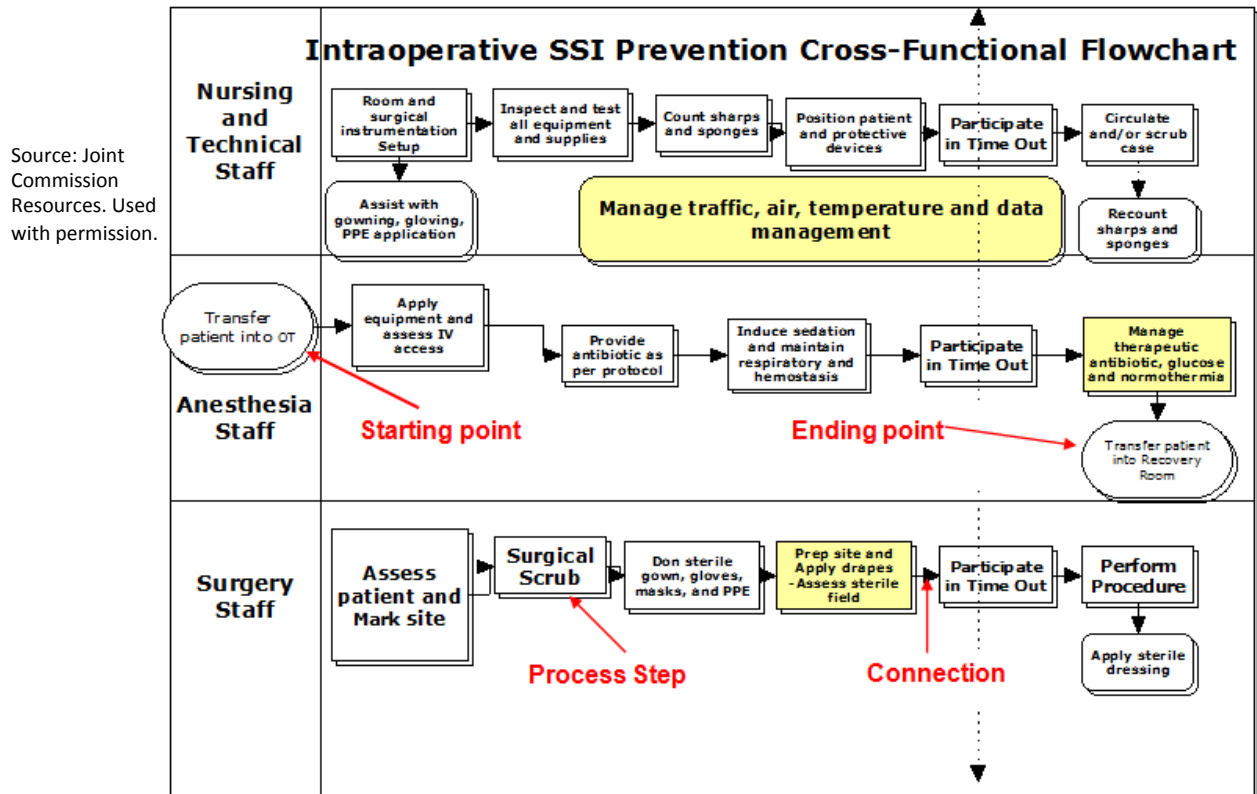
Preventing Sharps Injuries

Operating theater personnel may have contact with patient skin and/or mucous membranes during surgical procedures, and there is a risk to personnel of sharps injuries (for example, needlestick, lancet, or razor injuries during some procedures). Sharps injuries place staff at risk for exposure to bloodborne infections, including hepatitis B, hepatitis C, and the human immunodeficiency virus (HIV), the virus that causes acquired immunodeficiency syndrome (AIDS), and other pathogens (see Box 2-11, below). Studies indicate that about 80% of health care workers are affected by sharps injuries.⁶⁵ Overall, the number of health care workers who may be annually exposed to injuries from sharps contaminated with hepatitis B, hepatitis C, and HIV has been estimated to reach 926,000, 2.1 million, and 327,000, respectively, worldwide.⁶⁶ The United Kingdom's National Health Service (NHS) reported that the operating theater is the second most common site where sharps injuries occur.⁶⁷ A recent study in Saudi Arabia concluded that needle stick injuries are a continuing cause of exposure to serious and fatal diseases among health care workers and that more collaboration among stakeholders is needed to prevent such injuries and their tragic consequences.⁶⁸ Figure 2-6 on page 43 shows risk points for sharps injury by staff in the operating theater.

Box 2-11. Potential Pathogens Transmitted Through Sharps Injuries

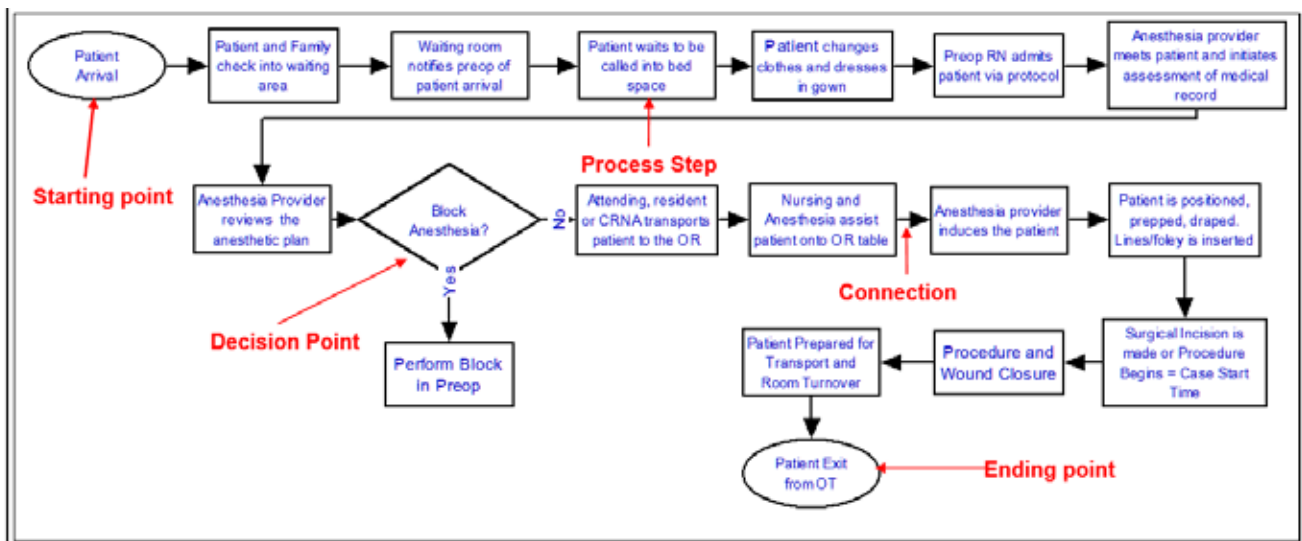
- Human immunodeficiency virus (HIV)
- T lymphotropic retroviruses (HTLV I and II)
- Hepatitis B virus (HBV)
- Hepatitis C virus (HCV)
- Hepatitis D virus (or delta agent)
- Hepatitis G virus (GB virus or GBV-C)
- Cytomegalovirus
- Epstein-Barr virus
- Parvovirus B19
- West Nile virus
- Malarial parasite
- Prion agents

Figure 2-6. Risk Points for Sharps Injury for Staff in the Operating Theater



OT, operating theater; PPE, personal protective equipment, IV, intravenous.

In this process flow chart, three groups of personnel are represented, Nursing and Technical Staff, Anesthesia and Surgical Staff. The orange boxes are risk points for sharps injuries as the surgical patient enters the operating theater and an IV is started and the procedure proceeds. Note that all staff participate in the Time-Out procedures. Below is a high level process flow map of the patient flow in the perioperative area.



Source: Joint Commission Resources, Oakbrook Terrace, Illinois.

The risk for injuries in the operating theater is greater during invasive procedures that last a long time and procedures that involve a lot of blood loss. Staff injuries are more likely to occur during situations such as the following:

- Passing sharps from one individual to another
- Blind suturing
- Using hollow bore needles
- Unsecured sharps on the surgical field (sutures and scalpel blades)
- Sharps falling from the surgical field
- Retracting or spreading tissue with the hand during dissection
- Disposal of sharps in an overfilled container

Strategies to reduce the risk for sharps injuries in the operating theater should be based on a framework of engineering controls and safe-work practice controls. Figure 2-7, below, presents a sharps injury risk-reduction audit tool using these practices.

Figure 2-7. Sharps Injury Risk-Reduction Practices Audit Tool

Issue	In Place		Comments
Lighting is adequate.	YES	NO	
Work space is tidy and organized.	YES	NO	
Hands-free sharps passing technique is used.	YES	NO	
Glove or instrument is used to pick up dropped instruments.	YES	NO	
Suture needle is removed before tying.	YES	NO	
Double gloves are worn.	YES	NO	
Gloves are periodically assessed for holes.	YES	NO	
The suture packet is used to load the needle holder.	YES	NO	
Safety devices are activated before disposal.	YES	NO	
Blunt suture needles are available.	YES	NO	
Blind suturing is not done.	YES	NO	
Hands are not placed in sharps container during disposal.	YES	NO	
During disposal, hands are placed behind the tips of sharps.	YES	NO	
Large sharps containers are available for the disposal bulky sharp items.	YES	NO	

For a culture of safety related to sharps, leaders must provide proven sharps safety devices whenever they become available in the marketplace. Leaders should enforce and monitor compliance with other reduction strategies for sharps injury prevention or initiate mitigation activities. Mitigation activities include the following:

- Double gloving for selected procedures
- Removing suture needles before tying
- Using gloves and/or instruments to pick up sharps from the floor
- Using a hands-free or neutral-zone technique to pass sharps and/or not recapping needles unless using a recapping device or laying the sharp on a flat surface and using a scooping motion to cap it.

Leadership in the Operating Theater and the Surgical Conscience

The operating theater leadership should foster and engender an environment of conscious concern by all team members for maintaining surgical asepsis and aseptic technique throughout the surgical experience. This can be achieved by developing and enforcing policies and procedures congruent with expectations and the philosophy of patient-centered care. All perioperative staff should act based on a surgical conscience and maintain surgical asepsis while the surgical procedure is in progress.

The Surgical Conscience

Surgical conscience can be described as maintaining an acute awareness of events and reporting any breeches or suspected breeches in aseptic technique with the knowledge, self-awareness, intelligence, and courage to make ethical and moral decisions that benefit the patient. In other words, if there is any doubt that a breach has occurred, the scrubbed personnel should be told and the glove or gown changed, or other corrective action taken immediately.

The operating theater leader (for example, the director, nurse manager, supervisor nurse, chief of surgery) is responsible for supporting a strong surgical conscience among the staff by emphasizing and expecting compliance to evidence-based practices, and by supporting staff members in acting on the principles of a surgical conscience, such as stopping a procedure if sterile technique has been breached, and by serving as a role model when in the surgical area. The case scenario in Box 2-12, below, demonstrates application of the surgical conscience by the surgical team.

Box 2-12. Case Scenario: A Surgeon's Support for Maintaining Sterility during a Procedure

The procedure, exploratory laparotomy with possible bowel resection, began 40 minutes ago. At the sterile field are the surgeon, Dr. Lina, her assistant, Dr. Hassan, and the surgical nurse, Mr. Nasser.

While Dr. Lina examines the bowels and Dr. Hassan holds the retractor in place, Mr. Nasser, the nurse asks that the light be adjusted. Dr. Hassan, still holding the retractor with one hand, reaches up with the other hand to grasp the sterile light handle to adjust the light. From his position three feet away, Mr. Nasser believes that Dr. Hassan has briefly touched the unsterile part of the light handle. He immediately says clearly, "Dr. Hassan, you have contaminated your glove." Dr. Hassan responds, "No, I touched only the light handle."

Dr. Lina, the chief surgeon, states, "Dr. Hassan, please step away from the sterile field." When Dr. Hassan steps away, Mr. Nasser removes his gloves and opens a new pair onto the sterile field. Mr. Nasser places the new sterile gloves on Dr. Hassan, who returns to the sterile field and the surgery continues safely. Dr. Lina's support to maintain sterility was important to patient safety, maintaining a surgical conscience, and teamwork.

Creating a Culture of Patient and Staff Safety

Operating theater leadership should foster a culture of safety in which personnel are expected to attend education and training on infection risk-reduction strategies and are encouraged to report hazards that may present a sharps or other injury risk. The environment must support patient safety practices, and each person must be accountable for his or her practice. In addition, the operating theater environment and leadership must support a no-blame just culture, where failures or mistakes (such as wrong-site surgery or incorrect antisepsis of skin) do not generate a blaming situation. Instead, the organization's culture should encourage staff members to analyze the mistake, review the system, and ensure that everyone learns from the error to reduce the chance of it happening again.

Summary

Caring for the patient during the intraoperative phase of the surgical process is challenging and complex. Staff must be aware of each patient's host characteristics, how they contribute to infection risk and how to intervene relative to modifiable factors to reduce or eliminate infections.⁶⁹ It is important to carefully prepare the patient for the surgical experience and during the intraoperative phase for the surgical procedure. In addition, the physical environment must be considered a potential reservoir of infectious agents and kept clean and sanitary. To accomplish all of these goals, the surgery personnel must function as a team with continuous vigilance to maintain the patient's safety at all times.

Discussion Questions for Intraoperative Staff

- Are the high risk factors for SSI being managed correctly during the intraoperative phase?
- Is the surgical antibiotic prophylaxis being given per hospital policy?
- How are blood glucose and normothermia being managed?
- How is blood loss being minimized?
- Are the operating theater staff wearing the appropriate PPE?
- Is skin antisepsis being performed correctly?
- Is access in and out of the operating theater suite minimized during the procedure?
- Are any razors being used for hair removal?
- Are trays of instruments inspected when opened for damage or contamination?
- What is the procedure for glove use during surgery? Double gloving? Changing?
- Is the environmental cleaning between cases and terminally being monitored?
- What type of sharps injury prevention processes are in place?
- Do all staff exhibit a surgical conscience?
- Is equipment being used according to the manufacturer's instructions?

Additional Tool

Ventilation and Humidity in the Operating Theater

Ventilation and humidity are key factors in reducing risk of infection in the operating theater. Surgical procedure rooms should be kept at positive pressure in relation to the hallways outside the room to avoid having potentially contaminated air enter the surgical suite. There should also be a minimum of 15 air exchanges per hour as best practice in the surgical suite. Humidity must be kept at a certain level to prevent the growth of molds and fungi. The Facility Guidelines Institute (FGI) recommends the operating theater should be maintained at 68°F to 75°F (20°C to 24°C) temperature and at 20% to 60% humidity with positive pressure to adjacent areas, as well as a minimum of 20 changes of filtered air per hour, with 4 of the changes consisting of outdoor air.⁶⁴ (See Table 2-12, below.)

Table 2-12. Temperature and Ventilation Requirements for the Operating Theater

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ACH	Minimum Total ACH	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/C°
SURGERY AND CRITICAL CARE							
Operating theater (Class Band C) (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Operating/surgical cystoscopy rooms, (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Delivery room (Caesarean) (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Substerile service area	NR	2	6	NR	No	NR	NR
Recovery room	NR	2	6	NR	No	20-60	70-75/21-24

Source: Adapted from Facility Guidelines Institute. *Guidelines for Design and Construction of Health Care Facilities*, 2010 ed. Chicago: American Society for Healthcare Engineering, 2010. ACH, air exchange per hour; NR, no requirement.

Notes for Table. Facility Guidelines Institute (FGI)

a. Except where indicated by a “No” in this column, recirculating room HVAC units (with heating or cooling coils) are acceptable for providing that portion of the minimum total air changes per hour that is permitted by Section 7.1 (subparagraph [a][5]). Because of the cleaning difficulty and potential for buildup of contamination, recirculating room units shall not be used in areas marked “No.” Recirculating devices with HEPA filters shall be permitted in existing facilities as interim, supplemental environmental controls to meet requirements for the control of airborne infectious agents. The design of either portable or fixed systems should prevent stagnation and short circuiting of airflow. The design of such systems shall also allow for easy access for scheduled preventative maintenance and cleaning.

- i.** Minimum total air changes per hour (ach) shall be that required to provide proper makeup air to kitchen exhaust systems as specified in ANSI/ASHRAE Standard 154.4 In some cases, excess exfiltration or infiltration to or from exit corridors compromises the exit corridor restrictions of NFPA90A,⁵ the pressure requirements of NFPA 96,⁶ or the maximum defined in the table. During operation, a reduction to the number of air changes to any extent required for odor control shall be permitted when the space is not in use. (See FGI [2010] in Informative Appendix B.)
- j.** In some areas with potential contamination and/or odor problems, exhaust air shall be discharged directly to the outdoors and not recirculated to other areas. Individual circumstances may require special consideration for air exhausted to the outdoors. To satisfy exhaust needs, constant replacement air from the outdoors is necessary when the system is in operation.
- k.** The RH ranges listed are the minimum and/or maximum allowable at any point within the design temperature range required for that space.
- l.** Systems shall be capable of maintaining the rooms within the range during normal operation. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those con
- m.** National Institute for Occupational Safety and Health (NIOSH) criteria documents regarding occupational exposure to waste an esthetic gases and vapors, and control of occupational exposure to nitrous oxide ⁷ indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized. Refer to NFPA 99 for other requirements.⁸
- n.** If pressure-monitoring device alarms are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube, or flutter strip shall be permitted for verification of airflow direction.
- o.** Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and/or air distribution methods that exceed the minimum indicated ranges.

Source: ASHRAE Table 7-1 Design Parameters. https://www.health.ny.gov/facilities/cons/docs/ashrae_table_7-1.pdf Accessed February 12, 2018

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Evidence-Based Principles and Practices for Preventing Surgical Site Infections



CHAPTER 3

Infection Prevention in the Operating Theater and Surgical Services: **The Postoperative Phase**

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Overview

Background

Approximately 187 to 281 million surgical procedures are performed worldwide each year—almost one surgical procedure for every 25 persons.¹ Most of these procedures result in good outcomes and improved health for the patients, but some do not. Surgical site infections (SSIs) are one of the undesirable and potentially very serious outcomes from surgery. The study cited above showed that in developed countries, 3% to 16% of surgeries resulted in major morbidity, and 0.4% to 0.8% in death.^{1,2} A report from the World Health Organization (WHO) in 2011 noted that in developing countries, the leading health care-associated infection, and the most frequently studied, is SSI. The WHO survey found that in low- and middle-income countries, the incidence rates of SSI ranged from 1.2 to 23.6 per 100 surgical procedures. This contrasted with rates between 1.2% and 5.2% in countries with more resources.³ Therefore, SSIs are a significant part of the historical, and current global public health issue of health care-associated infections (HAIs).

Brief History

The idea of preventing HAIs is reflected in the well-known admonition to physicians to “First, do no harm,” which is a cornerstone of the Hippocratic Oath.⁴ Infections that occur in association with care provided in hospitals and surgical clinics are challenging, because the patient did not have an infection upon entering the hospital or clinic but acquired it during or after a surgical procedure performed in these settings.

Historically, physicians did not understand why SSIs occurred and were not aware of the route of transmission of infection to man. They often attributed the cause of disease to “bad air,” “effluvia,” or “miasmas.” British surgeon Joseph Lister (1827-1912), a pioneer of antiseptic surgery, dramatically reduced HAIs in surgical patients. He believed that microbes might be responsible for infections and that by killing organisms in wounds he could prevent surgical infections and death. In his practice he used carbolic acid to “sterilize” dressings packed into the wounds of patients with compound fractures. He even soaked his fingers in carbolic acid, and sprayed the operating theater with the acid to kill germs in the air.⁵ Lister published his findings in 1867, and

the clear evidence of decreased infections in his surgical population was so compelling that his techniques gained acceptance over the next decades and his surgical asepsis principles remain foundational today in the operating theater.

Formerly, surgeons did not use personal protective equipment, such as gowns and gloves, when operating. This allowed transmission of organisms from staff to patient or vice versa. However, by 1910, sterile instruments, gowns, and gloves and masks were standard in many large teaching hospitals. The original use of rubber gloves was to protect the hands of the surgical team from carbolic acid, but the role of gloves in protecting patients from microorganisms on the hands of health care workers was eventually recognized, and gloves became standard garb where available. Eventually sterilizers were introduced, and they were fundamental to preparing sterile instruments and devices to help protect patients from surgical infections. In some clinics, staff silence during surgery was also required to limit bacterial contamination thought to be spread by talking. Some physicians began to keep records of infections and use active surveillance systems to track surgical infection trends.⁶

Today’s more sophisticated strategies for preventing wound infections take into account the host characteristics and risks, the technique of procedure, protective garb for staff, preparation of the patient, wound closure methods, the operating theater environment, and the disinfection and sterilization of the surgical instruments and supplies.

Overview

Although significant progress has been made in preventing and controlling infections, one of the limiting factors in preventing SSI is that different countries have unevenly implemented recommended prevention practices because of dramatic differences in their human and material resources, politics, and regulations. As a result, in addition to understanding and teaching best practices to prevent SSI, infection prevention and control professionals and health care epidemiologists have become more adept in understanding human behavior as to why proven practices are or are not adopted, the critical need for leadership and resources, and the effectiveness of teams in providing safer surgical care. They have also learned to use performance improvement and patient safety methods to enhance infection prevention practices that will reduce SSI.

Many current initiatives have endeavored to engage care providers in preventing SSI and will be discussed in this toolkit. For example, the WHO Safe Surgery Saves Lives challenge has helped reduce SSIs around the world.⁷ One of the WHO SSI prevention guidelines is the Surgical Safety Checklist to help reduce surgery-related infections and death. The checklist applies to the global population of patients in all phases of the perioperative experience. Newer guidelines from a variety of organizations have updated the science and evidence that should be used to make decisions about care. Many of these will be presented in this toolkit.

The Toolkit

This toolkit has four chapters. The three phases of the perioperative experience—preoperative, intraoperative and postoperative—form the majority of the content, and a chapter on patient safety and performance improvement strategies for surgical services completes the information. Each chapter presents the theory, science, and rationale for proven practices and practical tools to implement evidence-based best practices.

Chapters 1-3 focus on host characteristics and risks, processes and procedures, and education and safety of staff, patients, and families in each of the perioperative phases. Chapter 4 discusses patient safety principles and performance improvement methods and techniques and is supported by case studies and other practical examples.

References and resources are provided in each chapter. Current recommendations from groups such as WHO, the Centers for Disease Control and Prevention (CDC), Society for Healthcare Epidemiology of America (SHEA), American College of Surgeons (ACS), Surgical Infection Society (SIS), and others are referenced quite liberally throughout the toolkit.

The author and sponsors hope you find the toolkit valuable for your practice and your continuing efforts to reduce and eliminate SSIs for your patients and personnel.

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Introduction

Postoperative surgical care begins when surgery is completed and the patient leaves the operating theater suite to begin postoperative support. The patient is cared for immediately postoperatively, in a designated recovery area, such as a postanesthesia care unit (PACU), an intensive care unit (ICU), or a surgical nursing unit. The entire postoperative care phase may last for a few hours to several days or weeks to months, depending on the complexity of the surgery, the patient's condition after surgery, and postoperative events, such as an infection. The goal of postoperative care is to support the wound healing process, prevent complications, such as infection, and assist the patient to return to a healthy state.

Surgical site infections (SSIs) can result in considerable morbidity, mortality, and costs.¹ It is an ongoing challenge to effectively coordinate all the systems and variables that determine the surgical patient's outcomes. During the postoperative phase, the surgical team must continue to provide care begun in the preoperative and intraoperative phases.

This chapter reviews the host factors, procedural factors, and microbial factors that place surgical patients at risk for infection in the postoperative phase. The chapter discusses clinical protocols and best practices to minimize the effect of these risk factors and the exposure of the patient's healing wound to contamination during this time as well as educational support for the patients and families. Strategies for improving care processes and the roles of the staff and leaders during this time are reviewed. Reprocessing of surgical instruments and environmental concerns are covered.

Learning Objectives

After reviewing this chapter, the reader will be able to do the following:

1. Discuss intrinsic and extrinsic risk factors for infection in the postoperative phase.
2. Describe the postoperative risk assessment and strategies for optimizing health and preventing infection.
3. Discuss best practices for minimizing surgical wound contamination during the postoperative phase.
4. Describe key strategies for caring for the postoperative patient to decrease risk of SSI.
5. Identify educational opportunities for staff, patients, and families concerning infection prevention strategies in the postoperative care phase.
6. State methods to reduce infection risk to patients from the environment of care.
7. Discuss the key steps of reprocessing of surgical instruments.

Factors That Influence the Risk of Infection during the Postoperative Phase

Intrinsic Host Factors

As in all phases of the perioperative experience, host factors play important roles in the clinical outcomes of patients. Host factors have been reviewed in Chapters 1 and 2, covering the preoperative and intraoperative phases, respectively. Those host factors that may influence postoperative events are discussed briefly in Box 3-1 along with suggested interventions.

Box 3-1. Host Factors Influencing the Potential Risk for Surgical Site Infection in the Postoperative Phase I

Host Risk Factor	Intervention during the Postoperative Phase
Age	Continue assessments to monitor age-related postoperative infection risks.
Malnutrition	Provide nutrients, such as total parenteral nutrition (TPN) or total enteral nutrition (TEA).
Preexisting infections at remote sites	Continue treating any existing infections during the postoperative phase.
Smoking	Initiate smoking-cessation programs with education.
Underlying diseases and comorbid conditions	Maintain control of chronic conditions, such as diabetes mellitus (for example, control blood sugars).
Cancer	Maintain control of the effects of cancer during the postoperative phase. Boost immune status. Limit exposure to chemotherapy and other potential threats to the immune system.
Steroids	Administer during the postoperative phase, based on individual patient needs.

Extrinsic Risk Factors

During the postoperative phase, flora from exogenous sources can reach the wound in many ways and through various processes, including the following:

- Contact with the skin of colonized or infected people
- Lack of hand hygiene by staff
- Inadequate aseptic or sterile technique during postoperative care, such as during dressing changes
- Contaminated equipment or devices

Surgical Procedures and Risk Factors

In addition to patient host factors, procedural factors also influence SSI as an outcome after surgery. For example, patients having minor or “clean” procedures, such as hernia operations, are generally at lower risk for SSIs and may require only a few hours to a day of postoperative care, whereas those who have undergone lengthy and complex procedures, such as spinal or orthopedic surgery, may require days of care that extend well beyond the immediate postanesthesia recovery phase.

Surgical procedures that pose a significant risk of infection to the patient include the following:

- Those with long duration complexity and increased time for exposure to microorganisms
- Procedures in which the patient is exposed to bowel flora
- Abdominal surgeries that can interfere with the ability to cough to clear respiratory secretions
- Surgeries with extensive manipulation of tissues

A summary of other procedural and microbial factors affecting the development of an SSI are found in Box 3-2, below.

Box 3-2. Procedural and Microbial Factors Affecting the Onset of a Surgical Site Infection

Procedural Factors and State of the Wound	Microbial Factors
<ul style="list-style-type: none">• Length of surgery• Handling of tissues• Blood supply to wound• Type of wound closure—primary, secondary, delayed primary• Presence of foreign bodies (for example, dirt and debris from trauma)• Devitalized tissue (for example, gangrene)• Wound location and nature (for example, oral versus abdominal versus orthopedic)• Dead space• Hematoma or fluid accumulation• Presence of drains	<ul style="list-style-type: none">• Size of the inoculum of microorganisms• Virulence of the organism• Tissue adherence and invasion• Source of organisms: bowel flora and hands of health care personnel• Multidrug resistant

Source: Adapted from Mangram AJ, et al. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee *Infect Control Hosp Epidemiol.* 1999 Apr;20(4):250-278.

Each of these factors should be addressed as appropriate by the surgeon or the surgical team and, where applicable, interventions designed and implemented.

Prolonged Surgical Antibiotic Prophylaxis Following Surgery^{1,2}

The use of surgical antibiotic prophylaxis during the postoperative phase has been controversial. In the past, antibiotics have sometimes been continued for many days after the procedure. Currently, it is recommended that prophylactic antibiotics be discontinued at the time the incision is closed.^{1,3} Exceptions have been identified for surgeries that might benefit from longer postoperative prophylaxis. These include implant-based breast reconstruction, joint arthroplasty, cardiac surgery, and possibly other procedures.³ There is no evidence that in clean, clean-contaminated, and contaminated wounds antibiotic administration after the incision has been closed will decrease SSI risk.^{1,3} Some guidelines continue to recommend a stop time for antibiotics of 24 hours after surgery.^{4,5} Studies have demonstrated that patients who continue to receive prophylactic antibiotics for 48 hours or more after the incision are at risk for developing an antibiotic-resistant organism. Thus, negative outcomes in the postoperative phase of care, such as SSI, may be associated either with preoperative antibiotics that were not started within 1 hour prior to the incision or within 2 hours prior to incision for vancomycin and fluoroquinolones¹ or with extended use of the prophylactic antibiotics after the surgery is completed. It is recommended that antibiotics not be continued after surgery is completed even when a patient has a drain in place.¹

Types of Wound Closure

As described in the Chapter 2, on the intraoperative phase, the surgeon will determine how to close the wound following the procedure. The wound closure method will be determined by the condition of the wound, that is, clean, clean-contaminated, contaminated, or dirty. The type of closure will determine the risk to the patient from external contamination. Primary and secondary closures are discussed below in the section “Wound Healing and Dressings.”

Patient with a Drain

Some patients will have drains in place after the procedure to help eliminate fluid from the wound for better healing. These drains do not extend directly from the wound itself but are placed through a “puncture wound” near to but separated from the actual incision. This method helps reduce contamination from the drain to the wound. Drains are generally removed within a short time frame after the surgery, depending on the healing process. It is important to observe for any potential contamination of the wound that might be a result of draining fluids.

Caring for the Patient After Surgery

Assessing the Patient Postoperatively

It is particularly important during the postoperative phase to carefully assess the patient for factors that may increase the risk of infection. This assessment will inform the plan of care and be used to design interventions to reduce or to manage infection risks. Patient safety in the postoperative phase includes monitoring and assessing the functions of all body systems, such as the pulmonary, circulatory, neurologic, and urologic systems, and the surgical incision site.

During the immediate postoperative phase, the surgeon, anesthesiologist, nurse anesthetist, or perioperative nurse should report the patient's status to the PACU staff. The report is given when the patient enters the postanesthesia recovery unit or other location. This report provides the receiving staff with an overview of the patient's physiologic status at that time as well as the surgical procedure and the patient's anesthesia experience. Baseline vital signs, the status of the surgical site, and critical factors related to the patient's risk for infection should be conveyed. The report serves as the basis for a comprehensive postoperative risk assessment. The elements of a typical postoperative report are found in Box 3-3 below:

Box 3-3. Elements of Postoperative Report to Recovery Staff

- Type of surgery performed
- Number and location of drains
- Type of wound closure: staples, nylon sutures, adhesive strips, or tension sutures
- Expected amount of drainage
- Types of dressings: gauze, transparent semipermeable membrane, hydrocolloid, polyurethane foams, absorption dressing, hydrogel, impregnated dressings
- Surgical complications or challenges during the procedure
- Intravascular lines: number, type, and location
- Presence and location of any catheters
- Medical and treatment history as appropriate
- Serum glucose level
- Normothermia device in use
- Prophylactic antibiotic received (if any) and continuation/discontinuation order

Minimizing Contamination of the Wound Prior to Healing

The time for greatest risk for external contamination of the wound during the postoperative phase is early in the healing process. Thus, it is critical that staff caring for the wound use strict aseptic or sterile technique when examining the wound or changing dressings. It is also important to avoid wound colonization with multidrug-resistant organisms (MDROs) or other pathogens from exogenous sources by performing meticulous hand hygiene.

Table 3-1, below, outlines other prevention strategies for SSI in the postoperative phase. Many of these have been discussed previously in Chapter 1 (preoperative phase) and Chapter 2 (intraoperative phase).

Table 3-1. Strategies to Reduce SSI Risk in the Postoperative Phase

Colonization with MDROs	CHG bathing daily for 5-7 days postoperatively; consider decolonizing patient nose with nasal antiseptic product daily for 5-7 days post- op; encourage patient hand hygiene. Staff perform hand hygiene; use aseptic or sterile technique for dressing changes.
Glycemic control	Monitor patient's blood glucose, and use insulin protocol as necessary to maintain optimum levels.
Normothermia	Maintain normal temperature following surgery has been shown so decrease risk of SSI.
Hand hygiene employees	Use alcohol-based hand sanitizer (or wash with soap and water) before touching patient, changing dressing.
Patient hygiene	Begin daily patient bathing 12 hours post. Encourage frequent patient and family hand hygiene.
Environmental cleaning	Clean horizontal surfaces in patient zone three times a day while patient is in hospital; encourage same in home upon patient discharge.

SSI, surgical site infection; MDRO, multidrug-resistant organism; CHG, chlorhexidine gluconate.

Clinical Manifestations of Surgical Site Infections

SSIs are rarely evident during the immediate postoperative phase (the first few hours) but may emerge during a longer recovery time. Signs of infection generally emerge about 5 to 7 days after surgery but may not develop until up to 30 days or longer. When implants are used during surgical procedures, an SSI may not be evident until 90 days or even a year after the procedure.⁶ Clinical manifestations of SSIs are listed in Sidebar 3-1, right.

Personnel and Patient Hand Hygiene during the Postoperative Phase

Patient and health care worker hand hygiene are critical components of safe, patient care. Behavioral, environmental, and clinical factors influence adherence to hand hygiene recommendations in all health care settings, including the postoperative care environment. Health care workers perform hand hygiene in response to their patients' needs and their own personal safety and within the limits of their physical environments and the demands of their workloads. The World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), The Joint Commission's Center for Transforming Healthcare, and many national ministries of health actively promote campaigns to improve adherence to hand hygiene recommendations worldwide.⁷⁻¹⁰ Box 3-4 below describes activities to implement an effective hand hygiene program.

Sidebar 3-1. Clinical Manifestations of Surgical Site Infections

- Redness and/or excessive swelling, tenderness, or warmth of the incisional site
- Unexpected discharge (purulent or otherwise) and a foul smell
- Red streaks near the wound
- Increasing pain
- Body chills or fever
- Elevated pulse
- Swollen, painful lymph nodes near the wound area
- Fatigue, pain, anorexia, or mental status changes in the elderly
- Elevated white blood count

Source: Adapted from Mangram AJ, et al. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol.* 1999 Apr;20(4):250-278

Box 3-4. Effective Hand Hygiene Activities for Personnel and Patients

- Teach health care workers the rationale for hand hygiene (such as safety for staff), appropriate techniques, and indications
- Observe health care workers' hand hygiene performance and provide feedback to individuals and groups
- Educate patients about their hand hygiene and their expectations of health care worker hand hygiene practices
- Provide patients with hand hygiene products and instruction/reminders regarding use
- Implement engineering controls to ensure access to necessary supplies and equipment, such as sinks, soap and water, alcohol-based hand rub (ABHR), and single-use towels
- Provide environmental cues/reminders to perform hand hygiene, such as signs, notices, and instructions
- Establish a culture of safety with strong leadership support and expectations for hand hygiene, including role modeling by clinical leaders
- Reward adherence to hand hygiene recommendations and sanction lack of adherence
- Facilitate hand-skin health by providing lotions and creams for skin hydration
- Provide hand hygiene agents that support hand-skin health
- Enhance health care worker confidence regarding their abilities to adhere to hand hygiene recommendations
- Allow adequate time for hand hygiene

Personnel adherence to hand hygiene recommendations during the entire surgical experience, including the postoperative phase, is important. Patients who are exposed to microorganisms carried on the hands of postoperative staff may become colonized with these same organisms and potentially develop SSIs. To minimize the transmission of microorganisms from postoperative staff to their patients, postoperative areas should be designed to have an adequate number of hand-washing sinks and soap or antimicrobial soap dispensers and a sufficient number of ABHR dispensers. The CDC¹¹ and WHO⁷ have produced guidelines for performing hand hygiene in health care settings, and both provide Web-based resources to help health care organizations implement hand hygiene programs (see Sidebar 3-2, right).

WHO's *Guidelines on Hand Hygiene in Health Care* provides a comprehensive review of scientific data on hand hygiene rationale and practices and are intended to support training materials and implementation strategies in all health care organizations. Following is an overview of WHO Guidelines⁷:

- Perform hand hygiene before and after patient contact.
- Emphasize hand hygiene after the health care worker's gloves are removed.
- Use hand hygiene before insertion of all invasive devices, regardless of glove use.
- Use ABHRs or soap and water before handling medications.
- Remove visible dirt with soap and water prior to surgical hand preparation.
- Simplify soap terminology; do not differentiate between non-antimicrobial and antimicrobial soap, unless specified.
- Prohibit artificial nails for health care workers in all surgical and nonsurgical settings.
- Do not add soap to a partially filled soap dispenser. If dispensers must be reused, they should be cleaned thoroughly.
- Use ABHRs preferentially over soap and water unless hands are visibly soiled or patient has diarrhea. Use ABHRs for hand hygiene when water quality cannot be assured.
- Ensure that individual ABHR dispensers and their storage cabinets are flame retardant.
- Evaluate sink design to minimize risk of splashing and water contamination.
- Emphasize single-use (no reuse) of hand hygiene cloth towels by individuals.
- Encourage flexibility in the location of hand hygiene dispensers.
- Offer alternative hand hygiene products for health care workers with skin allergies or reactions.
- Implement a glove-reprocessing program for areas in which glove reuse may be necessary.

Sidebar 3-2. Web-Based Resources for Hand Hygiene

Centers for Disease Control and Prevention (CDC)

- *Hand Hygiene Resource Web Page* <http://www.cdc.gov/handhygiene/training/interactiveEducation/>. Accessed Feb 5, 2018.
- *Hand Hygiene in Healthcare Settings* <https://www.cdc.gov/handhygiene/index.html>. Accessed Feb 5, 2018.

World Health Organization (WHO)

- *WHO Guidelines on Hand Hygiene in Health Care* http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf
- *A Guide to the Implementation of the WHO Multimodal Hand Hygiene Improvement Strategy*: http://whqlibdoc.who.int/hq/2009/WHO_IER_PSP_2009.02_eng.pdf. Accessed Feb 5, 2018.

Gulf Cooperation Council

- *Educational Material: Hand Hygiene*: <http://www.icdkwt.com/education-resources.php>. Accessed Feb 5, 2018.
- *The Joint Commission Center for Transforming Healthcare Targeted Solutions Tool for Hand Hygiene*: https://www.centerfortransforminghealthcare.org/tst_hh.aspx. Accessed Feb 5, 2018.

Box 3-5, below, describes the WHO's five essential components of hand hygiene programs.

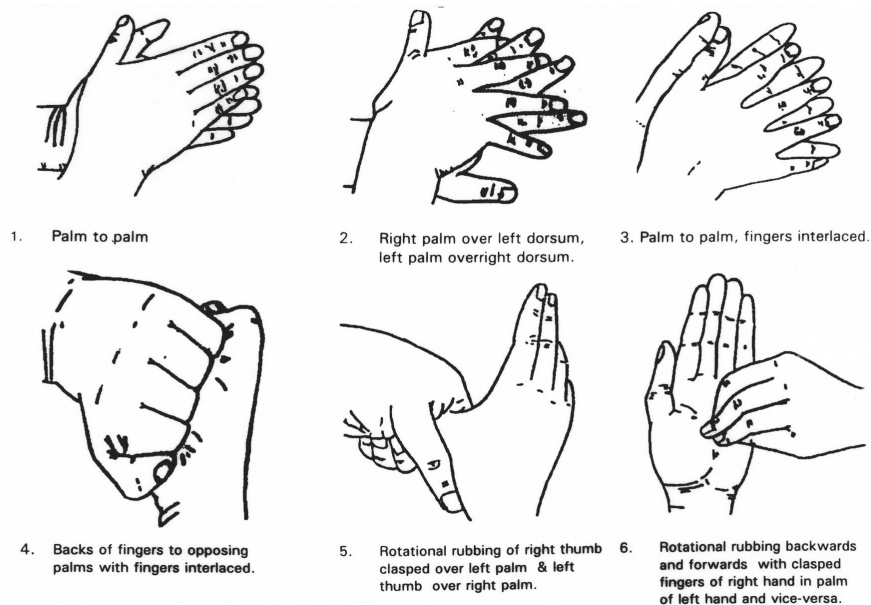
Box 3-5: WHO's Five Essential Components for Hand Hygiene Programs

1. Systems must exist to ensure that the necessary infrastructure is in place to facilitate and to support health care worker adherence to hand hygiene recommendations. Facility systems must support the following:
 - Access to a safe, continuous water supply
 - Accessible soap and towels
 - Readily accessible ABHRs at the point of care
2. Regular education and training must be provided to all levels of health care workers regarding hand hygiene indications, procedures, and importance.
3. Hand hygiene practices and the availability of necessary equipment and supplies must be monitored. Evaluations and feedback should be provided to staff. Health care worker perceptions about hand hygiene and knowledge of hand hygiene indications and procedures should be evaluated, with results communicated to staff.
4. Environmental reminders and prompts about hand hygiene should be placed in the workplace.
5. An institutional climate of safety must be established in which hand hygiene is a high priority and staff are aware of the important relationship between hand hygiene and patient safety.

Source: Adapted from World Health Organization (WHO). *WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge: Clean Care Is Safer Care*. Geneva: WHO, 2009. Accessed Aug 14, 2017. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.

Figure 3-1, below, shows one method of performing hand hygiene. Other examples can be found from the WHO,⁹ CDC,¹⁰ and Gulf Coordinating Council (GCC).¹²

Figure 3-1: One Method of Performing Hand Hygiene



Hands and wrists rubbed till end of 10 sec period. The number of strokes in each step is five.

<https://www.publicdomainpictures.net>

AORN recommends that clean surgical attire should be worn in the semi-restricted and restricted areas of the perioperative setting; personnel entering the semi-restricted and restricted areas should cover the head, hair, ears, and facial hair; and scrubs should be laundered by the organization to ensure correct water and drying temperatures and management of clean linen.²⁴ No definitive studies exist that show an increase in SSI with home laundering of scrubs,² but laundering scrub clothing at home may not provide the necessary water temperature, sufficient number of water changes, controlled concentrations of bleach, or drying temperature for the safe reduction of microorganisms. In addition, there is a risk of debris—including bacteria-laden pet hair—adhering to home-laundered scrubs in the home or in transit.²⁴ AORN recommends that surgical attire be laundered at the organization. Fluid-resistant or impervious gowns or aprons can be used to reduce the risk for strikethrough of patients' body fluids to scrubs. It is recommended that clean and appropriate professional clothing be worn during patient encounters outside the operating theater and that scrubs not be worn outside the hospital at any time. All surgical garb should be changed when visibly soiled or between contaminated cases, and staff should change or cover scrubs before seeing the patient and family following surgery.^{2,24}

Gloves

The use of sterile gloves is normal and best practice during any surgical procedure. Gloves should be selected based on the glove materials, tensile strength, length of use, and material stress, which will influence the gloves' integrity. Holes and tears compromise the integrity of the gloves, the sterility of the procedure, and the safety of the health care worker. Various studies demonstrate significant tears in gloves with orthopedic, obstetric, endoprosthetic, and other surgeries.^{25,26} When a health care worker recognizes that a hole or tear has occurred, the gloves should immediately be removed, the hands should be washed or sanitized, and the gloves should be replaced.

The Society for Healthcare Epidemiology of America and the Infectious Diseases Society of America (SHEA/IDSA)¹ and AORN²⁴ recommend double gloving for all procedures. Some studies have shown differences in hand contamination when double or single gloves are worn.²⁷ WHO and others reported that in many studies there were no differences in SSI outcomes when comparing double gloving versus a single pair of gloves or when a glove was torn during surgery or was intact.^{7,28,29} However adding a second pair of surgical gloves can significantly reduce perforations to innermost gloves. When reviewing triple gloving, knitted outer gloves, and glove liners, it was also evident that these gloves significantly reduce perforations to the innermost glove.²⁸

One study demonstrated an association between double gloving and SSI, with a 50% reduction in postoperative shunt infections.³⁰ Using double gloves is also thought to provide added protection from bloodborne pathogens from sharps injuries. Some surgeons prefer to change the outer glove during a long surgical procedure. There continues to be significant variability in the use of gloves during the intraoperative phase.

Recommendations from WHO regarding gloves used during surgery include the following⁷:

- Use sterile gloves.
- Do not perform glove decontamination with alcohol or other products.
- Do not reuse sterile surgical or medical exam gloves.

WHO did not present a recommendation on double gloving or changing of gloves during the operation or using specific types of gloves as more effective to reduce SSI risk.⁷

Both AORN²⁴ and SHEA/IDSA¹ recommend that sterile gloves should be changed when damaged and/or changed every 90 to 150 minutes during a case.

The 2016 ACS/SIS and 2017 Wisconsin Division of Public Health SSI prevention guidelines recommend that surgeons should change sterile gloves at the end of the procedure, prior to closing the wound.^{2,31}

Patient Body Hygiene during the Postoperative Phase

In addition to hand hygiene, postoperative patient body hygiene is important to reduce the risk of surgical wound contamination and infection. The instructions for postoperative patient bathing and dressing change are often based on surgeon preference versus science. The most current evidence-based guidelines addressing postoperative patient bathing conclude that early showering (12 hours postoperative) does not increase the risk of infection and that any specific timing of postoperative dressing removal does not increase infection risk. Thus patient hygiene should be encouraged and instructions included at discharge.³ There is some evidence that daily postoperative bathing beginning 12 hours post-op, with chlorhexidine soap, can support SSI prevention¹⁴

Wound Healing

Wound healing occurs by primary or secondary intention. In *primary intention*, the wound edges (from the deep tissues to the skin) are brought together surgically or mechanically to allow collagen to form and to stabilize the wound. The wound may be closed with sutures, staples, or adhesives. With primary intention, the wound seals within a few hours and heals within 5-7 days, and minimal tissue damage or scarring occurs. This reduces the patient's risk of infection from exogenous sources. The nursing care during primary intention is to observe the wound for any signs of infection and prevent contamination of the wound until healed.

Wound healing by *secondary intention* occurs when the wound is left open to heal and closes by granulation. Healing by secondary intention can result in a broader scar than a wound closed by primary intention, and the wound-healing process may be slowed because of infection, drainage, or debris. Wounds that are infected or contaminated may be cleaned, debrided, and left open for a period of time and surgically closed when the infection is resolved; this is termed *delayed primary closure or tertiary intention*. The nursing care during this phase is to observe the wound as it heals from below and to prevent contamination.

Wound Dressings

As described above, new cells form a seal across the wound after the incision is surgically closed. Dressings are used to support, stabilize, and protect the wound from injury and contamination; facilitate homeostasis; and absorb drainage. The dressings applied in the operating theater are generally allowed to remain on the wound for 48 to 72 hours. WHO suggests *not* using any type of advanced dressing versus a standard dressing on wounds that are closed primarily to prevent SSI. Advanced dressings include the following:

- Hydrocolloid
- Hydroactive
- Silver containing (metallic or ionic)
- Polyhexamethylene biguanide (PHMB)

WHO recommends sterile dry gauze dressings applied using sterile technique.¹

Observations during Dressing Changes

Dressing changes provide health care workers with opportunities to assess the condition of a wound and to observe the character of the drainage. Staff providing postoperative care should be aware of the symptoms of infection and the expected drainage that results from various surgical procedures. See Sidebar 3-1 Clinical Manifestations of Surgical Site Infections for observations to make during wound dressing changes and at other times.

Surgical Drains

Drains are used in many surgeries where the presence of fluid may create pressure; interfere with blood flow; damage tissue, particularly if the fluid is irritating (for example, urine or bile); or provide a culture medium for bacteria. It is important to remove it from the body. Usually, the drainage device uses suction or negative pressure to facilitate removal of the drainage. Electric or mechanical pressure activates and maintains suction for most portable wound drainage systems. The greatest amount of drainage is expected within the first 24 hours after the surgery. When the drainage amount decreases to an appropriate level, the drain is removed. To keep drainage from touching the incision site and potentially causing infection, drains are placed through puncture sites (sometimes called “stab wounds”) designated exclusively for the drain.^{15,16} Staff should inspect the drain and the drain site to ensure that it is functioning properly and that there are no signs of infection.

Summary: Postoperative Patient Care

In summary, patient care practices to prevent postoperative infections include using aseptic and sterile technique for dressing changes, observing the wound for signs of infection, preventing the drainage tube from making contact with the incision and ensuring that it is working properly, and changing or reinforcing dressings when they are wet or saturated with drainage. Patients and their families should also be taught about body hygiene after surgery, techniques to protect the incisions from contamination, and how to support the new wound during the healing process.¹⁶ Patient education about wound care is essential and is discussed later in this chapter.

Sidebar 3-3. Steps for Changing a Surgical Wound Dressing

1. Obtain necessary dressing supplies and equipment.
2. Perform hand hygiene.
3. Position the patient.
4. Establish a clean area on which to position dressing supplies.
5. Place a plastic or waxed disposable bag near the patient to dispose of used dressings.
6. Maintain sterility while opening each dressing package. Leave dressing in the open, sterile package until ready to use.
7. Perform hand hygiene.
8. Put on non-sterile gloves.
9. Pull wound dressing tape toward the incision.
10. Gently remove soiled dressings and place in the disposable bag.
11. Remove non-sterile gloves and discard in the disposable bag.
12. Open sterile package of gloves and put on sterile gloves.
13. Dress drain sites by making a slit or cut (using sterile scissors) in a gauze pad, and place the pad around the drain site. Place a second cut gauze pad at a right angle to the first gauze pad to absorb drainage around the drain site.
14. Place the appropriate dressing(s) over the wound.
15. Tape the dressing in place.
16. Remove gloves.
17. Perform hand hygiene.

Note: Depending on the dressing change protocol, dressings should be changed or reinforced when they are wet or saturated with drainage.

Source: Adapted from Perioperative nursing. In *Lippincott Manual of Nursing Practice*, 10th ed. Ambler, PA: Lippincott Williams & Wilkins, 2014, 102–133.

Postoperative Educational Strategies for Patients, Families, and Staff

Educating Patients and Families

Most of the education for surgical patients during the postoperative phase is provided after the patient has had time to wake up from the anesthesia. When the patient is confused, in discomfort, or inattentive, the educational efforts should be very basic and center on the patient's immediate physiological status and the care. When the patient is in less pain and fully awake, the staff can provide more comprehensive postoperative education throughout the immediate recovery period and prior to discharge. Some of the infection prevention topics that should be covered during this immediate postoperative phase are listed in Box 3-6, below, and that is followed immediately by Box 3-7, which provides ideas for educational resources that hospitals can use to educate patients about infection prevention.

Box 3-6. Postoperative Infection Prevention Topics to Be Discussed with Patients

- Wound-healing stages and expected symptoms (for example, wound edges approximated without gaps)
- Signs or symptoms of possible infection (for example, unusual drainage, swelling, pain or redness at the incision site; or unexpected fever)
- Care of the surgical site (for example, leaving scabs intact)
- Procedures for dressing changes, wound irrigations, or applying medications
- Instructions for bathing or showering and for caring for the wound and dressings during this time
- Managing drains, catheters (for example, urinary or vascular), and other tubes related to special surgeries
- Type of clothing that minimizes mechanical trauma to the wound (for example, wearing loose clothing and avoiding tight belts and underwear)
- Amount of bending, lifting, or stretching that is safe for the wound

Box 3-7. Surgical Site Infection Education Resources for Patients

Following is a sample of resources hospitals can use to provide patients with education about SSIs:

- Society for Healthcare Epidemiology of America (SHEA): *FAQs About "Surgical Site Infections,"* available at https://www.cdc.gov/hai/pdfs/ssi/ssi_tagged.pdf
- CDC: *Frequently Asked Questions About Surgical Site Infection (SSI),* available at https://www.cdc.gov/hai/ssi/faq_ssi.html.

During the immediate postoperative phase, the surgeon may educate family members about the following:

- Events and outcome of the surgery
- Expectations for the patient's recovery
- Timing for events (such as getting out of bed, bathing, and walking)
- Expected discharge date
- Efforts to prevent postsurgical infections
- Medications
- Communication for questions or concerns
- Opportunities for the family to assist in preventing infections
- Return visit to the surgeon's office

It is useful for essential information to be presented verbally and in writing so that the patient and the family can read after discharge, refresh the information in their minds, and keep the information in a safe place. Often a phone number is provided for patient or family to contact staff about questions or concerns.

Staff Education

Staff caring for the patient postoperatively should be well educated in signs and symptoms of infection such as unexpected drainage, redness, swelling or unusual pain; aseptic techniques; drain management; irrigation if ordered; medications; and other functions. This education should be followed with staff tested for knowledge, clinical decision-making skills, and competency in performing procedures in the postoperative phase. Below are some general discussion questions for postoperative care for consideration.

Questions for Postoperative Care

1. How frequently are surgical wounds assessed during the postoperative phase?
2. Is information about the wound condition, characteristics of drainage, wound drain system, and drain tubes adequately communicated to all health care workers involved in the postoperative care of patients with surgical wounds?
3. Are patients or family members instructed to report symptoms of an SSI (redness, increased swelling, increased warmth around the incision, foul odor, pus, red streaks)?
4. Is the SSI rate reported to the surgical team?
5. Are patients and families instructed on hand hygiene measures?
6. Is there a patient follow-up process for postdischarge contact with the patients?

Reducing the Patient's Exposure to Microorganisms in the Environment of Care

General Environmental Cleaning of the Operating Theater

Each patient should be provided with a clean and safe environment. After a surgical patient is transferred from the operative area, a clean environment should be reestablished to prepare for the next patient. The operating theater should be cleaned with an approved, hospital-grade disinfectant. The floors and walls should be cleaned and disinfected after each patient when visibly soiled, and terminal cleaning should be done at the end of the day.

Terminal Cleaning of the Operating Theater

Terminal cleaning includes cleaning the floors with either a wet vacuum or a single-use mop and a disinfectant, and disinfecting and cleaning all exposed surfaces of all items, including the following:

- Anesthesia carts and equipment
- Patient monitors
- Operating theater beds
- Reusable table straps
- Operating theater bed attachments (for example, arm boards, stirrups, headrests)
- Positioning devices
- Transfer devices
- Overhead procedure lights
- Tables and Mayo stands
- Storage cabinets
- Telephone and communication devices
- Chairs, stools, and step stools
- Trash and linen receptacles

Terminal cleaning and disinfection of perioperative areas, should occur at least once every 24 hours. Terminal cleaning should include all equipment—ceiling tracks, lights, horizontal shelves, tables, and the operating theater floor. Surgical staff members sometimes borrow equipment and supplies from rooms in the surgical suite that have not been in service. Therefore, it seems prudent that rooms not in use should also be cleaned once every 24 hours during the regular workweek. The multidisciplinary operating theater team should determine the frequency of terminal cleaning when rooms are and are not in use.¹⁷ To ensure that the cleaning activities include all appropriate areas and items, many hospitals require staff members to use checklists itemizing all surfaces. Two examples of checklists are provided in Figure 3-2 (page 22) and Figure 3-3 (page 23).

Figure 3-2. Terminal Cleaning Checklist

Operating Theater Room #:

Date:

Item	Completed—Initial	Comments
Light fixtures and switches		
Walls assessed		
Operating theater table		
Mattress, top and underneath		
Table controls		
Table straps		
Foot pedals		
All furniture in room		
All flat surfaces		
Telephone		
Cabinet handles		
Back table		
Mayo stand		
Operating theater door handles		
Hampers		
IV poles		
Floor		
Scrub sink		
Area around scrub sink		

Source: Adapted from Association for Healthcare Environment. *Practice Guidance for Healthcare Environmental Cleaning*, 2nd ed. Chicago: American Hospital Association, 2012. IV, intravenous.

Figure 3-3. Checklist for Monitoring Terminal Cleaning of the Operating Theater

Evaluate the following priority sites for each patient room:

Date:

Operating Theater Room #:

Staff Initials:

Operating Theater Room Surfaces	Performed or Cleaned Y/N	Enter Method	Comments
Stretcher			
Mattress			
Controls			
Light fixtures			
Excess furniture removed			
Floor cleaned			
Walls cleaned as applicable			
All horizontal surfaces			
Door and cabinet handles			
Straps, replaced or cleaned			
Back table			
Mayo stand			
Telephone			
Operating theater door handle			
Trash emptied			
Needle boxes changed			

Mark the monitoring method used for each:

Direct observation = D

Fluorescent gel = F

Swab cultures = SC

ATP system = AT

Agar slide cultures A

Source: Adapted from Centers for Disease Control and Prevention). *CDC Environmental Checklist for Monitoring Terminal Cleaning*. Accessed Aug 14, 2017. <http://www.cdc.gov/HAI/toolkits/Environmental-Cleaning-Checklist-10-6-2010.pdf>.

Other Areas to Be Cleaned in the Operating Theater

A risk assessment should be conducted to determine cleaning frequency. Although a monthly cleaning is the minimum standard, in some cases more frequent cleaning may be necessary. Areas and equipment that should be cleaned on a weekly or monthly basis should include, but are not limited to, the following¹⁷:

- Heating and air-conditioning equipment
- Pneumatic tubes and carriers
- Sterilizers and their carts/carriages
- Clean and soiled storage areas
- Walls and ceilings
- Unrestricted areas (such as offices, waiting rooms, lounges, lavatories, and locker rooms)

Sidebar 3-4, right, provides some additional tips for cleaning the operating theater.

In the PACU, special attention should be paid to cleaning stretchers and beds, including side rails, wheelchairs, and immediate patient-care surroundings after each patient is discharged to a clinical unit for continued postoperative care.

In the postoperative setting, many environmental surfaces can be sources of microorganisms that may contribute to SSIs. In addition to microorganisms that can be transmitted to patients from contaminated health care worker hands or the patient's own hands, microorganisms can be transmitted to patients through common patient-care equipment, such as IV poles, stethoscopes, and endoscopes, and through office equipment such as computer keyboards and charts.

Table 3-2 provides examples of surfaces that can harbor pathogenic organisms and must be cleaned on a regular basis.

Table 3-2. Potential Environmental Contamination in Postoperative Settings

General Surfaces	Colonized with pathogenic organisms including MRSA, or <i>Clostridium difficile</i> Standing liquids (for example, irrigating liquids)—can be reservoirs for organisms Sinks for hand washing
Personnel Equipment	Stethoscopes
Patient's Room:	Faucets, bed linens, drapes measuring containers, dials and knobs on monitors and biomedical equipment, intravenous (IV) poles, tables, chairs, bed rails, tray tables, light switches, bathroom toilet and sink.
Technology	Computer keyboards, tablets, mobile phones

MRSA, methicillin-resistant *Staphylococcus aureus*, IV, intravenous.

Sidebar 3-4. Tips for Cleaning the Operating Theater Environment

- Follow proper procedures for effectively using mops, cloths, and solutions.
- Prepare cleaning solutions daily or as needed, and replace with fresh solution frequently according to facility policies and procedures.
- Change the mop head at the start of the day and as required by facility policy, or after cleaning large spills of blood or other body substances.
- Clean mops and cloths after use, and allow them to dry before reuse; or use single-use, disposable mop heads and cloths.
- After the last surgical procedure of the day or night, wet vacuum or mop operating theater floors with a single-use mop using hospital disinfectant.

Source: Centers for Disease Control and Prevention. *Guidelines for Environmental Infection Control in Health-Care Facilities*. 2003. (Updated: Feb 15, 2017) Accessed Aug 14, 2017. <https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines.pdf>.

To reduce the risk of exposing patients and health care workers to environmental microorganisms, organizational protocols for the cleaning of recovery areas and the postoperative care clinical unit should clearly detail the following¹⁸:

- Designate which equipment and supplies should be cleaned as opposed to disposable equipment and supplies
- State the frequency of cleaning equipment and supplies.
- Indicate who is responsible for the cleaning.
- State the approved methods for cleaning, disinfecting, and/or sterilizing equipment and supplies, including what agents are to be used and their use instructions.

Organizations should also develop policies and procedures for cleaning the following areas or objects that can provide reservoirs for microorganisms in postoperative care settings:

- Cooling towers
- Air-ventilation systems
- Ice machines
- Carpeting and flooring
- Elevator shafts
- Garbage disposals
- Waste-management facilities

The environmental services and the surgical staff should select the agent used for cleaning based on the area to be cleaned and the requirements for cleaning results. Table 3-3, below, describes the advantages and disadvantages of various agents for cleaning and disinfection.

Table 3-3. Advantages and Disadvantages of Agents for Cleaning and Disinfection⁵⁶

Agent	Use	Advantages	Disadvantages
Alcohol	Disinfection of small surfaces	Bactericidal Virucidal Fungicidal Fast-acting	Not sporicidal Flammable No detergent activity
Chlorine (Bleach)	Disinfection of inanimate surfaces	Broad-spectrum Tuberculocidal Sporicidal	Corrosive to metals Inactivated by organic material
Hydrogen Peroxide	Disinfection of inanimate surfaces	Fast-acting Bactericidal Virucidal Fungicidal	Expensive May be incompatible with brass, zinc, copper, etc.
Iodophors	Commonly used disinfectant	Bactericidal Tuberculocidal Fungicidal	Not sporicidal Not suitable for hard surfaces
Quaternary Ammonium Compounds	Floors, walls, and furnishings Good for use with equipment that comes in contact with skin	Bactericidal Fungicidal Surface-compatible	Not sporicidal, tuberculocidal Not effective against some viruses, such as norovirus High-water hardness Cotton/gauze pads reduce microbial properties
Phenolics	Can be used for equipment that touches skin Good surface disinfectant	Bactericidal Virucidal Fungicidal Tuberculocidal Inexpensive	Absorbed by porous material Irritates tissue

Source: Adapted from: Association for Healthcare Environment. *Practice Guidance for Healthcare Environmental Cleaning*, 2nd ed. Chicago: American Hospital Association, 2012. Staphylococcus aureus, IV, intravenous.

Cleaning Supplies

It is important that only clean supplies be used in the operating theater. Mop heads, cleaning cloths, and other cleaning materials should not be reused between operating theater rooms. Some facilities have begun using microfiber mops and cloths to clean surfaces and floors. Microfibers are densely constructed, polyester and polyamide (nylon) fibers that are a fraction of the width of a human hair. The density of the material enables it to hold six times its weight in water, making it more absorbent than a conventional mop. The positively charged microfibers attract dust (which has a negative charge), and the tiny fibers are able to penetrate the microscopic surface pores of most flooring materials. These characteristics make microfiber an effective mopping material.¹⁹ If microfiber cloths are not available, acceptable substitutions are lint-free cotton or polyester cloths that can be laundered. Microfiber is most effective when used once; because it does a great job of attracting microorganisms, it is a challenge to clean effectively. Consequently, disposable microfiber may be safer than reusable microfiber.

Objective Methods for Evaluating Environmental Cleaning and Disinfection

Health care organizations should develop an evaluation program to optimize the thoroughness of cleaning and disinfection processes. This program should incorporate objective evaluation methods, which may include direct practice observation, swab cultures, agar slide cultures, fluorescent markers, and ATP bioluminescence.

A CDC toolkit summarizes various methods for evaluating environmental hygiene, ranging from direct observation to objective measures such as slides, fluorescent gel, and ATP.²⁰ Table 3-4, below, summarizes these evaluation methods.

Table 3-4. Evaluating Patient Zone Environmental Hygiene

Method	Ease of Use	Identifies Pathogens	Useful for Individual Teaching	Directly Evaluates Cleaning	Published Use in Programmatic Improvement
Direct Practice Observation	Difficult	No	Yes	Yes	1 Hospital
Swab cultures	Easy	Yes	Not Studied	Potentially	1 Hospital
Agar slide cultures	Moderately Easy	Limited	Not Studied	Potentially	1 Hospital
Fluorescent gel	Easy	No	Yes	Yes	49 Hospitals
ATP system	Easy	No	Yes	Potentially	2 Hospitals

Source: Adapted from Centers for Disease Control and Prevention. *Options for Evaluating Environmental Cleaning*. Guh A, Carling P; Environmental Evaluation Workgroup. Dec 2010. Accessed Aug 14, 2017. <http://www.cdc.gov/HAI/pdfs/toolkits/Environ-Cleaning-Eval-Toolkit12-2-2010.pdf>.

Summary: General Environmental Cleaning

Infection preventionists, biomedical technicians, sterile services department personnel, housekeeping staff, and other key care providers should be available to consult and support environmental services as they develop procedures for cleaning the operating theater. Organizations should create standardized protocols for routine cleaning and disinfection of the operating theater, the postoperative care units and patient rooms, equipment, and specialized approaches to preventing the transmission of microorganisms such as *Clostridium difficile*. For additional information, refer to the CDC's *Guidelines for Environmental Infection Control in Health-Care Facilities*.²³ The guidelines are available for download at <https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines.pdf>.

Cleaning and Sterilization of Surgical Instruments and Disinfection of Noncritical Instruments

Preventing SSIs requires the effective cleaning and sterilization of the surgical instruments, which begins in the operating theater. At the end of the surgical procedure the used instruments are returned from the operating theater to the central processing department for reprocessing. These instruments should have been kept moist in the operating theater with an enzyme solution, water, or a moist cloth. Lumens should be flushed as soon as possible after use. Noncritical instruments, such as a flexible gastrointestinal endoscope must also be cleaned and disinfected per protocol. Items are kept moist during transport.

Surgical and Central Sterile Supply Department (CSSD) leadership set the stage for safe and high-quality medical device reprocessing. When optimal facilities, equipment, and supplies are made available, standard work flows and procedures are established and enforced, best practices are implemented and followed by all, and staff members receive sufficient training and are competent, then the safety of patients and staff related to reprocessing of equipment can be achieved. Often, in low-and middle-income countries, not all required resources are available, in which case the organization must assess alternate means of safe reprocessing while trying to comply with best practices.

Centralized reprocessing facilities and staff is often the safest and most cost-effective arrangement to perform the reprocessing function, but many facilities are forced to replicate and decentralize reprocessing services in multiple areas because of unique health care facility characteristics and needs. If a decentralized model is chosen, there should be centralized policies and procedures followed by all areas performing disinfection and sterilization. Quality control and all staff must be educated, tested for competency, and monitored for performance. The same standards must be upheld in all areas where disinfection and sterilization take place. This is critical for the surgical instrument reprocessing.

A key role of the CSSD leader is to ensure standardization and consistency regardless of personnel or location. Within the limits of their facility and resources, CSSD leaders should do the following:

- Provide the optimal environment, equipment, and supplies for sterile instrument reprocessing.
- Establish clear and unambiguous policies and procedures.
- Ensure careful hiring and staff evaluation practices.
- Establish orientation and continuing education requirements.
- Ensure quality controls are in place.
- Establish a measurement and performance improvement program.
- Create a consistent process for evaluation of existing instruments and equipment as well as planned purchases to ensure that cleaning, disinfection, and, if applicable, sterilization follows manufacturer's instructions.

CSSD leaders must ensure that the reprocessing and storage environment is adequate for the procedures being performed, is sanitary, and is maintained in good repair at all times. Daily assessment—with a written checklist or an electronic monitoring system—in all areas where reprocessing is performed, starting in the operating theater, and storage areas is the best practice.

CSSD leaders must establish and enforce facility policies and procedures based on manufacturer's instructions for use, best practices, published standards, and local rules and regulations. Deviations from facility policies and procedures should be rare occurrences and should take place only when patient or staff safety would be compromised without a deviation from established policies and procedures. Any deviation should be documented and investigated as part of the CSSD follow-up and process improvement program. Case Study 3-1, pg. 28, illustrates one example of a deviation from facility policies and the result.

Case Study 3-1. Consequences of Deviation from Established CSSD Policy

The facility policy states that all departments submitting an item to CSSD for disinfection or sterilization must provide manufacturer's instructions for reprocessing. A nurse delivers a new piece of equipment and insists that it be steam sterilized for a procedure scheduled for the next day. The physician who will be performing the procedure is new and brought the equipment from his old office. He told the nurse to have the item washed, wrapped, and steam sterilized following standard CSSD procedure. The nurse was not given manufacturer's instructions for use, but the physician is contacted by the CSSD supervisor and confirms that he has previously had the item steam sterilized. The CSSD supervisor agrees to process the item this one time, while the department waits for manufacturer's instructions to be submitted.

The item is processed per the physician's instructions, but when the physician opens the wrapping, he finds that the equipment is no longer functioning and must cancel the procedure. An O-ring melted during reprocessing. Manufacturer instructions reviewed later that day indicate that low temperature sterilization should have been used. Although the supervisor wanted to accommodate the new physician, the standard policy should have been enforced.

As illustrated in Case Study 3-1, employees in the reprocessing department are often the ones asked to deviate from standard reprocessing procedures because of a tight schedule or a physician demand. The CSSD manager or supervisor must provide standard policy and procedures and realistic turnaround times to users and then support their staff by enforcing adherence of policies and procedures as well as minimum turnaround times. All quality control must be performed and documented unless immediate harm will occur.

- All personnel working in the CSSD should be trained and competent to perform their duties.
- All employees should receive education upon hire and periodically thereafter.
- The manager should maintain records of all education that is presented and any certificates of achievement.
- The CSSD employees should also obtain certification for their role.
- All supervisors of the CSSD should be well educated and optimally certified.

Some of the benefits of certification are listed in Sidebar 3-5, right.

A system is needed to ensure that staff reprocess each item according to facility standards and manufacturer's instructions each time. At minimum, the instructions listed in Sidebar 3-6, right, are recommended and should be provided to staff.

Sidebar 3-5. Benefits of Certification

- Indicates professionalism
- Increases credibility as an expert
- Promotes quality through initial and continuing education
- Assures a minimal level of competence
- Requires core knowledge to pass
- Encourages ongoing learning
- Requires continuing education
- Demonstrates core competency

Sidebar 3-6. Steps where staff education is needed

- Products and supplies needed
- Disassembly
- Sorting
- Soaking
- Cleaning and disinfection processes
- Sterilization parameters
- Special instructions or warnings (such as, reprocessing of items used on patients with known or suspected Creutzfeldt-Jakob disease)

Assessing Risk of Contaminated Instruments

The risk of contaminated instruments to transmit infectious agents being used in surgery depends on several factors, including the following:

- Presence, number, and virulence of organisms
- Type of procedures: invasive or noninvasive
- Body cavity where the instrument will be used

The Spaulding Classification, shown below in Table 3-5, describes how an instrument should be processed depending on its anticipated use during a surgical procedure.

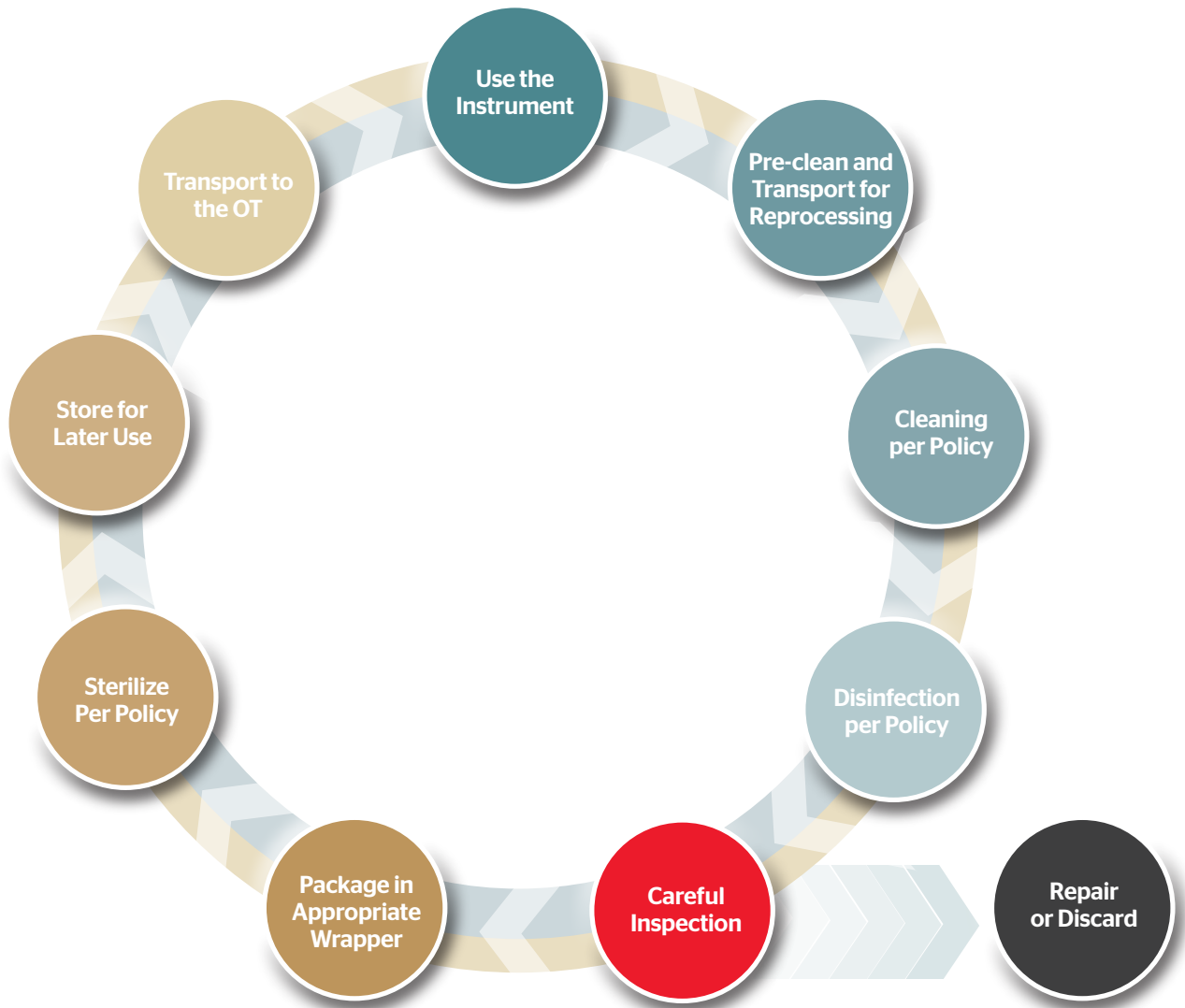
Table 3-5. The Spaulding Classification

Categorization of Items to be Reprocessed Based on Risk of Infection*				
Level	Risk of Infection	Description	Examples of Items	Reprocessing Methods
Critical	High	Item comes in contact with or enters sterile tissue, sterile body cavity, or the vascular system.	Surgical and dental instruments, inner surfaces of hemodialyzers, urinary catheters, biopsy forceps, implants, and needles	Sterilization
Semi-critical	Moderate	Item comes in contact with mucous membrane or non-intact skin.	Respiratory therapy and anesthesia equipment, some endoscopes, laryngoscope blades, esophageal manometry probes, vaginal ultrasound probes and specula, and diaphragm fitting rings	Minimum: High-Level Disinfection (When practical Sterilization preferred)
Noncritical	Low	Item comes in contact with intact skin.	Patient care items: bedpans, blood pressure cuffs, crutches, incubators, and computers Environmental surfaces: bed rails, bedside tables, patient furniture, counters, and floor	Low and Intermediate Disinfection*

* Must follow manufacturer's instructions for cleaning and disinfection.

This classification has been used for many years to determine how to process an instrument, and it provides a general structure for risk assessment. However, the evolution of heat-sensitive and complex medical equipment, transmission of infectious agents from dental instruments and endoscopes, limited evaluation of disinfection techniques for some items that contact mucous membranes, and resistance to disinfection or sterilization among some infectious agents such as prions, require that additional scrutiny be placed on reprocessing of instruments and equipment.²⁴⁻²⁷ Figure 3-4, below, illustrates basic steps for reprocessing surgical instruments.

Figure 3-4. Steps for reprocessing surgical instruments



OT, operating theater.

CSSD Workplace and Work Flow

The appropriate functional design of the physical space for CSSD will make it possible for staff to perform cleaning, disinfection, and sterilization procedures correctly and to minimize risk of cross-transmission. The physical space should be sufficient for the required work and built to appropriate standards so that staff and equipment can be protected during decontamination, equipment can be taken through a one-way flow from dirty to clean, and equipment can be disinfected (or be packaged and sterilized) and stored effectively.

The work areas should be physically divided into the following four functional areas^{28,29}:

1. Receiving, cleaning, and decontamination
2. Inspection, preparation, and packaging
3. Sterilization or disinfection
4. Storage

Figure 3-5, below, shows the work flow for disinfection and sterilization, and Figure 3-6 on page 32 provides a sample schematic of a CSSD regardless of location.

Figure 3-5. Workflow of an Instrument to be Sterilized in the CSSD

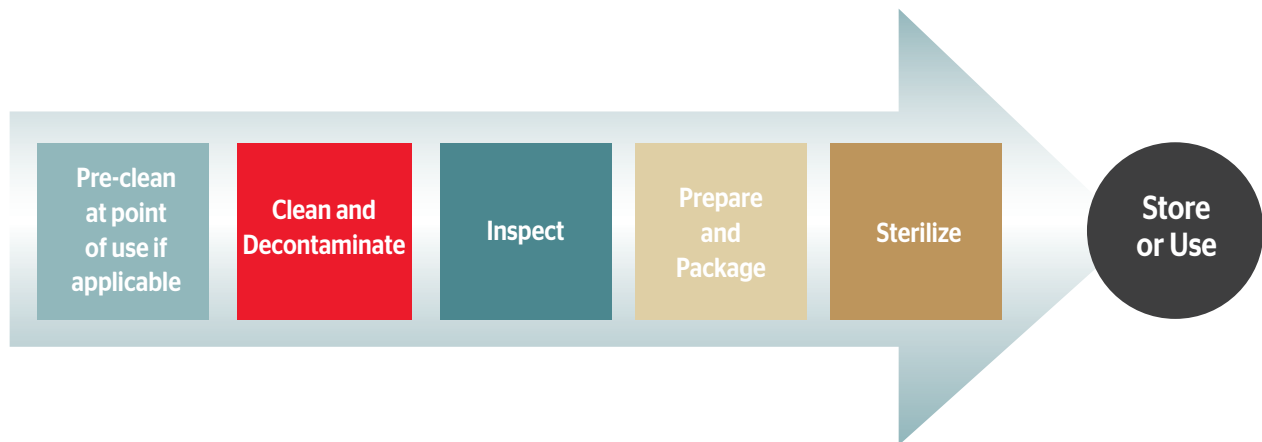
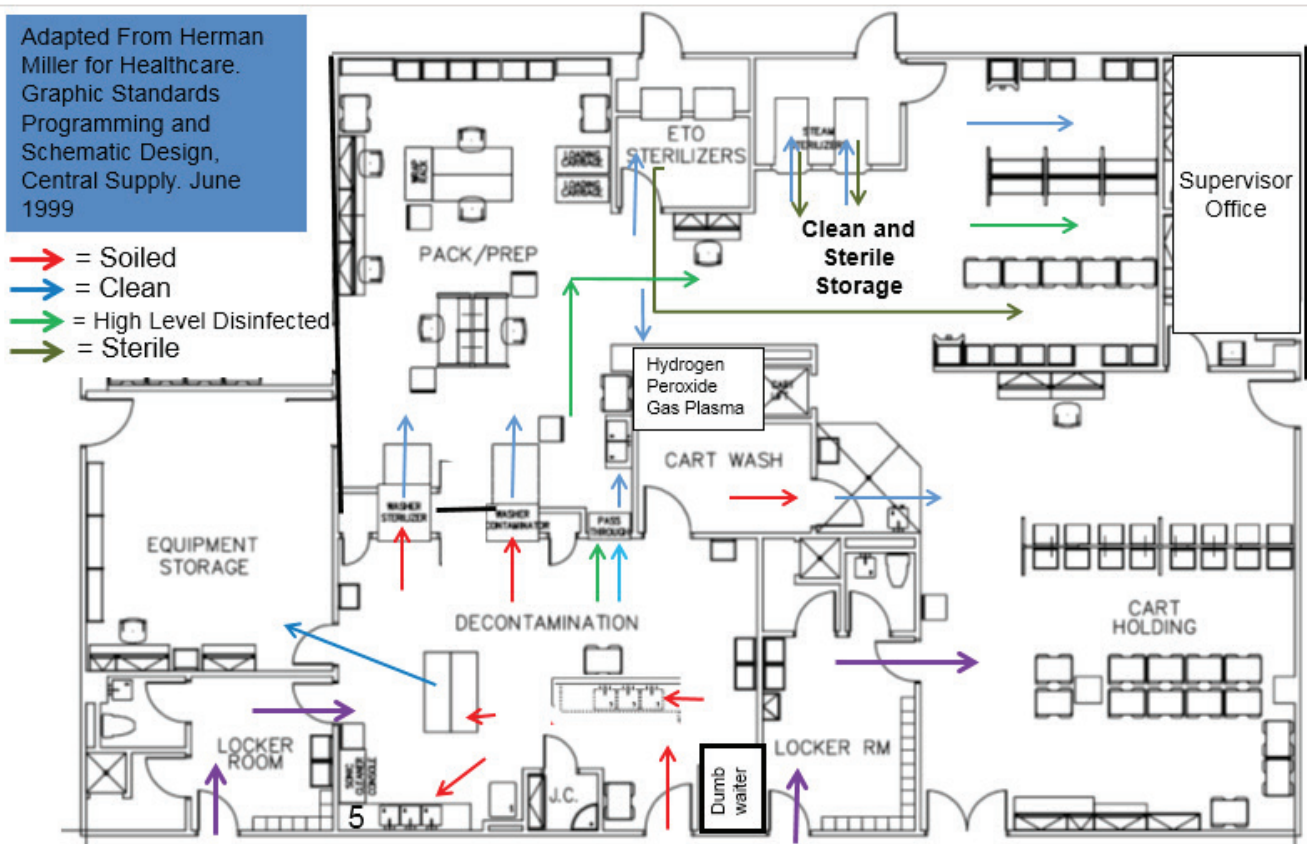


Figure 3-6. Sample Facility Design: Centralized Sterilization and High-Level Disinfection Areas and Flow Process of Instruments



Source: Adapted from Herman Miller for Healthcare. Graphic Standards Programming and Schematic Design, Central Supply. June 1999.

Cleaning and Inspection of Instruments

Cleaning or decontamination of instruments may be accomplished manually or by automation through a washer-disinfector. Manual cleaning is subject to human factors and variability, and there is little validation of the correct process. In countries where manual cleaning is the norm, there must be very comprehensive training and monitoring of these processes. Using automated cleaners is usually safer and more efficient.¹ A washer-disinfector may handle many trays in one load, and each load can be validated.

Inspection of instruments should be careful and detailed. The process should be performed with good lighting and a magnifying lamp. Instruments that are damaged with chips, cracks, hinges, or other problems should be sent for repair or replaced. Packaging should be standardized, and the appropriate wrapper for the instrument and the type of sterilization should be used (for example, steam, low level, ethylene oxide (ETO) hydrogen peroxide (H₂O₂), other).

Sterilizing Instruments

When the instruments are ready for sterilization, CSSD personnel must select the correct type of sterilization for the instrument(s) per the manufacturer's instructions. Commonly used sterilization technologies include steam, hydrogen peroxide gas plasma, 100% ethylene oxide, or ethylene oxide mixtures, vaporized hydrogen peroxide and ozone.³² Chemical agents are used as sterilants in some cases. These agents are only reliable when there is thorough cleaning before use and all directions for time, temperature and pH are met.^{32,33} The wrapped instruments or those in trays are then placed in the sterilizer in the correct position, again according to the sterilizer manufacturer's recommendations, and the sterilization process begins. Considerations for effective sterilization include the following:

- Correct loading of the sterilizer
- Correct operation of the sterilizer
- Regular maintenance of the sterilizers
- Releasing sterilized items

Instruments to be sterilized are monitored through chemical and biological means to determine the effectiveness of the procedure. Each sterilizer requires a certain type(s) of monitor based on the manufacturer's instructions for use. These directions from the manufacturer of the sterilizer should be easily available and must be strictly followed.

Immediate-Use Steam Sterilization (IUSS)

Sometimes, packaging and wrapping of an instrument or tray is not possible because of an unusual or emergent situation. When this occurs, facilities may resort to immediate-use steam sterilization (IUSS). IUSS refers to the covered or uncovered process for steam sterilization of instruments that are immediately aseptically transferred to the sterile field. This type of sterilization should not be used for convenience or to avoid the cost of additional instruments.

Closed trays designed for IUSS are recommended and available to prevent contamination as the instruments are transported from the sterilizer to the sterile field. All work practices used for regular sterilization and all monitoring and documentation should be consistent with the requirements for wrapped loads. The Association of periOperative Registered Nurses (AORN) recommends that the following information be documented for the IUSS instruments to verify the quality of the process and the need for IUSS^{30,31}:

- Operating theater room for use
- Surgeon
- Patient identifiers
- Cleaning procedure
- Reason for flash sterilization
- Result of indicator
- Staff member verifying that parameters were met

A group of seven professional organizations has issued a joint statement on IUSS, noting that cleaning, decontamination, and rinsing are critical and that users must follow and complete all required processing steps regardless of the sterilization exposure parameters being used.³⁴

Recall Process

When the sterilization monitors indicate that sterilization may not have occurred, there should be a process in place to retest the sterilizer, hold the instruments for sterilization determination, and notify the surgeon and administration that there may be a recall needed. When it is determined that there was a malfunction and the instruments were not sterilized, the staff should initiate a recall process.³⁵ A written procedure should be in place for carrying this out, including roles and responsibilities, and there should be a form letter that can be sent to the patient. Figure 3-7, page 34, shows a portion of a sample recall notice.

Figure 3-7. Partial Sample Recall Notice for Instrument Sterilization Issue

**CENTRAL STERILE PROCESSING – INFECTION CONTROL
RECALL NOTICE – WRITTEN REPORT**

Affix affected Sterilizer Load sticker(s) or Write in Load Information:

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[] **Recall Due to Chemical Indicators (indicators, integrators, sterilization tape):** The Central Sterile Processing Department (CSPD) has been notified of a chemical indicator, integrator or chemical indicator tape that did not change to proper color.

Complete each statement below

- The Biological Indicators (BI) results for this date and/or load are negative positive
- The mechanical parameters for this cycle were met not met

[] **Recall Due to Biological Spore Test Positive Results:** The CSPD has identified a biological spore test to be positive. This equipment will be removed from service until the manufacturer service technician qualifies this sterilizer to be in working condition. **NOTE: Recall all loads processed back to last negative BI**

Biological Indicator (BI) Lot Control Number _____ Sterilization Date _____

Complete each statement below

- The Biological Indicators (BI) results for this date and/or load are negative positive
- The mechanical parameters for this cycle were met not met

[] **Recall Due to Manufacturer Recall Notification**

[] **Recall Due to Wet Pack / Tray:** CSSD received notification of a wet pack /tray. **Action Immediately Initiated:** A CSSD designee is following the procedure for recalling the items listed below for this load/lot number. Items are being recalled randomly from the load.

Complete each statement below

- The Biological Indicators (BI) results for this date and/or load are negative positive
- The mechanical parameters for this cycle were met not met
- Additional wet packs identified yes no

FOLLOW-UP:

[] **Yes, ALL ITEMS contained in this sterilizer load/lot number were RETRIEVED AND REPROCESSED.**

Required: List all retrieved items on the 'Load Contents Information Log' on page 2 of this report

[] **No, NOT ALL ITEMS contained in this sterilizer load/lot number were retrieved.**

Required: List all items that could not be retrieved on the 'Load Contents Information Log' on page 2 of this report. **If items are presumed used, CSSD Manager will immediately notify**

- Infection prevention and control (IPC will notify Infectious Disease Consultant and assist in surgeon notification if required):** Date Notified ___/___/___ Time: __:__
- Perioperative manager (will identify affected patients)** Date Notified ___/___/___ Time: __:__
- Senior administrator**

Source: Sylvia Garcia-Houchins. Used with Permission.

Storing Instruments

Instruments that will not be used immediately must be stored safely until needed. Storage spaces for the CSSD have requirements for positive air pressure relative to external spaces, humidity parameters, and shelving with enough space to prevent injury to the package and with solid bottoms to prevent dust or debris from the floor to attach to the packages. Sidebar 3-7, right, summarizes the WHO guidelines for sterile instrument storage.

The nurse, technician, and surgeon in the operating suite each have responsibilities to ensure that the instruments used in each case are appropriate. The responsibilities of each role are spelled out in WHO *Global Guidelines*, but a brief summary includes the following¹:

- Ensure that the packs are intact and not torn, opened, and/or wet.
- All indicators show sterilization.
- Surfaces of the devices are clean, not dirty.
- Devices are not torn, broken, rusted, or unworkable.
- The surgeon is aware of any shortages.
- Ensure that there is no unnecessary delay in the procedures because of lack of instruments.

Transporting Instruments

The CSSD is responsible for transporting both dirty and sterile instruments. Following surgery, used supplies should be transported to the CSSD in a manner that avoids contamination of either personnel or areas of the hospital or clinic. Used instruments should be kept moist with an enzymatic solution, water, or a wet cloth, and any lumens are flushed after use. The instruments should be transported as soon as possible from the surgical suite to the CSSD to prevent body substances from coagulating and making it more difficult to clean. The instruments should be moved in closed containers; these might be carts, closed totes, or closed plastic bags. The containers should not permit sharps to puncture through the surface and present a risk to the transporter.

When moving newly sterilized instruments to the operating suite, the same principles pertain, that is, closed containers and safe transport. Many organizations use case carts for transport in both directions, and these must be washed and cleaned after transporting contaminated instruments.

Table 3-6, page 36, lists resources for managing medical instruments and equipment.

Sidebar 3-7. World Health Organization Guidelines for Sterile Instrument Storage

1. Store in a clean, dry environment (that is, far from moisture sources) that is protected from any damage.
2. Storage containers should not be made of absorbent material, such as wood.
3. The storage area must be bright, light, and airy with good air circulation.
4. The temperature must be moderate without wide fluctuations during the day.
5. The storage area should have an adequate level of lighting, and the walls should be smooth and easy to clean.
6. Access to the area should be restricted.
7. The packs should be placed on open racks, rather than closed shelves, in a single layer to prevent moisture from accumulating between the packs.
8. The labels must be visible and clear.
9. The pack inspection register should be clearly visible.
10. The racks must be at least 10 cm off the ground and from the ceiling.
11. Before use, packages should be inspected in order to verify that they meet the requirements for a sterile product

Source: Adapted from World Health Organization (WHO). *Global Guidelines for the Prevention of Surgical Site Infections*. Geneva: WHO, 2016. Accessed Aug 14, 2017. <http://apps.who.int/iris/bitstream/10665/250680/1/9789241549882-eng.pdf?ua=1>.

Table 3-6. Resources for Managing Medical Instruments and Equipment

- Association for the Advancement of Medical Instrumentation (AAMI): <http://www.aami.org/publications/standards/>
- American National Standards Institute (ANSI): <https://www.ansi.org/>
- International Organization for Standardization (ISO): <http://www.iso.org/iso/home/standards.htm>
- National Healthcare Safety Network (NHSN): <https://www.cdc.gov/nhsn/>
- Centers for Disease Control and Prevention, *Guideline for Disinfection and Sterilization in Healthcare Facilities*, 2008: <https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines.pdf>
- Association of periOperative Registered Nurses (AORN): <http://www.aorn.org/>
- International Association of Healthcare Central Service Materiel Management (IAHCSMM): <http://iahcsmm.org>
- Canadian Standards Association (CSA): <http://www.csagroup.org>
- Provincial Infectious Diseases Advisory Committee on Infection Prevention and Control (PIDAC-IPC): <http://www.publichealthontario.ca/en/BrowseByTopic/InfectiousDiseases/PIDAC/Pages/PIDAC.aspx>
- World Federation for Hospital Sterilisation Services (WFHSS): <http://www.wfhss.com/>
- Society of Gastroenterology Nurses and Associates, Inc.: <http://www.sgna.org>

Summary

When the surgical procedure has been completed, the patient enters the postoperative phase to begin healing and recovery. During this time, the patient is still at risk for developing an SSI, until the wound is healed. Staff must communicate about the patient's status, assess the patient's risk for infection, protect the wound from contamination by actions including health care worker and patient hand hygiene, manage the wound dressing and any drains, ensure good daily patient hygiene, and maintain a safe environment.

Immediately postoperatively, the patient will be cared for in recovery area or his or her room, depending on the situation. A patient with a transmissible infection will need special accommodation. Other activities in the immediate postoperative phase include returning the surgical instruments for reprocessing so they can be cleaned and sterilized for the next patient, and thoroughly cleaning the operating suite to ensure a clean, safe environment for the next patient and surgical team. During the full postoperative phase, patients and family must be well educated in both general and specific postoperative instructions. Verbal and written communication are both valuable. The postoperative phase is the final stage of the perioperative experience, and careful attention must be paid to preventing contamination of the surgical wound until it is healed.

Discussion Questions for Postoperative Care Personnel

- What processes are in place to address the host risk factors that patients experience in the postoperative phase?
- Have patients and family members been educated about risks in the postoperative period?
- When are patients assessed after surgery? Is there a standard reporting mechanism? Who receives the report? Is the information documented?
- Are all staff aware of the symptoms of a postsurgical site infection?
- What is the compliance rate of hand hygiene for the postoperative personnel?
- What are the strategies to reduce postoperative infection? Are they practiced? Are there written policies?
- What is the flow of instruments in the CSSD?
- How are instruments stored and transported to and from the operating theater?
- What is the compliance rate for appropriately cleaning the operating theater between cases and terminally at the end of the day?

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Evidence-Based Principles and Practices for Preventing Surgical Site Infections



CHAPTER 4

Measuring and Improving Care

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Overview

Background

Approximately 187 to 281 million surgical procedures are performed worldwide each year—almost one surgical procedure for every 25 persons.¹ Most of these procedures result in good outcomes and improved health for the patients, but some do not. Surgical site infections (SSIs) are one of the undesirable and potentially very serious outcomes from surgery. The study cited above showed that in developed countries, 3% to 16% of surgeries resulted in major morbidity, and 0.4% to 0.8% in death.^{1,2} A report from the World Health Organization (WHO) in 2011 noted that in developing countries, the leading health care-associated infection, and the most frequently studied, is SSI. The WHO survey found that in low- and middle-income countries, the incidence rates of SSI ranged from 1.2 to 23.6 per 100 surgical procedures. This contrasted with rates between 1.2% and 5.2% in countries with more resources.³ Therefore, SSIs are a significant part of the historical, and current global public health issue of health care-associated infections (HAIs).

Brief History

The idea of preventing HAIs is reflected in the well-known admonition to physicians to “First, do no harm,” which is a cornerstone of the Hippocratic Oath.⁴ Infections that occur in association with care provided in hospitals and surgical clinics are challenging, because the patient did not have an infection upon entering the hospital or clinic but acquired it during or after a surgical procedure performed in these settings.

Historically, physicians did not understand why SSIs occurred and were not aware of the route of transmission of infection to man. They often attributed the cause of disease to “bad air,” “effluvia,” or “miasmas.” British surgeon Joseph Lister (1827-1912), a pioneer of antiseptic surgery, dramatically reduced HAIs in surgical patients. He believed that microbes might be responsible for infections and that by killing organisms in wounds he could prevent surgical infections and death. In his practice he used carbolic acid to “sterilize” dressings packed into the wounds of patients with compound fractures. He even soaked his fingers in carbolic acid, and sprayed the operating theater with the acid to kill germs in the air.⁵ Lister published his findings in 1867, and

the clear evidence of decreased infections in his surgical population was so compelling that his techniques gained acceptance over the next decades and his surgical asepsis principles remain foundational today in the operating theater.

Formerly, surgeons did not use personal protective equipment, such as gowns and gloves, when operating. This allowed transmission of organisms from staff to patient or vice versa. However, by 1910, sterile instruments, gowns, and gloves and masks were standard in many large teaching hospitals. The original use of rubber gloves was to protect the hands of the surgical team from carbolic acid, but the role of gloves in protecting patients from microorganisms on the hands of health care workers was eventually recognized, and gloves became standard garb where available. Eventually sterilizers were introduced, and they were fundamental to preparing sterile instruments and devices to help protect patients from surgical infections. In some clinics, staff silence during surgery was also required to limit bacterial contamination thought to be spread by talking. Some physicians began to keep records of infections and use active surveillance systems to track surgical infection trends.⁶

Today's more sophisticated strategies for preventing wound infections take into account the host characteristics and risks, the technique of procedure, protective garb for staff, preparation of the patient, wound closure methods, the operating theater environment, and the disinfection and sterilization of the surgical instruments and supplies.

Overview

Although significant progress has been made in preventing and controlling infections, one of the limiting factors in preventing SSI is that different countries have unevenly implemented recommended prevention practices because of dramatic differences in their human and material resources, politics, and regulations. As a result, in addition to understanding and teaching best practices to prevent SSI, infection prevention and control professionals and health care epidemiologists have become more adept in understanding human behavior as to why proven practices are or are not adopted, the critical need for leadership and resources, and the effectiveness of teams in providing safer surgical care. They have also learned to use performance improvement and patient safety methods to enhance infection prevention practices that will reduce SSI.

Many current initiatives have endeavored to engage care providers in preventing SSI and will be discussed in this toolkit. For example, the WHO Safe Surgery Saves Lives challenge has helped reduce SSIs around the world.⁷ One of the WHO SSI prevention guidelines is the Surgical Safety Checklist to help reduce surgery-related infections and death. The checklist applies to the global population of patients in all phases of the perioperative experience. Newer guidelines from a variety of organizations have updated the science and evidence that should be used to make decisions about care. Many of these will be presented in this toolkit.

The Toolkit

This toolkit has four chapters. The three phases of the perioperative experience—preoperative, intraoperative and postoperative—form the majority of the content, and a chapter on patient safety and performance improvement strategies for surgical services completes the information. Each chapter presents the theory, science, and rationale for proven practices and practical tools to implement evidence-based best practices.

Chapters 1-3 focus on host characteristics and risks, processes and procedures, and education and safety of staff, patients, and families in each of the perioperative phases. Chapter 4 discusses patient safety principles and performance improvement methods and techniques and is supported by case studies and other practical examples.

References and resources are provided in each chapter. Current recommendations from groups such as WHO, the Centers for Disease Control and Prevention (CDC), Society for Healthcare Epidemiology of America (SHEA), American College of Surgeons (ACS), Surgical Infection Society (SIS), and others are referenced quite liberally throughout the toolkit.

The author and sponsors hope you find the toolkit valuable for your practice and your continuing efforts to reduce and eliminate SSIs for your patients and personnel.

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Introduction

Change is pervasive in health care, and the pace of change continues to increase. Despite advances, health care systems often remain fragmented and error prone, frequently harming patients. There has been an increasing awareness that patients are harmed every day in hospitals, including from surgical procedures.¹⁻⁵

The operating theater is an area that is particularly fast-paced and complex, which can contribute to the risk of human error. Adverse events may result from problems in practice, products, procedures, personnel, systems, or limited resources. Advancements in health care have introduced new technologies such as robotic surgery, stereotactic deep brain stimulation, and customized equipment for specific procedures. This new and complex equipment presents challenges for surgical services personnel and requires the need for the surgical services team to be in a constant learning mode and to measure processes and outcomes in order to guide improvements that will continually refine and improve care.

This chapter focuses on measuring and improving performance to reduce risk of surgical site infection (SSI). Discussion topics include performing postoperative surveillance for SSI to identify problem areas and opportunities for improvement; the role of leadership in setting a culture of safety and supporting positive change; and performance improvement (PI) models, tools, and techniques to assess challenges and to achieve change. The value of a care bundle for preventing SSIs is presented. The chapter also includes case studies to demonstrate how PI strategies can improve care.

Learning Objectives

After reviewing this chapter, the reader will be able to do the following:

1. Define surveillance and its importance for measuring SSI.
2. Describe surveillance methods for process and outcome measures.
3. State the components of an effective surveillance plan.
4. Discuss how surveillance can be used for performance improvement.
5. Discuss the rationale, theory, and goals for improving performance and sustaining change.
6. Explain key elements of an effective performance measurement and improvement program for preventing surgical site infections.
7. Discuss performance improvement models commonly used in health care organizations.
8. Use performance improvement tools for analyzing change for reducing infection risk.
9. Describe an SSI prevention care bundle.
10. Discuss the importance of leadership and a culture of safety for improving performance.
11. Describe barriers to change for patient safety and quality.
12. Explain factors that ensure sustained change.

Measuring Improvement

What Is SSI Surveillance? Why Is It Important?

Surveillance of surgical care and SSIs is a critical component of an infection prevention and control (IPC) program. Surveillance plays an important role in recognizing infection risk factors for SSI, and thus helping to target modifiable risk factors. Carefully obtained surveillance data can identify needed infection prevention interventions and areas of opportunity for improvements in care. The surveillance data can also help assess the quality of infection prevention efforts¹³ Both process measures (for example, the care we perform to prevent infections) and outcome measures (for example, surgical infections) should be measured through surveillance so infection prevention and control measures can be implemented, and performance improved.

The Basic Concepts of Designing and Implementing an Effective Surveillance Program for SSI

Surveillance for SSIs should be based on a risk assessment and on the goals and objectives developed by an Infection Prevention and Control Committee (IPC) or Quality and Patient Safety (QPS) Committee. The surveillance plan often focuses on targeted or selected procedures identified during the risk assessment. Surgical procedures vary in their infection risk, and procedures may be included in the surveillance plan based on the potential or experiential consequences of infections, such as serious morbidity or mortality, cost of treatment, or special concern of the surgeons, leadership, or the infection prevention team. A commonly used formula from the Centers for Medicare & Medicaid Services in the United States is to select surgical procedure types for the surveillance plan by focusing on procedures that are high volume, high risk, or problem prone⁶ and those that are of special interest to the organization.

To have consistent and reliable surveillance data, the surveillance plan must use validated criteria or definitions to determine cases of health care–associated infections. These definitions are provided by various agencies around the world, including the Centers for Disease Control and Prevention’s National Healthcare Safety Network (NHSN)⁷ and the Royal College of Surgeons, Ireland.⁸ Other surveillance programs may specify different times for follow-up and criteria change from time to time. Infection preventionists and surgical staff should periodically review the criteria they are using to remain current.

Surveillance for SSI involves tracking each selected surgical procedure by various criteria, including the following:

- Surgeon and assistants performing the surgery
- Status of the patient at the time of surgery—as an indicator of risk
- Complexity and time of the surgical procedure—to help determine patient risk

Specific guidance for SSI surveillance from NHSN can be found at <https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscscscurrent.pdf>.

For case finding of surgical infections during the postoperative phase, if the patient remains in the hospital following surgery, the surgical site should be assessed periodically and when the dressing is changed. If the patient is discharged shortly after surgery, he or she should be contacted within 24 to 48 hours and then 7 to 30 days later to assess for SSI. During these contacts, the patient or family caregiver should be questioned about the amount, color, and odor of any wound discharge, as well as fever, redness, and/or pain at the incision site. If the patient is experiencing these symptoms, he or she should be directed to return for a face-to-face assessment of the wound and possibly a wound culture.

IPC and operating theater professionals should work together to design the SSI surveillance program and the IPC Committee and/or the Quality and Patient Safety Committee should approve the surveillance plan as part of the overall monitoring for the IPC program. There are several components to a surveillance plan that should be considered as the program is designed.

See Table 4-1, below, for a list of the components that have been identified as being essential for surveillance in a variety of health care settings.

Table 4-1. Components of an Effective Surveillance Program

1. Assess and define the population(s) to be monitored.
2. Chose the events/indicators to be monitored (outcome, process).
3. Identify surveillance criteria/case definitions.
4. Select the surveillance methodology: prospective, retrospective, discharge.
5. Determine the time period for observation.
6. Identify specific data elements to be collected.
7. Determine methods for data collection, management, analysis, and reporting.
8. Identify recipients of surveillance data and reports.
9. Develop and implement a written surveillance plan.
10. Design interpretive surveillance reports.
11. Use surveillance findings in performance improvement activities.
12. Design and implement a method for periodically evaluating the effectiveness of the program.

Preparing a Written Surveillance Plan

When designing the SSI surveillance plan, it is important to engage the many stakeholders who will be interested in the results of the SSI surveillance and who contribute to preventing these infections. Figure 4-1, below, illustrates potential key stakeholders. Including them in the discussion to determine which procedures to monitor will help gain cooperation, compliance and acceptance of the surveillance data. It is also important to have adequate resources to perform surveillance. In many countries the IPC, hospital epidemiologist, a microbiologist, the chair of the IPC program, an IPC nurse, or an IPC officer manages the infection surveillance program, and an infection preventionist nurse who has special training in epidemiology, biostatistics, microbiology, infectious disease, and patient-care practices usually performs surveillance activities.

Figure 4-1. Surveillance Stakeholders



HAI, health care-associated infection; IPC, infection prevention and control; IC infection control.

Selecting Surgical Care Indicators to Be Monitored

A critical step when developing a surveillance program for SSI is selecting procedures to monitor.⁹ The SSI surveillance program should measure both infection rates and compliance rates with surgical infection prevention processes (for example, maintaining normothermia, and fluid volumes and appropriate technique for applying skin antiseptics).

To select surgical indicators for SSI, the IPC team and committee should review historical SSI data from the hospital, the scientific and professional literature, and the requirements of local public health officials or ministries of health. If no historical data exist, it may be necessary initially to perform comprehensive surveillance for all surgical procedures to establish baseline data from which to make future surveillance decisions and identify improvement opportunity areas. Many organizations find that focusing on selected high-volume, high-risk or problem-prone surgeries constitutes an effective framework for a surveillance program.

Process and Outcome Measures

SSI surveillance should include measures of processes to indicate whether caregivers are adhering to best practices and established policies as well as the outcomes of care during the preoperative, intraoperative, and postoperative phases.

Process Measures

As described in the previous chapters, patient care for the surgical patient involves multiple processes designed to prevent surgical infections. In the preoperative phase, hand hygiene, accurate assessment of patient status and risk factors, and initiating specific procedures such as maintaining normothermia, are examples of these infection prevention processes. In the intraoperative stage, infection prevention processes include skin antisepsis, maintaining normothermia, and glucose monitoring. Postoperatively, aseptic wound care is a primary prevention process. A sample of clinical processes designed to reduce surgical and other related health care-associated infection risks (for example, central or peripheral intravenous catheters) is seen in Table 4-2, below.

Table 4-2. Examples of Process Measures for Surgical Patients

Process Measures	
Preoperative care phase	<ul style="list-style-type: none"> • Risk assessment of patient host factors completed and recorded • Patient and/or family education completed and recorded • Central line insertion bundle completed • Adherence to peripheral IV insertion procedure
Adherence to peripheral IV insertion procedure	<ul style="list-style-type: none"> • Hand hygiene performed • Gloves used appropriately • Skin prepared per protocol • Aseptic technique maintained
Antibiotic administration procedure	<ul style="list-style-type: none"> • Prophylactic antibiotic ordered • Antibiotic selection accurate per protocol • Antibiotic dose accurate per protocol • Antibiotic administered within 60 minutes prior to incision • Antibiotic discontinued at close of incision or within 24 hours after surgery • Antibiotic administration and discontinuation documented • Verbal report of patient status provided to transport staff
Intraoperative care phase	<ul style="list-style-type: none"> • Personnel hand scrub completed correctly • Operating theater staff correctly wear scrub suits • Appropriate technique for hair removal on patient • Warning equipment present and working when needed • Blood glucose levels monitored if ordered • Break in sterile technique during surgery • Equipment failures during surgery • Medications labeled with expiration date • New needle and syringe used each time multidose vial is used
Postoperative phase	<ul style="list-style-type: none"> • Staff adherence to hand hygiene • Postoperative blood glucose levels monitored in cardiac patients per protocol • Postoperative normothermia maintained for colorectal surgery patients per protocol • Antibiotics discontinued within 24 hours after surgery per protocol (there are some exceptions) • Patient information transferred to postoperative care staff from operating theater staff per protocol

Table 4-2. Examples of Process Measures for Surgical Patients (cont.)

Process Measures	
Managing sterile items for surgery	<ul style="list-style-type: none"> • Staff who process sterile items receive training • Staff wearing appropriate PPE for cleaning, disinfection, or sterilization of surgical items • Correct manual cleaning and inspection of contaminated instruments per protocol • Correct functioning of sterilizer equipment • Instruments packaged per protocol • Anesthesia equipment cleaned per protocol • Endoscopes processed per protocol • Immediate-use sterilization limited to approved use • Number of positive biological indicators used for steam • Number of positive chemical indicators used for sterilization • Correct method used to transport contaminated instruments • Correct storage of sterile and clean supplies per policy
Environment of care	<ul style="list-style-type: none"> • Blood and body-substance spills cleaned per protocol • Operating theater suite cleaned per terminal cleaning procedure • Ventilator/air flow exchanges per requirements • Staff observe traffic patterns and traffic flow in the operating theater • Sharps injury rates among operating theater staff • Operating theater waste discarded per policy
Leadership, performance improvement, and patient safety culture	<ul style="list-style-type: none"> • Staff's perception of leadership support for patient safety • Leadership and surgical services walking rounds for patient safety performed • Staff-identified safety issues in the surgical setting addresses by leaders

PPE, personal protective equipment

All calculations performed by using the formula of number of events (numerator) divided by the number of persons at risk or number of expected processes, e.g. instruments packaged correctly (denominator) x 100 to obtain a percentage.

Example: Number of times immediate-use sterilization is used per protocol / number of time immediate-use sterilization is used / X 100. 23 times used according to protocol / 24 times immediate-use sterilization is used X 100 = 95.8 or 96%.

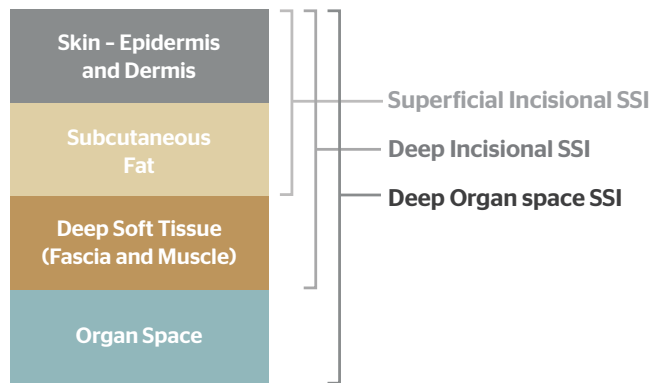
Outcome Measures

A landmark study on the efficacy of nosocomial (now called health care-associated) infections from the mid-1970s in the United States revealed that well-organized surveillance and infection control programs that included feedback of infection rates to surgeons were associated with significant reductions in SSI.¹⁰

Since then, surveillance of SSIs with feedback of data to health care workers, hospital leadership, and surgeons has become an important prevention activity in reducing SSIs. Providing information about SSI rates that are surgeon-specific may increase surgeons' awareness of SSI rates in their patients when compared to colleagues working in the same service who are performing similar surgical procedures. Surgeons who are more conscious of their SSI rates appear to be more inclined to use infection preventive measures¹ Often, this feedback of rates is "blinded" as to each surgeon's rates to avoid embarrassment of any surgeon, while communicating the outcomes.

For surveillance purposes, SSIs are divided into categories involving only skin and subcutaneous tissue (superficial incisional SSIs), those involving deeper soft tissues of the incision (deep incisional SSIs), and those involving any part of the deep anatomy (organ space SSIs), such as a joint space. (See Figure 4-2, page 13; and for more information on SSI surveillance definitions, refer to Box 4-1 on page 13)

Figure 4-2. Centers for Disease Control and Prevention Classification of Surgical Site Infections



Source: Adapted from Horan TC, et. al. CDC/ NHSN surveillance definition of health care- associated infection and criteria for specific types of infections in the acute care setting. *Am J Infect Control.* 2008 Jun;36(5):309-332

Box 4-1. Centers for Disease Control and Prevention/National Healthcare Safety Network Surgical Site Infection Categories

Superficial Incisional SSI (SIP or SIS)

The infection occurs within 30 days after the operative procedure and involves only the skin and subcutaneous tissue of the incision. In addition, the patient has at least one of the following characteristics:

- Purulent drainage from the superficial incision
- Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision
- At least one of the following signs or symptoms of infection: pain or tenderness; localized swelling, redness, or heat; and superficial incision is deliberately opened by surgeon and is culture positive or not cultured. A culture-negative finding does not meet this criterion.
- Diagnosis of superficial incisional SSI by the surgeon or attending physician

Deep Incisional SSI (DIP or DIS)

Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if the implant is in place, and the infection appears to be related to the operative procedure and involves deep soft tissues (for example, fascial and muscle layers) of the incision. In addition, the patient has at least one of the following characteristics:

- Purulent drainage from the deep incision but not from the organ/space component of the surgical site
- A deep incision spontaneously dehisces or is deliberately opened by a surgeon and is culture-positive or not cultured when the patient has at least one of the following signs or symptoms: fever > 38°C (100°F) or greater or localized pain or tenderness. A culture-negative finding does not meet this criterion.
- An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.
- Diagnosis of a deep incisional SSI by a surgeon or attending physician

Organ Space SSI

Infection occurs within 30 days after the operative procedure if no implant is left in place or within 90 days if the implant is in place, and the infection appears to be related to the operative procedure. An organ space SSI involves any part of the body excluding the skin incision, fascia, or muscle layers that is opened or manipulated during the operative procedure. Infection involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure. In addition, the patient has at least one of the following characteristics:

- Purulent drainage from a drain that is placed through a stab wound into the organ/space
- Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space
- An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination
- Diagnosis of an organ space SSI by a surgeon or attending physician

Source: Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. *Am J Infect Control.* 2008 Jun;36(5):309-332.

Case Finding

The evidence collected during surveillance to identify and classify persons (cases) of SSI is composed of information from various sources, including the following:

- Clinical chart and notes
- Laboratory culture and sensitivity reports
- Radiology and pathology reports
- Clinical reports from nurses and physicians
- Information from the patients and families
- Direct inspection of the wound site

At times, direct inspection of the wound is also part of the case finding process.¹¹ In addition to performing SSI surveillance on patients while they are on the clinical units, the SSI surveillance team should include a postdischarge follow-up component because most SSIs are not evident until after discharge. According to the NHSN criteria, SSIs occurring within 30 to 90 days of the surgical procedure are considered to be health care-associated.⁷ Guidance and details, including surveillance definitions and tools for surveillance for SSIs, are found at the NHSN website¹²: https://www.cdc.gov/nhsn/pdfs/pscmanual/17pscnosindef_current.pdf.

Role of the Infection Preventionist and Health Care Epidemiologist

The role of the infection preventionist and health care epidemiologist is to lead the development of the SSI surveillance plan in coordination with stakeholders and to perform the surveillance using established, approved, and consistent surveillance criteria or definitions. After the data are collected the infection preventionist and health care epidemiologist take the lead to analyze and present the analysis to the IPC Committee, the Quality and Patient Safety Committee (QPC), and the appropriate staff members such as the surgeons, operating theater staff, and senior leaders. Often staff from information technology or quality service assist in this analysis.

Summary: Careful and accurate surveillance is a foundational activity for the infection preventionist and health care epidemiologist and provides information that can lead to improved care and reduced risk for SSIs. It is also one of the PI tools used in the assessment phase of PI as seen in Table 4-6 on page 19.

Improving Performance

Rationale for Improving Performance and Sustaining Change

The dynamic health care environment requires organizations to continually adapt to new technologies, environmental concerns, and government regulations and to continually improve and sustain positive health care outcomes. To succeed in any practice change, surgical leaders must employ principles of change management, including clear communication regarding the expected patient outcome(s) and support for the change process.

For example, if a PI team recommends redesigning the operating theater based on an analysis showing insufficient surgical suites to accommodate the patient volume, data collected during this process can be used to structure the proposal in order to help secure approval and funding by senior leaders.

Leadership Role in Organizational Change

The role of leadership in assessing, evaluating, and facilitating surgical services change cannot be overstated or underestimated. The assessment must address the organization's infrastructure and the availability and nature of the human resources, including the ability of the staff to support the change. Leaders must provide resources (particularly human resources) and establish productive work groups that allow the organization to create and implement new strategies.

Given the dynamic technological innovations in the surgical world, and the associated need for expedient adaptation, there is growing appreciation that there are two components to support effective change management: technical and socio-adaptive (human behaviors). These are both key to successful and dynamic surgical infection prevention programs.

To create and maintain a culture of clinical excellence while inspiring and supporting staff members, leaders must involve and respect the wisdom of frontline caregivers and support staff, and incorporate both the technical and socio-adaptive behavioral aspects of care. Combining both science and behavior is essential to creating a culture of safety. A safety culture exhibits four high-level attributes that health care professionals strive to operationalize by implementing strong safety management systems¹³ (See Table 4-3, page 16.)

Creating a Culture of Safety

Characteristics of a safety culture are described in Table 4-3 below.

Table 4-3. Four Characteristics of a Safety Culture

1. A culture where all workers accept responsibility for the safety of themselves and others
2. A culture where safety is the top priority and safety goals are valued over financial and operational goals
3. A culture that encourages and rewards identification, transparency, and resolution of safety issues
4. A learning culture that provides the opportunity to learn from errors and accidents

Source: Adapted from Pronovost P, Vohr E. *Safe Patients, Smart Hospitals: How One Doctor's Checklist Can Help Us Change Health Care from the Inside Out*. New York City: Hudson Street Press, 2010.

A Fair, Just, and No-Blame Culture

One characteristic of high-performing organizations is their ability to learn from mistakes and to recognize that many mistakes come from *system* failures rather than *individual* failures. A prevailing blame culture (where persons are blamed for errors) in health care has been suggested as a major source of an unacceptably high number of medical errors. Blaming individuals for errors generally caused by broken systems creates anxiety and fear in staff and can change the way they perform. The concept of a “just culture” has emerged as an essential approach to improving the quality and safety of patient care.¹⁴

A fair and just culture is one in which leaders and staff members learn and improve by openly identifying and examining their own weaknesses and opportunities for improvement. David Marx describes a just culture as one in which individuals are not blamed for errors and feel supported and safe when identifying errors or defects¹⁴ Marx described 3 types of common errors in Table 4-4 below.

Table 4-4. Types of Errors in Health Care

Type of Error	Definition
Human error	Should have done other than what they did
At-risk behavior	Failure to execute expected care; should have been aware of substantial unjustifiable risk
Recklessness	Conscious disregard for substantial and unjustifiable risk

Source: In Conversation with Davide Marx, JD. Agency for Healthcare Research and Quality. PS Net. <https://psnet.ahrq.gov/perspectives/perspective/49/in-conversation-with-david-marx-jd> Accessed 2/16/2018.

Marx notes that most errors are a result of human error.¹⁴ The following case study emphasizes this point and describes tools to identify and mitigate risk.

Case Study 4-1. Human Error in the Operating Theater

Ms. Hanan was the circulating nurse for a prominent general surgeon. The surgeon could be quite demanding; however, Ms. Hanan has always prided herself on being able to meet his demands. During one long and difficult case, the surgeon asked for medication to irrigate the wound. Hanan realized that time was important, and she went to obtain the irrigation fluid.

While Ms. Hanan was obtaining the medication, the charge nurse, Ms. Fatima, entered the operating theater and interrupted Ms. Hanan to find out how much longer the case would take, as several nonscheduled cases had been added for surgery that day. Ms. Hanan was careful to check the medication but became distracted and took the wrong—non-sterile, non-irrigating—solution.

Someone had placed the wrong solution on the shelf where the irrigating solutions are kept. Ms. Hanan realized her mistake only after the surgeon complained that the solution did not look right and stopped the irrigation.

Reviewing the Case

This error is considered a human error that occurred because of a system failure. No one identified that a non-sterile, non-irrigating solution has been placed on the operating theater shelves. It had also become common practice in the operating theater to allow interruptions during surgery, regardless of the fact that these interruptions occurred during critical processes, such as preparing medications or solutions. The incident was addressed by an improvement and the system was changed to support best practice, including careful assessment of labels and unneeded interruptions during critical procedures.

Methods and Tools for Creating Change and Improvement to Reduce SSI

Organizations can use a variety of PI methods and tools to create change. Some of the methods and tools for identifying and analyzing opportunities for improvement are discussed below. The discussion also includes specific PI tools to accomplish change.

The topics presented reflect the general sequence for the PI and change process.

- **Eight Dimensions of Change:** How to evaluate whether the operating theater and surgical service is ready for change
- **Methods to Identify and Assess Current State:** Tools for analysis of strengths or weaknesses of current practice or current state
- **Performance Improvement Models:** Organizations select one to use for consistency. The model provides a framework for a systematic approach to change.
- **Performance Improvement Tools and Methods:** Tools that can be used to create change
- **Measuring Change:** To evaluate progress and provide communication to staff and leaders
- **Barriers to Effective Change in Patient Safety and Quality:** How to identify and overcome them
- **Sustaining Improvements:** Ensuring the sustainability of new practices

Eight Dimensions of Change

Before undertaking any change, the leadership of surgical services should assess whether the unit is ready and willing to make changes. These eight dimensions are assessed in an organization or a service by asking people to rate the organization with specific questions. Table 4-5, below, presents the eight (8) dimensions of change that can be monitored and assessed.

Table 4-5. Eight Dimensions for Organizational Change in the Operating Theater

Trustworthy Leadership	Do surgical services leaders earn the trust of the rest of the workers and demonstrate ways in which way to meet its collective goals?
Trusting Followers	Do members throughout surgical services have the ability to constructively dissent without fear of repercussions?
Capable Champions	Does surgical service attract, retain, and support change leaders?
Involved Management	Can staff and management effectively collaborate in surgical services?
Innovative Culture	Does surgical services support innovation and encourage innovative activity?
Accountable Culture	Does surgical service meet established deadlines?
Systems Communications	Can the surgical services staff communicate vertically and horizontally with all internal and external customers?
Systems Thinking	Do surgical service staff think in terms of the system, focus on root causes, and recognize interdependence within surgical services?

Source: Adapted from Judge WQ, Elenkov D. Organizational capacity for change and environmental performance: An empirical assessment of Bulgarian firms. *J Bus Res.* 2005;58:893-901. Accessed Aug 16, 2017. <http://www.betsaonline.com/omoumi/OrganizationalCapacityChange.pdf>.

Methods and Tools to Identify and Assess Current State

This section describes seven tools that can help organizations assess their current state. A summary of these seven tools is provided in Table 4-6, below.

Table 4-6. Tools to Identify and Analyze Organizational Strengths, Weaknesses, and Current State

Tool	Stage	Comments
Surgical Site Infection Surveillance	Surveillance, as described above, is a foundational assessment tool to identify both practices and outcomes that can indicate areas for improvement. Performed in initial assessment stage.	Designed and implemented by the IPC team with input from stakeholders and approval from the Infection Control or Quality and Patient Safety Committee on at least an annual basis.
Adverse Event Reporting Systems	To capture errors, injuries, equipment malfunctions, or potential events by the individual who was involved or witnessed the event.	Generally initiated by leadership or health care workers to report an incident error or potential error that could cause harm to patients or staff. Uses a standardized reporting format.
SWOT (strengths, weaknesses, opportunities, threats) Analysis	Identification tool that provides insight into strengths and weaknesses, and threats and opportunities. Helpful in group activities.	Helps decision makers decide if an objective is reasonable given the current strengths and weaknesses in an organization, or if there is an opportunity for improvement.
Gap Analysis	Provides a programmatic assessment of a current performance measure or process and gaps in desired best practice.	Particularly helpful in identifying process or procedural gaps between the current state and the desired state. Helps determine if there is a gap that warrants a performance improvement project.
Sentinel Event–Root Cause Analysis	Helps systematically analyze an issue—generally a poor outcome—by asking and answering certain questions to lead to a root or basic cause of the problem.	Very helpful in focusing the discussion on system issues rather than personalities when trying to figure out why a poor outcome occurred.
Learning from Defects Tool	Provides a structured approach to help staff and administrators identify the types of systems that contributed to the defect and to follow up to ensure that safety improvements are achieved.	Useful to assemble staff involved in a defect or error to collectively identify what led to the event and to generate solutions to prevent it from happening again.
Force Field Analysis	Assists in increasing awareness of forces that are inhibiting or promoting best practices.	Helpful in bringing a group to consensus on the factors that will generate success or failure in a change process.

IPC, infection prevention and control.

Surgical Site Infection Surveillance

Surveillance is a key activity of the IPC team to identify and analyze opportunities for improvement. This method has been discussed in detail above.

Adverse Event Reporting Systems

To successfully evaluate defects, there must be a reporting system in place that enables recognition of actual and potential problems. Staff must feel free to report these risk issues without repercussions. For example, if a surgeon or scrub nurse is observed repeatedly performing incomplete surgical hand scrub and has been counseled, the observing staff members should feel comfortable reporting this behavior. Or if instruments arriving to the operating theater are not clean, this should be reported immediately to the Central Sterile Supply Department (CSSD) staff and to the reporting system. The data reported should be reviewed and analyzed on a continual basis, trends identified, and key single events noted and followed by action(s) to address the particular issue as soon as possible after reporting. Trends should be shared with key staff members as aggregated data without identifiers, and staff and leadership should work together to remedy risk issues. Table 4-7, below, describes WHO guidelines for safety and adverse event reporting systems. And Box 4-2 on page 21 describes three main objectives of a reporting system.

Table 4-7. WHO Guidelines for Safety and Adverse Event Reporting Systems

Type	Characteristics
Non-punitive	Reporters do not fear retaliation for themselves or others as a result of error reporting.
Confidential	Identities of the patient, reporter, and institution remain anonymous.
Independent	The reporting system is independent of hierarchal authority to punish as a result of reporting.
Timely	Timely analysis of issues is promptly dissemination and shared with key stakeholders, particularly when serious events are identified.
Systems Oriented	Recommendations are focused on systems rather than people. Improvements are geared toward changes in processes and systems.
Responsive	Capable of rapidly disseminating reports. Organizations commit to implementing recommendations whenever possible.

Source: Adapted from World Health Organization. WHO Draft Guidelines for Adverse Event Reporting and Learning Systems: From Information to Action. 2005. Accessed Aug 16, 2017. <http://apps.who.int/iris/bitstream/10665/69797/1/WHO-EIP-SPO-QPS-05.3-eng.pdf>.

Box 4-2

WHO describes three main objectives of an adverse event reporting system in its Minimal Information Model for Patient Safety. Information to be reported when an adverse event occurs includes the following:

1. The Description—What happened and to whom; for example:

- **Patient characteristics** (such as age, sex, etc.)
- **Incident characteristics** (observations, measures, clinical features, tentative disease categories)
- **Location** where the incident occurred (hospital, clinic, etc.)
- **People involved** (attending physician and other health personnel)
- **Discovery** of the incident (how, when, and by whom the incident was noticed)
- **Possible harm** (direct and consequential)
- **Immediate action** taken to remedy the situation

2. The Explanation—Why it happened; for example:

- **Patient's condition** (according to the pathology or the patient's physical status), **causes** of the event
- **Contributing factors**
- **Mitigating factors**

3. The Remedial Measures—What were the reactions; for example:

- **Identification** of weak links in the care chain
- **Review** of clinical and supervisory processes and procedures
- **Administrative, educational,** and other requirements to prevent the reoccurrence of similar incidents
- **Minimize** the impact on the patient (sequels) and on the care organization (direct and indirect costs), if it reoccurs

Adapted from World Health Organization Preliminary Version of Minimal Information Model for Patient Safety, 2014. http://www.who.int/patientsafety/implementation/IMPS_working-paper.pdf?ua=1, Accessed August 28, 2017.

SWOT Analysis

A SWOT analysis is a detailed assessment of the strengths, weaknesses, opportunities, and threats related to a particular topic, issue, potential change, or other matter. The SWOT analysis can be used to assess processes and projects and can be used by organizations or departments to help analyze decision making.

As its name implies, a SWOT analysis examines four elements:

- **Strengths**—internal attributes, resources, or practices that support a successful outcome
- **Weaknesses**—internal attributes, resources, or practices that work against a successful outcome
- **Opportunities**—factors that can be used to enhance a project or process
- **Threats**—factors that could jeopardize a project or process

An effective method to perform a SWOT analysis is to assemble a team of people who are involved in or recipients of the issue and use a structured brainstorming method to identify elements in each of the four quadrants. Figure 4-3, below, demonstrates how a SWOT analysis is used to analyze central line–associated bloodstream infection (CLABSI) prevention practices in an organization. The SWOT analysis can be used to develop priorities for performance improvement strategies. To perform a SWOT analysis, identify the strengths, weaknesses, opportunities, and threats related to the risk issues being considered. After analysis and discussion, determine numeric rating if using quantitative method or statement of priority if using qualitative method for the risk assessment. It is valuable to perform the SWOT analysis with a team of staff who participate in the process. Use the SWOT Analysis to develop an improvement plan.

Figure 4-3. SWOT Analysis: Central Line–Associated Bloodstream Infection (CLABSI) Prevention Practices

<p>STRENGTHS</p> <ul style="list-style-type: none"> • Policy evidence-based and current (see reference) • Current ICU staff competent in approved practices based on periodic assessments • Hand hygiene compliance at 94% and improving • Physician leadership interested in patient safety and improving CLABSI practices 	<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • Education of new staff (nurses and physicians) for all CLABSI practices, e.g., formal education and competency assessments • Identify nurse and physician champions—empower to oversee practices and guide improvements • Revise procedure to assure availability of supplies at all times to enhance compliance, e.g., cart or kit • Use checklist to assure all tasks are carried out; report analysis to staff • Address adherence to MSB with physicians using MD champion • Public reporting of CLABSI rates
<p>WEAKNESSES</p> <ul style="list-style-type: none"> • Supplies not consistently available in timely manner for insertion procedures • Some physicians do not adhere to MSB • Nonoptimal sites sometimes chosen, e.g., femoral site often selected • Residents do not always feel they are well trained for safe insertion procedures and sites 	<p>THREATS</p> <ul style="list-style-type: none"> • Abuse to nurses who point out lack of adherence to CLABSI insertion protocol • Lack of proper insertion technique and placement in subclavian vein • Interruption of supplies from vendors

This figure shows SWOT (strengths, weaknesses, opportunities, and threats) analysis related to central line–associated bloodstream infection (CLABSI) prevention practices. ICU, intensive care unit; MSB, maximal sterile barriers; MD, physician.

Source: Adapted from Marschall J, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals. *Infect Control Hosp Epidemiol*. 2008 Oct;29 Suppl. 1:S22-30.

Gap Analysis

Gap analysis is a tool used to identify gaps in care or in a process. It is a risk assessment tool to help identify the current state and potential strategies for improvement. A gap analysis at General Hospital is described below, where accidental punctures occurred in the operating theater over the last six months. The punctures were a result of sharps as they were being removed from instruments as operating theater staff were preparing the instruments to be sent for reprocessing. The operating theater leadership team began their investigation into the cause of these injuries. A gap analysis indicated that staff members were sometimes careless when removing or handling sharps. Although preliminary actions, such as educating operating theater staff, showed moderate success, operating theater leadership decided to embark on a more comprehensive action plan and conduct another gap analysis to identify issues and then to change procedures as necessary and embed the changes into routine work processes starting with sharps disposal.

The gap analysis identified the current state and the desired state for sharps disposal. The assessment revealed that leadership needed to more actively demonstrate its commitment to safety and to promote individual accountability. It also showed that the method of handling sharps while removing them from instruments needed improvement. Table 4-8, below, provides a sample gap analysis for lancet injuries.

Table 4-8. Sample Gap Analysis for the Operating Theater for Sharps Injuries

Area/Issue	Current Status	Desired Status	Gap (Describe)	Action Plan and Evaluation	Priority
Lancet sticks	Five punctures by sharp instruments during disposal compared with zero the year before	No sharp punctures in operating theater, and 100% adherence to safe needle practices by all staff by 2018	Gap in safe needle practices protocol Staff survey indicates knowledge deficit Not all containers located near point of use	Staff and providers must complete competency on needle safety Operating theater must review policy for sending trays to CSSD after a case	High

CSSD, Central Sterile Supply Department.

Sentinel Events and Root Cause Analysis

Some severe events are termed “sentinel events.” According to The Joint Commission in the United States, a sentinel event is an unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof. *Serious injury* specifically includes loss of limb or function. The phrase “or the risk thereof” includes any process variation for which a recurrence would carry a significant chance of a serious adverse outcome.¹⁵ Such events are called sentinel, because they signal the need for immediate investigation and response. For example in surgical services a sentinel event might be operating on the wrong site, or the patient dying unexpectedly in the operating theater.

A method to evaluate a sentinel event usually involves root cause analysis. A root cause analysis focuses on *systems* and not *individuals*. A root cause analysis includes examination of human factors, equipment, environmental factors, human resources, information management, leadership issues, and communication. The objective is to get to the root or main cause of the incident to identify where improvement can make a difference.

Table 4-9, below, demonstrates how a root cause analysis is applied to the CSSD. Adequate sterilization is important to ensure that only sterile instruments are used on patients. An incident occurred in which a tray was not properly sterilized and was not detected until after the instruments were used on a patient. Root cause analysis presents an opportunity to determine why the event occurred by asking a series of questions that will often lead to identifying the root of the problem.

Table 4-9. Root Cause Analysis Example in the CSSD

Level of Analysis	Questions	Findings
Sentinel Event	<ul style="list-style-type: none"> • What happened? • When did it happen? 	<ul style="list-style-type: none"> • A tray of instruments that had failed sterilization was sent to the operating theater and used on a patient. • The tray was sent at about 16:00 hours (4:00 P.M.), during change of shift in the CSSD. It was used on the patient the next morning in surgery.
	<ul style="list-style-type: none"> • Why did it happen? 	<ul style="list-style-type: none"> • The sterilizer had not reached the appropriate temperature and time readings and had shut off prematurely. • A new employee was working in CSSD and assumed that sterilization was complete. • The tray was loaded with other sterile supplies and used in the OT on a patient.
What were the most proximate factors?		
Human factors	<ul style="list-style-type: none"> • What human factors were relevant to the outcome? 	<ul style="list-style-type: none"> • New employee working in the CSSD. • No readout (review) of completed sterilization cycle.
Equipment factors	<ul style="list-style-type: none"> • What equipment factors contributed? 	<ul style="list-style-type: none"> • The sterilizer shut off before the cycle was completed.
	<ul style="list-style-type: none"> • Were there any controllable environmental factors? 	<ul style="list-style-type: none"> • The incident happened at change of shift and was not noticed. • There was a lack of oversight for the new employee in her performance and competency. The sterilizer shut off before the cycle was completed.
What systems and processes underlie those proximate factors?	<ul style="list-style-type: none"> • Human factors 	<ul style="list-style-type: none"> • Training issues related to orientation and monitoring of new staff for competency. • Complacency of OT staff at point of use, e.g., sterilizer parameters were not checked.
	<ul style="list-style-type: none"> • Equipment factors 	<ul style="list-style-type: none"> • Sterilizer did not have preventive maintenance as per schedule.
	<ul style="list-style-type: none"> • Leadership factors 	<ul style="list-style-type: none"> • Due to staffing shortages, orientation for new employees was decreased by one week.

Source: Soule BM, Arias KM, editors. APIC/JCR Infection Prevention and Control Workbook, 2nd ed. Oakbrook Terrace, IL: Joint Commission Resources, Inc., 2010. Used with permission.

The final analysis identified a lack of training for new staff as well as a lack of periodic review of existing staff competency. Because the orientation was decreased by one week due to staffing issues, the training staff had cut essential elements of orientation.

In addition, preventive maintenance of the sterilizer was not performed on a regular basis. Table 4-10, below, describes the action plan that was initiated following the root cause analysis.

Table 4-10. Action Plan

Issue	Action	By whom and date
Staff orientation	<ul style="list-style-type: none"> Orientation was reviewed and the extra week was added again. 	Nurse educator Start Oct. 2017
Annual competency	<ul style="list-style-type: none"> Review of procedure with all staff will be part of annual performance review. All staff will have annual competency testing. 	Nurse manager Complete by March 2018
Sterilizer maintenance	<ul style="list-style-type: none"> Monthly preventive maintenance will be done by engineering. Reports will be documented with a copy to the nurse manager on a monthly basis. 	Maintenance and engineering staff Start Jan 2018 Nurse manager Start Jan 2018

Learning from Defects Tool

The learning from defects tool will help analyze a defect or error in such a way that the person or team can learn from the error, implement change, and prevent the same error in the future. A carefully selected multidisciplinary team should complete the form. The tool requires the team to identify and describe what happened and analyze the contributing factors that may have led to the error.

Figure 4-4, page 26, demonstrates how the learning defects tool can be used to provide a clear, concise analysis of the incident and a concrete action plan that identifies opportunities for improvement.

Figure 4-4. Learn from Defects Tool Worksheet

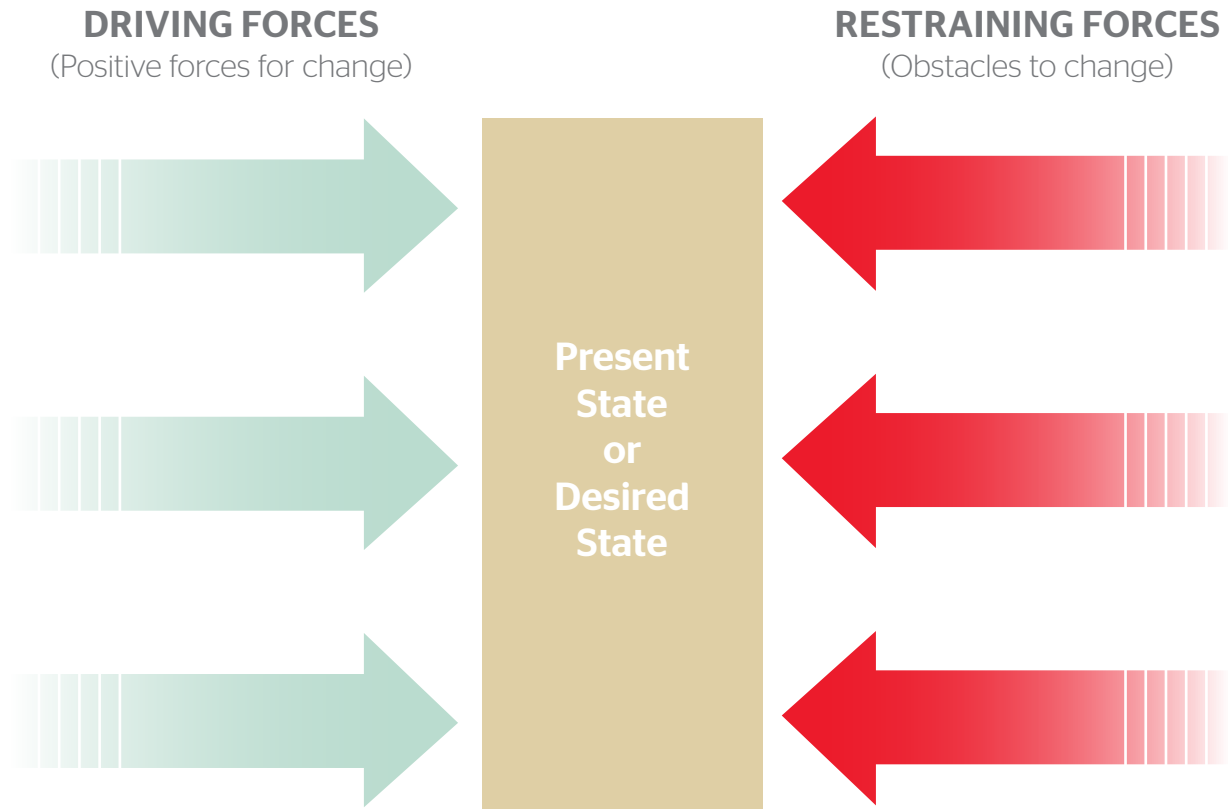
Date: September 2018			
Attendees: OR team			
What happened? (brief description)			
Non sterile, non-irrigating solution was used to mix a medication			
Why did it happen? (what factors contributed)			
Wrong solution was on shelf in OT room Interruption during critical process			
+ factors		- factors	
<u>What prevented it from being worse?</u>		<u>What happened to cause the defect?</u>	
Surgeon noticed solution did not look right		No process for checking supplies in rooms No process for interruptions during surgery 2 bottles look similar	
What can we do to reduce the risk of it happening with a different person?			
Action Plan	Responsible Person	Targeted Date	Evaluation Plan - How will we know risk is reduced?
Develop process to signal when an uninterrupted action is in place	Director	Sept. 2018	
Develop process to inspect supplies in room	Manager	Oct. 2018	
Put sticker on solutions to indicate "this is not irrigating solution"	Director	Sept. 2018	
Educate staff to check solutions carefully	Manager	Oct. 2018	
Educate and reinforce importance of stocking rooms with appropriate supplies	Manager	Oct. 2018	
With whom shall we share our learning? (Communication plan)			
Who	When	How	Follow Up
Manager and Director	As soon as possible	Staff meeting	Written follow up protocols distributed to all staff

Source: Learn from Defects Tool; CUSP Toolkit. <https://www.ahrq.gov/professionals/education/curriculum-tools/cusptoolkit/toolkit/learndefects.html> Accessed Feb 16, 2018.

Force Field Analysis

Force field analysis, developed by Kurt Lewin, is a structured process that helps a group identify, discuss, and evaluate the various forces that help (driving forces) and hinder (restraining forces) the current state or a change designed to achieve a desired state. Forces can be persons, habits, skills, expectations, knowledge, attitudes, equipment, culture, and customs that drive or restrain change. Figure 4-5 below, illustrates the force field analysis concept.

Figure 4-5. Force Field Analysis



Source: Change Management Coach. Force Field Analysis - Kurt Lewin. Accessed Aug 16, 2017. <http://www.change-management-coach.com/force-field-analysis.html>. Used with permission.

A force field analysis should be used when a group, such as the intraoperative team, needs to identify and discuss the driving and restraining forces associated with the current state or with a proposed change toward a desired state (for example, consistently maintaining normothermia during surgery). This tool can help identify the root cause of a problem, the forces that should be addressed to ensure that a change is successful, and/or to determine why an intervention was not successful. Finally, it can identify and prioritize specific actions that will strengthen driving forces and weaken or eliminate restraining forces to ensure that a change succeeds. Box 4-3, below, provides directions on using this tool.

Box 4-3. Instructions for Performing a Force Field Analysis

1. Gather participants who have interest and experience related to the focus of the activity.
2. Describe and clarify the current and/or desired state. Write a brief description of this at the top of the flip chart.
3. Identify and list all of the forces driving change toward the current or desired state.
4. Identify and list all of the forces resisting change toward the current or desired state.
5. If the focus of the activity is to identify forces associated with the current state, or status quo, the facilitator should describe the driving forces as those that drive or promote the current state and the restraining forces as those that hinder change toward a more desirable state.
6. If the focus of the activity is a proposed change to a desired state, the facilitator should describe the driving forces as those that facilitate or increase the likelihood of achieving the desired state and the restraining forces as those that decrease the likelihood of achieving the desired state.
7. Optional: Assign a score to each force (1 = weak and 5 = strong) to help prioritize the forces and the order in which the team should consider them.
8. Discuss actionable strategies to strengthen driving forces and weaken or eliminate restraining forces. This process might include creating new driving forces or a change in the intervention.
9. Discuss the probability that the driving forces can overcome the restraining forces and result in desired change. This will help the team determine next steps to create, modify, or abandon an intervention.
10. Create or modify an intervention to facilitate improvement.

Current State: _____

List of Driving Forces

List of Restraining Forces

Resources for Force Field Analysis can be found at the Minnesota Department of Health: www.health.state.mn.us/divs/opi/qi/toolbox/forcefield.html

Case Study 4-2 illustrates how Force Field Analysis was used to address a gap in practice related to the “time-out” policy in the operating theater.

Case Study 4-2. Force Field Analysis in the Operating Theater

In the operating theater, physicians were not consistently using the time-out procedure that is a key part of surgical policy. The time-out is a brief period when the surgeon and all staff in the room stop what they are doing and review the patient and the procedure to ensure that both the patient and the procedure are correct before starting surgery. The PI team of two surgeons of different specialties, two operating theater nurses, and the operating theater manager knew that it was critical to patient safety to ensure that a time-out was performed for each patient.

The team decided to perform a force field analysis to look at functions that encouraged (or drove) the desired performance (driving forces) and those that discouraged or restrained (restraining forces) desired performance. Each of the identified restraining actions was analyzed and resolved. Table 4-11, below, analyzes why surgeons did not consistently follow organization policy regarding time-outs prior to surgery.

Table 4-11. Question: Why aren’t surgeons consistently following policy and performing the time-out procedure before surgery?

Restraining Forces	Driving Forces
1. Perception of lack of time	1. Time was allotted in the surgery schedule for enough extra minutes to perform the time-out procedure.
2. No reminder to perform time out	2. Circulating nurse reminds team to perform the time-out procedure.
3. Surgeons arriving late to the procedure	3. Chief of surgery has issued directive to all surgeons to arrive on time.
4. Lack of assigned role and authority for circulating nurse to delay starting surgery until time-out performed	4. Circulating nurse can be given authority to delay start of surgery until time-out performed.

When analyzed, these four restraining forces were addressed, and a new process was implemented. These changes *unfroze* the current lack of compliance to time-out before each procedure.

The new processes were as follows:

1. Review of surgery schedule to ensure that adequate time for time-out procedures was included in each case.
2. Circulating nurse job description revised to incorporate the following:
 - a. Reminding the team to perform time-out
 - b. Authority to delay surgery until time-out was completed
3. Chief of surgery issued directive for surgeons to arrive on time or lose their preferred surgery schedule in the future. Surgeon arrival times were monitored.

During the next two months, the team practiced the new processes that supported time-out, and by month three the new processes were frozen in place and part of the normal operating theater routine. Time-out compliance increased from 62% to 98%.

Performance Improvement Models

A performance (or quality) improvement (PI or QI) model helps define, structure, and implement improvement projects in a consistent manner. This consistency promotes staff understanding and clarifies roles. A PI model that is used repeatedly and that is familiar throughout the surgical services make projects easier to conduct (see Table 4-12, below). Organizations should select the model that works well for them.

Table 4-12. Models for Performance Improvement Projects

Model	Stage	Comments
Plan-Do-Check (Study) - Act	This PI model is widely used in health care. Developed by Dr. Edward Deming.	A simple framework for PI projects that helps organize the work for success into continuous cycles.
4 Es	The 4 Es Model is an outcome of the CUSP project and has been used successfully to improve care.	A four-step PI model for improvement that can be adapted to many improvement projects. The elements are Engage, Educate, Execute, and Evaluate.
DMAIC and Six Sigma	DMAIC is a component of the Six Sigma model that has been used in industry and now in health care.	DMAIC uses a five-step model to improvement that includes defining, measuring, analyzing, improving, and controlling a changed or changing process.

PI, performance improvement; CUSP, Comprehensive Unit-based Safety Program.

Although there are many models for change, three will be described in some detail in this module. They are Plan-Do-Study (Check)-Act; the 4 Es: Engage, Educate, Execute, and Evaluate; and DMAIC; Define, Measure, Analyze, Improve, and Control.

Plan-Do-Check (Study)-Act (PDCA/PDSA)

The PDCA method was developed by Edward Deming for use in industry.¹⁶ The model was successful in Japan and then brought to the United States. The method has been used worldwide for rapid cycle improvement, most frequently accomplished through small rapid tests of change. The PDCA methodology is cyclical; that is, when completed, the process or the cycle begins again.

PLAN: It starts with determining the nature and scope of the problem and what changes can be made. Then a plan is developed.

DO: The change is tested and measured for what needs to occur.

CHECK/STUDY: Results are assessed and interpreted.

ACT: Action is taken.

Figure 4-6, page 31, illustrates the tasks of each stage of the PDCA/PDSA model.

Figure 4-6. Tasks in Each Phase of PDCA Methodology

Steps in the PDCA (Plan-Do-Check-Act) or PDSA (Plan-Do-Study-Act) Improvement Methodology	Completed
<p>PLAN</p> <ul style="list-style-type: none"> ✓ Identify potential projects. ✓ Evaluate potential projects. ✓ Use process mapping to describe the current state of the process of interest. ✓ Select the project (may use a project selection tool). ✓ Prepare the project mission statement. ✓ Select team members and launch the team. ✓ Obtain approval for the project from organization leaders. ✓ Move to the DO Phase. 	
<p>DO</p> <ul style="list-style-type: none"> ✓ Create measures to assess causative factors (root causes). ✓ Create a data collection plan. ✓ Collect data. ✓ Use data to analyze the current state. ✓ Review specific failures within the current state. ✓ Use results to define the scope of the improvement project. ✓ Review the project with leadership. ✓ Begin to generate solutions. ✓ Move to the CHECK Phase. 	
<p>CHECK or STUDY</p> <ul style="list-style-type: none"> ✓ Brainstorm to determine solutions that will eliminate the root cause(s) of problems. ✓ Establish the priority of potential solutions. ✓ Pilot test solutions to revise and to improve the process(es) of interest. ✓ Evaluate the improvement(s). ✓ Share results with leaders. ✓ Move to the ACT PHASE. 	
<p>ACT</p> <ul style="list-style-type: none"> ✓ Maintain and monitor the improvement. ✓ Refine the policy and procedures as needed. ✓ Educate staff and others about the refined process. ✓ Transfer learning to others. ✓ Recognize staff and faculty AND CELEBRATE SUCCESS. 	

The Institute for Healthcare Improvement (IHI) has created a model that uses the PDSA framework and that asks specific questions of the team. This model is used for small tests of change to determine if the change accomplishes the following;

- Will result in improvement
- Has barriers that must be
- Help implementation.

Case Study 4- 3. Example of Using the Institute for Healthcare Improvement (IHI) PDSA (PDCA) Performance Improvement Model in the CSSD Improvement Project for Turnover Time for Instruments

What are we trying to accomplish?

The CSSD staff needs to decrease the turnover time for processing instruments from the OT to avoid delayed surgeries due to lack of available sterile instruments.

How will we know if a change is an improvement?

The CSSD will know this change is an improvement when the turnover time is rapid enough that surgeries do not have to be delayed because of lack of instruments. Delayed surgeries will decrease from two per day to two or fewer per month. The staff knows that the current process, from receiving instruments to having them ready for use again, takes 3.25 hours. They want to decrease that time by at least 30 minutes.

What changes can we make that would result in an improvement?

The CSSD staff can identify steps to complete more efficiently and quickly to save time.

The CSSD's PDSA Process for Improvement

PLAN: The team decided to use the PDSA rapid cycle process. They met on a Monday to analyze current instrument processing. They selected a team consisting of one nurse or technician from each of the main areas of the CSSD: reception, washing, cleaning and setting up trays, sterilization, packaging, and storage; and two OT nurses. The CSSD manager was also on the team.

The team created a *process flow map of the steps* (see below) in the instrument processing system, starting with receiving dirty instruments and ending with having instruments ready for use. After analyzing the flow chart, the team used a *cause-and-effect diagram (Ishikawa or fishbone)* to further analyze each major step for risk points, in which the process slowed.

On Tuesday they compared their results and found that some steps were repetitive and could be eliminated, saving time. They decided which steps were the highest priority for change and should be the first to be addressed. To do this they used a *priority selection tool*. At this point the team completed a team charter to document their project so that they could take it to leadership for approval and support.

DO: On Wednesday the team developed a data collection plan and began to collect more data to have the best information on the timing of the step they selected. They analyzed that data to get a clear picture of the current state of the process. For troublesome items they used either the *5 WHYS* exercise or the force field analysis to get to the root cause of the extended times.

Case Study 4- 3. (cont.)

By the following Wednesday, they had determined which small changes to try, one at a time, to see if each change decreased the time for that step. This further refined the scope of the project and was documented on the team charter. The team also developed policies that reflected the changes they wanted to make. Friday they educated the staff about these changes, and everyone practiced under supervision for the next week.

CHECK/STUDY: The team monitored the new process for several days after putting it in place. They found that they were able to eliminate 30 minutes from their reprocessing system for the step selected. They continued to work on other priorities identified in the fishbone diagram and selected on the priority matrix. They again reviewed the project with leaders and shared results obtained thus far from the new, implemented processes.

ACT: The team started and continued monitoring the changed steps in the process to ensure that all staff members were practicing according to the new policy. As they continued, they refined their policies and continued to educate the staff. They kept everyone informed. By keeping track and monitoring, they found they had decreased the percentage of surgeries delayed because of lack of available instruments from 8% to 2%. Their ultimate goal is 0%. The successful changes were embedded into the normal work process.

The team reported their results to organizational leaders and celebrated the improvement with the CSSD and OT staffs.

Case Study 4-4. A PI Case Study in the CSSD using the PDCA Improvement Model

The Problem

The CSSD staff noted that complex equipment from surgery was being returned to the department with caked blood. The problem had become progressively worse in the last several months, especially since new equipment and instruments were introduced.

What are we trying to accomplish?

Eliminate any complex instruments and equipment from being returned to the CSSD from surgery with caked blood.

How will we know if a change is an improvement?

Through monitoring, the CSSD will determine that less than 0.5% of complex equipment is returned to their department with caked blood.

What changes can we make that would result in an improvement?

Develop a policy and procedure to eliminate blood from equipment before it is returned from surgery to the CSSD.

This organization's operating policy was to disassemble equipment and pre-clean it at the point of use (for example, right after surgery). This process was not occurring on a regular basis.

The CSSD staff members discussed their concerns with their manager. The CSSD manager spoke with the OT manager, and together they decided that a PI project was warranted. They formed a team and identified key stakeholders. They made certain that all the right people, those who know the processes, were represented on the team. They created a project charter and included the names of the members and other information.

Figure 4-7, page 35, shows the project charter in this case that will be completed by the team.

Figure 4-7. Project Charter

Project Charter			
<p>Problem / Goal Statement</p> <p><i>Why is this project important and why should it be important?</i></p> <p>Problem / Goal Statement</p> <p>Ensure that all equipment is properly cleaned and sterilized. Equipment with caked-on blood cannot be adequately cleaned. In some cases the equipment is damaged.</p>	<p>Problem / Goal Statement</p> <p>Prevention of SSI</p> <p>Potential for harm from damaged equipment</p>		
<p>What is the business case?</p> <p>More than \$25,000 has been lost in the last 3 months due to damaged equipment.</p>	<p>Organizational Benefit:</p> <p>Cost</p> <p>Safer patient care</p>		
Team members: List names	Stage	Target	Actual
<p>Stakeholders:</p> <p>Management</p> <p>Administration</p> <p>Surgeons</p> <p>Patients</p>	Plan		
	Do		
	Check/ Study		
	Act		
	Completion		

When the charter was completed and the team had obtained leadership commitment for the project, the team began their improvement process. They decided to use the PDCA improvement model.

PLAN

- The team completed a *cause-and-effect diagram* to identify areas of high risk for the process.
- They identified three specific areas of concern:
 - Lack of education
 - Lack of clear policies
 - Compliance issues with the current processes
- They then used the *project priority selection tool* to determine which issue they should address first. They decided to analyze the current processes first, and for each process they created a detailed *process flow map* with the team. They found several steps in which staff members were confused about what to do. The team also found some steps that were clear in written policy but were not carried out accordingly.

DO

- The team decided to collect more specific data on this process, and they created a checklist and data collection tool and assigned team members to collect data on the current state of instruments when they arrive from the operating theater to the CSSD.
- The team planned to ensure that the infrastructure supported the proper procedure, then to update policies followed by intensive educational sessions.
- The team used the *5 Whys* exercise to identify the root cause of why instruments were not consistently disassembled and cleaned before disinfection and sterilization. Then, based on the outcome of the *5 Whys*, they implemented a new process that required all surgical instruments to be disassembled and cleaned prior to sterilization. CSSD staff were responsible for these processes.

CHECK/STUDY

- After an improved process was in place for the disassembly and cleaning of instruments in the operating theater, the team began to monitor to ensure compliance and sustainability. They selected metrics that were easy to collect and conveyed the true performance of the staff.

ACT

- After the procedure was determined to be effective, it was published. The team educated all staff and put the process into formal policy and procedure. The procedure was now part of the normal work flow.

In the following weeks the team decided to address other issues identified in the cause-and-effect diagram.

The 4 Es: Engage, Educate, Execute, and Evaluate

The 4 Es represents a conceptual framework for improvement that grew out of the Comprehensive Unit-Based Safety Program (CUSP) concept from the Agency for Healthcare Research and Quality.^{17,18}

The 4 Es (Engage, Educate, Execute, and Evaluate) is an action-oriented model providing a simple structure that can be used either independently or in concert with other tools or philosophies.

In the 4 Es model, the first “E,” Engage, is relevant to change theory. Stakeholder engagement before the start of a project provides a framework for beginning a conversation and communication¹⁹

Educating, Executing, and Evaluating, the other Es, fit into virtually every change model, even though different terms may be used for the same or similar steps. This model has the benefit of being inclusive rather than exclusive and teaching staff new ways of performing as the leaders of the change. See Figure 4-8, below.

Figure 4-8. Engaging Team Members Using the 4 Es



Source: Agency for Healthcare Research and Quality, CUSP Toolkit: Assemble the Team. Slide 12: Engage Team Members Using the 4 E’s. Dec 2012. Accessed Aug 16, 2017. <https://www.ahrq.gov/professionals/education/curriculum-tools/cusptoolkit/modules/assemble/assembleteamsides.html#slide12>.

Example of an Implementation Model Using the 4 Es

The basis of the 4 Es was developed in 2003, when the Michigan Healthcare Association Keystone Center, together with patient safety innovators from the Johns Hopkins Hospital, implemented a project in 127 intensive care units in the state of Michigan in the United States to apply the CUSP culture change model and evidence-based interventions to reduce central line-associated bloodstream infection (CLABSI).¹⁹ This initiative was extremely successful, achieving significant reductions in CLABSIs. The use of this methodology has spread throughout the United States and to other countries, and a helpful toolkit has been developed.

The following discussion outlines the steps the group took to use the 4 Es:

Step 1: Engage. Unit teams shared stories about patients who develop CLABSI and estimates of the number of patients who developed CLABSI in their unit to help staff members understand the impact of preventable harm caused.

Step 2: Educate. Unit teams ensured that staff and senior leaders understood what they needed to do to prevent CLABSIs.

Step 3: Execute. Execution is based on the principles of safe system design: Simplify the system, create redundancy, and learn from mistakes. An example includes creation of a line cart where all necessary supplies are stored.

Step 4: Evaluate. Using standardized National Healthcare Safety Network (NHSN) definitions for CLABSI, teams regularly collected and submitted CLABSI rates along with the prevalence and appropriateness of central line catheter use.

Figure 4-9, below, demonstrates how to use the 4 Es model. A blank version of the 4Es worksheet is provided in the Toolbox, Chapter 5. A comprehensive toolkit for the CUSP project is located at <https://www.ahrq.gov/professionals/education/curriculum-tools/cusptoolkit/index.html>.²¹

Figure 4-9. How to Use the 4 Es Model

The Es	Who and What	How
Engage	Who are the stakeholders?	How do we determine effective methods for engaging stakeholders based on their background and discipline? Example: administration, physicians, staff members
Educate	What education is needed? Who will provide it?	How does education need to be provided? Are there different educational venues that would best meet the needs of different stakeholders? Example: lecture, video, just-in-time training
Execute	What needs to be done? Who will do it?	How do we best execute the intervention? Example: new policy, protocols, electronic interventions
Evaluate	What are the process and outcome measures necessary to evaluate effectiveness?	How will we report our data?

Case Study 4-5. Improving Environmental Cleaning in the Operating Theater Using the 4 Es Model

The Problem

The nurse manager in the operating theater received several reports of incomplete cleaning. The reports included items such as debris left on the floor under the anesthesia machine or in a corner, a dirty area under stretcher mattresses, dusty cupboards, and other areas that do not appear clean. The manager decides to use the 4 Es model to help reestablish implementation of correct cleaning procedures in the operating theater (see Table 4-13, below, which is the template the team completed on the improvement journey).

Table 4-13. The 4 Es Worksheet

The Es	Who and What	How
Engage	<p>Who are the stakeholders? Environmental services and OT staff</p>	<ul style="list-style-type: none"> Using the fluorescent gel, high-touch areas are targeted. The manager demonstrates to the operating theater staff in a meeting where cleaning was not complete. Staff members are able to visualize the gaps in cleaning. The manager asks for their help in keeping the operating theater environment cleaner. She solicits input from all staff members.
Educate	<p>What education is needed? The OT staff identify where there are knowledge gaps.</p>	<ul style="list-style-type: none"> The operating theater manager works with the operating theater trainer to prepare a video and fact sheets. These are reviewed at unit meetings.
Execute	<p>What needs to be done? The terminal cleaning policy has some processes that are inconsistent with current recommendations.</p>	<ul style="list-style-type: none"> A new policy and checklist are created. Operating theater staff are asked to use a checklist to ensure that appropriate areas are cleaned.
Evaluate	<p>What should be evaluated and when? Two tools are used to assess compliance after the new policy and checklist are put in place.</p>	<ul style="list-style-type: none"> The nurse manager performs random observations and random gel tests. Initial results showed significant improvement—complete cleaning increased by 63%. The plan is to continue these monthly assessments to sustain improvement.

The team decided to use a combination of fluorescent gel and ATP to assess the cleanliness of critical surfaces in the operating theater.²⁰ The team instituted the use of an environmental checklist (shown below in Table 4-14) for evaluating environmental cleaning. It can be used to evaluate the effectiveness and completeness of the cleaning process daily or more often as appropriate.

Table 4-14. Evaluating Environmental Cleaning in the Operating Theater

OR Room Surfaces	Performed or Cleaned Y/N	Enter Method	Comments
Stretcher			
Mattress			
Controls			
Light fixtures			
Excess furniture removed			
Floor cleaned			
Walls cleaned as applicable			
All horizontal surfaces			
Door and cabinet handles			
Straps, replaced or cleaned			
Back table			
Mayo stand			
Telephone			

Mark the monitoring method used for each:

- Direct observation = D
 Fluorescent gel = F
 Agar slide cultures = A
 Swab cultures = SC
 ATP system = AT

Source: Adapted from Centers for Disease Control and Prevention. Options for Evaluating Environmental Cleaning. Guh A, Carling P; Evaluation Workgroup. Dec 2010. Accessed Aug 16, 2017. <http://www.cdc.gov/HAI/pdfs/toolkits/Environ-Cleaning-Eval-Toolkit12-2-2010.pdf>.

The team collected data on the cleaning processes using the checklist above. The results were as follows:

- Stretchers—8/10 failure by fluorescent gel
- Doors and cabinets—4/10 failure by ATP (readings above acceptable limits)
- Light fixtures—5/10 failure by fluorescent gel

The operating theater leadership team reviewed these results and found similar findings on at least three other occasions when data were collected. They selected the cleaning improvement as their project using the project prioritization and selection tool. They decided to use the 4 Es change methodology (Engage, Educate, Execute, and Evaluate) to improve performance.

Engage: Staff members who were responsible for cleaning the operating theater did not understand the connection of their environmental services work with patient safety. The operating theater management team realized that they needed to work more closely with the environmental staff. They shared not only audit results, but also infection data. They invited the staff to regular meetings and huddles at which such issues were discussed. More importantly, they helped staff members see how their cleaning efforts were important to good patient outcomes.

Educate: They identified that the education plan was several years old. New equipment, cleaning products, and processes had been put in place, but communication was not standardized and was often sporadic. A new educational plan was developed, and all staff were scheduled to attend. Also, the opportunity for just-in-time learning was initiated. Staff received immediate feedback when a deficiency was identified.

Execute: The new process was integrated into the daily work flow. Thorough cleaning of lights, stretchers, and high-touch objects became part of the regular routine.

Evaluate: Periodic direct observations took place. In addition, cleaning assessment tools were used. The fluorescent marker system revealed a high rate of compliance, consistently more than 90%, and ATP readings were within normal limits. Continuous feedback of process and outcome measures helped to sustain the process.

DMAIC: Define, Measure, Analyze, Improve, Control

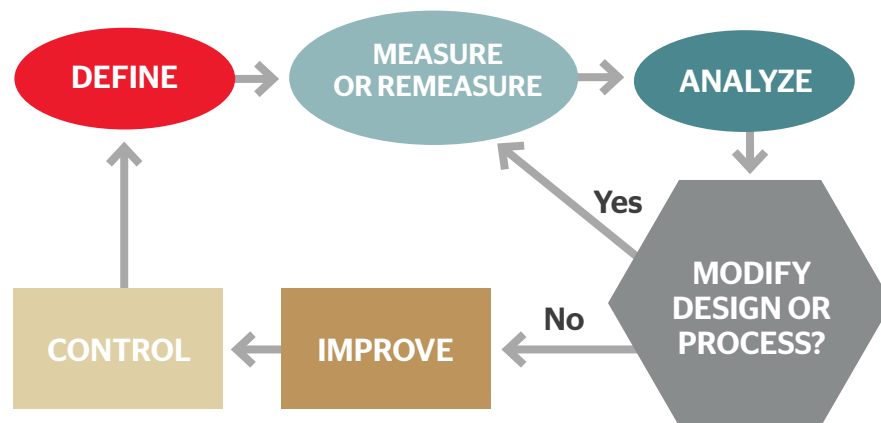
DMAIC is a five-step methodology that is generally considered to be a component of the Six Sigma process, but may be used separately. DMAIC stands for Define, Measure, Analyze, Improve, and Control.

The five steps of DMAIC are outlined below.

- 1. Define** the problem, internal and external customers, improvement activity, opportunity for improvement, the project goals, and project boundaries.
- 2. Measure** process performance to objectively establish current baseline performance.
- 3. Analyze** the process to determine root causes of variation or poor performance (defects).
- 4. Improve** process performance by addressing and eliminating the root causes.
- 5. Control** the improved process and sustain gains.

Figure 4-10, below, illustrates the DMAIC process.

Figure 4-10. Graphic Model for DMAIC



Case Study 4-6. Using DMAIC to Resolve Mislabeled Laboratory Specimens from the OT

Problem Statement:

Mislabeled specimens in the operating theater are a serious problem. At Hospital Kind Care, an increasing number (from 4% to 8%) of mislabeled specimens were received in the laboratory and pathology. Table 4-15, below, shows the steps in the DMAIC process that the team took to improve performance and reduce mislabeled specimens.

Table 4-15. Using DMAIC

Stage	Issue/Activity	Comments About Activity
Define	<p>State The Problem</p> <ul style="list-style-type: none"> • What is the opportunity for improvement? • What improvement activities? • Project goals? • Customer (internal and external) requirements? 	<p>Comments:</p> <ul style="list-style-type: none"> • Number of mislabeled specimens has doubled in the last year. • This represents potential patient harm because an inaccurate diagnosis could be life threatening. • The goal is to reduce mislabeled specimens to zero.
Measure	<p>What metrics will be used to monitor the process? Describe the metrics that need to be collected to track the issue.</p>	<p>List Metrics: Number of mislabeled specimens ranged from 2 to 4 per week (11 in the last month). Issues include the following:</p> <ul style="list-style-type: none"> • Wrong name x1 • Source not listed x4 • Lacking date and time x2 • Label fell off x2 • Not legible x2
Analyze	<p>Analyze the process to determine root cause and variations.</p>	<p>Describe findings from analysis:</p> <ul style="list-style-type: none"> • A new computer system required that labels be printed for all specimens. • The label printer often jammed, which required staff to handwrite the entire information. • The options in the electronic record did not include some of the specimen types sent to pathology. The staff had to guess which specimen type most closely matched the surgeon's information.
Improve	<p>Improve the process by addressing and eliminating the root cause.</p>	<p>What needs to be done?</p> <ul style="list-style-type: none"> • Information technology met with the operating theater team. • Changes were made to the electronic format. • Standardized forms were developed with check boxes for any instances in which there was printer failure or the computer was not working. • All staff were trained. • The specimen collection information was read back during the time-out process.
Control	<p>Control the process and future processes.</p>	<p>Discuss the control plan for the current process and future processes:</p> <ul style="list-style-type: none"> • A member of the information technology team was assigned to the operating theater quality team. • Laboratory and pathology staff members give immediate feedback whenever there are issues related to specimens. Future changes in the electronic record that may affect laboratory, pathology, or labeling are vetted by operating theater.

Performance Improvement Tools and Methods

This section provides an overview of selected tools used in the PI work of many organizations and will be followed by a case study. The tools will illustrate a systematic process for improvement work and are summarized in Table 4-16, below.

Table 4-16. Tools for Performance Improvement Projects

Tool	Stage	Comments
Project Charter	This tool is used at the beginning of a PI project.	Helps to frame the PI project with scope, team, measures, and target dates
Brainstorming	Purpose is to “expand” thinking and have many ideas presented for consideration	Helps involve all team members in the process; allows for all to be heard.
Process Flow Maps	When the charter is completed, this tool is used to visually analyze a process by drawing high-level or detailed steps in the process.	Helps a team to see the whole process, identify risk points, and begin to see where improvements may be possible.
Cause-and-Effect Diagram (Fishbone/ Ishikawa)	<p>Tool to depict potential or real causes of a specific effect, problem, or outcome of a process.</p> <p>Generally used after the process flow map to further define possible improvement areas of a process.</p>	Created by a full team, it has many benefits in identifying specific areas for improvement to set priorities.
Priority Selection Tool	This tool requires the team to quantify each potential project by assigning scores to rank the project.	When there are many issues to address, this tool will help the team agree on which has the highest priority.
5 Whys	A simple tool to lead the team to a root cause of a particular issue.	This tool is used after a problem is identified through the flow map or the cause-and-effect diagram.
Action Plan	A written clear tool to state the improvement actions to be implemented.	This tool will help staff remain focused on the priorities identified to reduce SSI risk.

Project Charter

The project charter is a tool to organize the PI team's thinking about the project. The charter helps to set boundaries within which the project will be explored so the project stays focused and does not expand beyond the original intent. This will help the team succeed. The project charter also guides the team in thinking about the aim (goal, objective) of the project. Each member of the team must receive a written copy of the charter so that everyone is clear about what the team wants to accomplish. This aim should preferably be measurable. In the project charter the team is expected to record what they think the benefit of the project is to patients and the organization, stating why the project is important. The project charter should be completed by the team and approved by the project champion or a designated senior leader. Figure 4-11, below, is a sample project charter.

Figure 4-11. Sample Project Charter

Project Charter			
<p>Problem / Goal Statement</p> <p><i>Why is this project important and why should it be important?</i></p> <p><i>What will this project achieve (Major Aim)?</i></p> <p><i>What is the business case for this project? (ROI)</i></p>	<p>Benefits</p> <p>Patient Benefit:</p> <p>Organizational Benefit:</p>		
Team members	Stage	Target Date	Actual Date
<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>Stakeholders:</p>	Plan		
	Do		
	Check		
	Act		
	Completion Date		

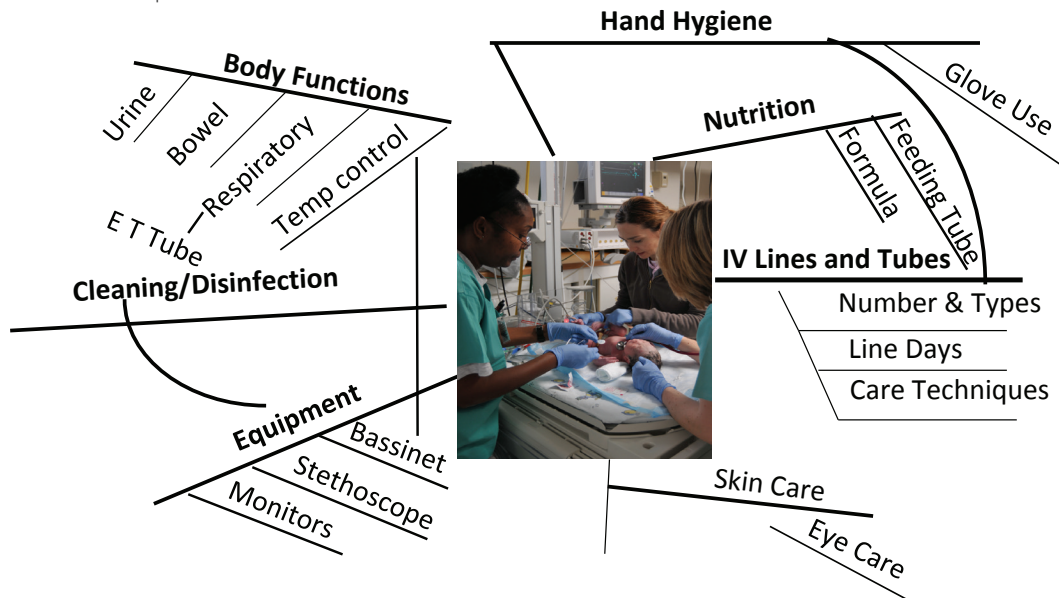
Source: Joint Commission Resources, Oakbrook Terrace, Illinois

Brainstorming

Brainstorming is a method to allow all persons to participate in the generation of ideas about the topic. This is called expanded thinking. Brainstorming is a group creativity technique to find a possible solution for a problem by gathering a list of ideas spontaneously contributed by its members. Brainstorming improves problem-solving skills and critical thinking for both individuals and a team. Some brainstorming is structured. One example is a mind map where the topic is placed in the center and ideas are “mapped” from the topic. See the sample mind map for care of a critically ill infant in Figure 4-12, below.

Figure 4-12. Mind Map for Infection Risks in Neonatal Intensive Care Child

Note: The items identified in mind mapping this image can be used to develop a plan of care for the infant in the NICU. Each line should be considered for the plan.



Mindmap Basic Structure

Image Source: <https://search.usa.gov/search/images?affiliate=www.army.mil>. Accessed March 10, 2018.

The Process Flow Map

The process flow map is a diagram that shows a process from start to end with all steps in between (for example, the process of admitting a patient to the preoperative care unit before surgery). The flow map should be created with a team of personnel who understand and work with the process being examined. The entire team creates the process flow map together, sharing ideas, experiences, and opinions. As team members map the steps, they may be surprised at what they see—compared to what they expected to see—and at what the map reveals, as steps, barriers, and shortcuts are listed. The flow map makes it easier for staff to see where in the process opportunities exist for improvement work. Analyzing work flow with a process flow map enables a PI team to do the following:

- See or visualize the whole picture.
- Determine where risk points (weak or lacking place) in a process exist.
- Identify improvements.
- Streamline work.
- Describe to staff and customers how processes occur in an organization, department, or service.

Flow maps can be high-level or detailed. In high-level maps, only the main steps in the process are recorded, including the beginning and ending step. In detailed maps, both major and minor steps are recorded to provide a precise visual of the process. Often, the high-level map is created first and detailed maps afterward.

Certain shapes are used in process flow maps to communicate different activities in the process. Figure 4-13, below, illustrates a few of the shapes used in mapping.

Figure 4-13. Shapes Used in Mapping

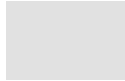






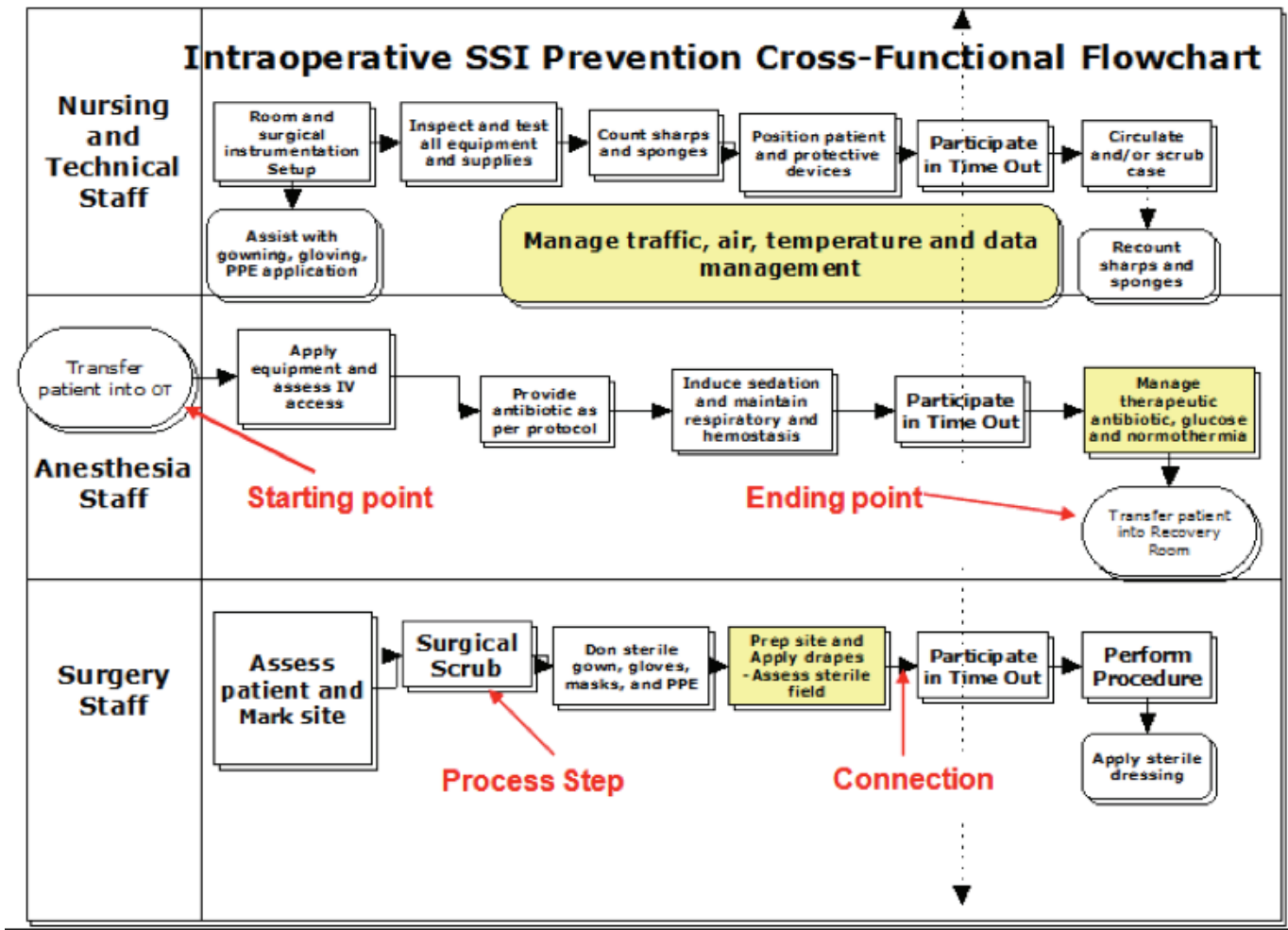
Shapes Used for Mapping		Corresponding Step in the Process
Box		Steps, activities, or tasks in a process
Diamond		Points where decisions are made
Circle		Starting and ending points in a process
Cloud		Point where the step or process is unknown
Delay		Indicates the location of the step where there is a delay in performing an activity
Arrow		Connections between activities, decisions, or starting and ending points
Document		Indicate some type of document is required

Figure 4-14, below, is an example of a high-level flow map. Figure 4-15 on page 47 is a cross-functional detailed flow map of responsibilities of three professionals getting a patient ready for surgery.

Figure 4-14. High-Level Flow Map



Figure 4-15. Detailed Flow Map



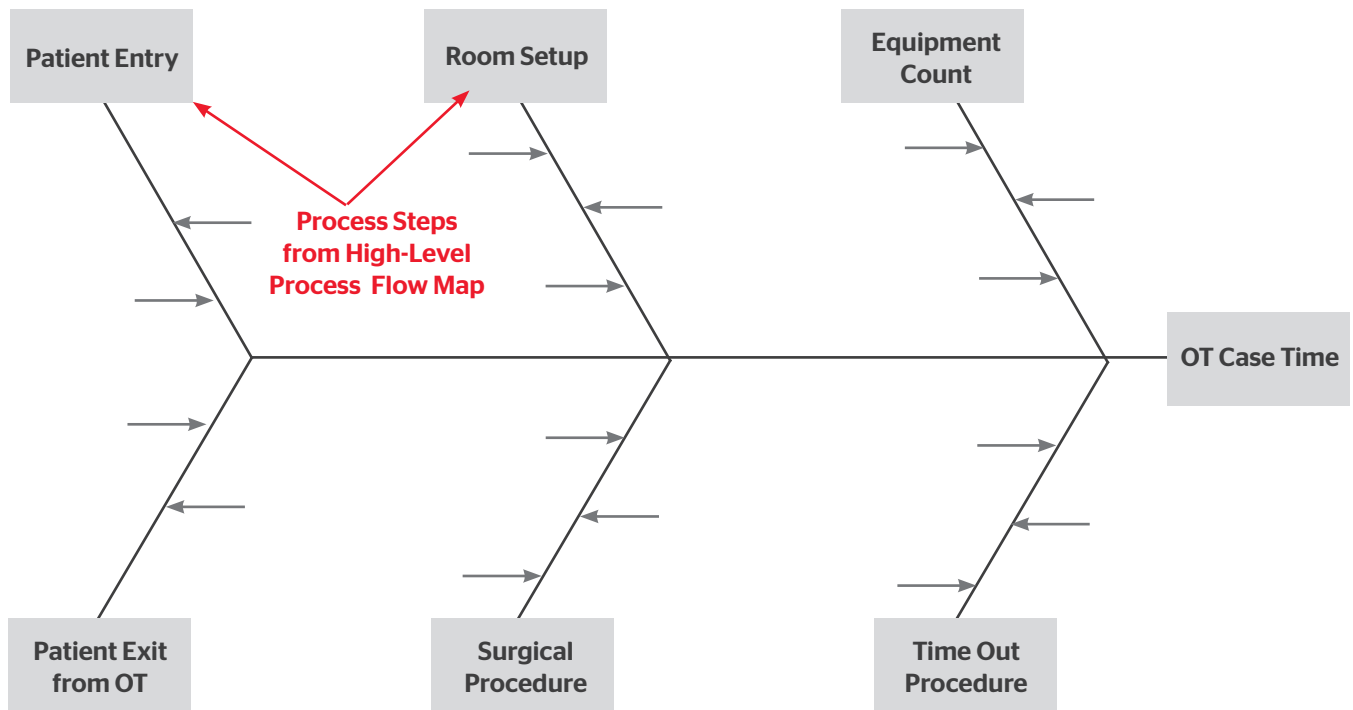
Note: This flow chart shows the process steps for SSI prevention in the Operating Room for each of three groups of staff; nursing and technicians, anesthesia and surgical personnel. While each group has functional steps specific to them, they all participate in the Time Out process as indicated by the upward arrow.

Cause-and-Effect Diagram (Ishikawa Diagram, Fishbone Diagram)

Cause-and-effect diagrams are generally created after the process flow map is completed. This tool is used to further explore the risk points identified in the process flow map and to identify causes of risks (failures in a process) and the possible effects of the failure. Other names for the cause-and-effect diagram are the fishbone diagram or the Ishikawa diagram, originally created by Kaoru Ishikawa, who pioneered quality management processes in the shipyards of Kawasaki, Japan.

Figure 4-16, below, is a basic schematic of a fishbone diagram, which is followed by a fishbone diagram that is completed (see Figure 4-17 on page 49). Note that the effect or outcome is charted on the horizontal spine of the fish and the potential causes of a problem are charted on the vertical bones of the fish. Each of the vertical bones is labeled with the name that signifies a general category relative to the process (for example, people, equipment, environment, policies, management, and materials).

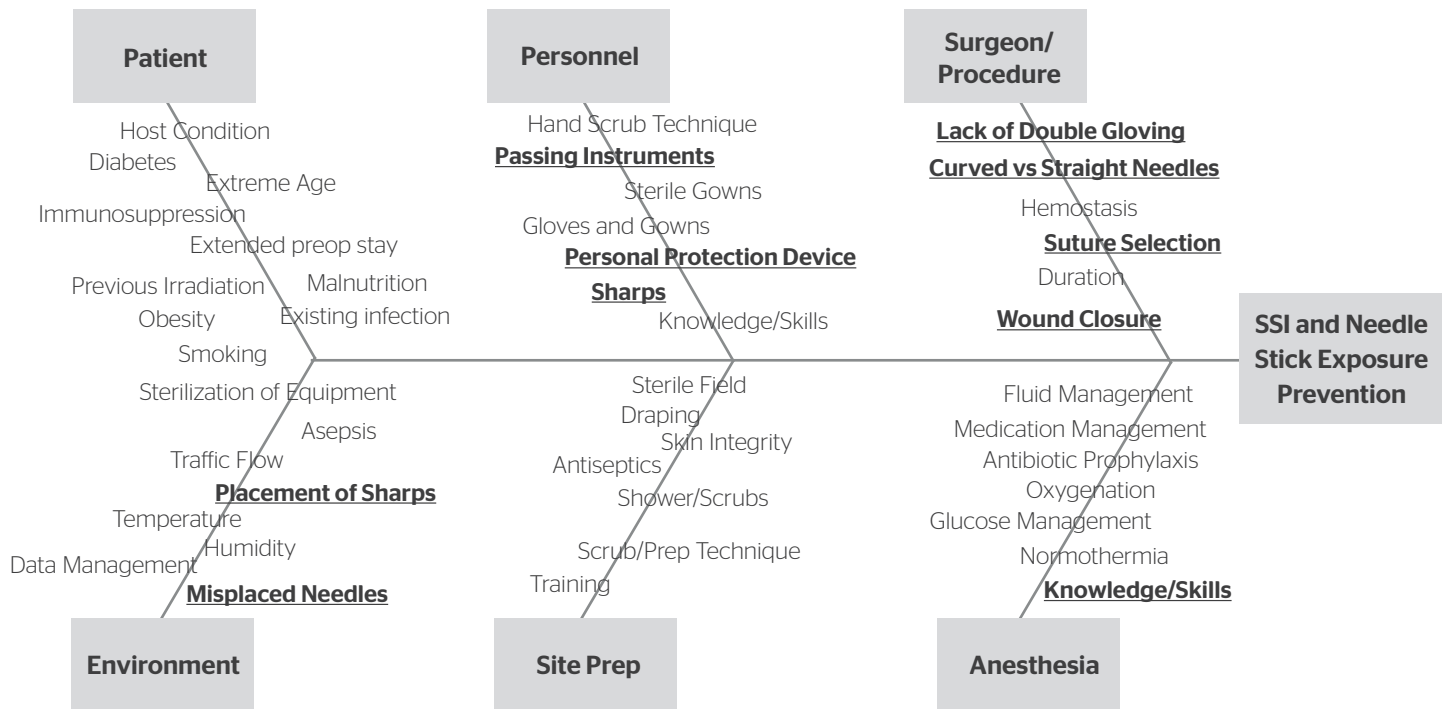
Figure 4-16. Fishbone Cause-and-Effect Diagram—Basic Template Following Process Flow Map



Source: Joint Commission Resources, Oakbrook Terrace, Illinois

The surgical process improvement team should select labels for the major bones that they think are most applicable to the process. After the major bones are labeled, the team can begin brainstorming to fill in the *specific causes* that should be placed under each bone. See Figure 4-17 on page 49.

Figure 4-17. Completed Fishbone Diagram for SSI and Needlestick Injury Prevention



In Figure 4-17 many possible causes of SSI and needlestick exposures are placed under the major *bones*, and those considered by the team to be the highest priority or the most likely causes are noted in bold. Cause-and-effect diagrams are helpful in identifying specific potential causes of poor outcomes that can then be further explored using other tools, including the 5 Whys, described below.

Project Prioritization and Selection Tool

This tool helps teams establish priorities for possible improvement projects by subjecting each topic or project to a list of questions. Depending on the answer to the question and based on the scoring key, each question receives a score. The scores are added and the totals will provide a ranking of projects so that the most important or the one with the highest score will usually be addressed first. Figure 4-18, below, is a simple matrix. The team can determine the questions to be asked and the scoring. It is best if the entire team agrees on the score for each question so when the item is selected, everyone will support the choice.

Figure 4-18. Project Prioritization and Selection Tool

Project Name	Consistent with Organizational Mission & Vision	Significant risk to patient or staff safety	Related to requirement or law	High volume or high cost	Identified in the organization as a problem	Identified in literature as a problem	Needed resources to address the problem	Complaints from patients or staff	Priority Score (8-72 points)
1.									
2.									
3.									
4.									
5.									
6.									

Scoring Points: Low: 1 Medium: 3 High: 9 Add the scores across the project.

B Soule. Used with Permission

The 5 Whys

A specific tactic to determine the “root cause of an issue” is a simple process termed the 5 Whys. When a problem occurs, it is helpful to assemble a group and ask WHY did this happen. However, each answer is followed by a subsequent WHY until the root cause of an issue is identified. The following example demonstrates the effectiveness of this process:

Example of the 5 Whys

Mr. Assiri, 57, is undergoing an exploratory laparotomy. The physician drains a large abdominal abscess and requests that the wound be irrigated with an antibiotic solution. The nurse selects the wrong solution off the shelf in the operating theater.

The solution is not sterile, and when it is mixed with the antibiotic, it starts to gel. The surgeon begins to irrigate the wound when he notices that something is wrong. The analysis of this error is made using the 5 Whys in Figure 4-19, page 51.

The Issue: The nurse provides surgeon with wrong solution for irrigating the patient’s wound.

Figure 4-19. The 5 Whys

Why	Response
1. Why was the wrong solution used?	The nurse selected the wrong solution.
2. Why did she select the wrong solution?	The nurse thought the solution looked correct.
3. Why did the nurse not read the label but still think the solution was correct?	The cabinet where the solution is kept contains only irrigating solution, and the outside label was the same color and looked exactly like what was generally used.
4. Why was there another solution in the cabinet?	The person stocking the cabinet placed the wrong solution there.
5. Why did the person stocking the cabinet place the wrong solution there?	The unsterile solution is not part of the operating theater stock but had been sent to the operating theater by mistake. The unsterile solution had the same label and color as the regular solution. The only difference was the fine print, and the difference was not recognized.

Solution: Use labels that are clearly different for unsterile and sterile solutions.

Action Plan: Work with operating theater, Materials Management/Stores to develop alternative system.

Theory of Change and Force Field Analysis: Freeze, Unfreeze, and Refreeze²²

The Freeze-Change (Unfreeze)-Refreeze theory was developed by Kurt Lewin in the early 1950s and has been used successfully for many years as a simple template for planned change. This three-stage theory of change is commonly referred to as Unfreeze, Change, Freeze (or Refreeze).

- 1. Unfreeze:** The unfreezing stage is probably one of the more important stages to understand. This stage is about getting ready to change. It involves getting to a point of understanding that change is necessary and getting ready to move away from a current comfort zone. One of the most popular and widely used tools of this stage is force field analysis.
- 2. Change or transition:** Change is not an event, but a process. Lewin notes that a process is a transition. Transition is the inner movement or journey we make in reaction to change. This second stage occurs as we make the changes that are needed. People are unfrozen and moving toward a new way of being.
- 3. Freeze or Refreeze:** Kurt Lewin refers to this stage as freezing, although many people refer to it as refreezing. The name refers to the fact that this stage is about establishing stability after the changes have been made. When these changes are accepted, they become the new norm.

Action Plan

The action plan can be a simple tool that helps organize what is to be accomplished (measurable goals), who will take the lead and others who will participate, time lines for accomplishing the goals. Needed resources may be included, as well as other variables for success.

Evidence-Based Care Bundle for SSI as a Performance Improvement Strategy

For several years, the IHI and others have proposed care bundles to prevent several health care-associated infections, such as central venous lines, urinary catheters, and surgeries. A care bundle is a structured way of improving the processes of care and patient outcomes. It involves a set of generally three to five evidence-based practices that, when performed collectively and reliably, have been shown to improve patient outcomes. Care bundles can significantly improve patient outcomes when used consistently and completely. To accomplish continual implementation, multidisciplinary teams work together and all persons participate. One example of such a tool is IHI's *How-to Guide: Prevent Surgical Site Infection for Hip and Knee Arthroplasty*.²³

Barriers to Effective Change in Patient Safety and Quality

Many of the current limitations to creating a culture of patient safety in the operating theater may stem from the lack of surgeon-driven leadership.²⁴ Transparent leadership and role modeling are fundamental to ensuring unwavering acceptance of safety practices by all members of the health care team and to implementing and embedding these practices into the daily work routine.

Other high-risk disciplines, including nuclear technology, professional aviation, naval submarine technology, and aerospace engineering, have historically embraced a culture of safety as a basic tenet for success in their respective missions. For example, in engineering, redundancy implies the fail-safe duplicate or triplicate availability of critical components or system functions. NASA endorses the fundamental principle of being double-fail-safe, that is, having primary safety and backup or secondary safety practices should primary safety fail.²⁵

The five core principles of NASA's proven safety culture paradigm could serve as a model to develop or enhance a surgical safety culture.²⁵ The NASA culture is a

- 1. Reporting culture**—Reporting concerns without fear of reprisal.
- 2. Learning culture**—Learning from successes and failures.
- 3. Flexible culture**—Changing and adapting to meet new demands.
- 4. Engaged culture**—Everyone is doing their part.
- 5. Just culture**—Treating each other fairly.

Sustaining Improvements

One of the challenges in a fast-paced, complex environment is to ensure that improvement changes can be sustainable. The sustainable project must no longer be a special task the department has to remind itself to do. It is now simply what one does, and what people do is aligned with what they believe. Even a successful project requires periodic monitoring, either to celebrate ongoing success or to identify gaps in implementation and address them. This monitoring should be done when the process is in place but not yet firmly established.

IHI highlights necessary components for sustainability²⁶:

- Supportive management structure: In supportive leadership, the manager is not so interested in giving orders and managing every detail as in giving employees the tools they need to work. While delegation is vital to supportive leadership, managers do not simply assign tasks and then obtain results. Instead, they work through tasks with employees to improve skills and talent until the manager does not need to worry about a task being done correctly, and the employee is fully empowered in a particular area.
- Formal capacity building programs: This includes orientation, education, and organizational capacity for change.
- Process: Is integrated into daily work flow.
- Robust, transparent feedback systems: Ongoing feedback related to processes and outcome delivered on a regular basis. Real-time data dashboards, and electronic reminders, provide mechanisms for feedback.
- Culture: There is a culture of improvement and deeply engaged staff. There is a shared sense of the systems to be improved.

Case Study 4-7, below, provides an example of how operating theater and CSSD services addressed sustainability for a change in procedure of batching and holding used instrument trays in the operating theater.

Case Study 4-7. An Example of Sustainability

A new process was developed to prepare instruments from the operating theater to be sent to the CSSD. In the old process, instrument trays were simply held for several hours until someone took them to the CSSD. The new process called for soaking the instruments to help dissolve blood and body fluids or tissue right after the surgery and until they could be transported to the CSSD.

To sustain this change, the organization developed the review grid shown in Table 4-17, page 54.

- All operating theater staff members were educated about the new process.
- The new process was incorporated into a new policy.
- Each nurse or technician was monitored to ensure that he or she followed the procedure and that the process was monitored on a random basis.
- This new process was consistent with the operating theater culture, which was to collaborate with the CSSD. The process was sustained and is now part of the normal work of the operating theater staff.

Table 4-17. Sample Sustainability Check Sheet

Need or Interest	Idea or activity	Tool to use	How will this happen?	Who will make this happen?	When will this happen?	What other information do I need to make this happen?
Reduction of SSI	Develop a multidisciplinary SSI team that meets monthly to review the core bundle of practices for prevention of SSI.	Develop core bundle policy and process. Use check-list to monitor progress.	Team will review evidence-based recommendations and identify top five processes for all surgical patients that must be adhered to consistently.	The nurse leader and chief of surgery will review this with the entire operating theater team.	1st quarter 2018	Most recent SSI literature Feedback from surgeons and other groups

Summary

Change is everywhere in health care organizations, and it is important that underlying systems and infrastructures complement the various changes that arise. Senior leaders in the operating theater must embrace the concepts of continuous and sustainable change improvement to create long-standing and sustainable cultural change.

As PI principles and methods are embedded into the work of the operating theater, staff members will start to identify problems within the operating theater, will identify broken systems, and will become the problem solvers of the future. As operating theater staff incorporate many improvement tactics into their work and insert them into their processes, they will develop autonomy. This autonomy will free problem-solving resources that can then be allocated to more complex problems and systemwide challenges aligned with their organization's strategic plan.

This chapter reviewed change theories, PI models, and tools to analyze the current state of the organization. The module also reviewed several tools commonly used in PI work worldwide. Case studies and other examples were used to illustrate the different approaches to PI. The module also presented common barriers to PI projects that operating theater staff may encounter and the essential step of sustainability. Throughout the chapter, the role of leaders and a culture of patient safety were stressed as fundamental and critical to change and PI leading to reduced SSI and other infection risks and greater patient safety in the operating theater and surgical services.

Additional Tools

Tool 4-1. Tips for Performing an Infection Control Risk Assessment for Surgical Services

The task:

Coordinate a department risk assessment

The purpose:

To determine priorities for infection control activities in the Operating Theater and Surgical Services.

Key Elements of an Infection Control Assessment

Partnerships

Form partnerships with:

- Key stakeholders, e.g., physicians, nurses, technicians, laboratory, special support services, administration to provide data and information, experiences, concerns for their area of responsibility. e.g., OT, Preoperative and Postoperative settings
- Those who have the information you need
- Opinion leaders in the department
- Leadership for support and endorsement

Team

- Create a team to help analyze the information from the assessment
- Engage 3-5 key staff or more to work as a team on the assessment
- Infection Prevention, Patient safety and performance improvement staff or committees can assist

Gather Data and Information

Organizational Data

- Gain access to key reports in the organization, e.g., services provided in surgery, populations served and characteristics and volumes, special environmental issues
- Tap into organizational data as needed (medical records, lab records, admission and discharge numbers)
- Review IPC program surgical site surveillance data

Scientific Data

- Review the literature for new trends – Infection Prevention and Control Journals and others
 - Link to key websites, e.g., Ministries of Health, Health Departments, CDC, WHO, SHEA, others

Community Data

- Connect with the local or regional health department to identify trends that may affect infection risk in the operating theater
 - Issues of emerging pathogens, community outbreaks

Systematic Methods and Templates

- Develop a systematic way of looking at data
- Develop a ranking scheme to determine highest priorities in the OT
- Team ranks data to determine priorities

(cont.)

Tool 4-1. Tips for Performing an Infection Control Risk Assessment for Surgical Services (cont.)

Educate Others to Assist in Assessment

- Provide support and guidance for the team to perform the risk assessment
- Provide an educational session
- Share data from surveillance, outbreaks, morbidity, mortality related to surgery
- Design a simple template or use the organization's template

Disseminate the Information

- Share the risk assessment results with the entire OT team. Develop concise, clear report with key points highlighted
- Acknowledge those who participate in the process

Tool 4-2. Grid for Risk Assessment for Surgical Services or CSSD

Year _____ Facility _____ Team _____

Risk Event	Probability the Risk will Occur				Potential Severity if the Risk Occurs				How Well Prepared is the Organization if the Risk Should Occur?			Risk Priority
	High	Med	Low	None	Life Threatening	Permanent Harm	Temp Harm	None	Poorly	Fairly	Well	
Score:	7	5	3	1	7	5	3	1	5	3	1	

Tool 4-3. Instructions for Performing Risk Assessment

Instructions for Completing a Surgical Services or CSSD Infection Risk Assessment

The surgical services risk assessment will identify the main areas that may contribute to surgical site infections (SSIs) in health care facilities and the CSSD risk assessment will identify processes for equipment and supplies that can be improved.

Select General Categories. An organization may select other categories.

1. Each general category has a number of subtopics listed under it. For example, under the Preoperative Phase of Care category, the subtopics of “patient risk assessment during preoperative phase is not performed” and “preoperative patient and family education not routinely provided” are listed.

2. The columns are divided into the following categories:

Column A: The event that could lead to risk in surgical services

Column B: Probability the risk will occur

Column C: Severity of the risk to the patient (should it occur); this includes the possibility of death or injury and understanding the risks related to a disease

Column D: Severity of the risk to health care personnel; this includes issues, such exposure to pathogens and sharps injuries

Column E: Organizational preparedness to address the risk event

Column F: Risk priority

Column G: Comments

3. To complete the risk assessment, assemble a team of key staff who can provide the information and experience necessary to rate the risk of each topic. Each staff member should bring any data that will assist the team in determining the risk of each topic (for example, risk related to administering antibiotics within 1 hour prior to incision or the rate of hand hygiene compliance). The more data that are used to determine risk, the more precise the assessment.

4. Discuss each subtopic listed under a particular category and determine its risk in contributing to an infection in surgical services. Each subtopic is assigned a numerical value based on the following score:

9 = High risk

5 = Moderate risk

3 = Low risk

1 = Not Applicable

Record each number on the grid.

5. For each subtopic, multiply the risk factors across the row to calculate the risk priority. When you first open the table, the risk priority column is populated with 0s. When you fill in the grid with the various rankings and reach the risk priority cell, the risk priority will automatically be calculated for you. Do not leave any of the grids blank; otherwise, the automatic calculation will not be performed.

(cont.)

Tool 4-3. Instructions for Performing Risk Assessment (cont.)

6. After the multiplication has been completed, the risk priority column will display the risk score for each subtopic. The subtopics that have the highest scores will be the issues in surgical services that have the highest risk of leading to infection, and the subtopics that have the lowest score have the least potential of leading to infection. The team can use these scores to select the infection risks that have the highest priorities in the short term or the long term. The team may wish to color code the scores to distinguish between high, medium, and low priorities.
7. The results of the surgical services risk assessment should be used to determine the activities that will be undertaken to reduce the incidence of SSIs and to improve care. This information may also be used to guide the surveillance activities, education, and performance improvement projects to reduce SSIs.
8. The surgical services risk assessment should be performed at least annually and more often if necessary. Each time the assessment is performed, subtopics on the list may remain or may be deleted and others may be added based on successfully addressing a particular risk or based on new scientific research or regulations.

Criteria for the Columns in the Grid for the Risk Assessment for Surgical Services

Second: Using the directions below and the grid, begin the assessment. (You may adapt the grid and its contents to your organization.)

Grid Column Name	Instructions
Risk Event	<ul style="list-style-type: none"> This column states the potential risk for Infection In the operating theater and surgical services. The purpose of this column is to state potential or actual risks that should be assessed. This column is completed in the example, but may be supplemented with additional concerns or risks for the particular organization. Some risks may be deleted if they are not applicable; these are just examples. Note that the risks are stated in a negative language to better communicate the risk to others.
Probability The Risk Will Occur	<ul style="list-style-type: none"> Probability is one of the keys to the risk assessment. Probability is the chance that the risk will occur. The probability should be determined by the team based on experience in the organization, monitoring and data collections, the literature, new laws or guidelines or other sources. In this column, the team is trying to evaluate the possibility or probability that a given risk will occur in the operating theater, surgical services or central sterile processing department. For each stated risk, give the Probability a numerical value. Examples include: Very Often, Often, Rarely or Never (each with a number such as 7, 5, 3 and 1). Or you could use High, Medium, or Low with a number, e.g. 7, 5, 3). You can use any categories or any numbers as long as they make sense to the team and they are consistent. Do <i>not</i> use 0 if you multiply the numbers (See below).
Severity of Risk to the Patient	<ul style="list-style-type: none"> In this column, the team is assessing how severe the risk and the outcome would be for a patient if the risk should occur. For example, in the Preoperative Phase of Care, how severe would it be if there was frequent shaving of patients for hair removal prior to surgery? The team can rate that as Extremely Severe (9) Moderately Severe (5), Not Very Severe (3) Not At All Severe (1). You can use any categories or numbers you like as long as you are consistent.
Severity of Risk to Personnel	<ul style="list-style-type: none"> In this column, the team is looking at the risk as it pertains to Personnel. Use the same directions as above for scoring, or you might choose: High, Medium, and Low and assign numbers. Some risks will relate primarily to personnel and others primarily for patients. Only score what makes sense for the particular risk.
Organizational Preparedness to Address the Risk	<ul style="list-style-type: none"> This column should answer the question of how prepared the organization is to effectively address the risk, should it occur. The team might use Very Well Prepared (1), Well Prepared (3), Not Well Prepared (5) or Not Prepared At All (7). Note that the more prepared the organization the lower the number value assigned because is it less of a risk.
Risk Priority	<ul style="list-style-type: none"> To obtain the numerical value for the risk priority, multiply the numbers across that the team has assigned to the columns. (That is why no zeros (0) should be used.) You can also add the numbers across.
Comments	<ul style="list-style-type: none"> As these values are assigned by a multidisciplinary team, not all may agree. So, comments can be made to explain some differences. These comments may be important during discussion and negotiations of which priorities should be selected for action during a time period. Once the numerical priority is agreed upon, all should support it.
Now What?	<ul style="list-style-type: none"> The highest risks will be those with the largest multiplied or added number. Once the risk priorities are determined, the team will select those priorities with the highest scores to act on first. There will be discussion and negotiation. The team should only select 2-3 risk issues to start as each may need a team, improvement strategy, action plan and measurement. However, some issues may be easily addressed and fixed. The risk assessment should be a "living document" that is reevaluated on a regular basis and changed as priorities are resolved and new issue surface. Results of the risk assessment should be shared with key staff and leaders. Most importantly, the risk assessment should be performed by a multidisciplinary team to get the benefit of many perspectives. The risks are used to develop an infection prevention plan with measurable goals, to assign resources to challenging issues and to develop and implement strategies to improve care and performance of procedures.

Tool 4-4. Risk Events for Infection in Surgical Services

Risk Events for Infection in Surgical Services Refer to Directions for Scoring Each Item	Probability	Severity			Risk Priority 5 = Very High 4 = High 3 = Moderate 2 = Low 1 = None
		Impact on Patient (Possibility of death or injury or understanding of risks related to disease)	Impact on Organization (Image, Extra Length of Stay, Financial)	Impact on Personnel	
Impact on Personnel					
There is a lack of accountability for actions in surgical services					
Mistakes and errors are "hidden" and not used as learning opportunities					
Individuals are "blamed" for errors					
There is a lack of a system's approach to improving care or preventing errors in surgical services					
Staff are reluctant to provide feedback to leaders when there are breaches in practice					
The surgical services hierarchy is a barrier to open communication about potential improvements					
Non surgeon staff do not have the authority to stop a procedure if appropriate practice has been breached					
There is not a clearly defined adverse event reporting system					
Errors are not fully analyzed and discussed with all staff					
There is lack of a formal structure for the safe reporting of errors					
The organization has not performed an assessment of the patient safety culture					
Open communication is lacking between staff in the OT and the preoperative and postoperative settings					
Communication is lacking between staff and leaders of surgical services					
There is a lack of a consistent model for performance improvement					
There is no assessment of infection risks for surgical services					
There are few or no performance indicators to measure processes for infection prevention					
There are few or no performance indicators to measure outcomes for infection prevention					
There is a lack of a formal surveillance program for surgical site infections					
Leadership					
Leaders do not conduct patient safety rounds					
Leaders do not always respond to staff concerns heard on patient safety round					
Performance expectations for infection prevention not included in annual performance evaluations (e.g. hand hygiene compliance)					
Leaders do not provide needed support for routine work					
Leaders do not provide needed resources for performance improvement					
Lack of leadership recognition for employee successes in improving performance and patient safety and infection reduction					
There is a lack of teamwork among the divisions of surgical services and support departments					

Tool 4-4. Risk Events for Infection in Surgical Services

Risk Events for Infection in Surgical Services Refer to Directions for Scoring Each Item	Probability	Severity			Risk Priority 5 = Very High 4 = High 3 = Moderate 2 = Low 1 = None
		Impact on Patient (Possibility of death or injury or understanding of risks related to disease)	Impact on Organization (Image, Extra Length of Stay, Financial)	Impact on Personnel	
Preoperative Phase of Care					
Hand Hygiene not practiced routinely per policy					
Lack of Patient Risk Assessment During Preoperative Care					
Lack of Assessment of Host Risk Factors for Surgical Site Infection					
Frequent Shaving of Patients for Hair Removal Prior to Surgery					
No Standard Procedure for Preoperative Bathing					
Lack of Consistent Administration of Preoperative Antibiotics within 60 minutes prior to incisions					
Lack of consistent Selection of appropriate antibiotic based on approved protocol Administration of Preoperative Antibiotics within 60 minutes prior to incisions					
Inappropriate dose of preoperative antibiotic based on protocol					
Patient and family education not provided routinely before surgery					
Patient and family education not recorded					
Adult Learning Principles not used to design education					
Individual learning needs not assessed to plan education					
Intraoperative Phase of Care					
Personnel do not perform scrub per policy					
Personnel do not wear scrub attire per policy					
Cover jackets are not worn when OT staff leave the department					
The appropriate type of gown is not always worn (based on exposure risk)					
Hair is not always covered by the cap					
Staff do not always wear mask to cover nose and mouth during surgery or anesthesia					
Eyewear is not always worn as directed by policy					
Shoe covers are not always worn as directed by policy					
Staff wear jewelry not approved by policy					
Staff keep nails longer than allowed by policy					
Staff wear artificial nails					
Surgical drapes do not meet accepted standards for infection risk reduction					
Sterile fields/trays are opened, covered, and unattended before use					
There is no routinely used checklist prior to surgery to assure all required steps are accomplished for patient safety					

Tool 4-4. Risk Events for Infection in Surgical Services

Risk Events for Infection in Surgical Services Refer to Directions for Scoring Each Item	Probability	Severity			Risk Priority 5 = Very High 4 = High 3 = Moderate 2 = Low 1 = None
		Impact on Patient (Possibility of death or injury or understanding of risks related to disease)	Impact on Organization (Image, Extra Length of Stay, Financial)	Impact on Personnel	
Intraoperative Phase of Care (cont)					
Non sterile equipment is positioned over the sterile field without a sterile cover					
Skin antiseptics not performed according to procedure e.g. from incision site outward					
Patient skin preparation agent not allowed to dry before beginning incision					
Patient not draped appropriately on surgical table					
Lack of consistent administration of preoperative antibiotics within 60 minutes prior to incision					
Lack of consistent selection of appropriate antibiotic based on approved protocol					
Inappropriate dose of preoperative antibiotic given based on protocol					
Antibiotic not discontinued within 24 hours after surgery					
Blood glucose levels not monitored and maintained for patients per policy					
Normothermia not maintained for colorectal patients					
Surgical technique does not meet standards for time and handling of tissue					
Post Operative Phase of Care					
Hand Hygiene not practiced according to policy					
Post operative risk assessment for host factors not routinely performed					
Dressings not applied using aseptic technique					
Appropriate dressing not selected for wound					
Staff not educated on signs and symptoms of drainage to identify potential infection					
Staff not educated on technique for dressing changes					
Drain not inserted in separate incision from wound					
Antibiotics not consistently discontinued at 24 hours or per policy					
Staff not knowledgeable about care of catheters in post operative phase					
Environmental surfaces and equipment not regularly cleaned in the postoperative care settings					
There is no consistent policy or procedure to guide staff about WHAT is cleaned and WHO cleans in the immediate postoperative care recovery unit					
There is no consistent policy or procedure to guide staff about WHAT is cleaned and WHO cleans in the general nursing postoperative care units					
There is lack of education for staff on appropriate cleaning procedures					
There is lack of education for staff on appropriate waste disposal					

Tool 4-4. Risk Events for Infection in Surgical Services

Risk Events for Infection in Surgical Services Refer to Directions for Scoring Each Item	Probability	Severity			Risk Priority 5 = Very High 4 = High 3 = Moderate 2 = Low 1 = None
		Impact on Patient (Possibility of death or injury or understanding of risks related to disease)	Impact on Organization (Image, Extra Length of Stay, Financial)	Impact on Personnel	
Post Operative Phase of Care (cont)					
There is lack of education for staff on disposal of sharps					
There is lack of education for staff on handling contaminated linen					
Regular postoperative education is not provided for patients and families about infection risks					
Regular postoperative education is not documented for patients and families about infection risks					
Managing Sterile Items					
Staff cannot distinguish between critical, semi critical and non critical items					
Facilities for cleaning, disinfection and sterilization are not spacious enough to perform tasks					
Facilities for cleaning, disinfection and sterilization do not have recommended environmental controls, such as humidity and ventilation					
Staff do not consistently follow procedures for manual cleaning of instruments					
Staff do not consistently follow wear personal protective equipment (PPE) when cleaning, disinfecting or sterilizing instruments					
There is no clear policy for the handling and management of surgical items and surfaces that may be contaminated with high risk prion contaminated tissues					
Single use devices are reused without a policy to guide processing of the items					
There is no clear policy or practice for using loaner instruments					
There is no clear policy or practice for using implants					
Staff are not well educated about how to clean and disinfect endoscopes					
There is not adequate equipment to clean and disinfect endoscopes					
There is a lack of consistent practice when cleaning endoscopes					
Anesthesia equipment is not consistently cleaned per procedure					
Single use devices for anesthesia are reused instead of discarded					
The same needle is used for multiple entries into a multidose vial when preparing anesthesia medication					
Cleaning, disinfection and sterilization are not performed in a standardized manner throughout the facility					
Storage space for sterilized items is poorly ventilated and not protected from insects					
There is not adequate shelving to prevent damage to packaged instruments and supplies					
Storage space for sterilized items has adequate shelving to prevent damage to packaged instruments and supplies					
Sterilized items are not consistently labeled					

Tool 4-4. Risk Events for Infection in Surgical Services

Risk Events for Infection in Surgical Services Refer to Directions for Scoring Each Item	Probability	Severity			Risk Priority 5 = Very High 4 = High 3 = Moderate 2 = Low 1 = None
		Impact on Patient (Possibility of death or injury or understanding of risks related to disease)	Impact on Organization (Image, Extra Length of Stay, Financial)	Impact on Personnel	
Managing Sterile Items (cont)					
There is not an effective tracking system for sterilized items					
There is a lack of closed containers or carts for transporting sterilized items to or from surgery and central sterile supply department (CSSD)					
Chemical monitors are not used in every pack					
Biological monitors are not reviewed regularly					
There is no clear procedure for a recall of items when a biological monitor fails					
Chemical sterilants are not tested or monitored after every use					
There is a lack of coordination between CSSD and Surgical Services Staff for managing surgical items.					
Contaminated Items are not labeled with biohazard signs					
CSSD and surgical staff do not receive adequate education about the processes they must perform.					
Environment of Care					
There is no clear policy for cleaning blood and body substance spills					
Staff have not been educated about how to clean blood and body substance spills					
OT rooms do not receive terminal cleaning at least every 24 hours					
OT rooms are not cleaned after every procedure					
The OT does not have flooring that is composed of hard-surfaced materials, that does not have any seams, and that curves partially up the wall (cove-fitted)					
Tacky mats are used as a method to reduce microorganisms in the operating theater or to reduce the SSI rate					
Portable fans, air conditioners, or portable humidifiers are used in the operating theater .					
Operating room air does not undergo at least 15 changes of filtered air per hour.					
There is a lack of regular preventive maintenance of the operating theater air system including cleaning and repair of air duct work, cooling apparatuses, grates, and other mechanical components					
There is no clearly defined, written traffic rules, with defined traffic zones in the OT					
There is hand-to-hand passage of sharps in the OT					
Sharps containers in the OT become overfilled and not emptied regularly					
Sharps containers are reused					
Containers of contaminated items are not regularly labeled with a biohazard label and / or color coded					
There is a lack of fluid proof containers for disposal of potentially infectious wastes					

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