National Association of Orthopaedic Nurses

Advancing the Art and Science of Orthopaedic Care

Clinical Practice Guideline
Surgical Site Infection Prevention

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Disclaimer

This clinical guideline was developed by subject matter experts within the NAON membership and is provided as an educational tool based on an assessment of current scientific and clinical research information.
The tool is not intended to replace a clinician's independent judgment and critical thinking, but to enhance the clinician's knowledge base regarding the prevention of surgical site infections (SSIs).

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Introduction

A surgical site infection (SSI) is defined by the Centers for Disease Control (CDC) as a healthcare-associated infection of the area of the body where surgery took place. The surgical procedure must involve an incision through the skin or mucous membranes. SSIs following surgical procedures can be superficial (involving skin only) or they can be more invasive and involve deep tissues, organs or implanted materials (Berrios-Torres et al., 2017).

Surgical site infections are recognized as one of the most prevalent healthcare associated infections (HAI) (Ken et al., 2020; Lebo et al., 2020). It has been estimated that between 160,000 and 300,000 surgical patients develop an SSI each year (Association for Professionals in Infection Control [APIC], 2018). SSIs play a major role in increasing morbidity and mortality, prolonging hospitalizations, and increasing hospital readmissions, in addition to contributing to rising healthcare costs (APIC, 2018). National data collection shows that the overall rates of SSIs do not appear to be decreasing despite an increased focus by healthcare organizations to try to reduce and prevent them (CDC, 2019) (Level III).

To reduce the risk of SSI, a systematic but realistic approach must be applied with the awareness that this risk is influenced by the presence of modifiable and non-modifiable factors (Conny & Wan-Yim, 2016). Modifiable risk factors include patient centered issues (e.g. blood glucose control, body weight, nutritional status) and procedure centered issues (e.g. surgical technique, facility infection prevention practices) (Qvistgaard et al., 2019). Non-modifiable risk factors include the presence of patient co-morbidities, the type of procedure performed (emergent vs. non-emergent), and the presence of wound contamination prior to surgery (World Health Organization [WHO], 2016).

Purpose

The purpose for the Surgical Site Infection Prevention Clinical Practice Guideline is to educate staff in promoting a multi-faceted approach to prevent all orthopaedic surgery related infections. A consistent implementation of evidence-based practices related to preoperative surgical site preparation, intra-operative care, and postoperative care are essential to improve patient outcomes.

Rationale for Guideline

Due to increasing prevalence, extent of injury, rising healthcare costs pertaining to SSIs, and the increasing incidence of Methicillin-resistant *staphylococcus aureus* (MRSA) related SSIs, prophylaxis pertaining to SSIs has become an international healthcare priority (WHO, 2016). From 2010 to 2017, the incidence of SSIs in a few specific procedures has decreased but much work remains to decrease SSIs across all surgeries and in all settings (Berrios-Torres et al., 2017; WHO, 2016).

The Surgical Care Improvement Project (SCIP) is a national partnership that was developed in 2003 by the Centers for Medicare and Medicaid Services (CMS), the CDC, and various organizations committed to improving the safety of surgical care through the reduction of postoperative complications by utilizing evidence-based core measures. The SCIP was developed in part to collect core measures pertaining to the prevention of surgical infections in what is now referred to as the Hospital Inpatient Quality Reporting Program (Centers for Medicare & Medicaid Services (CMS), 2017).

Goal of Clinical Practice Guideline

Identification of evidence-based prevention measures pertaining to SSIs will provide orthopaedic nurses with the knowledge base needed to effectively deliver continuous high-quality care among patients undergoing surgery of the musculoskeletal system. This guideline is intended to help orthopaedic nurses to understand the current research evidence that has been developed regarding the prevention of surgical site infections. It is important to remember that recommendations can only be made where quality data exists to support the intervention. Additionally, nurses should remember that the absence of evidence is not the same as evidence of an ineffective intervention (i.e., lack of evidence for an intervention may present an area of opportunity for future research).

Assessment of Scientific Evidence

The evidence within this clinical practice guideline is rated to differentiate evidence of varying strengths and quality. The Johns Hopkins Nursing Evidence-based Practice Model and Guidelines were used to evaluate the works referenced in this updated guideline (Dang & Dearholt, 2017). Refer to the Appendix for an overview of the levels of evidence contained within this guideline.

Nursing Diagnoses

The following nursing diagnoses represent some of the issues that patients may encounter in the orthopaedic surgical setting. Risks can be decreased by nurses who are educated in comprehensive orthopaedic patient assessment, knowledge of patient risk factors, and are properly educated for the specialties of perioperative nursing (i.e., pre, intra, and post-operative nursing).

- Knowledge deficit
- Risk for infection
- Risk for impaired skin/tissue integrity
- Risk for imbalanced nutrition
- Risk for ineffective tissue perfusion
- Risk for hypothermia
- Risk for injury
- Potential for ineffective thermoregulation
- Risk for fluid imbalance
- Risk of impaired self-image

Risk Factors

In 2016, the World Health Organization (WHO) identified the following characteristics that may increase the k of an SSI development; characteristics emerged from research with strength of evidence from Level II and III studies:

- High body mass index
- Severe wound class or trauma
- High score on US National Nosocomial Infections Surveillance (NNIS) Risk Index
- Diabetes
- Prolonged surgical duration
- American Society of Anesthesiologists (ASA) score of 3 or more
- Presurgical hospital stay of at least 2 days
- Wound classification of contaminated or dirty
- Reoperation (for total hip arthroplasty patients)
- Age above 60 years (for total hip arthroplasty patients)

Definition of the Problem

- SSIs can lead to compromised wound healing, failure of components and hardware, as well as increased medical costs, morbidity, and mortality (WHO, 2016).

Pathophysiology

- The majority of SSIs involve the following microorganisms: *Staphylococcus aureus, Coagulase-negative staphylococci, Pseudomonas, Enterococcus spp.,* and *Escherichia coli* (APIC, 2018).
- The types of bacteria found in surgical wounds are also associated with body location involved (APIC, 2018).
- Methicillin-sensitive *staphylococcus aureus* (MSSA) and methicillin-resistant *staphylococcus aureus* (MRSA) bacteria can live with other bacteria on a person's skin, such as on the hands or in a person's nose. Whenever

a person touches people or objects, he or she can transmit the bacteria (APIC, 2018).

- Every surgical wound is able to tolerate some degree of host damage locally and a certain amount of bacterial flora; however, the condition of the wound and the bacterial flora are interrelated. If either of these exceeds a tolerable threshold, an infection may develop. The threshold may be determined by host factors such as the presence of comorbidities (e.g., diabetes, autoimmune disorders), age, and nutritional status. (Rothrock & McEwen, 2019).

Utilization of Healthcare Data

- The growing use of electronic health records and data sharing collaboratives have the potential to improve clarity regarding which SSI prevention strategies are the most effective by linking real data with researchers in more efficient ways (Stanford Medicine, 2017).
- Healthcare quality surveillance to understand SSI rates is a team effort and requires the input and cooperation of the entire healthcare team (e.g., physicians, nurses, infection control, physician assistants, nurse practitioners, and other allied health care professionals) (APIC, 2018).
- Clinical quality indicators (CQIs) allow for the identification of areas that need improvement and serve as evidence-based guidelines that assist with the measurement of the quality and safety of patient care (Agency for Healthcare Research and Quality [AHRQ], 2019).
- CQIs specific to infection prophylaxis include measures based on current best practices that change periodically to keep up to date with emerging knowledge (AHRQ, 2019).

Nursing Interventions and Expected Outcomes

The CDC Prevention Guidelines for reducing the transmission of SSIs include utilizing contact precautions for patients with known or suspected infections, employing appropriate hand hygiene measures, and performing effective environmental cleaning utilizing accepted current practices (Berrios-Torres et al., 2017) (based on Level I and II studies). The spread of infectious disease can be prevented by maintaining contact precautions for patients with an infection that is present or suspected. This includes, but is not limited to, good hand-washing practices, utilizing private patient rooms, implementing contact precautions, using personal protective equipment (PPE), and maintaining sterility when performing all sterile and aseptic procedures. Soap and water are the most effective means of removing infectious organisms from the hands and fingers. Hand antiseptics should be used on clean, debris free hands as directed by the manufacturer's instructions for use (Association of periOperative Registered Nurses [AORN], 2019) (Level I and II). Prior to entering the operating room, traditional soap and water hand washing or alcohol-based rub used on hands must occur to help prevent the development of SSIs.

Nursing Assessment Pertaining to Patient Care

- Consider establishing and utilizing nurse-led preoperative clinics to assess patients for elective orthopaedic surgery (Conny & Wan-Yim, 2016) (Level III).
- Conduct an initial preoperative assessment to include skin assessment, NPO status, medication reconciliation, verification of procedure and informed consents.
- Determine wound classification to predict the risk for development of an SSI.
- Assess nutritional status.
- Determine the presence of co-morbidities that may increase incidence of an SSI.
- Determine presence of modifiable and non-modifiable risk factors.
- Review with the patient previous history of infections.
- Ask the patient to describe his or her living environment. (AORN, 2019; Rothrock, & McEwen, 2019)

Patient Care Management

Determine Wound Classification

The CDC recommends assessing surgical wounds and determining the probability of an SSI by utilizing a classification system consisting of four types of surgical wounds (AORN, 2019).

- Clean Wounds (Class I): uninfected operative wounds where no inflammation is present and there are no signs of infection. These wounds are primarily closed and are able to be drained with a closed wound drainage

system. An example of a clean wound is a total joint arthroplasty.

- Clean Contaminated Wounds (Class II): operative wounds that involve entering the respiratory, alimentary, or genitourinary tracts. There are no signs of infection present. Examples include hysterectomy, non-perforated appendectomy, or lobectomy.
- Contaminated Wounds (Class III): open, fresh, accidental wounds. These wounds include any type of penetrating trauma or open fractures.
- Dirty-Infected Wounds (Class IV): wounds that involve an existing clinical infection. Examples include an incision and drainage (I&D) of an infected wound or a delayed primary closure of a contaminated wound.

Preoperative Care

Decolonization with mupirocin ointment

- Preoperative nasal swabbing may be utilized to screen for patients who are carriers of *Staphylococcus aureus* (i.e., MRSA or MSSA). Initiating treatment for those patients who test positive preoperatively may decrease the risk of them developing a post-operative total joint arthroplasty SSI (American Academy of Orthopaedic Surgeons [AAOS], 2019; WHO, 2016) (Level III and IV).
- If preoperative nasal swab screening is conducted, it should be completed in a timeframe that will allow for treatment with a 5-day course of 2% mupirocin intranasally twice a day leading up to the days before surgery (AAOS, 2019; Ban et al., 2016; WHO, 2016) (Level III and IV).

Pre-op Patient Skin Cleansing

- It is recommended clinical practice to instruct patients to shower or bathe prior to surgery. Soap and water or products containing chlorhexidine gluconate require several applications to attain maximum antimicrobial benefit; repeated antiseptic showers are usually indicated preoperatively (i.e., preferably the evening before surgery and the morning of surgery). If there is advanced notice prior to surgery, cleansing can be recommended each day up to approximately 5 days before surgery (APIC, 2016; Berrios-Torres et al., 2017; WHO, 2016) (Level III and IV).

Pre-op Patient Hair Removal

- If hair removal is required, it should be removed just prior to the surgical procedure in the preoperative area if possible. It is recommended that hair removal be performed with electric clippers. Shaving is always strongly discouraged (Ban et al., 2016; WHO, 2016) (Level III and IV).

Blood Transfusions

- Do not withhold necessary blood transfusions from a surgical patient to prevent SSI (Berrios-Torres et al., 2017) (Level III).

Standard Antibiotic Prophylaxis (SAP)

A single weight-based dose of pre-operative antimicrobial prophylactic therapy should be administered intravenously prior to the incision in to allow for optimal serum and tissue concentration.

- Antibiotics to be administered up to 60 minutes prior to incision include: cefazolin, cefuroxime, and clindamycin.
- Antibiotics to be administered up to 120 minutes before incision: vancomycin and fluoroquinolones.
- In procedures that involve a tourniquet, infusions should be completed a minimum of 10 minutes prior to tourniquet inflation. (AAOS, 2019; Anderson et al., 2014; American Society of Health-System Pharmacists [ASHP], 2013; Berrios-Torres et al., 2017; WHO, 2016) (Level III and IV).

Standard Antibiotic Prophylaxis (SAP) Prolongation

- Prolonged use of SAP is not recommended after completion of the surgery (ASHP, 2013; WHO, 2016) (Level III and IV).
- Redosing antibiotic intraoperatively may be warranted when the surgical procedure exceeds one to two times the antibiotic's half-life or when there is significant blood loss (Ban et al., 2016; ASHP, 2013) (Level IV).
- When using postoperative doses, discontinue within 24 hours after closure of the incision (Ban et al., 2016; ASHP, 2016) (Level IV).

- Patients with a higher-than-normal body mass index (BMI) may require higher dosages of antimicrobial therapy (ASHP, 2013) (Level IV).

Additional Preoperative Considerations

- Whenever possible, identify and treat all infections remote to the surgical site before elective surgery. Postpone elective surgery on patients with remote site infections (i.e., cellulitis, urinary tract infection, or pneumonia) until the infection has resolved (AAOS, 2019) (Level IV).
- Pre-operative evaluation and management of modifiable risk factors should be considered and include uncontrolled diabetes (i.e., elevated blood glucose levels and hemoglobin A1C), malnutrition, alcohol use disorder, tobacco use disorder, obesity, poorly controlled behavioral health disorders, and renal failure (AAOS, 2019) (Level IV).
- Adequately control serum blood glucose levels of less than 200 mg/dl in all diabetic patients and avoid hyperglycemia perioperatively. Hyperglycemia reduces the body's natural resistance to infection (Berrios-Torres et al., 2017) (Level III).

Intraoperative Care

Sterile Technique

Sterile technique is a large collection of work practices and principles that address establishing sterile fields, sterile table set ups, patient skin preps, surgical draping, gowning, and gloving. It is through the application of rigorous sterile technique that nurses and other healthcare providers create a safe environment for the patient undergoing surgery. There are many elements to sterile technique and the following descriptions are meant to introduce those elements. Nurses should follow the work setting's established protocols and training methodologies.

Surgical Attire

Surgical team members should wear clean, hospital-acquired clothing (i.e., scrubs) that does not shed fibers, surgical hats that cover hair fully, minimal to no jewelry, and a scrub jacket when performing skin prep (AORN, 2019) (Level III). Masks are recommended when in the presence of a sterile field and should be worn so that the mouth and nose are securely covered (AORN, 2019; WHO, 2016) (Level IV and V).

Surgical Hand Antisepsis

Surgical hand antisepsis is a crucial factor in preventing SSIs and is performed before donning sterile attire. The purpose of surgical hand antisepsis is to reduce transient and resident microorganisms on the hands and maintain the bacterial levels below baseline, as this may help reduce SSIs (APIC, 2018) (Level II). In the U.S., a standardized surgical hand scrub or rub should be performed using either an antimicrobial surgical agent or an alcohol-based antiseptic surgical hand rub with documented persistent and cumulative activity that has met the U.S. Food and Drug Administration (FDA) regulatory requirements for surgical hand antisepsis. Double gloving is strongly recommended for orthopaedic surgeries (AORN, 2019) (Level III).

Surgical Site Skin Antisepsis

The selection of the intraoperative skin antiseptic agent should be based on the patient assessment for any allergies or sensitivity to skin preparation agents. After a patient has been anesthetized and properly positioned on the operating room table, the surgical site should be prepped using a chlorhexidine-based product according to the manufacturer's Instructions For Use (IFU) unless contraindicated due to open wounds or mucous membranes in the prep zone (Privitera et al., 2017) (Level II). Chlorhexidine-based products have been shown to be most effective for both reducing skin bacterial load and reducing SSI rates (APIC, 2018; Privitera et al., 2017) (Level II).

Antibiotic Prophylaxis

- Many facilities include antibiotic prophylaxis as a routine part of the surgical time-out. An important consideration in limb surgery such as total knee arthroplasty is the infusion of the antibiotic prior to inflation of the tourniquet (APIC, 2018; WHO, 2016) (Level III).

Air Quality

- The quality of air entering the operating room (OR) should be carefully controlled by keeping operating room doors closed except as needed for passage of equipment, personnel, and the patient (AORN, 2019) (Level III).

Traffic Patterns

- Personnel entering the operating room should be limited to necessary personnel only (AORN, 2019) (Level III).

Prevention of Hypothermia

- Measures to prevent hypothermia, which is defined as a core temperature less than 96.8°F, should be implemented (AORN, 2019) (Level III).

Sterilization of Surgical Instruments

- Sterilize all surgical instruments according to institutional policies and manufacturer IFUs (ANSI/AAMI, 2017) (Level III).
- Immediate Use Steam Sterilization (IUSS) (i.e., flash sterilization) should only be utilized in emergent situations when instruments are needed immediately. IUSS should not be used for reasons of convenience, as an alternative to purchasing additional instrument sets, or to save time (AORN, 2019).

Postoperative Care

Postoperative Incisional Care

- An incision that has been closed primarily should be protected with a sterile occlusive dressing (Glennie et al., 2015; Bains et al, 2017) (level III).
- Dressings should be left intact for the first five days postoperatively (Tan et al., 2020) (Level II).
- Additional best practices and recommendations for how to care for postoperative wounds lack strong evidence in the literature (i.e., lack of RCT research), but expert consensus for wound care includes:
    - using sterile technique when changing incision dressings in the immediate postoperative period
    - performing hand hygiene before and after dressing changes
    - educating patients and family regarding proper incision care, symptoms of an SSI, and the need to report such symptoms (Gillespie, et al., 2020; Rothrock & McEwen, 2019) (Level IV).

Postoperative Skeletal Pin Care

- Weekly pin site cleaning is appropriate (Campbell & Watt, 2020) (Level V).
- Chlorhexidine is considered superior to saline for cleaning pin sites (Kazmers, et al., 2016) (Level V).
- If a chlorhexidine solution is contraindicated, then a combination of freshly prepared, half strength hydrogen peroxide with a sterile, non-adhering protective dressing impregnated with a petroleum jelly may be utilized (Kazmers, et al., 2016) (Level V).
- Dressing changes should commence on post-operative day 2 to 3 (Kazmers, et al., 2016) (Level V).
- Although some evidence suggests that pin site crusts should be left intact unless there is evidence of infection at pin site (Georgiades, 2018) (Level III) it is also appropriate to follow hospital protocol (Lethaby et al., 2013; Kazmers, et al., 2016) (Level V).

Postoperative Care Use of Negative Pressure Wound Therapy

- The use of negative pressure wound therapy is unwarranted in spine surgery involving low levels of surgical invasiveness (i.e., micro discectomy, single-level laminectomy, anterior cervical discectomy, and fusion) (Tan et al., 2020) (Level II).
- Negative pressure wound therapy should be considered for invasive procedures such as long segment decompression and fusions as well as deformity corrections (Tan et al., 2020) (Level II).
- Research on the use of negative pressure wound therapy in the lumbosacral spine indicates this approach does not alter the overall rate of infection (Tan et al., 2020) (Level II).
- Postoperative care should be carried out per manufacturer's IFU or per physician's orders.

Disinfection of Non-Critical Items

- Non-critical items include those items that come in contact with intact skin. Examples of non-critical items include reusable tourniquet cuffs, ice therapy packs, and blood pressure cuffs (AORN, 2019) (Level II).
- Non-critical items should be cleaned at the point of use with an immediate-level or low-level disinfectant such as alcohol, sodium hypochlorite, a phenolic solution, or an ammonium solution (AORN, 2019) (Level II).

Nursing Responsibilities with Prophylaxis Antibacterial Therapy

- Help establish and enforce department processes that reflect adherence to antibiotic prophylaxis protocols (e.g., use of clear instructions, education of providers, and use of audits to monitor compliance) (Bodansky et al., 2017).
- Assess the patient's allergy history before initiating IV antibacterial therapy or applying topical antiseptic agents (AORN, 2019).
- Practice strict hand washing and contamination precautions before handling each patient's IV site (CDC, 2019).
- Monitor infusion/injection sites for signs of extravasation (i.e., pain, edema, and drainage) (AORN, 2019).
- Ensure IV antibiotics are given on time as ordered if the patient is receiving post-operative inpatient antibiotic IV therapy (AORN, 2019).
- Closely monitor for a hypersensitivity reaction during and after each dose (AORN, 2019).
- Monitor for and instruct the patient to report signs of adverse reactions (i.e., change in urine output or color, diarrhea, skin reactions (Rothrock & McEwen, 2019).
- Ensure IV antibiotics are discontinued within 24 hours of the surgery end time (WHO, 2019).

Patient Education

Preoperative

- Modifiable risk factors should be examined. Patients should be educated about those risks and referred to appropriate providers to reduce modifiable risk factors when appropriate prior to elective orthopaedic procedures (Bedard et al, 2018) (Level III).
- Malnutrition is a recognized risk factor for SSIs in surgery including spine surgery (Tan et al., 2020) (Level II).
- Encourage tobacco cessation. At a minimum, instruct patients about the risks of smoking and tobacco use. The nicotine in tobacco products results in microvascular vasoconstriction, and tissue hypoxia that can contribute to the development of multiple postoperative complications including delayed wound healing, infections, and poor surgical recovery (Bedard et al., 2018) (Level III).
- Advise patients to shower or bathe (full body) with soap or an antiseptic agent the night before surgery (Berrios-Torres et al., 2017) (Level III).

Postoperative patient and family education should include:

- Signs and symptoms of infection (Rothrock & McEwen, 2019) (Level IV).
- Proper hand washing (Rothrock & McEwen, 2019) (Level IV).
- Appropriate wound care (Rothrock & McEwen, 2019) (Level IV).
- Glycemic control. Patients with and without diabetes should use a blood glucose target level of less than 200mg/dl (Berrios-Torres et al., 2017; McLaren, et al, 2018) (Level III and Level V).
- Maintenance of proper nutrition to avoid postoperative malnutrition (Tan et al., 2020) (Level II).

Discharge Destination

The discharge destination for the patient is based on the level of care required and the support system available to the patient. The goal is for the patient to return to his or her pre-hospital environment, but special considerations are

required based on the need for oral or intravenous antibiotics and/or wound care. Assistance with placement for follow-up care may be needed.

Trends and Controversies

- There is no current recommendation to taper or discontinue systemic steroid use (when medically permissible) before elective surgery.
- There is no current recommendation to provide measures that enhance wound space oxygenation to prevent SSI.
- There are no current recommendations regarding the appropriate time to shower or bathe with an uncovered incision.
- There is no current recommendation on the preoperative use of Novel 2 % Chlorhexidine Gluconate Cloths.
- Some controversy exists on skeletal pin care and dressing application.
- There is no current recommendation on best practice to maintain normothermia intraoperatively (e.g., forced air warming, radiant heating versus reflective warming blankets)

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Appendix: System for Rating the Strength of Evidence

Overview of System for Rating the Strength of Evidence

Level I	• Experimental study, randomized controlled trial (RCT) • Explanatory mixed method design that includes only level I quantitative study • Systematic review of RCTs, with or without meta-analysis
Level II	• Quasi-experimental study • Explanatory mixed method design that includes only a level II quantitative study • Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis
Level III	• Non-experimental study • Systematic review of a combination of RCTs, quasi-experimental and non-experimental studies or non-experimental studies only, with or without meta-analysis • Exploratory, convergent, or multiphasic mixed methods studies • Explanatory mixed method design that includes only a level III quantitative study • Meta-synthesis of qualitative studies
Level IV	• Opinion of respected authorities and/or nationally recognized expert committees or consensus panels based on scientific evidence Includes: Clinical practice guidelines, consensus panels, and position statements
Level V	• Based on experiential and non-research evidence • Integrative Literature reviews; Quality improvement programs; Quality improvement financial evaluations; Case reports; Opinion of nationally recognized expert(s) based on experiential evidence

Derived from the Johns Hopkins Nursing Evidence-Based Practice Model© (Dang & Dearholt, 2017)