

# Guide to the Elimination of Orthopedic Surgical Site Infections



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#### On the Cover:

Cover image courtesy of CDC/ Jeff Hageman, M.H.S.  
Photo Credit: Janice Haney Carr, 2005

This 2005 scanning electron micrograph (SEM) depicted numerous clumps of methicillin-resistant *Staphylococcus aureus* bacteria, commonly referred to by the acronym, MRSA; Magnified 2381x.

Recently recognized outbreaks, or clusters of MRSA in community settings have been associated with strains that have some unique microbiologic and genetic properties, compared with the traditional hospital-based MRSA strains, which suggests some biologic properties, e.g., virulence factors like toxins, may allow the community strains to spread more easily, or cause more skin disease. A common strain named USA300-0114 has caused many such outbreaks in the United States. See PHIL 7823 for a black and white version of this micrograph.

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# Guide Overview

The purpose of this guide is to provide practical tools, strategies and resources for infection preventionists (IPs), care providers, surgical staff and quality improvement teams to use in their efforts to eliminate surgical site infections (SSIs) in orthopedic surgery.

## Scope

This guide focuses on orthopedic surgeries in clean, primarily elective cases, with a major emphasis on joint replacements. However, the tools, protocols and general information are also applicable to a variety of other orthopedic surgeries in both inpatient and outpatient settings. Because orthopedic surgery is performed in a variety of inpatient and outpatient settings, the need for increased vigilance, strict adherence to aseptic technique, attention to adequacy of reprocessing, and management of intraoperative breaches of sterile technique are vitally important to ensure a safe and consistent standard of care. Breaches of sterile technique, inadequate sterilization of equipment and lack of adherence to aseptic technique have been associated with outbreaks of SSIs.<sup>1</sup>

Several references and regulatory issues discussed in this guide pertain to the United States. However, many of the principles and practices are applicable to the global setting. Discussion of products outside the U.S. should comply with that jurisdiction's relevant licensing and regulatory authority requirements, which may be different from those of the U.S. Food and Drug Administration (FDA).

## Key Concepts

An effective facility-wide infection prevention and control program is composed of many components and interventions that can reduce the risk of infection in surgery patients. This includes an understanding of the surgical population and the associated risk factors, effective methods for case finding, expertise in the analysis of data, effective communication of outcomes, and implementation of evidenced-based strategies to improve outcomes. Central to this theme is collaboration. In order to ensure patient safety and optimum patient outcomes, IPs, surgeons, perioperative staff, nurses, and all members of the healthcare team must work together to implement evidence-based practices that minimize the risk of infection.

# Background

Klevens and others reported that in 2002, approximately 20% of total healthcare-associated infections (HAIs) were SSIs, making this the second most common HAI in U.S. hospitals. This report also estimates that 8,205 deaths occur from SSIs annually.<sup>2</sup> The Agency for Healthcare Research and Quality (AHRQ) reported that more than one million knee and hip arthroplasty surgeries were performed in hospitals in the United States in 2008.<sup>3</sup> This number, along with other orthopedic procedures, represents a significant number of bone and joint surgeries done in the United States each year. The most recent National Healthcare Safety Network (NHSN) report includes data from 2006 to 2008. This report published knee replacement postoperative infection rates ranging from 0.68% to 1.60%, depending on patient risk, and hip replacement infection rates from 0.67% to 2.4%.<sup>4</sup> If these rates were applied to all of the hip and knee replacements done in the U.S., we could estimate that somewhere between 6,000 and 20,000 SSIs occur annually in hip and knee replacements alone. Estimates of the total number of patients who have SSIs following all orthopedic surgery is somewhere between 31,000 and 35,000. One study estimated that orthopedic SSIs prolong total hospital stays by a median of two weeks per patient, approximately double readmission rates, and increase healthcare costs by more than 300%. Moreover, patients with orthopedic SSIs have substantially greater physical limitations and significant reductions in their quality of life.<sup>5</sup> Infectious complications may range from superficial infections to deep and organ-space infections, many of which may be associated with increased mortality.

## State and Federal Initiatives

Consumer demand for public reporting of healthcare quality data has increased since the 1999 publication of the Institute of Medicine's *To Err is Human: Building a Safer Health System*.<sup>6</sup> The report was based upon analysis of multiple studies by a variety of organizations and concluded that between 44,000 to 98,000 people die each year as a result of preventable events such as medication errors, surgical complications and infections. Subsequently, there was demand for greater transparency and a concerted effort to reduce and eliminate HAIs. The development of an HAI is no longer considered an inevitable consequence of healthcare.

After years of debate on both the federal and state levels, mandatory public reporting of HAIs has become a reality in an increasingly large number of states. Additionally, the department of Health and Human Services (HHS) has set specific five-year targets for reducing the incidence of selected HAIs in acute care hospitals. These targets, along with a series of proposed action steps, were published in the *HHS Action Plan to Prevent Healthcare-Associated Infections*. ([www.hhs.gov/ophs/initiatives/hai/actionplan/index.html](http://www.hhs.gov/ophs/initiatives/hai/actionplan/index.html)). The campaign targeted the four categories of infections that account for approximately three-quarters of HAIs in the acute care hospital setting:

1. SSIs
2. central line-associated bloodstream infections (CLABSIs)
3. ventilator-associated pneumonia (VAP)
4. catheter-associated urinary tract infections (CAUTI)

*Clostridium difficile* disease (CDAD) and methicillin-resistant *Staphylococcus aureus* (MRSA) have also been added to the priority list. Additionally, further work will include Ambulatory Surgery Centers (ASCs) as part of the Tier Two Action Plan.

On July 30, 2010, a rule released by the Centers for Medicare & Medicaid Services (CMS) laid out HAI reporting requirements for Medicare eligible hospitals that participate in CMS's pay-for-reporting program. More than 3,500 hospitals will be required to use the U.S. Centers for Disease Control and Prevention (CDC)'s NHSN to report CLABSI and SSI data to CMS. The SSI reporting will begin October 2012 for 2014 payment. Specifics related to procedures have not yet been determined. Nevertheless, it is clear that prevention of SSIs is a top clinical, administrative and political priority, and that orthopedic infections comprise a large portion of these infections.



# Incidence, Scope & Epidemiology

## Incidence of SSIs Following Hip, Knee, and Spine Procedures

According to the NHSN report, a large U.S. database for HAI aggregation and comparison report titled: “Data Summary for 2006 through 2008,” issued December 2009, SSI rates for hip replacement, knee replacement, open fracture reduction, spinal fusion, and laminectomy procedures are as follows:

**Table 1:** Pooled means of SSI rates by operative procedure and risk index categories, 2006 through 2008<sup>7</sup>

Procedure	Inpatient or Outpatient	Risk Index Category	Number of Procedures	Number of SSIs	Pooled Mean
Spinal fusion	Inpatient	0	20,059	140	0.70
Spinal fusion	Inpatient	1	16,640	306	1.84
Spinal fusion	Inpatient	2,3	4,511	187	4.15
Open reduction of fracture	Inpatient	0	3,600	40	1.11
Open reduction of fracture	Inpatient	1	5,629	100	1.78
Open reduction of fracture	Inpatient	2,3	1,249	42	3.36
Hip prosthesis	Inpatient	0	49,576	334	0.67
Hip prosthesis	Inpatient	1	65,046	938	1.44
Hip prosthesis	Inpatient	2,3	15,769	379	2.40
Knee prosthesis	Inpatient	0	70,675	409	0.58
Knee prosthesis	Inpatient	1	79,653	786	0.99
Knee prosthesis	Inpatient	2,3	20,855	333	1.60
Laminectomy	Inpatient	0	20,972	150	0.72
Laminectomy	Inpatient	1	15,054	166	1.10
Laminectomy	Inpatient	2,3	4,051	93	2.30
Knee prosthesis	Outpatient	0,1,2,3	16	0	0.00
Laminectomy	Outpatient	0,1,2,3	901	7	0.78

## Research Related to Incidence, Morbidity, Mortality, and Cost

SSIs following clean orthopedic procedures, such as joint replacement and certain spinal procedures, have become increasingly rare since evidence-based practices related to skin preparation, surgical technique, and antibiotic prophylaxis have become the accepted standard of care in orthopedic surgery.

However, the adverse outcome of SSIs related to a clean orthopedic surgical procedure continues to be associated with significant morbidity, cost, and even mortality. The patient’s functional status may also be adversely affected by an orthopedic SSI.

Various researchers have published data related to incidence, morbidity, mortality, and cost. Many reports describe outcomes for a specific orthopedic procedure, but some include a variety of procedures in their study.

Pollard et al. determined that hip fracture patients, treated with either fixation or hemiarthroplasty, developed infection-accrued costs three times greater than those of non-infected control patients (\$38,000 versus \$11,255). Costs were also higher for infections caused by MRSA as opposed to methicillin-susceptible strains. Although not

statistically significant, there was a decreased likelihood of patients with infection surviving to discharge from the hospital. Of borderline significance was the finding that patients with infection were less likely to return to their pre-fracture residence.<sup>8</sup>

Using a multivariate logistic regression analysis, Veeravagu et al. studied patients undergoing spinal decompression and fusion. In a study of 24,774 patients' data from the Veteran's Administration Surgical Care Improvement Project (SCIP) database, an incidence rate of 3.04% was calculated. Other findings included an extended hospital stay (7.12 days for infected patients versus 4.20 days for non-infected controls), increased 30-day mortality rate (1.06% versus 0.5%), increased complication rate (1.24% versus 0.05%) and an increased return to surgery rate (37% versus 2.45%).<sup>9</sup>

Kuper, in 2008, published a literature review of research articles related to total knee and hip replacement SSIs. His findings include an annual cost of total joint replacement infections in the U.S. of \$250 million. Cost of revision of a total joint due to infection is 2.8 times higher than cost of revision for aseptic loosening, and 4.8 times higher than costs associated with primary total hip arthroplasty. The cost of total knee arthroplasty revision due to infection ranges from \$15,000 to \$30,000. Total hip arthroplasty revision due to infection results in significantly more hospitalizations, total length of stay, number of operative procedures, outpatient visits and charges, and additional complications than revision due to aseptic loosening of the prosthesis.<sup>10</sup>

Lee et al. studied outcomes for a variety of orthopedic procedures, including hip and knee replacement, open reduction of fracture, other joint replacement, spinal fusion and laminectomy. Patients older than 64 years of age were included in her two-nested case control study, and infections were either deep incisional or organ space, per CDC definitions, requiring operative debridement. Of the 15,218 procedures reviewed, 169 infections were studied. There were 171 controls. Statistically significant findings included a higher one-year postoperative mortality (17% versus 4%), increased length of stay, including readmission within 90 days of surgery (13 versus four days), and a mean of 9.31 days of hospitalization attributable to infection.<sup>11</sup>

Olsen et al. conducted a retrospective case control study of patients who had either laminectomy or spinal fusion procedures. Forty-one patients with SSI or meningitis were compared to 178 uninfected patients. Of the patients with SSI, all received additional antibiotic therapy, 30 (77%) underwent re-operation due to their infection, and 30 (77%) were re-hospitalized at least once for wound care treatment. The mean readmission length of stay was 8.5 days (mean 6 days, range 0-45 days).<sup>12</sup>

Whitehouse et al. studied patients undergoing a variety of orthopedic procedures, including open reduction of fracture, fusion, laminectomy and joint replacement. The methodology used was a pairwise matched (1:1) case-control study within a cohort. Of 59 case patients, 11 (19%) were patients who had undergone joint replacement surgery. Findings that reached statistical significance included increased median initial length of stay, total number of hospitalizations, number of surgical procedures, total length of stay, and cost. Although the mortality rate was higher among patients who experienced infection, that finding did not achieve statistical significance. Whitehouse also addressed the quality of life issue, using a questionnaire that was completed by 62% of study participants. Patients with SSIs reported substantial reductions in the quality of life measures one year after the initial procedure, compared to non-infected control patients.<sup>13</sup>

Partanen studied deep wound infections in patients who underwent hip procedures, including repair with screws, hemiarthroplasty, total arthroplasty, and gamma nail repair. Of 2,276 patients older than 50 years of age, 29 (1.3%) experienced deep infection requiring surgical revision. These cases were matched with controls who did not experience infection. Greater rates of impaired function and mortality were noted, although neither of these findings achieved statistical significance.<sup>14</sup>

Lentino reported an estimated cost of treating an infected arthroplasty of more than \$50,000 and a mortality rate that was double that of uninfected patients during the first three months following arthroplasty.<sup>15</sup>

Wilson reviewed infection rates in 125 English hospitals from April 2004 through March 2005 and noted an infection rate of 1.26% following total hip replacement procedures and a rate of 4.06% following hemiparthroplasty. Of statistical significance was the finding that SSI risk was greater following revision procedures than following the primary operation.<sup>16</sup>

## Epidemiology of, and Risk Factors for, Orthopedic SSI

Epidemiology is defined as the study of health-related events in defined populations, observing specific illnesses and conditions and the exposures and host factors that may be associated with their occurrence. The diseases or conditions may be infectious or non-infectious.<sup>17</sup> Epidemiologic investigations of infectious diseases can lead to a better understanding of the pathogenesis of infection, and ultimately to improved and evidence-based prevention and control strategies.

The rates of SSI following various orthopedic procedures appear to be increased when certain risk factors are present. Risk factors can be either patient- or procedure-specific, and may be modifiable or non-modifiable.

With regard to clean spinal procedures, risk factors that have been associated with increased SSI include estimated blood loss of greater than one liter, previous SSI at the operative site, diabetes, obesity, longer procedure times (more than five hours), current smoking, ASA score of three or more, weight loss, dependent functional status, preoperative hematocrit of less than 36, disseminated cancer, elevated preoperative or postoperative serum glucose level, suboptimal timing of antibiotic prophylaxis, and two or more surgical residents participating in the operative procedure. Additionally, posterior approach or combined anterior/posterior approach were associated with higher rates of infection.<sup>18,19,20,21</sup>

For knee replacement procedures, factors associated with increased risk of postoperative wound infection include male gender, rheumatoid arthritis or fracture as indication for arthroplasty, low volume of cases performed by the operating surgeon, morbid obesity, and diabetes.<sup>22,23,24</sup>

Risk factors associated with higher rates of infections following clean hip procedures include undergoing arthroplasty surgery in a hospital with low volumes of arthroplasty procedures and prolonged wound drainage following the procedure.<sup>25,26</sup> Edwards, in a 2008 study conducted in England, found no statistically significant preoperative risk factors for infection following hip surgery.<sup>27</sup>

Various researchers have studied infection rates in both hip and knee procedures. The factors identified that are associated with increased risk of infection in either of these procedures are diabetes and greater number of medical comorbidities (at least three).<sup>28,29</sup>

A 2010 study of orthopedic procedures in general demonstrated that nasal carriage of *Staphylococcus aureus* increases the risk of *Staphylococcus aureus* wound infection following orthopedic surgery<sup>30</sup> and that admission from a healthcare facility increases the risk of orthopedic SSI.<sup>31</sup>

In summary, a variety of patient or host- and procedure-associated factors appear to be associated with increased risk of infection following orthopedic surgery. The following table summarizes those factors, including potential for modification of each factor:

**Table 2:** Modifiable and Non-Modifiable Host- and Procedure-Related Orthopedic SSI Risk Factors

	Modifiable	Non-Modifiable
Host-specific	Obesity Current smoking Hematocrit < 36 Elevated preoperative or postoperative serum glucose Nasal carriage of <i>Staphylococcus aureus</i> (as risk factor for <i>Staphylococcus aureus</i> infection)	Diabetes Male gender Rheumatoid arthritis ASA score of 3 or greater Recent weight loss Dependent functional status Disseminated cancer Admission from a healthcare facility
Procedure-specific	Estimated blood loss of > 1 liter* Longer procedure time* Suboptimal timing of prophylactic antibiotic Two or more surgical residents participating in procedure Prolonged wound drainage* Spinal procedure via the posterior or the anterior/posterior approach	Estimated blood loss of > 1 liter* Longer procedure time* Previous infection at site Prolonged wound drainage* Low volume of procedures performed at hospital Low volume of procedures performed by surgeon

\*These factors may be modifiable if related to surgical technique or non-modifiable if related to a specific and discrete operation. For example, if a particular surgeon consistently has surgical procedure times that are significantly longer than the NHSN average for that procedure, the risk factor of procedure time could be modifiable with changes in the surgeon's practice. However, if the procedure duration of one discrete operation is prolonged due to intraoperative complications, then the risk factor of longer procedure time would be considered non-modifiable for that particular operation.

Most infections at orthopedic surgical sites are diagnosed within the first two postoperative years. Indeed, to be considered an SSI according to CDC NHSN guidelines, the diagnosis must be made within 12 months of the procedure.

Kurtz et al. reviewed a sample of Medicare patients who underwent total knee replacement surgery and noted an infection incidence rate of 1.55% within the first two years after surgery; between years two and 10, the incidence rate was 0.46%.<sup>32</sup>

The same research group reported similar findings in total hip arthroplasty patients a year earlier, using Medicare data as well. The two-year infection rate among this population was 1.63%; for years two through 10, the rate fell to 0.59%.<sup>33</sup>

# Pathogenesis

## Pathogenesis and Microbiology of SSIs, including Clean Orthopedic Procedures

For all surgical procedures, infection at the operative area has always been recognized as a potential complication. With the advent of antibiotics in the 1940s, this dreaded adverse outcome became less common (or more treatable) and, with recent advances in infection prevention measures, including standardized antimicrobial prophylaxis protocols, even greater reductions in SSI rates have resulted. Nevertheless, infection at the operative site remains a potentially devastating, even fatal, event.

An SSI is similar to all infections, in that it is typically multi-factorial in origin. The occurrence of a postoperative infection is dependent upon the interaction of patient- or host-related factors, such as host immunity, nutritional status, comorbid conditions; procedure-related factors, including the presence of foreign bodies and tissue trauma associated with the procedure; microbial properties, such as ability to adhere to tissue or foreign bodies and innate virulence, and appropriate and timely antimicrobial prophylaxis.

Surgical wounds are classified by the degree of bacterial contamination (or microbial load) at the time of the procedure. Greater microbial loads result in increased infection risk. The CDC classifies wounds as clean, clean-contaminated, contaminated, or dirty in the NHSN patient safety component, SSI data collection. Orthopedic surgical wounds addressed in this document would almost always be classified as clean.

**Table 3:** Surgical Wound Classification<sup>34</sup>

Classification	Wound Parameters
Clean	<ul style="list-style-type: none"> <li>An uninfected operative wound in which no inflammation is encountered and there is no entry into the respiratory, alimentary, genital, or urinary tract</li> <li>Clean wounds are closed primarily and, if necessary, drained with closed drainage</li> </ul>
Clean-contaminated	<ul style="list-style-type: none"> <li>Operative wounds in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination</li> <li>No evidence of infection is encountered or major break in technique occurs</li> </ul>
Contaminated	<ul style="list-style-type: none"> <li>Open, fresh accidental wounds</li> <li>Operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract</li> <li>Incisions in which acute, non-purulent inflammation is encountered</li> </ul>
Dirty or infected	<ul style="list-style-type: none"> <li>Old traumatic wounds with retained devitalized tissue</li> <li>Existing clinical infection or perforated viscera is encountered</li> <li>This definition suggests that the organisms causing postoperative infection were present in the operative field prior to the procedure</li> </ul>

Contamination of the surgical wound is almost unavoidable despite the best efforts of the surgical team. The goal in surgical antisepsis is minimization of the bacterial load to the greatest degree possible. Lack of adherence to asepsis by scrubbed personnel or those in close proximity to the sterile field can be a risk factor for development of an SSI.<sup>35</sup> Quantitatively, it has been shown that if a surgical site is contaminated with >10<sup>5</sup> (100,000) microorganisms per gram of tissue, the risk of SSI is markedly increased. However, the dose of contaminating microorganisms required to produce infection may be much lower when foreign material (i.e., implants or sutures) is present at the site (i.e., 10<sup>2</sup> or 10<sup>0</sup> microorganisms per gram of tissue).<sup>36</sup>

Preparation of the patient's skin is a significant intervention taken to reduce bacterial contamination. However, since as much as 20% of the skin's bacteria are resident (living beneath the epidermal layer of skin, in appendages such as hair follicles and sebaceous glands), any incision made through the skin has the potential of carrying some of this bacterial load directly to the operative site.<sup>37,38</sup> According to the 1999 CDC Guideline for Prevention of Surgical Site Infections, for most SSIs, the source of pathogens is the endogenous flora of the patient's skin, mucous membranes or hollow visera (gastro-intestinal tract). Bacteria can be found on all areas of the body, but are found in significantly higher numbers in those moist areas that include the axilla, skin folds, webs of the feet, perineal area, and peri-anal area.<sup>39</sup>

Environmental factors in the operating environment can play a role in the pathogenesis of infection. The microbial load in the surgical suite is directly proportionate to the number of people in the room.<sup>40</sup> Additionally; nasal carriage of *S. aureus* has been identified as a major risk factor for wound infections after both orthopedic total joint and cardiac surgery. A study published in 2004 by Wertheim, et al demonstrated that genotyping revealed that 80 percent of *S. aureus* bacteremia infections were caused by the patient's own clonal nasal flora.<sup>41</sup> In a study done in 2002 by Kalmeijer, et al, it was determined that high-level nasal carriage of *S. aureus* was the most important and only significant independent risk factor for developing SSI with *S. aureus* following orthopedic surgery with prosthetic implants.<sup>42</sup>

Investigation of an outbreak of SSIs in knee replacement surgeries in a single operating room, described by Babkin et al. in 2007, implicated environmental factors, including multiple entrances to the operating room with frequent movement through them during procedures; non-standardized horizontal-flow air conditioning installed above the main door to the room; and utilization of a washing sink just beyond the main door for cleaning of instruments during procedures. When the sink was removed, the air conditioning unit was disconnected, and the door was locked during procedures, the infection rate fell from 5.6% to 2.2%.<sup>43</sup> Likewise, issues such as contamination or inadequate sterilization of instruments, are also an important risk factor for development of infection. Inadequate sterilization of surgical instruments has resulted in SSI outbreaks.<sup>44</sup>

## Microbiologic and Virulence Factors

Orthopedic surgery frequently involves placement of a foreign body, either a prosthetic joint, joint components, or hardware used to stabilize bony structures or repair fractures. These implants can facilitate infection by either locally introduced contamination or by hematogenous spread of microorganisms. Locally introduced contamination occurs during the perioperative period. Hematogenous spread of microorganisms is typically an event that happens following the perioperative period, and is associated with primary bacteremia or infection at a distant site with secondary bacteremia, leading to microbial seeding of the prosthetic joint.

Infections that arise due to local contamination are the result of an infection adjacent to the prosthesis or to contamination during the surgical procedure. Delay in wound healing predisposes a patient to wound infection. Ischemic necrosis, infected wound hematomas, superficial wound infection, and suture abscesses may be precursors of deeper SSI. Physical barriers that normally protect the deep joint are interrupted during the surgical procedure, increasing the risk of infection.

Bloodstream infection can result in joint replacement wound infection via the hematogenous route. Thus, a primary bacteremia or an infection at a distant site with secondary bacteremia creates a risk for periprosthetic SSI. It is estimated that 20% to 40% of prosthetic joint infections arise via the hematogenous route.

One researcher cited an SSI rate following total knee replacement surgery attributed to hematogenous spread of at least 50%.<sup>45</sup> For infections that develop more than one year after the procedure, the hematogenous route of infection should be strongly considered.<sup>46</sup>

The specific microbiology of an orthopedic wound infection has an impact on the severity, onset, and even the outcome of infection due to differences in rates of growth, ability to survive in the host environment, and virulence. Biofilm plays a significant role in the pathogenesis of infection, including orthopedic SSIs. Once microorganisms have made contact and formed an attachment with a living host or non-living surface or object, development of a biofilm can take place.<sup>47</sup> Bacteria living in a biofilm can have significantly different properties from free-floating bacteria, as the dense extracellular matrix of biofilm and the outer layer of cells may protect the bacteria from antibiotics and normal host defense mechanisms of the white blood cells, such as phagocytosis.

Microorganisms may contain or produce toxins and other substances that increase their ability to invade a host, produce damage within the host, or survive on or in host tissue. Characteristics of the specific infecting microorganism, particularly related to virulence as well as the ability to adhere to a foreign object such as an implantable device, play a role in the presentation of infection. *Staphylococcus aureus*, one of the most common organisms associated with orthopedic SSIs, can possess a high degree of virulence due to its ability to produce toxins and to develop resistance to many classes of antimicrobial agents. Infections caused by this organism are associated with more rapid onset and poorer outcomes.

Coagulase-negative *Staphylococcus*, another common agent associated with orthopedic infection, readily develops antimicrobial resistance, but often presents later in the postoperative period.

*Pseudomonas aeruginosa* may be introduced into the bone or joint via direct inoculation during the surgical procedure, hematogenous spread, or spread from a contiguous infection. *Pseudomonas* infection often has a delayed presentation and may become a chronic infection following fracture repair.

Gram-positive organisms predominate in orthopedic SSIs, with coagulase-negative *Staphylococcus* historically being the most common microorganism, followed by *Staphylococcus aureus*, both methicillin-resistant and susceptible. Other organisms that have been isolated from surgical wounds include *Pseudomonas*, *Proteus spp.*, coliforms, enterococci, Group C *Streptococci*, *Serratia marsescens*, corynebacterium, micrococcus, propionibacterium, anaerobes, yeast, mycobacterium, *Listeria*, bacillus, and other gram-negative bacteria. *Candida* is a rare causative agent in orthopedic SSIs, accounting for approximately 1% of infections.

*Distribution of pathogens related to orthopedic surgery is summarized below:*

*From table 5 Distribution of Selected Pathogens Associated with Cases of Surgical Site Infection Reported to the National Healthcare Safety Network, January 2006–October 2007, by type of Surgery. NHSN Update on Antimicrobial Resistance 2006–2007;1001.*<sup>48</sup>

Pathogen	Orthopedic surgery (N = 963)	Pathogen	Orthopedic surgery (N = 963)
Coagulase-negative Staphylococcus	173 (15.3)	Escherichia coli	34 (3.0)
Staphylococcus aureus	548 (48.6)	Pseudomonas aeruginosa	38 (3.4)
Enterococcus Species		Klebsiella pneumoniae	14 (1.2)
E. faecalis	57 (5.1)	Enterobacter species	37 (3.3)
E. faecium	13 (1.2)	Acinetobacter baumannii	10 (0.9)
Not specified	34 (3.0)	Klebsiella oxytoca	5 (0.4)
Candida Species		Total number of pathogenic isolates by surgery type	1,128
Candida albicans	2 (0.2)		
Other or not specified	2 (0.2)		

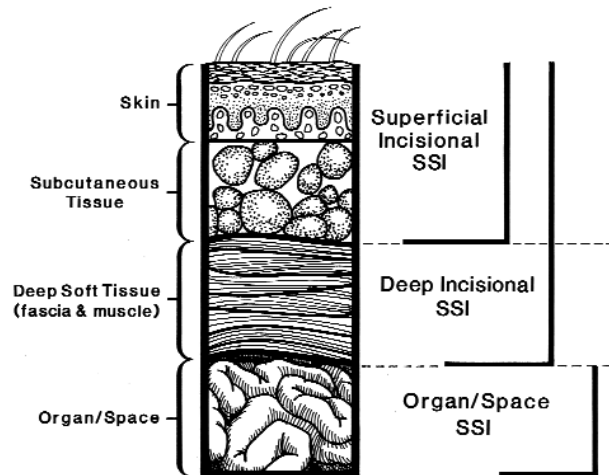
*Staphylococcus aureus* was also identified as the major pathogen in hip replacement surgery, as reported in the New York State 2009 Hospital-Acquired Infection Report. There were 186 isolates of *Staphylococcus aureus* reported. This organism accounted for 59.8% of the total isolates. Of these 186 isolates, 102 were methicillin-resistant (55% of all staph, and 32.8% of total pathogens).<sup>49</sup>



# Surgical Wound Definitions and Diagnosis

SSIs are well defined by the CDC's NHSN. Surgical procedures can be classified as either inpatient or outpatient. For inclusion in the NHSN database, the surgical procedure must involve an incision through skin or mucous membrane, be performed in an operating room, and be included in the list of NHSN operative procedures. These classifications, although confined to the U.S. NHSN system, have been adapted and widely adopted globally.

Wounds following surgical procedures are classified as superficial incisional, deep incisional, or organ/space, depending upon the tissue or body part involved.



**Figure 1:** Layers of skin and deep space.

Superficial incisional SSIs must meet the following criteria:

infection occurs within 30 days after the operative procedure

*and*

involves only skin and subcutaneous tissue of the incision

*and*

patient has at least one of the following:

- 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 is not cultured (a culture-negative finding does not meet this criterion)
- diagnosis of superficial incisional surgical by the surgeon or attending physician

Deep incisional SSIs must meet the following criteria:

infection occurs within 30 days after the operative procedure if no implant is left in place, or within one year if implant is in place and the infection appears to be related to the operative procedure

*and*

involves deep soft tissues (e.g., fascial and muscle layers of the incision)

*and*

patient has at least one of the following:

- purulent drainage from the deep incision but not from the organ/space component of the surgical site

- b. 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 ( $>38^{\circ}\text{C}$ ), or localized pain or tenderness (a culture-negative finding does not meet this criterion)
- c. an abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination
- d. diagnosis of a deep incisional SSI by a surgeon or attending physician

An organ/space SSI must meet the following criteria:

infection occurs within 30 days after the operative procedure if no implant is left in place, or within one year if implant is in place and the infection appears to be related to the operative procedure

and

infection involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure

and

patient has at least one of the following:

- a. purulent drainage from a drain that is placed through a stab wound into the organ/space
- b. organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space
- c. 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
- d. diagnosis of an organ/space SSI by a surgeon or attending physician

Diagnosis of SSI related to clean orthopedic surgical procedures is a complex process, using clinical signs and symptoms, laboratory data, and radiologic findings and /or surgeon or medical officer confirmation or diagnosis.

The clinical presentation of infection is dependent on the properties of the infectious agent (i.e. innate virulence), the nature of host tissue at the site of infection, and the route of infection (locally introduced versus hematogenous spread from a distant site or bloodstream). Inflammatory signs may be variable. Typically, progressive joint pain is a patient complaint, with or without presence of a sinus tract (or tracts) with drainage.

A fulminant presentation is suggestive of infection with a virulent organism, such as *Staphylococcus aureus* or  $\beta$ -hemolytic streptococci. Less virulent, coagulase-negative *Staphylococcus*-related infections present a more delayed course.

Properties of affected tissue affect the clinical presentation due to their ability to support microbial growth. The ability of bacteria to flourish is enhanced in wound hematomas, fresh operative wounds, ischemic wounds, and the tissue of diabetic patients or those on long-term steroid therapy. Size of the infectious inoculum also affects the clinical presentation, with a larger inoculum producing a more toxic picture.

Joint pain is the principal symptom of deep tissue infection, regardless of the mode of presentation. It suggests either acute inflammation of periarticular tissue or loosening of the prosthesis as a result of subacute erosion of the bone at the bone-cement interface. Acute inflammation may present earlier in the postoperative course, while subacute erosion may be associated with later onset infections.

Clinical manifestations of joint pain, swelling, erythema, and warmth all reflect an underlying inflammatory process, but are not specific for infection.

If the presentation of pain at the joint includes fever or purulent drainage from the overlying cutaneous sinuses, infection may be presumed. More often, though, infection must be differentiated from aseptic and mechanical

problems, which are more common causes of pain and inflammation in orthopedic surgical patients. Constant pain or pain at night or rest is indicative of infection (or malignancy); pain of sudden onset that occurs with motion or weight bearing suggests another cause, such as prosthetic loosening. A history of postoperative hematoma or delayed wound healing suggests that joint pain is infection-related.

Laboratory findings of erythrocyte sedimentation rate (ESR) elevation beyond six months after surgery is suspicious for infection. Fulminant infection or infection with secondary bacteremia is more likely to result in the typical infection-related laboratory findings of elevated white blood cell count. Culture of joint aspirate is inconsistently predictive of infection. Barrack and Harris reviewed 270 cases in which aspiration of the hip joint was performed prior to revision surgery. They discovered 32 false-positive aspirations. Of six infected hips, only two aspirations were positive (there were four false-negative aspiration specimens).<sup>50</sup>

In summary, the incidence of orthopedic postoperative SSI varies by the type of surgery and may be influenced by both modifiable and non-modifiable risk factors. Understanding the risks associated with these infections will help the IP and all members of the healthcare team develop strategies to prevent postoperative infections in orthopedic surgeries.

# The Infection Prevention Program

An effective infection prevention program for orthopedic surgery has many components. Implementation of, and consistent adherence to, evidence-based practices to reduce the risk of SSI is key to success. However, it is important to conduct a thorough risk assessment and to collect and analyze surveillance data to drive improvements. Surveillance data can provide measurable results to evaluate the effectiveness of infection prevention interventions.

## The Risk Assessment

A risk assessment is a systematic evaluation for identifying risks in the healthcare setting. Infection Control assessment identifies risks for acquiring or transmitting infections, and includes strategies for prioritizing and mitigating those risks.

A risk assessment can be either quantitative or qualitative, and can include both process and outcome measures.

### Steps for Performing the Risk Assessment:

Create the risk assessment team, ensuring input from key support and clinical departments. The team should gather organizational information and set a timeline for assessment.<sup>51</sup> Current literature and past trends should be evaluated. Example: No less than annually and whenever new risks or procedures are identified.

#### *Questions to consider:*

What is the volume of orthopedic surgery?

What are the major procedures performed?

What is the frequency of infections in orthopedic surgery?

What are the major pathogens identified? What is the proportion of multiple drug-resistant organisms?

Are there any new procedures performed?

What is the frequency of readmissions related to postoperative SSIs in orthopedic surgery?

### Evaluation of Process Measures:

Are antibiotic prophylaxis criteria, including preoperative timing, antibiotic selection and postoperative duration, part of standing orders and pathways?

Are there standardized procedures for preoperative preparation of the skin that specify the appropriate antiseptic agent(s), and correct application?

Do patients and families receive instructions as to their preoperative, perioperative and post-discharge roles in prevention of SSIs?

Do healthcare workers and licensed independent practitioners receive education upon hire and annually related to prevention of SSIs?

### Risk Assessment Type and Template

#### *Example:*

Joan directs an infection prevention program in a mid-size community teaching hospital. She has collected data on total joint replacement surgeries using NHSN for the past two years.

Last year, 357 total hip replacements and 240 total knee replacements were performed at her facility. There were seven postoperative hip infections and one knee infection.

Of the seven postoperative hip infections, the pathogens isolated were:

- 5 methicillin-resistant *Staphylococcus aureus* (MRSA)
- 1 coagulase-negative *Staphylococcus*
- 1 methicillin-sensitive *Staphylococcus aureus* (MSSA)

The pathogen associated with the one postoperative total knee infection was also MSSA.

Of the seven hip infections and one knee infection in joint replacement surgery, there were five (5) deep or organ space infections that required surgical intervention. All five SSIs were hip replacements.

There are 10 orthopedic surgeons on staff, but the majority of total joint replacement procedures were performed by seven surgeons who each perform approximately 75-80 procedures annually. The infections are not attributable to a single surgeon and occur sporadically throughout the year.

Appropriate antibiotics are ordered 100% of the time. Timing demonstrates that 98% of patients receive antibiotics in the appropriate time frame. Only 88% of patients have antibiotics discontinued within the recommended 24 hours.

Joan and the team review current literature on prevention practices. A perioperative nurse from the orthopedic service is added to the team.

The risk assessment can be either qualitative or quantitative.

### Qualitative Risk Assessment:

The qualitative risk assessment uses an approach that assesses the risk based upon written descriptions. One example is described below:

#### Sample Gap Analysis – Total Hip Replacement

Areas/ Topic	Current Status	Goals	Identified Gap	Actions	Priority
SSIs in hip replacements	7 actual Infections versus 3.7 expected (NHSN)  SSI rates twice the mean in the first two risk categories  5 of the patients required further surgical intervention	Reduce SSIs in hip replacements by at least 30%  Improve adherence to discontinuing antibiotics within 24 hours to at least 95%	No standard order sets or pathways for discontinuing antibiotics  Knowledge deficits by nursing when IV infiltrates or is interrupted during immediate postoperative period  MRSA incidence increased from previous year  No standard protocols for addressing patients who may be colonized with MRSA preoperatively	Incorporate orthopedic prophylactic antibiotic protocols into order sets and pathways  Develop MRSA screening program for orthopedic surgery  Engage stakeholders to develop standard prep procedure	HIGH (rates have doubled since last year)
<i>(continued)</i>					

Areas/ Topic	Current Status	Goals	Identified Gap	Actions	Priority
			No standard perioperative prep procedure  No standardized practices for warming patients	Incorporate temperature management protocol using active warming, such as forced-air warming, to maintain patient normothermia including prewarming, intraoperative and post-operative warming.	

Source: Linda R. Greene, RN, MPS, Rochester General Hospital, Rochester, N.Y.

## Quantitative Risk Assessment

A quantitative risk assessment is one in which a number is assigned to specific pre-determined criteria.<sup>52</sup>

SSIs	Benchmark	High Risk	High Volume	National Initiative	Financial Initiative	Risk Rating
Hip replacement						

Template provided by Shannon Oriola, RN, COHN, CIC, Sharp Metropolitan Medical Center, San Diego, California.

Relative Risk 0-3

3 = High Risk

2 = Moderate Risk

1 = Minimal Risk

0 = No Risk

Score 10 or above = High priority

## Using the Tool

The following is a hypothetical example of how the tool may be used, based upon the information obtained in the risk assessment example described above:

1. **Benchmark** – Rates of SSIs in hip replacement surgery are above the NHSN mean, but not by a statistically significant difference. This was considered a moderate risk. Risk score = 2
2. **High Risk** procedure or activity – Patients who develop SSIs may require removal of the prosthesis. Only 88% of patients have antibiotics discontinued within the recommended 24 hours, and there is a high proportion of MRSA in patients who develop an SSI. This was considered high risk. Risk score = 3
3. **High Volume** – Hip replacements are a high-volume procedure in this organization. It is the third highest volume procedure performed, and therefore was identified as a high risk. Risk score = 3
4. **Potential Negative Outcome** – SSIs in hip replacements are associated with increased morbidity, mortality and length of stay. Five patients last year developed deep or organ space infections requiring surgical intervention. Risk score = 3

5. **National Initiative** – At the time of the risk assessment, there is not a national initiative associated with outcome measures in orthopedic surgery. Risk score = 0
6. **Financial Incentive** – The cases involved an average of 7-10 days increased length of stay and an excess average cost per case of \$ 32,000. Risk score = 3

SSIs	Benchmark	High Risk	High Volume	Potential Negative Outcome	National Initiative	Financial Initiative	Risk Rating
Hip Replacement	2	3	3	3	0	3	14

## Evaluation

Since this procedure is above the 10-point risk priority ranking, it will be part of the annual infection prevention plan. It is important to set goals and expectations as well as strategies for achieving the goals.

### Set Goals and Expectations

Reduce SSI in total hip replacements by at least 30%.

Improve adherence to discontinuing antibiotics within 24 hours to at least 95%.

### Actions

Develop MRSA screening program for orthopedic surgery.

Engage stakeholders to develop standard prep procedure.

Incorporate orthopedic prophylactic antibiotic protocols into order sets and pathways.

The above risk assessments use NHSN surveillance criteria. Organizations that do not use NHSN may use overall data collected from surveillance activities. As an alternative, if no surveillance data exists, administrative data may be utilized to assist in case findings. This data cannot be compared to NHSN means, but may be helpful to assist in determining the overall scope of the issues. Likewise, microbiology data may be helpful in determining pathogen frequency and occurrence.

# Surveillance

Surveillance is a systemic and ongoing method of data collection, presentation and analysis, which is then followed by dissemination of that information to those who can improve the outcome.

In a healthcare setting, information obtained from surveillance of HAIs can be extremely important in the context of continuous quality improvement as objective data is used to improve patient outcomes.

Surveillance helps to:

- determine baseline rates of adverse events (including HAIs);
- detect changes in the rates or distribution of these events;
- facilitate investigation of significantly increased rates of infection;
- determine the effectiveness of infection prevention and control measures;
- monitor compliance with established hospital practices;
- evaluate changes in practice;
- identify areas where research would be beneficial.

There are many factors to consider when designing an orthopedic surgery surveillance program. The first steps are defining the population at risk and determining the resources available. For example, based upon the risk assessment, consider whether all orthopedic surgeries will be monitored or if just selected procedures such as total hip surgeries or total knee surgeries will be followed. Often, if opportunities for improvement are identified in one procedure, such as total hip replacements, then process improvement activities that are identified can be applied to the service as a whole. Criteria used to conduct surveillance must remain consistent.

## Case Finding Methodology

The case finding methodology may depend on what resources are available and may include:

1. wound culture reports
2. operating room reports
3. admission and readmission diagnosis
4. antibiotic lists
5. administrative data; coding data associated with infection codes
6. medical record reviews
7. data obtained from healthcare providers, i.e., surgeon or nursing reports
8. post-discharge surveillance data

## Surgical Surveillance

- The numerator for the rate calculation is the number of SSI events.
- The denominator for the rate calculation is the number of surgical cases during that same time frame.



### SSI Surveillance Denominator

A count of the specific surgical procedures performed per month is necessary to calculate the SSI rate in a facility. Electronic medical record documentation and operating room records can generally provide a report of the number of patients each month. If this is not available, a manual count must be done of the number of patients undergoing the specific surgical procedure.

### SSI Surveillance Numerator

All patients having a selected procedure are monitored for signs of SSI. This surveillance can be done prospectively and retrospectively at the time that criteria is reviewed and evaluated.

### SSI Surveillance Methods

The primary methods for determining a baseline rate of SSI is to utilize the NHSN methodology and definitions for SSI. By using NHSN methodology to determine the rate of SSI, cases are risk-stratified by the type of surgery and are also compared to the rates of participating NHSN hospitals.

### NHSN Denominator Data

A description of the NHSN surgical component can be accessed at: [www.cdc.gov/nhsn/PDFs/pscManual/9pscSSIcurrent.pdf](http://www.cdc.gov/nhsn/PDFs/pscManual/9pscSSIcurrent.pdf)

The following provides a brief description:

An NHSN procedure is one which:

- is performed on a patient who is an NHSN inpatient or an NHSN outpatient
- takes place during an operation where a surgeon makes at least one incision through the skin or mucous membrane, including laparoscopic approach, and closes the incision before the patient leaves the operating room
- includes one of the NHSN procedure categories:

Example of select orthopedic operative procedure categories:

Procedure	Description	ICD 9 codes
Knee prosthesis	Arthroplasty of knee	00.80-00.84, 81.54, 81.55
Hip prosthesis	Arthroplasty of hip	00.70-00.73, 00.85-00.87, 81.51, 81.53
Open reduction of fracture	Open reduction of fracture or dislocation of long bones that requires internal or external fixation; does not include placement of joint prosthesis	79.21, 79.22, 79.25, 79.26, 79.31, 79.32, 79.35, 79.36, 79.51, 79.52, 79.55, 79.56

Specific denominator information for the operative procedure includes demographic and procedure information, such as patient identifier, date of birth, date of procedure, procedure code or ICD 9 code, surgical wound class, length of time for surgical procedure, ASA score, trauma, emergency or elective case.

NHSN surgical methodology is:

- active
- patient-based
- prospective

- retrospective
- priority-directed
- risk-adjusted, incidence rates

NHSN Risk Stratification:

The index used in NHSN assigns surgical patients into categories based on the presence of three major risk factors:

1. Operation lasting more than the duration of cut point hours, where the duration cut point is the approximate 75th percentile of the duration of surgery in minutes for the operative procedure, rounded to the nearest whole number of hours.
2. Contaminated (Class 3) or Dirty/infected (Class 4) wound class.
3. ASA classification of 3, 4, or 5.

The patient's SSI risk category is simply the number of these factors present at the time of the operation.

The collection of infection data should be overseen by a trained or certified IP and/or by an infectious disease physician. The IP shall seek out infections during the patient's stay by screening various data sources (i.e. micro reports, patient records, clinical notes, etc.).

As NHSN methodology requires that surveillance for SSIs is done for up to 30 days following the procedure, and up to one year for surgeries involving implantables, post-discharge surveillance is needed.

## Orthopedic SSI Worksheet

Procedure \_\_\_\_\_  
Patient name \_\_\_\_\_ Medical record or ID \_\_\_\_\_  
Type of infection? Superficial \_\_\_\_\_ Deep \_\_\_\_\_ Organ space \_\_\_\_\_  
Radiological evidence of infection \_\_\_\_\_  
Date of surgery \_\_\_\_\_ Surgeon \_\_\_\_\_  
Purulent drainage? Yes/No. Antibiotic therapy? Yes/No. Antibiotic \_\_\_\_\_  
Pain \_\_\_\_\_ Redness \_\_\_\_\_ Other symptoms \_\_\_\_\_  
Type of implant if applicable \_\_\_\_\_ Blood loss \_\_\_\_\_ Transfusion? Yes/No.  
Date of infection \_\_\_\_\_ Date of admission to hospital \_\_\_\_\_  
Culture data # 1 date \_\_\_\_\_ Pathogen \_\_\_\_\_ Other culture data \_\_\_\_\_  
Date of readmission if applicable \_\_\_\_\_ Readmission diagnosis \_\_\_\_\_  
Opened at bedside or I and D by surgeon \_\_\_\_\_  
Return to surgery? Yes/No. Date \_\_\_\_\_  
Physician diagnosis of SSI? Yes/No.  
If yes, by whom: Surgeon Medical Attending Hospitalist ED Physician Other  
Notes \_\_\_\_\_

Medical history \_\_\_\_\_ History of MDRO \_\_\_\_\_  
 Diabetes? Yes/No. Smoker? Yes/No. BMI \_\_\_\_\_ Other risk factors \_\_\_\_\_  
 Drains (list) \_\_\_\_\_

**Process measures:**

Preoperative antibiotic \_\_\_\_\_ Dose \_\_\_\_\_  
 Administered within 1 hour (2 hours for vancomycin) Y \_\_\_\_\_ N \_\_\_\_\_  
 Time \_\_\_\_\_  
 Tourniquet time (if applicable) \_\_\_\_\_  
 If not on time: Not documented \_\_\_\_\_ Early \_\_\_\_\_ Late \_\_\_\_\_  
 Antibiotic discontinued within 24 hours? Yes/No. If no, why? \_\_\_\_\_  
 Pre-op shower or skin cleaner: identify \_\_\_\_\_  
 Hair removal Yes/No. If yes, clip? Yes/No.  
 Postoperative temperature Greater than or = to 36 degrees C \_\_\_\_\_  
 Documentation of patient education on SSI prevention? Yes/No.  
 Identified opportunities for improvement \_\_\_\_\_

Worksheet provided by L.Greene RN, MPS,CIC and M. Vignari, RN,CIC Rochester General Hospital Rochester, NY

**Electronic Surveillance**

Although it is beyond the intent of this guide to discuss electronic surveillance or data mining, a number of facilities rely heavily on these systems to assist in case findings. These systems have the ability to pull essential clinical information for individual patients from hospital data sources throughout the facility. A number of commercial and facility programs interface with a pharmacy database to track antibiotic usage as well.<sup>53</sup> Some commercial programs have the capability to allow the IP to upload denominator and numerator data into NHSN.

NHSN requires that surgical denominator data as well as numerator data be entered into the database to allow for appropriate risk adjustment. The NHSN will allow importation of procedure data in an ASCII comma delimited text file format. The reports can be obtained from different external sources, such as databases or hospital information systems, and imported into NHSN. Steps are described in NHSN and can be accessed at: [www.cdc.gov/nhsn/PDFs/ImportingProcedureData\\_current.pdf](http://www.cdc.gov/nhsn/PDFs/ImportingProcedureData_current.pdf).

**Data Collection**

Criteria used to define the outcome should reflect generally accepted definitions. The best way to determine whether an infection has occurred is to use NHSN criteria, regardless of whether the facility participates in NHSN reporting. This methodology is widely accepted as the gold standard for surveillance and is validated and reliable. NHSN definitions were discussed in a previous section. It is important that strict adherence to definitions be followed, especially when data is used for public reporting purposes in order to ensure consistency across organizations. Additional clinical findings may be appropriate for care and treatment decisions but are not appropriate for surveillance purposes due to variations among healthcare providers and organizations.

## Post-discharge Surveillance

There is no gold standard for post-discharge surveillance. Most cases of healthcare-associated SSIs appear after discharge from the hospital. Rates of post-discharge SSI between 2% and 14% have been reported in a number of articles suggesting that organizations with active post-discharge surveillance systems will report higher rates of infection. The 2009 New York State Report for Hospital-Acquired Infections notes that post-discharge surveillance rates are highly variable and are dependent upon resources, technology, and the time frame in which data is collected.

Since most deep and organ space infections require readmission, the 2009 state report does not include any infections detected by post-discharge surveillance that do not require readmission to a hospital. They note that this issue needs further evaluation.<sup>54</sup> Platt described automated surveillance methods based on pharmacy and financial claims data and reported that they are more sensitive for detection of post-discharge SSI.<sup>55</sup> Prospero et al. concluded that certain procedures, such as breast surgery, hernia repair and other endocrine surgery may be at higher risk for post-discharge SSI, and that post-discharge surveillance should be targeted at specific procedures.<sup>56</sup> One major challenge relates to free-standing ASCs and the new CMS requirements. With increasing numbers of orthopedic procedures performed in ASCs, the new CMS requirement to “identify infections” means that all ASCs must implement a working surveillance system for SSIs if one is not already in place. Such surveillance in ASC facilities, by definition, means post-discharge surveillance.

Methods utilized by facilities include:

1. line lists of patients undergoing surgical procedures who are sent to respective surgeons and returned on a regular basis (usually monthly)
2. follow-up phone calls to patients
3. outpatient culture reports
4. readmission data to hospital or to another hospital
5. self reporting by surgeons
6. outpatient reports of antibiotic usage data

### Example: Surgeon Post-discharge List

**Month:** January 2010

**Surgeon:** John Smith

Name	DOB	Procedure	Procedure date	Infection Y/ N	Antibiotic Y/N (list)	Comment
Doe, John	12/11/54	Total knee	1/4/10			

*Please complete last three columns.*

*Return to Infection Prevention Department, Rosewood General Hospital.*

*Example: Phone call to patient*

**Instructions:**

The hospital call center will contact the patient between the hours of 11 a.m. and 7 p.m. A phone call is made 30 days after surgery. Three attempts will be made to contact the patient.

**Patient Name:** Jane Doe

**MR:** 111111

**Date of Surgery:** 01/25/10

**Procedure:** Laminectomy

Phone Number : (xxx) xxx-xxxx

1. Have you followed up with your doctor?
2. Has he or she prescribed any antibiotics for you? If so, what was the reason for the antibiotics?
3. Did you have any drainage from the incision?
4. Describe the drainage.
5. Any pain or redness? Fever?
6. Were you admitted to the hospital or any other hospital since your last surgery? If so, why?
7. Did your surgeon open or drain your incision in his office?

*Patient: Return to Infection Prevention Department.*

*Infection Prevention Department: Evidence of purulent drainage, antibiotics to treat suspected infection, deliberate opening of wound, or readmission to another hospital with complications of surgery will require follow-up with surgeon.*

Infection Prevention Department to Complete:

Meets criteria: Y N

If yes, complete postoperative case report.

# Outcome Reports

## Infection Rate

The numerator (the number of SSIs) and the denominator (the total number of procedures performed) should be calculated on a routine basis and expressed as a percentage by x number of procedures. It is important that the numerator includes all cases performed in a given timeframe and the denominator includes all cases in that same time frame. The surgery date, rather than the infection date, is used for the numerator data. Although some organizations continue to calculate rates based on degree of wound contamination (all class 1) or by service, the most accurate data is SSI calculated by procedure type.

Example:

There were 104 total knee replacements performed in January; 160 in February; 120 in March; and 118 in April. There was one SSI in knee replacement surgery identified during those four months. The case is described below:

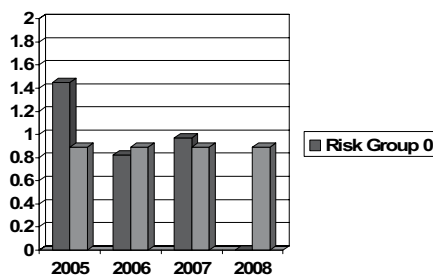
Mrs. X was admitted on April 15 with fever and purulent drainage from her knee. Her original surgery was performed on January 16. Radiological results show a collection of fluid around the prosthesis and a possible abscess. The surgeon has documented that she has a postoperative infection and she is taken to surgery for debridement and removal of her prosthesis on April 17. In this example, the monthly SSI rate would be calculated as follows:

## Knee Replacements

Month (2010)	Number of surgeries performed	Number of infections	Rate
January	104	1*	1%
February	160	0	0
March	120	0	0
April	118	0	0

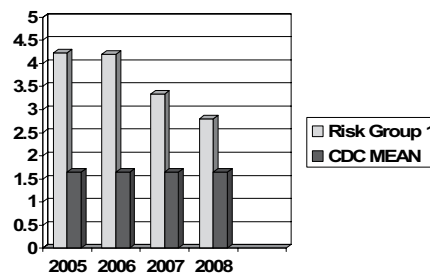
\* Although the infection was identified in April, the surgery was performed in January.

Total Hip Replacement SSI by Year Risk group 0



Risk group zero means that patient had No comorbidities that would put them at increased risk of infection

SSI Total Hip Replacement risk Group 1



Risk Group 1 denotes that patient had one or more comorbidities or excess time in surgery

Figure 2

## Standardized Infection Ratio (SIR)

This indirect standardization method accounts for differences in the risk of SSIs among a group of procedures.<sup>57</sup>

An SIR is the number of observed infections divided by the number of predicted infections. The expected number is based on the national average, the number of procedures performed by a hospital, and historical data for those procedures. This method is helpful when small numerators and denominators are present.<sup>58</sup>

- An SIR of **1.0** means the observed number of infections is equal to the number of expected infections.
- An SIR **above 1.0** means that the infection rate is higher than that found in the “standard population.” For HAI reports, the standard population comes from data reported by the hundreds of U.S. hospitals that use the NHSN system. The difference above 1.0 is the percentage by which the infection rate exceeds that of the standard population.
- An SIR **below 1.0** means the infection rate is lower than that of the standard population. The difference below 1.0 is the percentage by which the infection rate is lower than that experienced by the standard population.

Example: Total Hip Replacement

Year	Number of infections	Number of infections expected	SIR calculation
2007	7	3.74	$7/3.74 = 1.87$
2008	6	3.7	$6/3.70 = 1.49$
2009	1	3.8	$1/3.80 = 0.26$

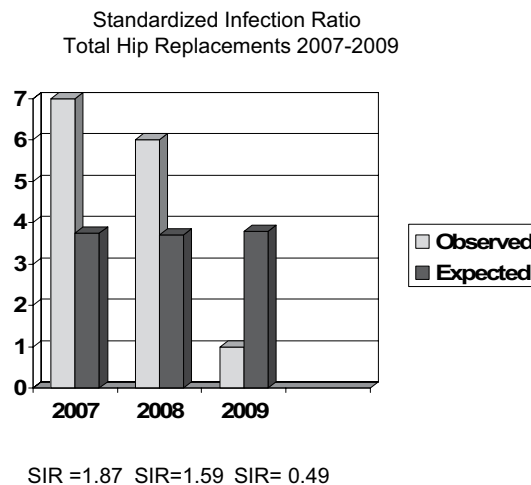


Figure 3

## Disseminating Data

One of the most important aspects of surveillance data is the analysis and dissemination of data. Line lists are helpful in providing nursing staff, surgeons and other members of the healthcare team with valuable information. Case information should be disseminated as soon as possible to allow for case reviews. Many organizations post infection rates in prominent areas. One method of displaying data is to calculate the number of cases between infections. Although this method is not useful for inter-hospital comparisons, it provides a useful tool, which is easily understandable by staff. Goals can be set based upon the volume of cases. Process control charts, bar charts and other visual feedback provide methods to display data.

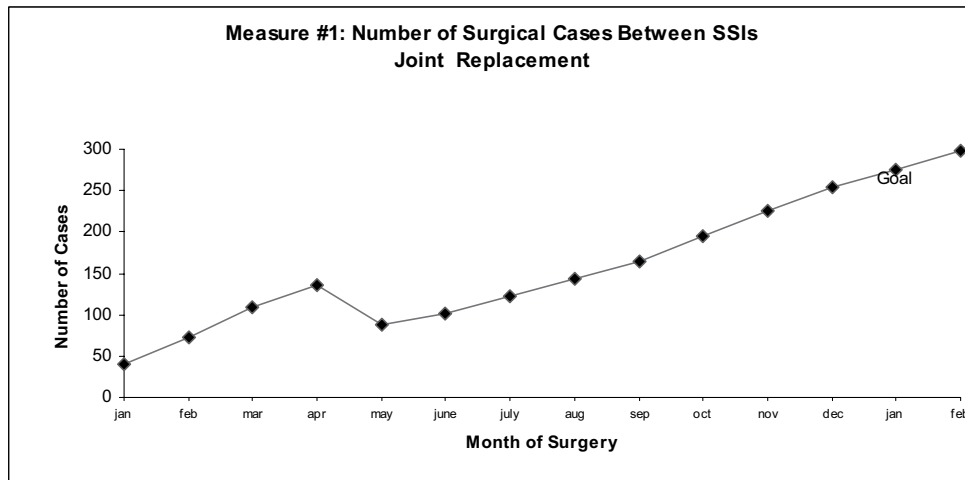


Figure 4



# Surgical Care Improvement Project (SCIP) & CMS Value-Based Purchasing

In 2006 in the U.S., SCIP was launched as a national initiative to reduce postoperative morbidity and mortality by 25% by the year 2010. SCIP is a national partnership of organizations committed to improving the safety of surgical care through the reduction of postoperative complications. Initiated by CMS and the CDC, the SCIP partnership is coordinated through a steering committee of 10 national organizations. More than 20 organizations provide expertise to the steering committee through a technical expert panel. The project's steering committee is composed of members from the following national organizations:

- Agency for Healthcare Research and Quality
- American College of Surgeons
- American Hospital Association
- American Society of Anesthesiologists
- Association of periOperative Registered Nurses
- Centers for Disease Control and Prevention
- Centers for Medicare & Medicaid Services
- Department of Veterans Affairs
- Institute for Healthcare Improvement
- The Joint Commission on

The SCIP was initially composed of four prevention modules: infection, venous thromboembolism (VTE), cardiac and respiratory. The infection prevention component addressed six separate core measures, including delivery of prophylactic antibiotic within one hour prior to incision, appropriate prophylactic antibiotic selection, antibiotic discontinuation within 24 hours post-op (cardiac surgery was given a 48-hour window), glycemic control in cardiac patients (measured by controlled 6 a.m. postoperative serum glucose), appropriate hair removal and normothermia. In order to meet the current CMS Normothermia Measure (SCIP-Infection-10), active warming must be used intraoperatively or achieve the target temperature of  $\geq 36^{\circ}\text{C}$  within 30 minutes before or 15 minutes immediately after anesthesia end time. This measure applies to all acute care surgical patients, regardless of age, undergoing general or neuraxial anesthesia for 60 minutes or longer.<sup>59</sup>

## 1. Specifications Manual for National Hospital

CMS is continuing to implemented incentives for acute care hospitals to collect and report levels of adherence with SCIP measures. In 2011 CMS will encourage hospitals to report certain HAI events, i.e. CLABSI as part of their Hospital Inpatient Quality Reporting Program (formerly Reporting Quality Data for Annual Payment Update (RQDAPU) Facilities that choose not to report select events would accept a 2% reduction in reimbursement by CMS. In 2012 this incentive will include SSIs following select procedures. The roster of procedures remains in development but may include certain orthopedic procedures. Prior to the SCIP initiative, the antibiotic measures were part of the Surgical Infection Prevention (SIP) initiative; they have long been thought to be the cornerstone of good surgical infection prevention.

However, a recent investigation using a retrospective analysis of 405,720 patients from 398 hospitals failed to document an association between adherence to selective SCIP process measures and occurrence of postoperative SSIs. Furthermore, the authors documented an increase in SSIs, despite an improvement in SCIP compliance over a two-year study period.<sup>60</sup> However; adherence measured through an “all-or-none” composite infection prevention score was associated with a lower probability of developing a postoperative infection. This would suggest that the complexity of the surgical procedure requires a comprehensive team-based approach that is inclusive but not limited to a few process measures. Of note, this investigation used claims/administrative data to define SSI. Claims data is not as precise as epidemiologic criteria such as that used by NHSN or NSQIP. Therefore one remaining question is whether in significant reduction in SSI rates using epidemiologic SSI criteria.

The following strategies are examples of methods to increase compliance to antibiotic prophylaxis:

1. provide visual reminders, checklists, and antibiotic prophylaxis as part of the “time out.” A study by Wax et al. demonstrated very high rates of compliance when a visual electronic interactive reminder was added to the anesthesia electronic record.<sup>61</sup>
2. incorporate documentation of prophylaxis into electronic documentation forced field functions.
3. incorporate antibiotic selection and duration into order sets and pathways.
4. provide feedback to care providers, on both an individual and overall aggregate level.

**Examples of Feedback:**



September 5, 2010

\_\_\_\_\_, M.D.  
 Anesthesiology Service Medical Group  
 3626 Ruffin Road  
 San Diego, CA 92123

Dear Dr. \_\_\_\_\_,

The Medical Executive Committee has requested that the Infection Prevention Department monitor the administration of preoperative prophylactic antibiotics for total hip/knee arthroplasty procedures and provide feedback to surgeons and anesthesiologists should our department identify missed opportunities for the optimal use of prophylactic antibiotics.

Enclosed is a copy of the Anesthesia Record (MR# \_\_\_\_\_) and Visit #(\_\_\_\_\_) that documents the administration of cefazolin 2 grams at 0804 with the operative procedure start time of 0851 and completed at 1242.

Generally, if an operative procedure exceeds the half-life of the antibiotic, then a repeat dose is given. The half live of cefazolin is 3-4 hours; therefore, a repeat dose before 1204 would have been ideal. It is the time that the antibiotic is initially given and not the incision time that determines when the antibiotic is redosed.

Thank you for your attention to this matter. We appreciate your efforts to further minimize the risk of post-operative surgical site infections.

Sincerely,

Hospital Epidemiologist

Example provided by Shannon Oriola , RN, COHN, CIC Sharp Memorial Hospital, San Diego, California.

Providing individuals with feedback related to process measures is an important component. The following example provides process measure feedback:



July 19, 2010

Doctor  
Address  
San Diego, CA

Dear Dr. xxx :

The Peer Review Oversight Committee of the Medical Executive Committee has requested that the Infection Prevention Unit produce annual surgeon-specific data on adherence to the recommended choice of pre-operative prophylactic antibiotic and to duration of antibiotic administration for designated surgical procedures. This information will be reviewed as part of the re-credentialing process. Optimal use of prophylactic antibiotics decreases the risk of post-operative surgical site infections<sup>1,2</sup>. Infection Prevention is reporting data on hip and knee arthroplasties performed between January 1, 2009 and December 31, 2009.

For this report, the choice of cefazolin, clindamycin or vancomycin was considered appropriate and the presence or absence of allergies was not considered.

Listed below are your rates (number of cases adhering to guidelines/total number of opportunities) and compared to the rates for 2009 SMH surgeons performing these procedures.

Quality Measure	Your Rates 2008	Your Rates 2009	SMH Surgeons 2009
ABX Choice			99.8% 617/618
Duration ≤ 24hrs			99.7% 616/618
Preop Nasal Screening			98.5% 609/618

Surgeon specific information: [cases that feel out]

The following are accepted guidelines:

For initial preoperative prophylaxis:

- Infuse cefazolin 2 grams within 1 hour of the incision.
- For cephalosporin allergic individuals, those with type I hypersensitivity reactions to penicillin, or those colonized with MRSA, use vancomycin 15mg/kg given over 60– 90 minutes and within 2 hours of incision.
- For patients allergic to cephalosporins and vancomycin, use clindamycin 600mgs infused within 1 hour of incision.

If the procedure is longer than 3-4 hours after initial antibiotic infusion, NOT incision, 1-2 grams of cefazolin, or for allergic individuals, 600mgs of clindamycin is recommended.

The duration of prophylaxis should be ≤ 24 hours from initial dose.

Thank you for your cooperation. If you need clarification, please contact us at [raymond.chinn@sharp.com](mailto:raymond.chinn@sharp.com) or [judith.vargo@sharp.com](mailto:judith.vargo@sharp.com).

Sincerely,

Robert Tonks, M.D.  
Chief, Orthopedic Supervisory Committee

Raymond Chinn, MD  
Hospital Epidemiologist

cc: Peer Review Oversight Committee

<sup>1</sup> Classen DC, Evans RS, Pestotnik SL, Menlove RL and Burke JP, The Timing of Prophylactic Administration of Antibiotic and the Risk of Surgical-Wound Infection. NEJM 326:281-286  
<sup>2</sup> Bratzler DW, Houck PM. Antimicrobial Prophylaxis for Surgery: An Advisory Statement from the National Surgical Infection Prevention Project. Clin Infect Dis June 15, 2004;38:1706-1715

Figure 5

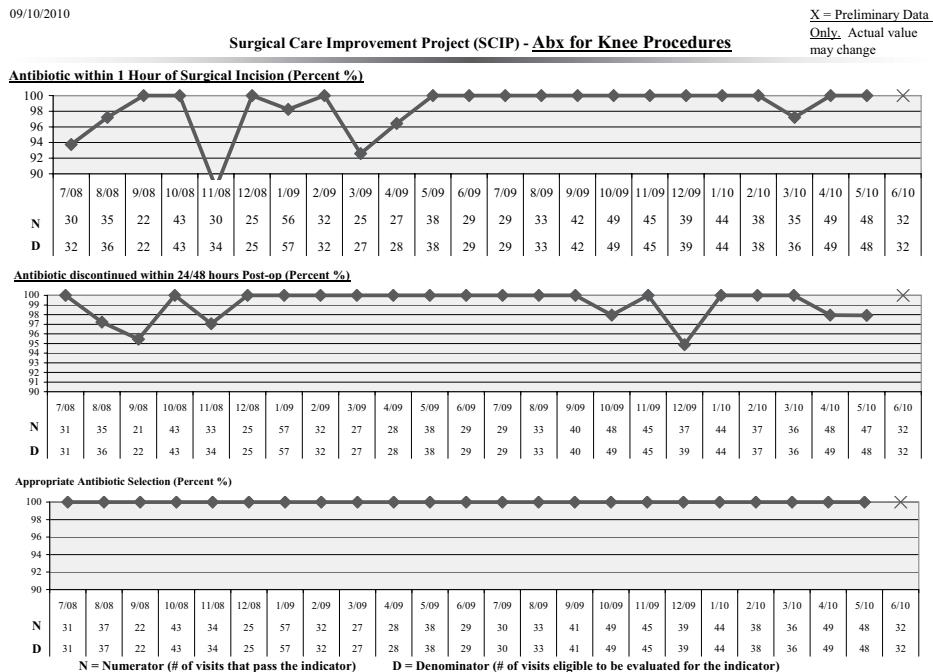


Figure 6

## Hair removal

Preoperative shaving of the surgical site the night before an operation is associated with a significantly higher SSI risk than other methods of hair removal or no hair removal at all.<sup>62</sup> The increased SSI risk associated with shaving has been attributed to microscopic cuts in the skin that provide a portal of entry for bacteria and a focus for bacterial multiplication. The hair removal methodology should be reviewed with the perioperative staff. The timing of the hair removal and the removal with the use of clippers versus razors are important processes. If hair is removed, it should be as close to the incision as possible. One of the most effective strategies is to remove razors from the OR. In many cases, no hair removal is needed. However, the decision to remove surgical site hair should include consideration of the potential for access to the surgical site and the field of view. Female patients who are undergoing knee replacements, hip replacements or other lower leg surgeries should be instructed not to shave their legs prior to surgery for the reason described above.

## Perioperative Normothermia

Several studies specifically address the importance of normothermia in orthopedic surgery. Perioperative hypothermia is physiologically stressful because it elevates blood pressure, heart rate and plasma catecholamine concentration, which may increase the risk of cardiac complications, bleeding, wound infection, and post-anesthesia care unit stay.<sup>63</sup> In the OR, surgical patients are exposed to factors that may alter their thermoregulatory mechanism, leading to postoperative hypothermia. These factors may include cold OR rooms, IV fluids, skin preparations and various forms of anesthesia. One randomized control study of total knee replacements found that forced air warming was more effective than cotton or reflective blankets for preventing hypothermia.<sup>64</sup> Other studies have concluded that active warming is beneficial, does not increase contamination, and decreases the potential for postoperative infections.<sup>65</sup> Studies of the impact of hypothermia on the incidence of wound infection have shown that the hypothermic patient is at an appreciably greater risk for wound infection than a normothermic patient.<sup>66</sup> Intraoperative hypothermia triggers thermoregulatory vasoconstriction, decreasing the partial pressure of oxygen in the tissues, thereby lowering resistance to infection. A reduction in core temperature of 1.9°C has been shown to triple the incidence of surgical wound infections after colon resection and to increase length of hospital stays.<sup>67</sup> A number of organizations have standing protocols for active warming of patients whose core temperature is at or below 36 degrees Centigrade.

## Global Initiatives

The World Health Organization (WHO) has undertaken several initiatives aimed at safe surgical care. International experts around the world convened to review the literature on patient safety and to identify key areas for improvement. One of WHO's major initiatives focused on improved surgical safety by reducing surgical deaths and complications during surgery in four ways:<sup>68</sup>

- by providing information on the role and patterns of surgical safety in public health to clinicians, hospital administrators and public health officials;
- by defining a minimum set of uniform measures, or “surgical vital statistics,” for national and international surveillance of surgical care;
- by identifying a simple set of surgical safety standards that are applicable in all countries and settings and are compiled in a checklist for use in operating rooms;
- by initially evaluating and disseminating the checklist and surveillance measures at pilot sites in every WHO region, and then to hospitals worldwide

# Preoperative Preparation

Patients who undergo elective surgery should ideally enter the hospital on the day of surgery. Patients who have a prolonged length of stay prior to surgery will be at greater risk for infection due to the likelihood of exposure to infectious organisms, including resistant pathogens, and possible use of invasive devices prior to surgery.

In the preoperative setting, it is important to evaluate patients for medical conditions, encourage them to stop smoking, and instruct them not to shave near the surgical site prior to surgery. Instruction sheets and videos may be useful.

**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:








Figure 7

## Preoperative Skin Preparation

The goal of preoperative preparation of the patient's skin is to reduce the risk of postoperative SSI by removing soil and transient microorganisms from the skin; reduce the resident microbial count to subpathogenic levels in a short period of time, with the least amount of tissue irritation; and inhibit rapid, rebound growth of microorganisms.

The 1999 Hospital Infection Control Practices Advisory Committee (HICPAC) guidelines for prevention of SSIs recommend that patients be required to shower or bathe with an antiseptic agent at least the night before the operative day.<sup>69,70</sup>

A systematic review of the evidence for preoperative bathing or showering with antiseptics for prevention of an SSI was conducted.<sup>71</sup> A total of six randomized controlled trials were included in the review. Chlorhexidine gluconate (CHG) 4% solution was compared to a placebo, to unmedicated soap, or to nothing (no wash), administered at various times preoperatively to all types of patients undergoing all types of surgeries. In two studies, washing was performed after hospital admission. In the other four studies, it was not clear if the antiseptic washes were administered at home or in the hospital. Compared to a placebo or soap, washing with CHG did not result in a reduction in SSI. Results were mixed when comparing CHG to no wash. One study found that the CHG wash, when compared to no wash, resulted in a statistically significant reduction in the number of patients with a SSI. Conversely, another study found no difference in the SSI rate between patients who washed with CHG and those who did not wash preoperatively. Finally, in one study, total body washing showed a statistically significant reduction in SSI compared with partial body wash. The authors concluded that there is no clear evidence to support the practice of preoperative showering or bathing with CHG.

Preoperative showering with agents such as CHG has been shown to reduce bacterial colonization of the skin, despite the fact that the evidence is inconclusive as to its link to prevention of SSIs. The act of washing and rinsing removes microorganisms from the skin. Some organisms may be difficult or impossible to kill with the application of CHG alone. *Staphylococcus aureus* is the most common organism causing SSIs and, in 2004, 63% of HAIs were from methicillin-resistant *Staphylococcus aureus*.<sup>72</sup> Many SSIs result from colonization of the surgical site with the patient's own flora, and colonization with *Staphylococcus aureus* is a known risk factor for SSIs.<sup>73</sup> Clinical trials support the use of preoperative antiseptic showers to reduce the number of microorganisms on the skin, including *Staphylococcus aureus*. However, to gain maximum antiseptic effect, it must be allowed to dry completely and not be washed off.<sup>74</sup>

A rinse-free cloth has been introduced as an alternative to CHG showers, and some data suggests ease of use and improved patient compliance as well as reduced rates of SSI.<sup>75</sup> One advantage of the cloth is that CHG is allowed to remain on the skin rather than being washed off. Edminston et al. compared the 2% CHG-impregnated cloth with 4% CHG as topical antiseptic for preparation of the skin prior to surgery, noting greater microbial reductions with the 2% cloth.<sup>76</sup> Further studies are needed to better evaluate the effectiveness of the rinse-free cloth in preventing SSIs.

One strategy to ensure compliance to organizational protocols is a comprehensive tool kit that includes interventions, references, product order information and patient education tools.

See appendix for sample policies

## Nasal Decolonization

SSIs continue to be an important complication of orthopedic surgery. *Staphylococcus aureus*, particularly MRSA, remains a significant pathogen in postoperative orthopedic SSIs. A 2000 study that reviewed multiple risk factors

for SSIs following orthopedic surgery identified *Staphylococcus aureus* as the most important and independent risk factor for developing a postoperative infection.<sup>77</sup> An article published in the *New England Journal of Medicine* by Perl and colleagues studied whether preoperative intranasal application of mupirocin ointment would decrease the rate of infections at surgical sites. Results of this randomized control study concluded that use of mupirocin did decrease *Staphylococcus aureus* HAIs but not necessarily SSIs. However, authors suggested that the use of mupirocin was safe and cost-effective for patients with *Staphylococcus aureus* carriage.<sup>78</sup> A recently produced expert guidance document indicated that the role of decolonization therapy to prevent SSIs remains an unresolved issue.<sup>79</sup>

A recent publication by Lee et al. used a computerized model to evaluate the cost-effectiveness of routine preoperative screening and decolonization of orthopedic surgery patients who were colonized with MRSA. They concluded that this routine preoperative screening and decolonization of orthopedic surgery patients may save hospitals and third-party payers money while reducing postoperative infections, even in populations where there is low prevalence of MRSA.<sup>80</sup> A number of organizations report that they routinely screen for MRSA preoperatively and decolonize patients who carry MRSA, using mupirocin nasal ointment. Although organizations may vary in their approaches, it is important that protocols and strategies be standardized. Including these protocols in order sets and pathways is one method of standardization. Most recently Bode and others found that preoperative screening for *S. aureus* and then cleansing with CHG and intranasal mupirocin were effective in preventing SSI. This investigation did include patients undergoing orthopedic procedures. [see Bode LG, et al. *NEJM* 2010;362:9-17] One of the concerns with the use of intranasal mupirocin ointment, because it is an antibiotic, is development of resistance. Mupirocin resistance has been documented.<sup>81</sup> Protocols for decolonization in the home or outpatient setting may also be appropriate.

See appendix for sample protocol



# The Perioperative Setting

The term “perioperative” encompasses the entire continuum of care for a patient undergoing an elective invasive procedure. While prevention of infection is the goal for all surgical patients, it is a primary concern for orthopedic surgery patients.<sup>82</sup> One of the expected outcomes for surgical intervention is that the patient is free from signs and symptoms of infection, such as pain, foul odor, purulent drainage, and/or fever through 30 days following the procedure.<sup>83</sup> Throughout the patient’s perioperative journey, infection prevention requires the application of the principles of microbiology and aseptic practice,<sup>84</sup> as well as effective teamwork.

## Preoperative Period

There are several aspects of care that reduce the risk for the development of an SSI in the preoperative period. As noted above, it is important to preoperatively evaluate patients for pre-existing medical conditions. A thorough assessment of the patient’s susceptibility and risk factors for infection is a key nursing activity in the preoperative period. This assessment should include identification of the patient’s specific risk factors, such as health problems and situations predisposing the patient to infection by:<sup>85</sup>

- identifying pathophysiological risk factors, including, but not limited to, altered gastrointestinal system; anatomic abnormality; autoimmune diseases; blood dyscrasias; chronic diseases; immunodeficiency disorders; impaired circulation; periodontal disease; obesity; sleep deprivation
- identifying treatment-related risk factors, including, but not limited to, chemotherapy; dialysis; medications (i.e., antacids, antibiotics, antifungal agents, antiviral agents, immunosuppressants, steroids); organ transplants; presence of implants; presence of invasive lines; radiation therapy; recent blood transfusions; surgery
- identifying personal and environmental risk factors, such as bites; exposure to contagious agents (healthcare-associated or community-acquired); history of infections; lack of immunizations; personal hygiene factors; malnutrition; moist skin areas; prolonged immobility; smoking; stress; thermal injuries; trauma
- identifying patients at high risk for transmitting HAIs, e.g., persons with antibiotic- or medication-resistant microorganisms, prion diseases, tuberculosis, preoperative colonization of *Staphylococcus aureus*
- identifying maturational risk factors, including but not limited to:
  - newborn: lack of maternal antibodies; lack of normal intestinal flora; open wounds; immature immune system
  - infant or child: lack of immunizations
  - elderly: debilitated, diminished immune response, friable tissues and chronic diseases
- identifying recent history of travel inside or outside the United States
- noting the ASA physical status classification system
- using Spaulding’s wound classification system
- determining if the patient is at high risk for infection from endogenous or exogenous sources
- identifying those individuals at high risk for HAIs; a person is considered to be at high risk if he/she has one or more contributing factors or one or more predictors.

Assessment parameters include:

- infection predictors: length and type of procedure; presence of other devices or instruments
- confounding factors: age, nutritional status, health status.

In the ambulatory surgery practice setting, the preoperative nursing assessment is often performed on the day of surgery. Assessments for special populations, such as pediatric patients, older adult patients, high-risk patients, and patients with special needs, may require additional preparation.<sup>86</sup>

Reinforcement of patient education is another vital component in preventing an SSI. When the patient arrives in the preoperative area, a nurse should verify that all preoperative protocols were followed (e.g., preoperative shower or skin cleansing, etc.). Other points to emphasize include questioning the patient as to any skin irritation or hypersensitivity in prior surgical experiences or any new skin conditions, such as boils, eruptions, or rashes.

Hand hygiene, recognized as the single most important method of decreasing HAIs,<sup>87</sup> is a key infection prevention strategy in the preoperative period. Since there are many opportunities for contact in the preoperative setting, organisms that are present on a patient's skin, or shed onto inanimate objects in close proximity to a patient, may be transferred to the hands of caregivers. If hand hygiene is inadequate or omitted entirely, the contaminated hands of the care provider may come in direct contact with another patient. To mitigate the risk of cross contamination, care providers must perform hand antisepsis before and after contact with a patient or objects in close proximity to the patient. If hands are visibly soiled, they should be washed with soap and water for a minimum of 10-15 seconds. The basic principles of antisepsis are especially important, given the volume of orthopedic procedures performed in ambulatory surgery settings where large volumes of patients are often seen in a very short time span.

## Intraoperative Period

### **Skin Antisepsis**

Once the patient is placed securely on the OR bed and monitoring devices are applied, the specific type of anesthesia, e.g., general, regional, or monitored anesthesia care (MAC), is administered. The patient is then positioned to accommodate the type of procedure that will be performed. Once the patient is properly positioned, the surgical team then determines the type of skin preparation that will be used. The selection of the preoperative skin antiseptic agent should be based on patient assessment for any allergy or sensitivity to skin preparation agents. The preoperative antiseptic agent should:<sup>88</sup>

- significantly reduce microorganisms on intact skin
- contain a non-irritating antimicrobial preparation
- be broad spectrum and fast acting
- have a persistent effect.

Perioperative personnel must be aware of the clinical considerations regarding the various types of skin antiseptic agents. Some skin preparations that are used include:

- PCMX (has been proven to be minimally effective in the presence of organic matter. The FDA has classified PCMX as a category III; it is still being evaluated. Povidone iodine is an aqueous based prep that is safe and effective in concentrations from 5-10% (0.5-1% available iodine). It has bactericidal activity against gram-positive and gram-negative bacteria. It is also active against mycobacteria, fungi and viruses. Warnings include: avoid "pooling" beneath the patient; prolonged exposure may cause irritation or, rarely, severe skin reactions; and, do not heat prior to application.
- Contraindications in the form of aqueous solutions include irritation and toxicity. If left on the skin for extended periods, it can cause "burning" of tissue.
- Aqueous Chlorhexidine gluconate (CHG) antiseptics are available in 2% or 4% concentrations. CHG exhibits excellent activity against gram-positive and good activity against gram-negative vegetative

organisms and fungi. CHG is also known to have excellent persistent activity.<sup>89</sup> Warnings include avoidance of use on the head or face, the genital area or contact with the meninges.

- Two types of skin preparations available for use appear to have superior efficacy in terms of antimicrobial properties. These include but are not limited to iodophor based compounds with alcohol and Chlorhexidine with alcohol. The results of a randomized, double-blind, placebo-controlled trial published in January 2010 in the *New England Journal of Medicine* in clean-contaminated surgery identified CHG with alcohol as superior to iodoform-based compounds.<sup>90</sup> This study did not compare iodophor based compounds with alcohol to chlorhexidine with alcohol. An observational study published by Swenson, et al. compared the effects of different skin preparation solutions on surgical-site infection rates. An iodine preparation with alcohol was associated with the lowest infection rate. However both the iodine with alcohol and the povidone iodine followed by alcohol were associated with significantly lower infection rates than the CHG in alcohol group.<sup>91</sup>

Two additional observational trials among patients undergoing orthopedic procedures offer additional support for CHG in alcohol.<sup>92,93</sup> There is also indirect supportive evidence from preparation of skin prior to insertion of central lines that demonstrates CHG-IPA is more effective than povidone iodine in preventing catheter-related bloodstream infection. Still a definitive randomized trial comparing the iodine in alcohol to CHG in alcohol is needed.

- Any skin preparation using alcohol MUST be allowed to dry before beginning surgery due to the flammability of the product. Special care must be taken to allow the prep to dry completely especially before use of electro-surgical equipment.
- The National Quality Forum has recommended use of an antiseptic that contains a combination of CHG or iodine in combination with alcohol in their safe practices for surgery. Conclusions could be drawn that the rapid bactericidal activity of alcohol may be key to successful skin prep and that dual agent skin preps are superior. It is important to note that any product containing alcohol must have a second active ingredient: such as those described above.

Skin flora, particularly *Staphylococcus aureus* and coagulase-negative *Staphylococcus*, are the most common pathogens found in SSIs following orthopedic surgery. Bacteria can enter the wound through the surgical incision. If an implanted prosthesis is present, bacteria can lodge in or near the prosthesis. Because the skin is the easiest access to the wound, adequate skin preparation is a vitally important process.<sup>94</sup>

### **Surgical Hand Antisepsis**

Surgical hand antisepsis, performed before donning sterile gloves, is another important factor in SSI prevention. The purpose of a surgical hand antisepsis is to reduce transient and resident microorganisms on the hands and maintain the bacterial level below baseline, as this may reduce HAIs.<sup>95</sup> 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. FDA regulatory requirements for surgical hand antisepsis. Outside the U.S., products should comply with that jurisdiction's relevant licensing and regulatory authority requirements, which may be different than those of the FDA.

A Cochrane review found alcohol-based rubs to be as effective as aqueous solutions for preventing SSIs in patients.<sup>96</sup> Other investigators reported that the use of scrub brushes had no positive effect on asepsis and may actually increase the risk of infection as a result of skin damage.

### **Antibiotic Prophylaxis**

As part of The Joint Commission's Universal Protocol for Preventing Wrong Site, Wrong Procedure, and Wrong Person Surgery™, the surgical time-out, performed immediately before starting the invasive procedure or making

the incision, is now a standard of care in surgical settings.<sup>97</sup> Many facilities include antibiotic prophylaxis as a routine part of the time-out. An important consideration in total knee replacements is the infusion of the antibiotic prior to inflation of the tourniquet.

## **Other Intraoperative Factors**

### Air Quality

The most common method by which bacteria can gain access into a wound is when the wound is open during the intraoperative period. The quality of air entering the OR should be carefully controlled.<sup>98</sup> Operating room air may contain microbial-laden dust, lint, skin squames, or respiratory droplets.<sup>99</sup> The risk of contamination can be minimized by providing consistent adequate air flow. There are increased numbers of orthopedic cases performed in ambulatory centers which do not operate on a 7 day a week schedule. However, the need to have uninterrupted air flow is vitally important. If airflow is interrupted, rapid air turbulence can stir settled particles, enabling them to become airborne thus increasing the risk for wound contamination.<sup>100</sup> Additional infection prevention measures such as laminar flow in the operating room and body-exhaust surgical suits are other techniques that have been used to prevent infection.<sup>101</sup> Laminar air flow refers to systems that produce little or no turbulence. It is not clear that these measures are essential. As an example, prospective and controlled studies demonstrated a decrease in rates of surgical site infections in total hip and knee prosthesis procedures when laminar airflow technology was used.<sup>102</sup> However, the value and cost-effectiveness of laminar airflow is questionable when surgery occurs in modern facilities that have high rates of air exchange and antimicrobial prophylaxis is given.<sup>103, 104</sup> In a case control study of 26,505 patients undergoing total hip or knee replacement, the infection rate was 1.8 percent and laminar flow ventilation was not a significant factor in reducing infections in a univariate analysis. Computational fluid dynamic (CFD) modeling has been used to assess impact of variations in heating, ventilation and air conditioning (HVAC) parameters on air quality in the OR. This analysis found that vertical, unidirectional, low velocity supply air with returns at various heights in opposite corners was optimal for removal of airborne particulates in an OR. This model has been adopted in the Facility Guideline Institute's Guidelines for Design and Construction of Healthcare Facilities.

Recommendations [ANSI/ASHRAE/ASHE Standard 170: *Ventilation of Health Care Facilities* :

The ceiling in the OR should be monolithic

- air entering the OR should be sequentially filtered through two filters: the first of which should be rated at 30% efficient; the second at 90% efficient.
- The OR should be maintained in positive pressure
- a minimum of 20 air exchanges per hour, with 4 of these from outside air are recommended.
- The airflow should be unidirectional, downwards, with an *average velocity* of the 25 to 35 cfm/ft<sup>2</sup> (127 L/s/m<sup>2</sup> to 178 L/s/m<sup>2</sup>) delivered by non-aspirating diffusers. The diffusers should provide an airflow pattern over the patient and surgical team.
- Details on temperature, humidity, etc., are provided in the 2010 FGI Guidelines.
- There should be at least two returns low on sidewalls or at opposite corners with the bottom of these installed approximately 8 in. (203 mm) above the floor.

### Double Gloving

The orthopedic literature contains a number of articles on glove use and double gloving. Most experts agree that the addition of a second pair of surgical gloves significantly reduces perforations to innermost gloves and provides a protective barrier to both the patient and surgeon.<sup>105</sup> Therefore, healthcare practitioners should double glove during invasive procedures; a practice supported by AORN, the CDC, the American College of Surgeons, and AAOS.<sup>106</sup>

### Traffic Patterns

Studies have also shown that the number of individuals in the operating room and the amount of movement of these individuals within the OR both increase the number of colony-forming units as measured by settle plates within the room.<sup>107</sup> Olsen et al. reported that two or more residents participating in the operative procedure was an independent risk factor for SSIs in spine surgery.<sup>108</sup> Therefore, it is important that movement of personnel is kept to a minimum while invasive procedures are in progress.

Furthermore:<sup>109</sup>

- the doors to the OR should be kept closed except during movement of patients, personnel, supplies and equipment, in order to maintain positive pressure; and
- talking and the number of people present in the OR should be minimized during procedures since movement, talking, and uncovered skin areas can contribute to airborne contamination.

### Gowns and Drapes

The materials used in gowns and drapes are protective barriers against the transfer of microorganisms, particulates, and fluids to minimize strikethrough and the potential for personnel contamination. Microorganisms can be transferred through barrier materials by wicking of fluids and/or pressure or leaning on a flooded area of the product. Mechanical action such as pressure can result in both liquid and dry penetration of microbes if the pressure exceeds the maximum level of resistance that the material provides.<sup>110</sup> Surgical gowns and drapes should be resistant to tears, punctures, and abrasions. The inability to withstand tears, punctures, and abrasions may allow for passage of microorganisms, particulates, and fluids between sterile and nonsterile areas and expose patients to exogenous organisms.

### Bone Cement

Another relevant intraoperative factor in total joint arthroplasty (TJA) is the use of methyl methacrylate, or bone cement. Initially, bone cement was used as a spacer to maintain the joint space and soft-tissue tension for subsequent reconstruction; when antibiotics were added to the cement, they were found to elute into involved tissue area, thus aiding in the eradication of an infection.<sup>111</sup> Antibiotic laden cement (ABLC) was released for commercial distribution in the United States in May 2003, specifically for the treatment and reimplantation of infected arthroplasties. In Europe, Australia and likely other settings, ABLC has been available for many years. The indications and scientific evidence for its use have expanded to primary arthroplasty; however, the use of ABLC for this purpose remains controversial in the United States. Since its release, a variety of cements, cement preparation methods, antibiotics, and doses have been used with varying outcomes. It is important for the OR team to keep in mind that the current principles of bone cement preparation do not apply in the treatment of infection.

Although the addition of more than 2 g of antibiotic per 40 g of cement reduces the antibiotic's mechanical strength, this is irrelevant to the treatment of infection. Vacuum mixing decreases the cement's porosity, thereby reducing elution of the antibiotic; for this reason, vacuum mixing is contraindicated. Homogeneous, commercial mixing of the antibiotic in cement results in better mechanical strength, but potentially less elution. Using what is considered to be a traditionally poor mixing technique, i.e., "whipping" of the mixture, may actually *improve* elution. Hand mixing, without fully crushing the antibiotic crystals, may also improve elution. Normally, cement is used only in powder form because the liquid reduces mechanical strength. In this application, however, the liquid may increase the elution rate of the antibiotic.

## Sterility Assurance

Inadequate sterilization of surgical instruments has resulted in SSI outbreaks.<sup>112</sup> Sterilization processes should be monitored to detect potential failure modes with the goal of improving patient outcomes. A variety of monitoring tools are used to help ensure sterility, such as physical monitors, chemical indicators and biological indicators. These monitoring tools are used to help ensure that instruments and supplies being used on patients are free from microorganisms. Biological indicators have the ability to detect conditions that are not able to kill spores.

The importance of routine inspection of sterile supplies cannot be underestimated. Event-Related Sterility refers to the maintenance of the sterility of packages until they are used. This is based upon the concept that contamination of a sterile item is event-related, and the probability of its occurrence increases over time and with increased handling, storage or environmental conditions. All items should be inspected immediately before being placed on the sterile field and should be visually inspected for proper packaging, processing, package integrity, and inclusion of the sterilizer indicator. If an expiration date is provided, the date should be checked before the package is opened and not used if the item is outdated. The Association for Advancement of Medical Instrumentation (AAMI) has revised the former term “flash sterilization” to immediate use steam sterilization as “the process for steam sterilization of patient care items for immediate use.”<sup>113</sup> Although the need for emergency sterilization of any equipment may arise during a surgical case, this process should not be used for convenience or as an alternative to purchasing additional equipment. Flash sterilization is not recommended for implantable equipment such as screws, plates or wires frequently used in orthopedic surgery. Biological indicators (BI) within Process Challenge Devices should be used to monitor every load containing implants. Implants should be quarantined until the results of the BI testing are available.<sup>114</sup>

See Appendix for a sample perioperative nursing care plan.

## ***The Surgical Team: The Importance of Teamwork***

In the dynamic and often hectic surgical practice environment, the importance of teamwork as a factor in infection control and prevention must be recognized. There is increasing evidence that teamwork and collaboration are essential to improved patient outcomes. However, because the word “team” has been used so loosely and for so long in healthcare, in many ways it has lost its true meaning. For example, six individuals in a room, each performing his or her own job, can be called a group, but not necessarily a team, since a team is defined by its members’ interactions, interdependence, and shared goals.<sup>115</sup>

A team is defined as a group of two or more individuals who must interact and adapt to achieve a common objective.<sup>116</sup> There are two important aspects of the nature of teamwork: the individual’s ability to function as a member of the team; and the entire team’s ability to function as an efficient collective entity. There are several factors that influence the team’s performance, such as task demands, team composition, and the organizational context. Teams must be able to accomplish tasks as a unit, although team members may have individual tasks that change from member to member and from day to day. Consequently, each team member must possess general team competencies and skills that can be transferred from task to task and from team to team. One primary objective in team training is encouraging participation from individual team members, while developing the knowledge and skills necessary to successfully perform as a group member. As a result, team training, involving perioperative staff, surgeons and other members of the surgical team, has become routine in many organizations throughout the country.

In the surgical practice setting, the traditional hierarchical culture has been blamed for the failure of individuals to function as teams in this environment.<sup>117</sup> In this setting, as with all of healthcare, there is a close correlation between communication and safe care.<sup>118</sup> An ethnographic study of OR functioning classified 30% of procedurally

relevant communications between team members as communication failures; more than one-third of these communication failures led immediately to noticeable and potentially dangerous effects on system processes, such as inefficiency, team tension, resource waste, work-around, delay, patient inconvenience, and procedural error.<sup>119</sup> Poor teamwork and communication are latent human failures that must be addressed to achieve an effective safety program within an organization.<sup>120</sup>

Successful surgical intervention depends on interdisciplinary teamwork, which consists of both technical and non-technical skills, defined as follows:<sup>121</sup>

- technical skills consist of knowledge of anatomy, pathology, dexterity, hand-eye coordination, and technical proficiency
- non-technical skills include significant cognitive and interpersonal skills of health care professionals, such as communication, teamwork, leadership, situational awareness, and decision-making.

It has been shown that many of the underlying causes of errors stem from the non-technical aspects of care, rather than a lack of technical expertise. Further, it is stated that improving non-technical skills could reduce the number of errors during surgery, thereby improving patient safety and reducing the risk for SSI.<sup>122</sup>

An example of effective teamwork in the OR is the surgical time-out noted above, which is a key component of The Joint Commission's Universal Protocol for Preventing Wrong Site, Wrong Procedure, and Wrong Person Surgery.<sup>TM</sup> In addition to confirming appropriate antibiotic prophylaxis, for orthopedic surgical patients, it is also important to:

- identify all items that are required for the procedure and use a standardized list to confirm their availability; these items include:<sup>123, 124, 125</sup>
  - relevant documentation (e.g., history and physical, signed procedure consent form, nursing assessment, and pre-anesthesia assessment)
  - labeled diagnostic and radiology test results (e.g., radiology images and scans, or pathology and biopsy reports) that are properly displayed
  - any required blood products, implants, devices, and/or special equipment for the procedure; items that are to be available should be matched to the patient in the procedure area
- agree, at a minimum, on the:
  - correct patient identity
  - correct site, including laterality and the implant to be used (the site should be marked and visible)
  - procedure to be done
  - need to administer antibiotics or fluids for irrigation purposes
  - necessary safety precautions, based on patient history or medication use
- confirm sterility indicators
- identify and address any equipment issues or concerns.

Documentation of the completion of the time-out should include: the correct patient; correct site and side; agreement to procedure; correct patient position; and implants and/or special equipment or special requirements available. See the ASC success story below for an example of teamwork in promoting patient safety related to antibiotic prophylaxis.

### ***Teamwork in Action: An ASC Success Story***

A busy ASC developed an effective process for preoperative administration of antibiotics for orthopedic surgery patients in an effort to streamline patient preparation and reduce medication errors as a result of its performance improvement initiatives and SCIP requirements.

In that system, the pharmacy prepares the antibiotic per the physician's order. Upon admission to the pre-op holding area, the RN verifies the patient's allergies and the physician order, and then tapes the prepared antibiotic to the IV solution bag. The CRNA then administers the antibiotic when the patient is being transported to the OR. This process allows the antibiotic to be administered within one hour prior to the incision. During the pre-procedure time-out, the OR team – RN, CRNA, and surgeon – ask if the antibiotic has been administered. Antibiotic administration is then documented in the electronic record. If the patient requires vancomycin, the preadmission testing RN calls the patient to request that he/she arrive two hours prior to the scheduled surgery time to allow adequate time for administration of the antibiotic.

Example provided by Donna Bowers, RN, Executive Director Asheville Surgery Center, Asheville,

### ***Teamwork in Action: An Inpatient Success Story***

The infection prevention team, in collaboration with surgeons, nursing and perioperative staff, developed a comprehensive approach towards reduction of SSIs on the orthopedic service. Noting that more than 50% of the orthopedic SSIs were caused by MRSA, and that overall rates of SSI in total joint replacements were higher than the NHSN mean, a comprehensive orthopedic infection elimination program was instituted. This program consisted of skin preparation with CHG cloths the night before and morning of surgery, preoperative screening for MRSA colonization, addition of intravenous vancomycin prophylaxis to the standard antibiotic prophylaxis protocol for identified carriers, and administration of intranasal mupirocin ointment to all patients, regardless of colonization status for five days, beginning the day before surgery. This comprehensive approach required extensive teamwork and collaboration. Preoperative prophylaxis protocols and mupirocin decolonization therapy was added to order sets and pathways. Surgeons, perioperative and postoperative staff received extensive education. To showcase progress and motivate staff, results were displayed prominently on the post-op unit. The service has not had a MRSA SSI in a year, and overall SSI rates on orthopedics decreased by 60%.

Example provided by Michelle Vignari, RN, CIC, Rochester General Hospital, Rochester,

Checklists, which can be customized by each facility, have also been developed to assist the perioperative team in conducting and documenting the surgical time-out. See below for a sample checklist developed by AORN.





Another essential aspect of teamwork in the care of the orthopedic surgery patient is effective collaboration between the perioperative nurse and the IP. Both of these professionals possess knowledge of surgical procedures and infection prevention protocols, including literature findings and practice guidelines; additionally, they both have a broad range of communication and leadership skills (see Table Y).<sup>131</sup> Today, successful utilization of these skills requires an evolving set of new skills due to the change in reporting structures, treatment practices, job responsibilities, and work force composition. For example, as noted above, the traditional hierarchical culture, i.e., the flow of power and authority from the “top down,” is being replaced by horizontal, lateral interactions among staff members with equal power and authority. As a result, both perioperative nurses and IPs may find that they need to influence the behavior of other team members over whom they have no direct authority. These new roles encourage interdepartmental teamwork by sharing information about safety, for the wellbeing of both patients and coworkers.

**Table Y:** Comparison of Expertise of the Perioperative Nurse and IP

Perioperative Nurse	IP
<ul style="list-style-type: none"> <li>• Clinical expertise; in-depth knowledge of perioperative clinical needs</li> <li>• Knowledge of findings in nursing and perioperative literature</li> <li>• A patient care focus: both patient safety and infection prevention</li> <li>• Ability to prioritize patient needs, surgeon preferences, costs</li> <li>• Representation to achieve consensus within the surgical team</li> <li>• A “surgical conscience”</li> <li>• Knowledge of regulations and compliance in perioperative areas identified by the state health department, The Joint Commission, and CMS</li> </ul>	<ul style="list-style-type: none"> <li>• Clinical expertise on infection risk, control, and prevention</li> <li>• Knowledge of findings in infection control and prevention literature</li> <li>• Experience of compliance with policies, procedures, and accepted practices</li> <li>• A focus on patient and healthcare worker safety; identifying infection safety risks both to patients and staff members, with an emphasis on control and prevention</li> <li>• An understanding of compliance with regulations set forth by OSHA, U.S. FDA, and CDC</li> <li>• Ability to apply national guidelines in a cost-effective manner</li> <li>• A “facility conscience”</li> </ul>

This collaboration is particularly relevant in the selection, use, and standardization of products and medical devices. The goals of product standardization and value analysis processes are to select functional and reliable products that are safe, cost-effective, and promote quality care. A multidisciplinary committee, with representation by IPs, should be assembled in order to select the most appropriate products and medical devices.<sup>132</sup> Together, perioperative nurses and IPs not only offer leadership in product evaluation, selection, and introduction into clinical practice, they can also integrate this process into established practices based on standards of safety and quality of patient care. Ultimately, this results in the incorporation of new products and technology efficiently and correctly, without compromising the quality of patient care.<sup>133</sup>

Collaboration between perioperative personnel and IPs is also valuable in the ambulatory surgery setting. As previously noted, in the U.S., additional work by the HHS will include ASCs as part of the Tier Two Action Plan to prevent HAIs.<sup>134</sup> The new infection prevention and control requirements set forth by CMS will help to ensure that ASCs develop infection prevention policies based upon nationally recognized guidelines and that the policies are under the direction of a professional trained in infection control.

However, the ultimate accountability for HAI prevention and safe care rests with the ASC itself. ASCs need to proactively embrace a culture of safety and make staff allocation of resources and education for HAI risk reduction

a priority. Understanding where and in what ways the risks and hazards associated with infections are embedded in the process and structure of care within ASCs is vital to the development of safe practices for HAI prevention. Moreover, ASCs may benefit from regular access to an individual trained or certified in infection prevention, who could provide more customized education for the staff and therefore meet the specific needs of the facility better than the more generalized information provided by non-customized educational sessions on infection prevention and control.

## Postoperative Period

Upon completion of the procedure, a sterile dressing is applied to the wound and secured with tape, based on patient characteristics such as skin condition, allergies, amount of strength and elasticity required, and anticipated frequency of dressing changes.<sup>135</sup> For wounds that are primarily closed, the sterile dressing should remain in place for 24-48 hours postoperatively. There is some debate over occlusive versus absorptive dressings. Hutchinson and McGuckin reviewed 111 studies and found that the rate of infection under occlusive dressing was lower than under non-occlusive dressings (2.6% compared with 7.1%)<sup>136</sup> A 2003 review of dressings recommended three layers: a non-adhering layer, an absorptive layer and an occlusive dressing.<sup>137</sup>

In the PACU, all surgical dressings should be checked for drainage and closure.<sup>138</sup> The PACU nurse should measure the patient's temperature upon admission and apply active warming measures, such as forced-air warming, until the patient reaches a temperature of  $\geq 36^{\circ}\text{C}$ . Because patients undergoing orthopedic surgery can suffer dire consequences from an infection, strict asepsis in changing dressing and handling drains is required. If drains are present to minimize blood accumulation and the potential for infection, care must be taken to ensure that these drains maintain suction. The characteristics of wound drainage, e.g., type, consistency, amount, and color should be observed and evaluated for signs of infection; additional PACU interventions include:<sup>139</sup>

- assess the wound if the patient has signs or symptoms of infection, such as a fever, unusual wound pain, redness and heat at the wound site, or edema
- examine and compare the characteristics of the incision regularly, observing for well-approximated incision edges and signs of infection (e.g. heat, redness, swelling, unusual pain, odor), dehiscence, or evisceration.

The PACU nurse should also assess the patient for the development of compartment syndrome as an infection prevention measure. Compartment syndrome develops when swelling or bleeding occurs within a compartment, i.e., the fascial sheath that encloses bone, muscle, nerves, blood vessels and soft tissue.<sup>140,141</sup> Because the fascia does not stretch, the increased pressure placed on the capillaries, nerves, and muscles in the compartment causes circulatory compromise, which leads to diminished function of the limb and tissue necrosis. The two primary causes of increased pressure in the compartment are constriction from the outside, such as a cast or bandage that reduces the size of the compartment; or increased pressure from within the compartment, e.g., swelling. The characteristic symptoms of compartment syndrome are intense pain that is unrelieved by conventional methods, paresthesia, and sharp pain on passive stretching of the middle finger of the affected arm or the large toe of the affected leg. Progressive symptoms include decreased strength, sensation, and capillary refilling; peripheral pulses are not usually compromised. In order to prevent tissue damage and reduce the risk for infection, a nurse must intervene immediately by elevating the extremity, applying ice, and releasing the restrictive dressing.

At the time of discharge, written postoperative and follow-up care instructions should be provided to the patient. These instructions should reflect the patient's individual informational needs specific to home care, response to unexpected events, and physician follow-up.<sup>142</sup> It is important that the patient be compliant with postoperative instructions. The patient must watch for signs and symptoms of infection after surgery that include, but are not limited to, fever, malaise, erythema of incision site, and drainage from incision site. Comorbidities that are detrimental to healing include, but are not limited to, obesity, immunosuppression, use of steroids, chronic illness, diabetes, and advanced age.

## Summary of Key Points<sup>143,144</sup>

Key Point	Recommendation
<b>Vertical, Unidirectional Flow at low velocity over the OR table</b>	A minimum of 20 air changes/hour
<b>Body Evacuation Suits</b>	Generally recommended for total joint arthroplasty
<b>Surgical Hand Antisepsis</b>	Use either an antimicrobial surgical scrub agent or an alcohol-based surgical hand rub with documented cumulative and persistent activity. Use of alcohol product immediately reduces resident flora by 95% and continues to act for hours
<b>Hair Removal</b>	Hair removal: either no hair removal or removal with clippers immediately before surgery; razors are not appropriate and are associated with an SSI rate of 3.1%-20%
<b>Skin Prep</b>	Preoperative skin cleansing ( CHG)  Surgical prep Use a dual agent with alcohol and active ingredient ( CHG, iodine povacrylex, povodine iodine)  Allow prep to dry completely  Avoid pooling of the prep.
<b>Drains</b>	Controlled studies show no benefit  Meta-analysis: shows increased transfusions and no benefit in total knee or hip
<b>Antibiotic Cement</b>	Norwegian Arthroplasty Register 2006: evidence of effectiveness; now widely used in primary surgery in Europe  FDA-approved in the U.S. for revision surgery
<b>Traffic Control</b>	Multiple studies support limiting the number of and movement of OR personnel
<b>Maintenance of Body Temperature</b>	Active warming of patients whose core temperature is at or below 36 degrees C
<b>Universal Protocol/Time-Out</b>	Identify all items required for the procedure: <ul style="list-style-type: none"> <li>• relevant documentation</li> <li>• labeled diagnostic and radiology test results are properly displayed</li> <li>• any required blood products, implants, devices, and/or special equipment for the procedure; match the items to the patient in the procedure area</li> <li>• use a standardized list to confirm availability</li> </ul> <p>Agree on the:</p> <ul style="list-style-type: none"> <li>• correct patient identity</li> <li>• correct site (site is marked and visible)</li> <li>• procedure to be done</li> </ul> <p>Confirm sterility indicators</p> <p>Identify and address any equipment issues or concerns</p> <p>Document the time-out</p>

## Future Trends

Although the use of antimicrobial sutures is not a routine practice, the benefits are becoming increasingly apparent. Recent evidence-based clinical studies have demonstrated both the clinical and economic benefit of this technology.<sup>145</sup> Future studies may prove useful. Likewise, advances in antimicrobial coatings for products such as implants, instruments, equipment and the environment may provide additional support to reach the goal of zero SSIs.<sup>146</sup> The practice of prescreening selected patients for MRSA prior to surgery is controversial. However, future trends could incorporate this as a recommended practice, as part of a comprehensive program to eliminate SSIs in orthopedic surgery, especially in cases involving an implantable device. Future trends in preoperative preparation will likely include standardized protocols for preoperative showers and state-of-the-art skin cleansing, which will become the recommended standard of practice. Innovative techniques for postoperative care, including optimal dressing materials and techniques, will most likely become the standard of care.

### Targeting Zero

As healthcare has attempted to move from silos of care driven by specialized groups to collaborative groups and integrated systems, it is imperative that both processes and products are designed and implemented in the most effective and efficient manner to achieve desired outcomes. Central to this theme is the philosophy of targeting zero. Targeting Zero is the philosophy that every healthcare institution should be working toward a goal of zero HAIs. While not all HAIs are preventable, APIC believes that all organizations should set the aspirational goal of elimination and strive for zero infections. Every HAI impacts the life of a patient and a family, and even one HAI should be considered too many.

To improve our results, it is important to collaborate with all stakeholders in the development of a culture that holds each other accountable for adhering to proven infection prevention measures and practices. Essential components include a focus on patient-centered care, an engaged and committed leadership, teamwork and communication. Several organizations critically evaluate each individual event to identify gaps and opportunities in developing and fostering a culture that even one infection is “one too many.”

(A sample critical event analysis is included in the Appendix.)

## LESSONS LEARNED

- In today's surgical practice environment, challenged by newly recognized pathogens and well-known pathogens that have become resistant to current therapeutic modalities, all members of the healthcare team must remain aware of the impact of HAIs in orthopedic surgical patients and must implement evidence-based prevention strategies to reduce the incidence of HAIs.
- Given the associated unnecessary morbidity and mortality that could be prevented, the suffering that could be eliminated, and the money that could be saved, no healthcare organization can risk ignoring the benefits of effective strategies aimed at preventing HAIs.
- Effective teamwork and communication among all members of the surgical team is an important factor in improving patient outcomes.
- Various tools and checklists, which can be customized by the facility, have been developed to assist in preventing SSIs in orthopedic surgical patients.
- Perioperative personnel and IPs are in a unique position to provide leadership in improving the quality and safety of patient care; by forming an alliance, they can be effective change agents in product evaluation and selection, thereby promoting positive patient outcomes.

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# Appendices

## Infection Control and Prevention Surgical Services Audit Checklist

Patient Name: \_\_\_\_\_ MRN #: \_\_\_\_\_ Admit date: \_\_\_\_\_

Surgery Date: \_\_\_\_\_ Day of week: \_\_\_\_\_

Scheduled Time: \_\_\_\_\_ First case/Last case/Other (circle one)

OR Pavilion: \_\_\_\_\_ OR Room: \_\_\_\_\_ Surgeon: \_\_\_\_\_

Scheduled Procedure: \_\_\_\_\_ Emergent Case: Y/N

Actual Procedure: \_\_\_\_\_

IC Time in: \_\_\_\_\_ IC Time out: \_\_\_\_\_ Total minutes of observation: \_\_\_\_\_

Time of incision: \_\_\_\_\_ Time of closure: \_\_\_\_\_ Duration of case: \_\_\_\_\_

Case #:

Patients initials:

Observer initials:

Intraoperative Observation	Performed Y/N/ND	Detail	Instructions and Comments
Environment—Environmental Services observed cleaning between cases			
Environment—room has been terminally cleaned			For first case only
Environment – General Cleanliness			
Environment – Equipment Clean			Anesthesia equipment, cords, lights
Environment – Room temperature/ humidity		_____F° _____C° Relative humidity _____% Time observed: _____	
Environment – Ventilation			Confirm appropriate pressure settings
Pre-Op Skin Prep—Hair removal		Performed prior to OR or Performed in the OR or NA	Circle one
Pre-Op Skin Prep—Hair removal method		Clipper Razor Depilatory cream	Circle one

Case #:  
 Patients initials:  
 Observer initials:

Intraoperative Observation	Performed Y/N/ND	Detail	Instructions and Comments
Pre-Op Skin Prep		Product Used:  Detail Procedure:	
OR Personnel—number present	Surgeon: Resident: Medical Student: Anesthesia: Circulating RN: Scrub RN/Tech: Vendor: Other: Unknown: Total:		Tick mark for each individual present during observation
Scrub Procedure—role of personnel observed		#1: #2: #3:	
Scrub Procedure—nail pick used		#1: #2: #3:	If first case
Scrub Procedure—hand wash		#1: #2: #3:	

Case #:

Patients initials:

Observer initials:

Intraoperative Observation	Performed Y/N/ND	Detail	Instructions and Comments
Scrub Procedure—products used		#1: Avaguard Brush Brush Type: #2: Avaguard Brush Brush Type: #3: Avaguard Brush Brush Type:	Brushes by color: • Ultradex (blue package) • Povidone Iodine (brown package) • Detergent Free (green package)
Scrub Procedure—technique		#1: Correct sequence: Y/N Correct duration: Y/N #2: Correct sequence: Y/N Correct duration: Y/N #3: Correct sequence: Y/N Correct duration: Y/N	
Sterile Tray Set Up		Integrity of wrapping: Indicator Check: Integrator Check:	
Sterile Tray—closing tray for dirty cases			
Sterile Field Maintained			
Environment—Frequency of door opening		Door to core:  Door to semi-restricted corridor:  Door to substerile:	Tick mark for each door opening
Time Out Performed		Y/N	Circle one
Surgical attire—cap/hood		Worn by all present? Y/N Appropriate use? Y/N Removed at end of procedure? Y/N/not observed	
Surgical attire—mask		Worn by all present? Y/N Appropriate use? Y/N Removed at end of procedure? Y/N/not observed	
Surgical attire—gown		Worn by all present? Y/N Appropriate use? Y/N Removed at end of procedure? Y/N/not observed	
Surgical attire—safety shields		Worn by all present? Y/N Appropriate use? Y/N Removed at end of procedure? Y/N/not observed	
Surgical attire—shoe covers		Worn by all present? Y/N Appropriate use? Y/N Removed at end of procedure? Y/N/not observed	

Case #:

Patients initials:

Observer initials:

<b>Intraoperative Observation</b>	<b>Performed Y/N/ND</b>	<b>Detail</b>	<b>Instructions and Comments</b>
Surgical attire—gloves		Appropriate use? Y/N Changed with tears? Y/N Removed at end of procedure? Y/N/not observed	
Surgical attire—gloves changed for dirty cases			Change before closing?
Surgical attire—name badges			
Surgical attire—jewelry		Rings removed? Y/N? Other jewelry removed or totally confined under attire? Y/N Comments:	Other jewelry – watches, earrings, bracelets, necklaces
Surgical attire--fingernails		Excess fingernail length? Y/N/ND Comments:  Artificial nails: Y/N/ND Comments:	Excess=greater than ¼ inch.
Flash Performed		Reason and Item/s Flashed:	
Pt Temp		Temp monitoring?: Y/N/ND Warming Performed? Y/N/ND Location (geographic): Location (anatomic): Method:	
General Observations			

Case #:

Patients initials:

Observer initials:

Retrospective Review	Performed Y/N/ND	Detail	Comments
Wound class—recorded in Surginet			
Wound class—IC assessment			If different than above
ASA score			
Pre-op Antiseptic showering			
Pre-op nares cultures (for sternotomies)			
Peri-op mupirocin (for sternotomies)			
Pre-op oral decontamination (for colorectal surgery only)		Agent used: Times administered: Time of incision: Meets guidelines: Y/N	1 g of neomycin plus 1 g of erythromycin at 1 PM, 2 PM and 11 PM <b>OR</b> 2 g of neomycin plus 2 g of metronidazole at 7 PM and 11 PM the day before an 8 AM operation
Antimicrobial Prophylaxis—timing		Time of infusion: Time of incision: Meets guidelines? Y/N	Cefazolin/Ancef: 0-60 min. prior to incision. Vanco/fluoroquinolone: 60-120 min. prior to incision.
Antimicrobial Prophylaxis—choice		Agent used: Allergies: Consistent with NMH guidelines?: Y/N	
Antimicrobial Prophylaxis—redose		Was a second dose of cefazolin administered for cases > 4 hours? Y/N	
Estimated blood loss			
# Units PRBC			If transfused
Intraoperative—euglycemia (for cardiac surgery)			
Intraoperative—Drains placed		Y/N	
Intraoperative—Drains placed		# of drains: Type of drains:	
Post-operative—Timing of drain removal		POD:	

# Guideline to Attempt Decolonization from MRSA

Published studies have shown below procedures often effective. Guidance from large scale clinical trials is not available. In response to increasing MRSA, both from the community (CA-MRSA) as well as health care associated MRSA, below consensus recommendations have been created.

## Experienced clinicians may vary in their treatment approach

### Basic principles of therapy:

- *Staph aureus* is a very common organism. We all are exposed.
- Colonization of the nose, and subsequently on the skin, is frequent. Approximately 60% of people are intermittently colonized, 20% always colonized, 20% never.
- Colonization with a certain strain of bacteria can persist for years.
- Spread between people is by skin contact (shaking hands, etc.) and sometimes on equipment (eg. hospital bedrail, gym workout equipment, home utensils, cups, TV remote, computer keyboards, stethoscopes).

### **Decolonization procedure:**

- 1. All active skin infection sites must be resolved before decolonization becomes feasible.** Boils must be drained. Antibiotics may be needed. Soaks or warm compresses are appropriate.
- 2. Ideally, no chronic intravenous device is present** (e.g. Hickman, PICC line, etc.), and urinary catheters should be avoided.
- 3. Colonization eradication should be attempted at home,** not in the hospital.
- 4. Chlorhexidine or hexachlorophene antiseptic soap:**
  - Wash whole body (from scalp to toes) once daily. A big lather is not necessary! Skin moisturizer may be applied for dry skin after bathing.
  - Remove all artificial nails and all fingernail polish.
  - Scrub fingernails for one minute with nail brush twice daily.
  - **Duration: 7 days**
- 5. Mupirocin 2% ointment**
  - Apply inside each nostril twice daily for 7 days, using a cotton tipped swab. No need to put deep into the nose. One Rx enough for all.
  - **Duration: 7 days**
- 6. Oral antibiotics:**
  - Are not required for decolonization
  - May be used to decrease gastrointestinal colonization, and may include clindamycin, doxycycline, or TMP-SMZ, occasionally with rifampin
- 7. Encourage treatment of all household members (and regular sexual contacts) with chlorhexidine/hexachlorophene and mupirocin during the same time period.**
- 8. Post-treatment nasal culture for surveillance is optional and not encouraged.**

# Patient Information for Decolonization (trying to get rid) of MRSA (a strain of staphylococcus “staph” aureus)

## Approved by Chiefs of Infectious Disease and Dermatology, August 2006

MRSA, a resistant staph bacteria, is causing more infections throughout the country, often not associated with hospitals or health care. This strain, as well as hospital strains of MRSA, spread easily from person to person.

- **They may look like spider bites, but probably are not.**
- Anyone can get this new strain, it does not mean you were not keeping clean.
- Some people may be colonized without having symptoms.

### Basic principles of therapy:

- ***Staph aureus* is a very common organism. We all are exposed.**
- Colonization of the nose, and subsequently on the skin, is frequent. Approximately 60% of people are intermittently colonized, 20% always colonized, 20% never.
- **Everyone should wash their hands after touching their nose or face.**
- Colonization with a certain strain of bacteria can persist for years.
- **Spread between people is by skin contact** (shaking hands, etc.) and sometimes on equipment (eg. hospital bedrail, gym workout equipment, home utensils, cups, TV remote, computer keyboards, door knobs, stethoscopes)
- Infection **may** continue to recur until the new strain is removed from your body, and for that decolonization has been recommended to you. Please follow the steps below.

### Decolonization procedure:

**All active skin infection sites must be resolved before decolonization becomes feasible.** Boils must be drained. Antibiotics may be needed. Soaks or warm compresses are appropriate.

**Colonization eradication should be attempted at home,** not in the hospital.

### **Chlorhexidine or hexachlorophene antiseptic soap:**

- Wash whole body (from scalp to toes) once daily. A big lather is not necessary! Apply skin moisturizer for dry skin after bathing.
- Remove all artificial nails and all fingernail polish.
- Scrub fingernails for one minute with nail brush twice daily.
- Pay special attention to washing your armpits, groin, and by your rectum. Dry with a clean towel, and always put on clean clothes. Change bed sheets frequently.
- **Duration: 7 days**

### **Mupirocin 2% ointment**

- Apply inside each nostril twice daily for 7 days, using a cotton tipped swab. No need to put deep into the nose. One Rx enough for all.
- **Duration: 7 days**

Oral antibiotics are not required for decolonization, but may be used in some settings.

**Household members (and regular sexual partners) should be treated with chlorhexidine or hexachlorophen and mupirocin during the same time period** (because they may be asymptomatic carriers; this is safe for children).












# SURGICAL SITE INFECTION (SSI) PREVENTION:


**IHI How To Guide:** <http://www.IHI SSI Prevention How To Guide>













1. Appropriate use of antibiotics
2. Appropriate use of prophylactic antibiotics
3. Appropriate hair removal

## ADDITIONAL OR “PLUS” MEASURES TO OPTIMIZE INFECTION RISK REDUCTION:

Intervention	References	Product Order Info	Tools
Chlorhexidine (CHG): <ol style="list-style-type: none"> <li>1. Skin Prep: Chlorhexidine/alcohol</li> <li>2. Pre-op antiseptic bathing</li> <li>3. Pre-op CHG oral rinse night before and morning of surgery to reduce the risk of post op pneumonia for those to receive general anesthesia</li> <li>4. Post op antiseptic bathing</li> </ol>	<ol style="list-style-type: none"> <li>1.  C:\Documents and Settings\DNSSAB\My</li> <li>2.  C:\Documents and Settings\DNSSAB\My       C:\Documents and Settings\DNSSAB\My</li> <li>3.  C:\Documents and Settings\DNSSAB\My       C:\Documents and Settings\DNSSAB\My</li> <li>4.  C:\Documents and Settings\DNSSAB\My</li> <li>5.  C:\Documents and Settings\DNSSAB\My</li> </ol>	Skin Prep: Order Number CHG impregnated wash cloths: CHG oral rinse (pre op)	Pt instructions: <a href="#">Kaiser Sunnyside Preop Skin Prep Patient Teaching</a> <b>4 min video:</b> pre/post op CHG cloths, oral rinse, oral care:
5. OR traffic control	 C:\Documents and Settings\DNSSAB\My	N/A	<b>Traffic counters:</b>  C:\Documents and Settings\DNSSAB\My

## SSI Prevention continued:

Intervention	References	Product Order Info	Tools
6. Hair removal: <ul style="list-style-type: none"> <li>• Avoid if possible</li> <li>• By clipper instead of razor immediately before surgery (in pre op <b>not</b> OR)</li> <li>• Sterilization of clipper hand piece between cases</li> <li>• Removal clipped hair from skin</li> <li>• Patient teaching: e.g. ensure female patients do not shave legs one week before total knee replacement</li> </ul>	 C:\Documents and Settings\DNSSAB\My	<ul style="list-style-type: none"> <li>• Clipper kit</li> <li>• clipper blades blade for sensitive skin</li> </ul>	<b>Patient education:</b> <a href="#">Kaiser Sunnyside Patient Teaching SSI</a> First do do harm patient info: <a href="http://www.SSI Prevention education">http://www.SSI Prevention education</a> Safe Care patient info: <a href="http://www.safe care campaign">http://www.safe care campaign</a>

Intervention	References	Product Order Info	Tools
7. Formal observations in OR looking for infection prevention related issues	Bardowski L et al "Direct observation in the OR: First step to best practice" APIC conference June 2009 #18-201	N/A	 C:\Documents and Settings\DNSSAB\My   C:\Documents and Settings\DNSSAB\My
8. Ensure for ortho cases that pre op antibiotic is infused 20 minutes prior to tourniquette application.			
9. Antiseptic dressings post op	 C:\Documents and Settings\DNSSAB\My   C:\Documents and Settings\DNSSAB\My  C:\Documents and Settings\DNSSAB\My		N/A
10. Decolonization - MRSA prior to high risk procedures; schedule MRSA+ infected patients at end of day if possible	 C:\Documents and Settings\DNSSAB\My  C:\Documents and Settings\DNSSAB\My		 C:\Documents and Settings\DNSSAB\My
11. Glucose level: minimizing the extremes of glucose during perioperative care	 C:\Documents and Settings\DNSSAB\My  C:\Documents and Settings\DNSSAB\My		N/A
12. Normothermia other than colon procedures	 C:\Documents and Settings\DNSSAB\My		N/A
13. Covering implants/grafts on OR table with sterile, non-linting towel if unwrapped ahead of time.	 C:\Documents and Settings\DNSSAB\My		N/A
14. Change surgical mask between cases/breaks (after 90 minutes can measure nasopharyngeal shedding).	Recommended by one content expert: Charles Edmiston, PhD: <a href="mailto:cedmisto@mcw.edu">cedmisto@mcw.edu</a>		N/A
15. Routine schedule for ultrasonic scrubbing/cleaning of OR equipment including tables, guerneys and IV poles.			
16. Routine ventilation check to ensure HEPA filters changed per schedule and OR rooms are positive pressure minimum of 15 ACH/hr			

**2010 OR OBSERVATION CHECKLIST for Assessment of Infection Prevention Efforts**

Date of observation: \_\_\_\_\_ Time: from \_\_\_\_\_ to \_\_\_\_\_ OR# \_\_\_\_\_ Observer: \_\_\_\_\_  
 Procedure(s): \_\_\_\_\_

OR/PATIENT STANDARDS	Compliant: YES	Compliant: NO	NA	DESCRIPTION/COMMENTS
<b>OR Environment:</b>				
OR appears clean, dust free, uncluttered				
OR facility in good repair e.g. no holes in walls, floors or ceiling				
Solid ceiling – no tiles				
Interim (between cases) environmental cleaning performed – directionally from top to bottom				
Doors closed, traffic in and out of room kept to minimum during case				# door openings/hour
Number personnel in room kept to a minimum				# personnel in room during case
<b>Perioperative Patient Care:</b>				
Pre-op antibiotic given by anesthesia personnel within 60 minutes prior to incision				
IV injection ports swabbed prior to access				
Hair removal: performed <b>before</b> entering OR room (planned hair removal - occasionally additional hair must be clipped or done in the OR)				Name antiseptic
Pre-op skin prep:				
⇒ Dual agent prep used (Chloraprep or Duraprep)				Describe application method
⇒ Application technique (from center out)				
<b>Attire:</b> (for any person entering semirestricted and restricted areas of surgical suite)				
Properly tied surgical masks				
Surgical caps/hood cover <b>all</b> head hair				
Chest and beard hair fully covered				
For all staff, no artificial nails, natural nails short				
Dress code followed				
⇒ No rings. Other jewelry (watches, earrings, bracelets, necklaces, piercing) should be removed or totally confined within scrub attire				
⇒ No fanny packs				
⇒ All wear long sleeves (approved cover jacket)				
⇒ No turtlenecks				
⇒ Shirts tucked				
⇒ No fleece				
<b>Sterile Field:</b>				
Sterile items left open no > than 60 minutes prior to patient entering room and should be constantly monitored during that time period				

**OR Observation Checklist**

Developed by KP Periop/IC based on a tool shared by Gwenda Felizardo, RN, BSN, CIC, Group Health Cooperative, Tacoma, Washington

OR/PATIENTS STANDARDS	Compliant YES	Compliant NO	N/A	DESCRIPTION/ COMMENTS
Scrubbed persons maintain sterility of sterile gown, gloves, supplies Hands remain above waist				
Items introduced into sterile field opened, dispensed, transferred by methods to maintain sterility/integrity				
Items/devices dropped below level of the OR table are considered contaminated				
Surgical equipment (e.g. cables, tubing) should be secured to sterile field with non-perforating devices.				
Nonsterile equipment (e.g. mayo stands, C arms) should be covered with sterile barrier materials. Only sterile items should touch sterile surfaces. Sterile barrier material should be applied to any equipment adjacent to the sterile field.				
All personnel moving in/around sterile field do so in manner to maintain sterility – e.g. <ul style="list-style-type: none"> <li>⇒ Staff do not turn back to sterile field</li> <li>⇒ Scrubbed personnel pass front to front or back to back</li> <li>⇒ Separation of sterile team from non-sterile team maintained</li> <li>⇒ Unscrubbed personnel do not pass between two sterile fields</li> </ul>				
<b>Anesthesiology:</b>				
Drainage bags (e.g. Foley) kept off the floor				
Aseptic practice used for IV tubing, fluids, medications – injection ports swabbed prior to access				
Sterile equipment including IV solution/tubing is assembled <b>immediately</b> prior to use				
Aseptic practice used for all invasive procedures: (epidurals, blocks, IV insertion)				
Anesthesia cart appears clean - degermer readily available				
Re-usable personal equipment (e.g. stethoscope) cleaned between cases				
<b>OSHA/Bloodborne Pathogen Standard:</b>				
Appropriate eye protection used				
Sharps containers not overfull				
Sharps are passed in a basin or by using neutral zone rather than by hand				
Sharps safety devices utilized where available				Devices used:
<b>General Infection Prevention and Control:</b>				
Sterile team removes gloves and washes hands at end of case				
Personnel appear free from communicable disease (no open skin lesions on hands/face/forearms)				
Clean, sterile, and soiled items are kept separate				
Used sterile instruments/equipment transported to CSP for decontamination and sterilization				

# SAMPLE PLAN OF CARE: INFECTION PREVENTION FOR PATIENTS UNDERGOING ORTHOPEDIC SURGERY

**Nursing Diagnosis:** Risk for Infection

**Outcome:** The patient will be free from signs and symptoms of postoperative surgical site infection.

**Interventions:**

- Confirm patient compliance with preoperative skin preparation (as appropriate)
- Implement strict aseptic practices for:
  - Establishing and maintaining the sterile field:
    - Opening supplies and equipment for the procedure
    - Draping the patient and equipment
  - Preparing the patient’s skin; removing hair, as necessary
  - Controlling traffic patterns in the OR
  - Ensuring perioperative environmental sanitation
  - Adhering to standard and transmission-based precautions
  - Dressing wound at completion of the procedure
  - Caring for incision sites, invasive-devices sites, urinary drainage systems, and other drainage systems
- Protect from cross-contamination
- Initiate traffic control
- Prepare for pulsatile lavage or irrigation, as needed
- Initiate antibiotic therapy preoperatively and/or intraoperatively per physician’s orders; verify medication allergies prior to antibiotic administration
- Establish a normothermia maintenance plan.
- Implement procedure-specific activities, such as using body evacuation suits and pulsatile lavage
- Anticipate equipment needs
- Check equipment function
- Implement safety precautions when using equipment
- Sterilize instruments according to facility policy and procedure and the manufacturer’s guidelines:
  - Minimize the use of flash sterilization; use only in selected clinical situations and in a controlled manner
  - Flash sterilization should *not* be used for implantable devices except in cases of emergency when no other option is available
- Handle implants according to the manufacturer’s recommendations
- Classify surgical wound according to the CDC
- Monitor for signs and symptoms of infection
- Minimize the length of invasive procedure by planning care
- Maintain continuous surveillance to detect and prevent potential adverse clinical events
- Administer care to wound sites
- Administer care to invasive device sites
- Evaluate factors associated with increased risk for postoperative infection at the completion of the procedure

### Infection event analysis

#### WHAT CAN WE LEARN FROM THIS?

##### The Patient

Describe patient history.

##### The Course

Describe clinical course of patient and the hospital-acquired infection detail.

Review: Invasive devices, insertion dates and other contributing factors, (pre-op antibiotics if surgical patient)

Review: Any recalls or devices that may have been associated with infection. Report any association with recalled devices or products

Identify : patient characteristics that may be associated with course  
Summarize; Modifiable and non-modifiable patient risk factors

##### Positive Findings

Summarize documentation or observed compliance with infection prevention measures :

##### Opportunities for Improvement

Summarize infection prevention measures that could have prevented Infection :

##### **Lessons Learned**

Share lessons learned from this patient and how compliance or procedure changes may prevent infection in other patients.

## Glossary of Terms

Ambulatory Surgery Center (ASC): An ASC is a health care facility that specializes in providing surgery, including certain pain management and diagnostic (e.g., colonoscopy) services in an outpatient setting in which the patient does not require an overnight hospital stay.

Fulminant: Occurring or flaring up suddenly and with great severity. A potentially fatal complication.

Hematogenous: Originating in or spread by the blood.

Implant: A nonhuman-derived object, material, or tissue that is permanently placed in a patient during an operative procedure and is not routinely manipulated for diagnostic or therapeutic purposes. Examples include: porcine or synthetic heart valves, mechanical heart, metal rods, mesh, sternal wires, screws, cements, and other devices

Pathogenesis: The origination and development of disease

Perioperative: The period of time immediately before, during and after surgery.

Phagocytosis: The engulfing and destruction of phagocytes which serves as an important defense mechanism against infection by microorganisms

Phagocyte: A white blood cell that consumes and destroys foreign material (such as microorganisms) and debris

Post discharge surveillance: The process used to seek out infections after patients have been discharged from the hospital. It includes screening a variety of data sources, including re-admissions and emergency department visits.

Toxin: One of a number of poisons produced by certain plants, animals, and bacteria. Frequently used to refer specifically to a particular protein produced by some higher plants, animals and pathogenic (disease-causing) bacteria

Work Around: A workaround is a method, sometimes used temporarily, for achieving a task or goal when the usual or planned method isn't working or is difficult or time consuming to implement.

