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SUPPLEMENT ARTICLE: SHEA/IDSA PRACTICE RECOMMENDATION

Strategies to Prevent Surgical Site Infections in Acute Care Hospitals

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PURPOSE

Previously published guidelines are available that provide comprehensive recommendations for detecting and preventing healthcare-associated infections. The intent of this document is to highlight practical recommendations in a concise format designed to assist acute care hospitals to implement and prioritize their surgical site infection (SSI) prevention efforts. Refer to the Society for Healthcare Epidemiology of America/Infectious Diseases Society of America "Compendium of Strategies to Prevent Healthcare-Associated Infections" Executive Summary and Introduction and accompanying editorial for additional discussion.

SECTION 1: RATIONALE AND STATEMENTS OF CONCERN

1. Burden of SSIs as complications in acute care facilities.
   a. SSIs occur in 2%-5% of patients undergoing inpatient surgery in the United States.[1]
   b. Approximately 500,000 SSIs occur each year.[1]

2. Outcomes associated with SSI
   a. Each SSI is associated with approximately 7-10 additional postoperative hospital days.[1,2]
   b. Patients with an SSI have a 2-11 times higher risk of death, compared with operative patients without an SSI.[3,4]
      i. Seventy-seven percent of deaths among patients with SSI are directly attributable to SSI.[5]
   c. Attributable costs of SSI vary, depending on the type of operative procedure and the type of infecting pathogen; published estimates range from $3,000 to $29,000.[4,6-12]
      i. SSIs are believed to account for up to $10 billion annually in healthcare expenditures.[3,4,13]

SECTION 2: STRATEGIES TO DETECT SSI

1. Definitions
   a. The Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System[14] and the National Healthcare Safety Network definitions for SSI are widely used.[14,15]
   b. SSIs are classified as follows (Figure):
      i. Superficial incisional (involving only skin or subcutaneous tissue of the incision)
      ii. Deep incisional (involving fascia and/or muscular layers)
      iii. Organ/space

2. Methods for surveillance of SSI
   a. The direct method, with daily observation of the surgical site by the physician, physician extender, a trained nurse, or infection prevention and control professional

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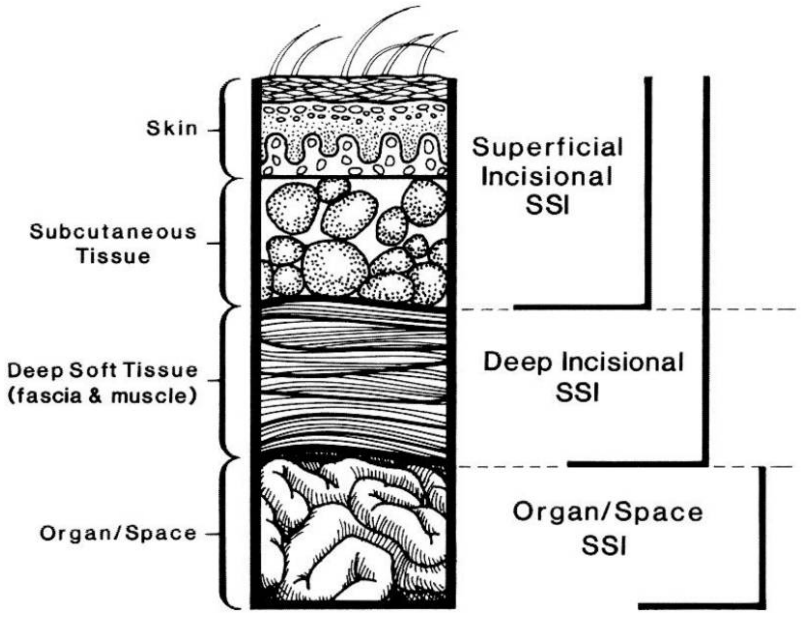

FIGURE. The Centers for Disease Control and Prevention National Healthcare Safety Network classification for surgical site infection (SSI). Reproduced from Horan et al.[14]

starting 24-48 hours after surgery, is the most accurate method of surveillance.[2,16-18]

i. Although the direct method is used as the "gold standard" for studies, it is rarely used in practice because of its resource utilization requirements and impracticality.

b. The indirect method of SSI surveillance consists of a combination of the following:

i. Review of microbiology reports and patient medical records

ii. Surgeon and/or patient surveys

iii. Screening for readmission of surgical patients

iv. Other information, such as coded diagnoses or operative reports

c. The indirect method of SSI surveillance is less time consuming and can be readily performed by infection prevention and control personnel during surveillance rounds.

d. The indirect method of SSI surveillance is both reliable (sensitivity, 84%-89%) and specific (specificity, 99.8%), compared with the "gold standard" of direct surveillance.[19,20]

e. Automated data systems can be used to broaden SSI surveillance.

i. SSI surveillance can be expanded by using hospital databases that include data on administrative claims, days of antimicrobial use, readmission to the hospital, and return to the operating room, and/or by implementing a system that imports automated microbiologic culture data, surgical procedure data, and general demographic information into a single surveillance database.[21-23]

ii. These methods improve the sensitivity of indirect surveillance for detection of SSI and reduce the need for efforts by infection prevention and control professionals.[21]

3. Postdischarge surveillance

a. Surgical procedures have been shifting to the outpatient setting during the past 3 decades.[24]

i. Patients now have shorter postoperative stays.[25]

b. No standardized or reliable method for postdischarge surveillance has been established. Different methods of postdischarge/outpatient SSI surveillance have been employed. Postdischarge surveillance based on surgeon and patient questionnaire results have been shown to have poor sensitivity and specificity. Regardless of which method is used, the overall rate of SSI for an institution typically increases after postdischarge surveillance methods are implemented.[26]

c. SSIs occurring and managed in the outpatient setting are usually superficial incisional infections. In contrast, deep incisional and organ/space infections typically require readmission to the hospital for management.

SECTION 3: STRATEGIES TO PREVENT SSI

1. Existing guidelines, recommendations, and requirements

a. Hospital Infection Control Practices Advisory Committee guidelines

i. The most recently published guidelines for prevention of SSI were released in 1999 by Mangram et al.[5]

ii. The pathogenesis of and likelihood of developing

an SSI involve a complex relationship among the following factors:

(a) Microbial characteristics (eg, degree of contamination and virulence of pathogen)

(b) Patient characteristics (eg, immune status and comorbid conditions)

(c) Surgical characteristics (eg, type of procedure, introduction of foreign material, and amount of damage to tissues)[27]

iii. Risk factors for SSI can be separated into intrinsic, patient-related characteristics and extrinsic, procedure-related characteristics. Table 1 summarizes the risk factors for each of these categories and provides recommendations (when available) to decrease the risk of SSI.

b. Surgical Infection Prevention Collaborative

i. The Centers for Medicare and Medicaid Services created the Surgical Infection Prevention Collaborative in 2002.

ii. After review of published guidelines, an expert panel identified 3 performance measures for quality improvement related to antimicrobial prophylaxis:[33,35]

(a) Delivery of intravenous antimicrobial prophylaxis within 1 hour before incision (2 hours are allowed for the administration of vancomycin and fluoroquinolones)

(b) Use of an antimicrobial prophylactic agent consistent with published guidelines

(c) Discontinuation of use of the prophylactic antimicrobial agent within 24 hours after surgery (discontinuation within 48 hours is allowable for cardiothoracic procedures for adult patients)

iii. The Surgical Infection Prevention Collaborative focuses on 7 procedures: abdominal hysterectomy, vaginal hysterectomy, hip arthroplasty, knee arthroplasty, cardiac surgery, vascular surgery, and colorectal surgery.

iv. Many hospitals that implemented and improved compliance with Surgical Infection Prevention Collaborative performance measures decreased their rates of SSI.[36]

c. Surgical Care Improvement Project

i. The Surgical Care Improvement Project, a multiagency collaboration created in 2003, is an extension of the Surgical Infection Prevention Collaborative.

ii. The Surgical Care Improvement Project, in addition to assessing the 3 performance measures of the Surgical Infection Prevention Collaborative, also focuses on 3 additional evidence-supported process measures to prevent SSI:[35]

(a) Proper hair removal: no hair removal or hair removal with clippers or depilatory method is considered appropriate; use of razors is considered inappropriate

(b) Controlling blood glucose level during the immediate postoperative period for patients undergoing cardiac surgery: controlled 6:00 AM blood glucose level (lower than 200 mg/dL) on postoperative day 1 and postoperative day 2, with procedure day being postoperative day 0

(c) Maintenance of perioperative normothermia for patients undergoing colorectal surgery

d. Institute for Healthcare Improvement

i. The Institute for Healthcare Improvement created a nationwide quality improvement project to improve outcomes for hospitalized patients.[37]

ii. The Institute for Healthcare Improvement recommends the same 6 preventive measures recommended by the Surgical Care Improvement Project and has included these in the 100,000 and 5 Million Lives campaigns.[37]

e. Federal requirements

i. Centers for Medicare and Medicaid Services

(a) In accordance with the Deficit Reduction Act of 2005, hospitals that are paid by Medicare under the acute care inpatient prospective payment system receive their full Medicare Annual Payment Update only if they submit required quality measure information to the Centers for Medicare and Medicaid Services.

(b) The Centers for Medicare and Medicaid Services now requires inclusion of 2 Surgical Care Improvement Project measures (antimicrobial prophylaxis provided within 1 hour before incision and discontinuation of antimicrobial prophylaxis within 24 hours after surgery) in the quality measure set of the inpatient prospective payment system.[38]

(c) Furthermore, the Centers for Medicare and Medicaid Services has proposed that additional Surgical Care Improvement Project measures described above (appropriate antimicrobial prophylactic agent, proper hair removal, perioperative glucose level control, and maintenance of normothermia) be included in the quality measure set in the near future.[38]

2. Infrastructure requirements

a. Trained personnel

i. Infection prevention and control personnel must be specifically trained in methods of SSI surveillance, have knowledge of and the ability to prospectively apply the Centers for Disease Control and Prevention definitions of SSI, possess basic computer and mathematical skills, and be adept at providing feedback and education to healthcare personnel when appropriate.[5]

b. Education

i. Regularly provide education to surgeons and perioperative personnel through continuing education activities directed at minimizing perioperative SSI risk through implementation of recommended process measures.

(a) Several educational components can be com-

TABLE 1. Selected Risk Factors for and Recommendations to Prevent Surgical Site Infections (SSIs)

Risk factor	Recommendation	Grade[a]
Intrinsic, patient related (preoperative)		
Unmodifiable		
Age	No formal recommendation: relationship to increased risk of SSI may be secondary to comorbidities or immune senescence [28-30]	…
Modifiable		
Glucose control, diabetes	Control serum blood glucose levels [5]; reduce glycosylated hemoglobin A1c levels to <7% before surgery, if possible [31]	A-II
Obesity	Increase dosing of prophylactic antimicrobial agent for morbidly obese patients [32]	A-II
Smoking cessation	Encourage smoking cessation within 30 days before procedure [5]	A-II
Immunosuppressive medications	No formal recommendation; in general, avoid immunosuppressive medications in perioperative period, if possible	C-II
Extrinsic, procedure related (perioperative)		
Preparation of patient		
Hair removal	Do not remove unless hair will interfere with the operation [5]; if hair removal is necessary, remove by clipping and do not use razors	A-I
Preoperative infections	Identify and treat infections (eg, urinary tract infection) remote to the surgical site before elective surgery [5]	A-II
Operative characteristics		
Surgical scrub (surgical team members' hands and forearms)	Use appropriate antiseptic agent to perform 2-5–minute preoperative surgical scrub [5] or use an alcohol-based surgical hand antisepsis product	A-II
Skin preparation	Wash and clean skin around incision site; use an appropriate antiseptic agent [5]	A-II
Antimicrobial prophylaxis	Administer only when indicated [5]	A-I
Timing	Administer within 1 hour before incision to maximize tissue concentration[b] [5, 33]	A-I
Choice	Select appropriate agents on the basis of surgical procedure, most common pathogens causing SSI for a specific procedure, and published recommendations [5, 33]	A-I
Duration of therapy	Stop prophylaxis within 24 hours after the procedure for all procedures except cardiac surgery; for cardiac surgery, antimicrobial prophylaxis should be stopped within 48 hours [5, 33]	A-I
Surgeon skill/technique	Handle tissue carefully and eradicate dead space [5]	A-III
Asepsis	Adhere to standard principles of operating room asepsis [5]	A-III
Operative time	No formal recommendation in most recent guidelines; minimize as much as possible [34]	A-III
Operating room characteristics		
Ventilation	Follow American Institute of Architects' recommendations [5]	C-I
Traffic	Minimize operating room traffic [5]	B-II
Environmental surfaces	Use a US Environmental Protection Agency–approved hospital disinfectant to clean surfaces and equipment [5]	B-III
Sterilization of surgical equipment	Sterilize all surgical equipment according to published guidelines; minimize the use of flash sterilization [5]	B-I

[a] See Table 2 for definitions.

[b] Vancomycin and fluoroquinolones can be given 2 hours before incision.

bined into concise, efficient, and effective recommendations that are easily understood and remembered.[39]

ii. Provide education regarding the outcomes associated with SSI, risks for SSI, and methods to reduce risk to all patients, patients' families, surgeons, and perioperative personnel.

iii. Education for patients and patients' families is an effective method to reduce risk associated with intrinsic patient-related SSI risk factors.[40,41]

c. Computer-assisted decision support and automated reminders

i. Several institutions have successfully employed computer-assisted decision-support methodology to improve the rate of appropriate administration of antimicrobial prophylaxis (including redosing during prolonged cases).[42-44]

ii. Computer-assisted decision support, however, is potentially expensive, can be time consuming to implement, and, in a single study, was reported to initially increase the rate of adverse drug reactions.[45]

iii. Institutions must appropriately validate computer-assisted decision-support systems after implementation.

d. Utilization of automated data

i. Install information technology infrastructure to facilitate data transfer, receipt, and organization to aid with the tracking of process and outcome measures.

SECTION 4: RECOMMENDATIONS FOR IMPLEMENTING PREVENTION AND MONITORING STRATEGIES

Recommendations for preventing and monitoring SSIs are summarized in the following section. They are designed to assist acute care hospitals in prioritizing and implementing their SSI prevention efforts. Criteria for grading of the strength of recommendation and quality of evidence are described in Table 2.

I. Basic practices for prevention and monitoring of SSI: recommended for all acute care hospitals

A. Surveillance of SSI

1. Perform surveillance for SSI (A-II).

a. Identify high-risk, high-volume operative procedures to be targeted for SSI surveillance on the basis of a risk assessment of patient populations, operative procedures performed, and available SSI surveillance data.

b. Identify, collect, store, and analyze data needed for the surveillance program.[5]

i. Implement a system for collecting data needed to identify SSIs.

ii. Develop a database for storing, managing, and accessing collected data on SSIs.

iii. Prepare periodic SSI reports (the time frame will depend on hospital needs and volume of targeted procedures).

iv. Collect denominator data on all patients undergoing targeted procedures, to calculate SSI rates for each type of procedure.[39]

v. Identify trends (eg, in rates of SSI and pathogens causing SSIs).

c. Use Centers for Disease Control and Prevention National Healthcare Safety Network definitions of SSI.[14]

d. Perform indirect surveillance for targeted procedures.[19,20,47,48]

e. Perform postoperative surveillance for 30 days; extend the postoperative surveillance period to 12 months if prosthetic material is implanted during surgery.[14]

f. Surveillance should be performed for patients readmitted to the hospital.

i. If an SSI is diagnosed at your institution but the surgical procedure was performed elsewhere, notify the hospital where the original procedure was performed.

g. Develop a system for routine review and interpretation of SSI rates to detect significant increases or outbreaks and to identify areas where additional resources might be needed to improve SSI rates.[47]

2. Provide ongoing feedback on SSI surveillance and process measures to surgical and perioperative personnel and leadership (A-II).

a. Routinely provide feedback on SSI rates and process measures to individual surgeons and hospital leadership.[5]

i. For each type of procedure performed, provide risk-adjusted rates of SSI.

ii. Anonymously benchmark procedure-specific risk-adjusted rates of SSI among peer surgeons.[5]

b. Confidentially provide data to individual surgeons, the surgical division, and/or department chiefs.

3. Increase the efficiency of surveillance through the use of automated data (A-II).

a. Implement a method to electronically transfer operative data, including process measures when available, to infection prevention and control personnel to facilitate acquisition of denominator data and calculation of SSI rates for various procedures.

b. If information technology and infrastructure resources are available, develop automated methods for detection of SSI by use of automated data on readmissions, microbiological test results, and antimicrobial dispensing.[23]

i. Implementation of automated surveillance may improve the sensitivity of surveillance.

B. Practice

1. Administer antimicrobial prophylaxis in accordance with evidence-based standards and guidelines (A-I).[5,49,50]

TABLE 2. Strength of Recommendation and Quality of Evidence

Category/grade	Definition
Strength of recommendation	
A	Good evidence to support a recommendation for use
B	Moderate evidence to support a recommendation for use
C	Poor evidence to support a recommendation
Quality of evidence	
I	Evidence from ⩾1 properly randomized, controlled trial
II	Evidence from ⩾1 well-designed clinical trial, without randomization; from cohort or case-control analytic studies (preferably from >1 center); from multiple time series; or from dramatic results from uncontrolled experiments
III	Evidence from opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees

NOTE. Adapted from the Canadian Task Force on the Periodic Health Examination.[46]

a. Administer prophylaxis within 1 hour before incision to maximize tissue concentration.[33,35]

i. Two hours are allowed for the administration of vancomycin and fluoroquinolones.

b. Select appropriate agents on the basis of the surgical procedure, the most common pathogens causing SSI for a specific procedure, and published recommendations.[33,35]

c. Discontinue prophylaxis within 24 hours after surgery for most procedures; discontinue within 48 hours for cardiac procedures.[33,35]

2. Do not remove hair at the operative site unless the presence of hair will interfere with the operation; do not use razors (A-II).[5]

a. If hair removal is necessary, remove it by clipping or by use of a depilatory agent.

3. Control blood glucose level during the immediate postoperative period for patients undergoing cardiac surgery (A-I).[35]

a. Maintain the postoperative blood glucose level at less than 200 mg/dL.

i. Measure blood glucose level at 6:00 AM on postoperative day 1 and postoperative day 2, with the procedure day being postoperative day 0.

b. Initiating close blood glucose control in the intraoperative period has not been shown to reduce the risk of SSI, compared with starting blood glucose control in the postoperative period. In fact, a recently performed randomized controlled trial showed that initiating close glucose control during cardiac surgery may actually lead to higher rates of adverse outcomes, including stroke and death.[51]

4. Measure and provide feedback to providers on the rates of compliance with process measures, including antimicrobial prophylaxis, proper hair removal, and glucose control (for cardiac surgery) (A-III).[35]

a. Routinely provide feedback to surgical staff and leadership, regarding compliance with targeted process measures.

5. Implement policies and practices aimed at reducing the risk of SSI that meet regulatory and accreditation requirements and that are aligned with evidence-based standards (eg, Centers for Disease Control and Prevention and professional organization guidelines) (A-II).[5,35,36]

a. Policies and practices should include but are not limited to the following:

i. Reducing modifiable patient risk factors

ii. Optimal cleaning and disinfection of equipment and the environment

iii. Optimal preparation and disinfection of the operative site and the hands of the surgical team members

iv. Adherence to hand hygiene

v. Traffic control in operating rooms

vi. See Table 1 for a more detailed list.

C. Education

1. Educate surgeons and perioperative personnel about SSI prevention (A-III).

a. Include risk factors, outcomes associated with SSI, local epidemiology (eg, SSI rates by procedure and the rate of methicillin-resistant *Staphylococcus aureus* [MRSA] infection in a facility), and basic prevention measures.

2. Educate patients and their families about SSI prevention, as appropriate (A-III).

a. Provide instructions and information to patients before surgery, describing strategies for reducing SSI risk. Specifically provide preprinted materials to patients.

b. Examples of printed materials for patients are available from the following Web pages:

i. JAMA patient page: wound infections (from the *Journal of the American Medical Association;* available at: http://jama.ama-assn.org/cgi/reprint/294/16/2122)

ii. Surgical Care Improvement Project consumer info sheet (available at: http://www.ofmq.com/Websites/ofmq/Images/FINALconsumer_tips2.pdf)

iii. What you need to know about infections after surgery: a fact sheet for patients and their family members (available at: http://www.ihi.org/NR/rdonlyres/0EE409F4-2F6A-4B55-AB01-16B6D6935EC5/0/SurgicalSiteInfectionsPtsandFam.pdf)

D. Accountability

1. The hospital's chief executive officer and senior management are responsible for ensuring that the healthcare system supports an infection prevention and control program that effectively prevents the occurrence of SSIs and the transmission of epidemiologically significant pathogens.

2. Senior management is accountable for ensuring that an adequate number of trained personnel are assigned to the infection prevention and control program.

3. Senior management is accountable for ensuring that healthcare personnel, including licensed and nonlicensed personnel, are competent to perform their job responsibilities.

4. Direct healthcare providers (such as physicians, nurses, aides, and therapists) and ancillary personnel (such as housekeeping and equipment-processing personnel) are responsible for ensuring that appropriate infection prevention and control practices are used at all times (including hand hygiene; strict adherence to aseptic technique; cleaning and disinfection of equipment and the environment; cleaning, disinfection, and sterilization of medical supplies and instruments; and appropriate surgical prophylaxis protocols).

5. Hospital and unit leaders are responsible for holding personnel accountable for their actions.

6. The person that manages the infection prevention and control program is responsible for ensuring that an active program to identify SSIs is implemented, that data on SSIs are analyzed and regularly provided to those who can use the information to improve the quality of care (eg, unit staff, clinicians, and hospital administrators), and that evidence-based practices are incorporated into the program.

7. Personnel responsible for healthcare personnel and patient education are accountable for ensuring that appropriate training and educational programs to prevent SSIs are developed and provided to personnel, patients, and families.

8. Personnel from the infection prevention and control program, the laboratory, and information technology departments are responsible for ensuring that systems are in place to support the surveillance program.

II. Special approaches for the prevention of SSI

Perform an SSI risk assessment. These special approaches are recommended for use in locations and/or populations within the hospital that have unacceptably high SSI rates despite implementation of the basic SSI prevention strategies listed above.

1. Perform expanded SSI surveillance to determine the source and extent of the problem and to identify possible targets for intervention (B-II).

a. Expand surveillance to include additional procedures and possibly to all National Healthcare Safety Network procedures.[5] Align expanded surveillance with the hospital's strategic plan.

III. Approaches that should not be considered a routine part of SSI prevention

1. Do not routinely use vancomycin for antimicrobial prophylaxis (B-II).

a. Vancomycin should not routinely be used for antimicrobial prophylaxis, but it can be an appropriate agent for specific scenarios. Reserve vancomycin for specific clinical circumstances, such as a proven outbreak of SSI due to MRSA, high endemic rates of SSI due to MRSA, targeted high-risk patients who are at increased risk for SSI due to MRSA (including cardiothoracic surgical patients and elderly patients with diabetes), and high-risk surgical procedures during which an implant is placed.[52]

i. No definitions for "high endemic rates of SSI due to MRSA" have been established.

ii. Studies of the efficacy of vancomycin prophylaxis were published before the emergence of community-acquired MRSA.

b. A recent meta-analysis of 7 studies comparing glycopeptide prophylaxis with β-lactam prophylaxis before cardiothoracic surgery showed that there was no difference in rates of SSI between the 2 antimicrobial prophylaxis regimens.[53]

c. No study has prospectively analyzed the effect of providing both glycopeptide and β-lactam antimicrobials for preoperative antimicrobial prophylaxis. Thus, it is unclear whether treatment with vancomycin, when indicated, should be added to or used in place of standard recommended antimicrobial prophylaxis. Because vancomycin does not have activity against gram-negative pathogens, some experts recommend *adding* vancomycin treatment to standard antimicrobial prophylaxis for the specific clinical circumstances described above.

2. Do not routinely delay surgery to provide parenteral nutrition (A-I).

a. Preoperative administration of total parenteral nutrition has not been shown to reduce the risk of SSI in prospective, randomized controlled trials and may increase the risk of SSI.[54,55]

IV. Unresolved issues

1. Preoperative bathing with chlorhexidine-containing products

a. Preoperative showering with agents such as chlorhexidine has been shown to reduce bacterial colonization of the skin.[56] Several studies have examined the utility of preoperative showers, but none has definitively proven that they decrease SSI risk. A recent Cochrane review[57] evaluated the evidence for preoperative bathing or showering with antiseptics for SSI prevention. Six randomized, controlled trials evaluating the use of 4% chlorhexidine gluconate were included in the analysis, with no clear evidence of benefit noted. To gain the maximum antiseptic effect of chlorhexidine, it must be allowed to dry completely and not be washed off.

2. Routine screening for MRSA or routine attempts to decolonize surgical patients with an antistaphylococcal agent in the preoperative setting

a. A recent double-blinded, randomized, controlled trial involving more than 4,000 patients showed that intranasal application of mupirocin did not significantly reduce the *S. aureus* SSI rate.[58] In a secondary analysis of these data, however, the use of intranasal mupirocin was associated with an overall decreased rate of nosocomial *S. aureus* infection among the *S. aureus* carriers.[58] Mupirocin resistance has been documented.[59]

b. In contrast, other studies have suggested that mupirocin may be effective for particular patient groups, including patients undergoing orthopedic[60,61] or cardiothoracic[62,63] surgery. However, these were not randomized controlled trials.

3. Maintaining oxygenation with supplemental oxygen during and after colorectal procedures

a. Three randomized clinical trials have been published comparing 80% fraction of inspired oxygen (FiO_2) with 30%-35% FiO_2 during the intra- and postoperative periods.

i. Two trials showed a significant decrease in the rate of SSI associated with the higher FiO_2 value,[64,65] and one actually showed a significant increase in the rate of SSI.[66]

ii. Both studies with results showing a beneficial effect of supplemental oxygen included patients who underwent colorectal surgery, whereas the study with results showing a negative effect of supplemental oxygen included all types of patients.

iii. When results of the 3 studies are pooled, the rate of SSI decreases from 15.2% among patients who received 30%-35% supplemental FiO_2 to 11.5% among patients who received 80% FiO_2 during surgery (3.7% absolute risk reduction; $P = .10$).[67]

4. Maintaining normothermia (temperature higher than 36.0°C) immediately after colorectal surgery

a. One randomized trial with 200 patients undergoing colorectal surgery found that infection rates were significantly reduced among patients randomized to have normothermia maintained during surgery.[68]

b. Controversy still exists regarding this recommendation, because of the following:

i. The trial examined the effect of *intraoperative* normothermia, not postoperative normothermia, and did not include risk adjustment for type of procedure.

ii. An observational study showed no impact of normothermia on infection rates.[69]

5. Preoperative intranasal and pharyngeal chlorhexidine treatment for patients undergoing cardiothoracic procedures[70]

a. Although data exist from a randomized, controlled trial to support its usage, chlorhexidine nasal cream is neither approved by the US Food and Drug Administration nor commercially available in the United States.

SECTION 5: PERFORMANCE MEASURES

I. Internal reporting

These performance measures are intended to support internal hospital quality improvement efforts and do not necessarily address external reporting needs.

The process and outcome measures suggested here are derived from published guidelines, other relevant literature, and the opinion of the authors. Report process and outcome measures to senior hospital leadership, nursing leadership, and clinicians who care for patients at risk for SSI.

A. Process measures

1. Compliance with antimicrobial prophylaxis guidelines

a. Measure the percentage of procedures in which antimicrobial prophylaxis was appropriately provided. Appropriateness includes (1) correct type of agent, (2) start of administration of the agent within 1 hour before incision (2 hours allowed for vancomycin and fluoroquinolones) and (3) discontinuation of the agent within 24 hours after surgery (48 hours for cardiac procedures).

i. Numerator: number of patients who appropriately received antimicrobial prophylaxis.

ii. Denominator: total number of selected operations performed.

iii. Multiply by 100 so that the measure is expressed as a percentage.

2. Compliance with hair-removal guidelines

a. Measure the percentage of procedures for which hair removal is appropriately performed (ie, clipping, use of a depilatory, or no hair removal, rather than use of a razor).

i. Numerator: number of patients with appropriate perioperative hair removal.

ii. Denominator: total number of selected operations performed.

iii. Multiply by 100 so that the measure is expressed as a percentage.

3. Compliance with perioperative glucose control guidelines

a. Measure the percentage of procedures for which serum glucose levels are maintained below 200 mg/dL at 6:00 AM on postoperative day 1 and postoperative day 2 after cardiac surgery.

i. Numerator: number of patients with appropriately maintained serum glucose at 6:00 AM on both postoperative day 1 and postoperative day 2 after cardiac surgery.

ii. Denominator: total number of cardiac procedures performed.

iii. Multiply by 100 so that measure is expressed as a percentage.

B. Outcome measures

1. Surgical site infection rate

a. Use National Healthcare Safety Network definitions and risk adjustment methods.[15]

i. Numerator: number of patients with surgical site infections after selected operations.

ii. Denominator: total number of selected operations performed.

iii. Multiply by 100 so that measure is expressed as a percentage.

iv. Risk adjustment: rates of SSI can be risk adjusted by use of one of 2 methods: stratification using the National Nosocomial Infections Surveillance risk index[27] or calculation of the standardized infection ratio.[71]

(a) The National Nosocomial Infections Surveillance risk index is a widely used, operation- and patient-specific, prospectively applied risk score that predicts SSI.[72] This risk index includes 3 predictors of increased risk of SSI: estimators of wound microbial contamination, duration of operation, and markers for host susceptibility.[73] Because rates of SSI published by National Healthcare Safety Network include superficial incisional infections, it is appropriate to collect data on superficial incisional infections for internal benchmarking.

(b) The standardized infection ratio (SIR) is the ratio of the observed number of SSIs *(O)* that occurred to the expected number for surgeons performing a specific type of procedure *(E)* (ie, SIR = *O/E*).[71] The expected number of SSIs can be obtained by multiplying the number of operations done by the surgeon in each procedure risk category by the National Nosocomial Infections Surveillance rate for the same procedure risk category and dividing by 100. Values that exceed 1.0 indicate that more SSIs than expected occurred.

II. External reporting

There are many challenges in providing useful information to consumers and other stakeholders while preventing unintended adverse consequences of public reporting of healthcare-associated infections.[74] Recommendations for public reporting of healthcare-associated infections have been provided by the Hospital Infection Control Practices Advisory Committee,[75] the Healthcare-Associated Infection Working Group of the Joint Public Policy Committee,[76] and the National Quality Forum.[77]

The following is an example of an external performance measure that is currently required by some healthcare stakeholders and regulators.

A. Process measure

1. Compliance with Centers for Medicare and Medicaid Services antimicrobial prophylaxis guidelines (see section 5.I.A.1 above: Performance Measures; Internal Reporting; Process Measures)

a. Measure the percentage of procedures in which antimicrobial prophylaxis was appropriately provided. Appropriateness includes correct type of agent, administration of the agent within 1 hour before incision (2 hours allowed for vancomycin and fluoroquinolones), and discontinuation of the agent within 24 hours after surgery (48 hours for cardiothoracic procedures).[38]

B. State and federal requirements

1. Federal requirements

a. Hospitals that receive Medicare reimbursement must collect and report quality measures required by Centers for Medicare and Medicaid Services (see above).

2. State requirements

a. Hospitals in states that have mandatory reporting requirements must collect and report the data required by the state. For information on state and federal requirements, check with your state or local health department.

3. External quality initiatives

a. Hospitals that participate in external quality initiatives must collect and report the data if required by the initiative.

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