# Preventing Surgical Site Infections

Edward L. Goodman, MD

September 16, 2013

# Outline

- NHSN Reporting and Definitions
- Magnitude of the Problem
- Risk Factors
- Non Pharmacologic Interventions
- Pharmacologic Interventions
- Conclusions

# Definitions and Public Reporting

# National Health Safety Network (NHSN)

## What is NHSN?

CDC's National Healthcare Safety Network is the nation's most widely used healthcare-associated infection (HAI) tracking system. NHSN provides facilities, states, regions, and the nation with data needed to identify problem areas, measure progress of prevention efforts, and ultimately eliminate healthcare-associated infections.

In addition, NHSN allows healthcare facilities to track blood safety errors and important healthcare process measures such as healthcare personnel influenza vaccine status and infection control adherence rates.

NHSN provides medical facilities, states, regions, and the nation with data collection and reporting capabilities needed to:

- identify infection prevention problems by facility, state, or specific quality improvement project
- benchmark progress of infection prevention efforts
- comply with state and federal public reporting mandates, and ultimately,
- drive national progress toward elimination of HAIs.

Beginning decades ago with 300 hospitals, NHSN now serves more than 11,000 medical facilities tracking HAIs. Current participants include acute care hospitals, long-term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centers, ambulatory surgery centers, and nursing homes, with hospitals and dialysis facilities representing the majority of facilities reporting data. Participation among the other facility types is expected to continue to grow in coming years.

# THR:Public Reporting of SSI

| Metric | Reported To | Reporting Interval |
|---|---|---|
| **SSI:** | | |
| Colon | THR/CMS/TDSHS 2013 | monthly |
| Abd Hsyterectomy | THR/CMS/TDSHS 2013 | monthly |
| CABG | THR/CMS/TDSHS 2013 | monthly |
| Hip replacement | THR/TDSHS | monthly |
| Knee replacement | THR/TDSHS | monthly |
| AAA | THR/TDSHS 2013 | monthly |
| Carotid Endarterectomy | THR/TDSHS 2013 | monthly |
| Femoral Popliteal Bypass | THR/TDSHS 2013 | monthly |
| Gastric | THR for Quest | monthly |
| Fusion of elbow | THR for Quest | monthly |
| Fusion of shoulder | THR for Quest | monthly |
| Fusion of spine | THR for Quest | monthly |

# Infection Prevention: Multifactorial Approach

- Classic Infection Control
  - Surveillance
    - Standard definitions
    - Agreed upon targets
    - Pre-intervention data
    - Post-intervention data
  - Feedback to customers
    - Comparison between institutions
    - Best practice models

# Infection Control Program Components

- Trained surveillance personnel
  - APIC trained and certified
- Accurate denominator data for targeted procedures
  - Electronic collection
  - Stratified by NHSN categories
- Actively obtain numerator data
  - Micro reports via Safety Surveillor™
  - Clinical reporting
  - Shoeleather epidemiology: “walking the halls”
  - Post discharge letters to surgeons

# Definitions

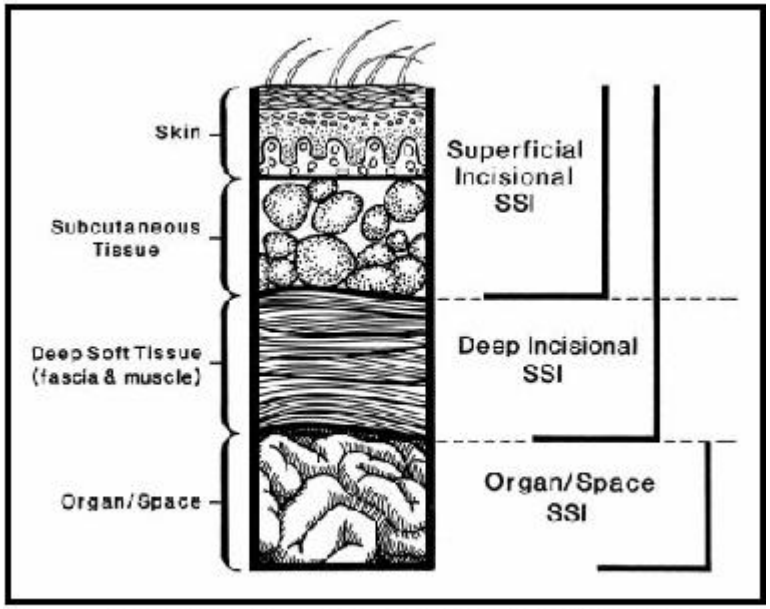



**FIGURE.** Cross-section of abdominal wall depicting CDC classifications of surgical site infection.[22]

**Table 2.** ***Surgical Site Infection Criteria***

| Criterion | Surgical Site Infection (SSI) |
|---|---|
| | **Superficial incisional SSI**<br>Must meet the following criterion: |
| | Infection occurs within 30 days after any NHSN operative procedure, including those coded as 'OTH'*<br>*and*<br>involves only skin and subcutaneous tissue of the incision<br>*and*<br>patient has at least one of the following:<br>a. purulent drainage from the superficial incision.<br>b. organisms isolated from an aseptically-obtained culture of fluid or tissue from the superficial incision.<br>c. superficial incision that is deliberately opened by a surgeon and is culture-positive or not cultured<br>*and*<br>patient has at least one of the following signs or symptoms: pain or tenderness; localized swelling; redness; or heat. A culture negative finding does not meet this criterion.<br>d. diagnosis of a superficial incisional SSI by the surgeon or attending physician or other designee (see reporting instructions). |

**Deep incisional SSI**

Must meet the following criterion:

Infection occurs within 30 or 90 days after the NHSN operative procedure according to the list in Table 3

*and*

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

*and*

patient has at least one of the following:

a. purulent drainage from the deep incision.
b. a deep incision that spontaneously dehisces or is deliberately opened by a surgeon and is culture-positive or not cultured
   *and*
   patient has at least one of the following signs or symptoms: fever (>38°C); 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 that is found on direct examination, during invasive procedure, or by histopathologic examination or imaging test.
d. diagnosis of a deep incisional SSI by a surgeon or attending physician or other designee (see reporting instruction).

**Organ/Space SSI**

Must meet the following criterion:

Infection occurs within 30 or 90 days after the NHSN operative procedure according to the list in Table 3

*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 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 invasive procedure, or by histopathologic examination or imaging test
d. diagnosis of an organ/space SSI by a surgeon or attending physician or other designee (see reporting instruction).

*and*

meets at least one criterion for a specific organ/space infection site listed in Table 4.

**Table 3.** *Surveillance Period for Deep Incisional or Organ/Space SSI Following Selected NHSN Operative Procedure Categories*

| 30-day Surveillance | | | |
|---|---|---|---|
| **Code** | **Operative Procedure** | **Code** | **Operative Procedure** |
| AAA | Abdominal aortic aneurysm repair | LAM | Laminectomy |
| AMP | Limb amputation | LTP | Liver transplant |
| APPY | Appendix surgery | NECK | Neck surgery |
| AVSD | Shunt for dialysis | NEPH | Kidney surgery |
| BILI | Bile duct, liver or pancreatic surgery | OVRY | Ovarian surgery |
| CEA | Carotid endarterectomy | PRST | Prostate surgery |
| CHOL | Gallbladder surgery | REC | Rectal surgery |
| COLO | Colon surgery | SB | Small bowel surgery |
| CSEC | Cesarean section | SPLE | Spleen surgery |
| GAST | Gastric surgery | THOR | Thoracic surgery |
| HTP | Heart transplant | THYR | Thyroid and/or parathyroid surgery |
| HYST | Abdominal hysterectomy | VHYS | Vaginal hysterectomy |
| KTP | Kidney transplant | XLAP | Exploratory Laparotomy |
| | | OTH | Other operative procedures not included in the NHSN categories |

| 90-day Surveillance | |
|---|---|
| **Code** | **Operative Procedure** |
| BRST | Breast surgery |
| CARD | Cardiac surgery |
| CBGB | Coronary artery bypass graft with both chest and donor site incisions |
| CBGC | Coronary artery bypass graft with chest incision only |
| CRAN | Craniotomy |
| FUSN | Spinal fusion |
| FX | Open reduction of fracture |
| HER | Herniorrhaphy |
| HPRO | Hip prosthesis |
| KPRO | Knee prosthesis |
| PACE | Pacemaker surgery |
| PVBY | Peripheral vascular bypass surgery |
| RFUSN | Refusion of spine |
| VSHN | Ventricular shunt |

NOTE: Superficial incisional SSIs are only followed for a 30-day period for all procedure types.

# Magnitude of the Problem

Burke. N Eng J Med 2003;348:651-6

**Table 1. Nosocomial Infections in the United States.***

| Variable | Year | |
|---|---|---|
| | 1975 | 1995 |
| No. of admissions ($\times 10^{-6}$) | 37.7 | 35.9 |
| No. of patient-days ($\times 10^{-6}$) | 299.0 | 190.0 |
| Average length of stay (days) | 7.9 | 5.3 |
| No. of inpatient surgical procedures ($\times 10^{-6}$) | 18.3 | 13.3 |
| No. of nosocomial infections ($\times 10^{-6}$) | 2.1 | 1.9 |
| Incidence of nosocomial infections (no. per 1000 patient-days) | 7.2 | 9.8 |

# Magnitude

Burke

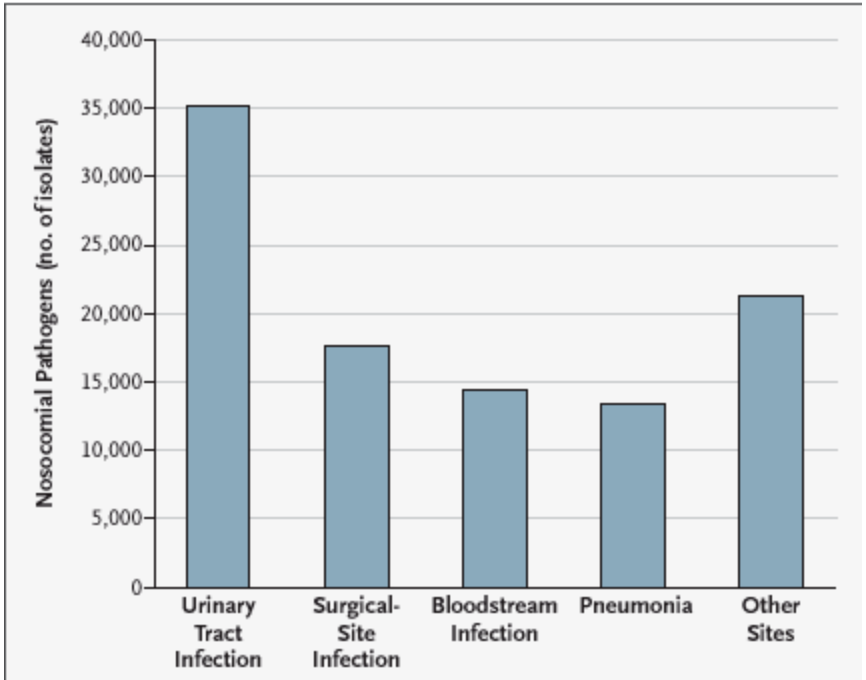



**Figure 1. Number of Nosocomial Pathogens, According to Infection Site, Identified in the Hospital-Wide Component of the National Nosocomial Infections Surveillance System from January 1990 to March 1996.**

The hospital-wide component of the National Nosocomial Infections Surveillance System consists of a subgroup of hospitals reporting data on nosocomial infections from all patients. In January 1999, this component was eliminated from the system.

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 |

# Microbiology by Surgery Site

| Operations | Likely Pathogens†‡ |
|---|---|
| Placement of all grafts, prostheses, or implants | *Staphylococcus aureus;* coagulase-negative staphylococci |
| Cardiac | *S. aureus;* coagulase-negative staphylococci |
| Neurosurgery | *S. aureus;* coagulase-negative staphylococci |
| Breast | *S. aureus;* coagulase-negative staphylococci |
| Ophthalmic | *S. aureus;* coagulase-negative staphylococci; streptococci; gram-negative bacilli |
| Limited data; however, commonly used in procedures such as anterior segment resection, vitrectomy, and scleral buckles | |
| Orthopedic | *S. aureus;* coagulase-negative staphylococci; gram-negative bacilli |
| Total joint replacement | |
| Closed fractures/use of nails, bone plates, other internal fixation devices | |
| Functional repair without implant/device | |
| Trauma | |
| Noncardiac thoracic | *S. aureus;* coagulase-negative staphylococci; *Streptococcus pneumoniae;* gram-negative bacilli |
| Thoracic (lobectomy, pneumonectomy, wedge resection, other noncardiac mediastinal procedures) | |
| Closed tube thoracostomy | |
| Vascular | *S. aureus;* coagulase-negative staphylococci |
| Appendectomy | Gram-negative bacilli; anaerobes |
| Biliary tract | Gram-negative bacilli; anaerobes |
| Colorectal | Gram-negative bacilli; anaerobes |
| Gastroduodenal | Gram-negative bacilli; streptococci; oropharyngeal anaerobes (e.g., peptostreptococci) |
| Head and neck (major procedures with incision through oropharyngeal mucosa) | *S. aureus;* streptococci; oropharyngeal anaerobes (e.g., peptostreptococci) |
| Obstetric and gynecologic | Gram-negative bacilli; enterococci; group B streptococci; anaerobes |
| Urologic | Gram-negative bacilli |
| May not be beneficial if urine is sterile | |

# Non Pharmacologic Operative Interventions

- Skin prep
  - Clipping not shaving when at all possible
  - Skin Antisepsis
- Supplemental oxygen during surgery
- Maintenance of normothermia
- Maintenance of normoglycemia

New Eng J Med 2010;361:1

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

# Chlorhexidine–Alcohol versus Povidone–Iodine for Surgical-Site Antisepsis

Rabih O. Darouiche, M.D., Matthew J. Wall, Jr., M.D., Kamal M.F. Itani, M.D., Mary F. Otterson, M.D., Alexandra L. Webb, M.D., Matthew M. Carrick, M.D., Harold J. Miller, M.D., Samir S. Awad, M.D., Cynthia T. Crosby, B.S., Michael C. Mosier, Ph.D., Atef AlSharif, M.D., and David H. Berger, M.D.

## BACKGROUND

Since the patient's skin is a major source of pathogens that cause surgical-site infection, optimization of preoperative skin antisepsis may decrease postoperative infections. We hypothesized that preoperative skin cleansing with chlorhexidine–alcohol is more protective against infection than is povidone–iodine.

## METHODS

We randomly assigned adults undergoing clean-contaminated surgery in six hospitals to preoperative skin preparation with either chlorhexidine–alcohol scrub or povidone–iodine scrub and paint. The primary outcome was any surgical-site infection within 30 days after surgery. Secondary outcomes included individual types of surgical-site infections.

## RESULTS

A total of 849 subjects (409 in the chlorhexidine–alcohol group and 440 in the povidone–iodine group) qualified for the intention-to-treat analysis. The overall rate of surgical-site infection was significantly lower in the chlorhexidine–alcohol group than in the povidone–iodine group (9.5% vs. 16.1%; P=0.004; relative risk, 0.59; 95% confidence interval, 0.41 to 0.85). Chlorhexidine–alcohol was significantly more protective than povidone–iodine against both superficial incisional infections (4.2% vs. 8.6%, P=0.008) and deep incisional infections (1% vs. 3%, P=0.05) but not against organ-space infections (4.4% vs. 4.5%). Similar results were observed in the per-protocol analysis of the 813 patients who remained in the study during the 30-day follow-up period. Adverse events were similar in the two study groups.

**Table 2. Proportion of Patients with Surgical-Site Infection, According to Type of Infection (Intention-to-Treat Population).**

| Type of Infection | Chlorhexidine–Alcohol (N=409) | Povidone–Iodine (N=440) | Relative Risk (95% CI)* | P Value† |
|---|---|---|---|---|
| | *no. (%)* | | | |
| Any surgical-site infection | 39 (9.5) | 71 (16.1) | 0.59 (0.41–0.85) | 0.004 |
| Superficial incisional infection | 17 (4.2) | 38 (8.6) | 0.48 (0.28–0.84) | 0.008 |
| Deep incisional infection | 4 (1.0) | 13 (3.0) | 0.33 (0.11–1.01) | 0.05 |
| Organ-space infection | 18 (4.4) | 20 (4.5) | 0.97 (0.52–1.80) | >0.99 |
| Sepsis from surgical-site infection | 11 (2.7) | 19 (4.3) | 0.62 (0.30–1.29) | 0.26 |

* Relative risks are for chlorhexidine–alcohol as compared with povidone–iodine. The 95% confidence intervals were calculated with the use of asymptotic standard-error estimates.
† P values are based on Fisher's exact test.

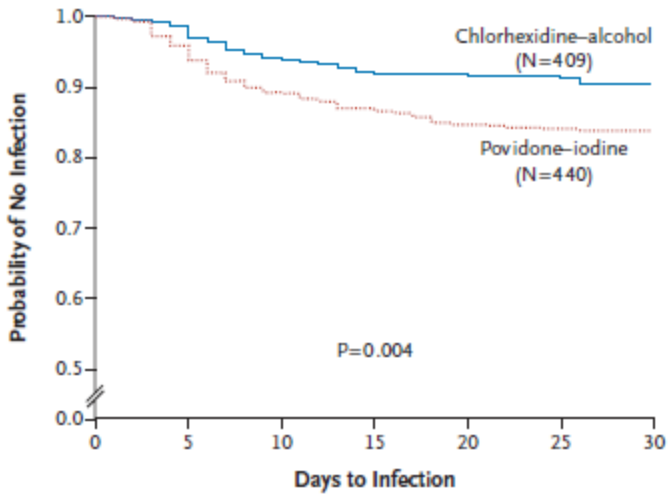



**Figure 2. Kaplan–Meier Curves for Freedom from Surgical-Site Infection (Intention-to-Treat Population).**
Patients who received chlorhexidine–alcohol were significantly more likely to remain free from surgical-site infection than were those who received povidone–iodine (P=0.004 by the log-rank test). In the chlorhexidine–alcohol group, 39 patients had events (9.5%) and data from 370 patients (90.5%) were censored; in the povidone–iodine group, 71 patients had events (16.1%) and data from 369 patients (83.9%) were censored.

# Perioperative Antimicrobials

- Topical
- Systemic

# Topical Mupirocin

- Nasal Source of Staph Aureus for subsequent SSI
- Preoperative topical use in nares
  - Only on those patients known to be carriers
  - Screening required to stratify
- Resistance is becoming an issue
  - Prolonged use CONTRAINDICATED
  - No evidence of any benefit beyond 5-7 days

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 7, 2010 VOL. 362 NO. 1

# Preventing Surgical-Site Infections in Nasal Carriers of *Staphylococcus aureus*

Lonneke G.M. Bode, M.D., Jan A.J.W. Kluytmans, M.D., Ph.D., Heiman F.L. Wertheim, M.D., Ph.D., Diana Bogaers, I.C.P., Christina M.J.E. Vandenbroucke-Grauls, M.D., Ph.D., Robert Roosendaal, Ph.D., Annet Troelstra, M.D., Ph.D., Adrienne T.A. Box, B.A.Sc., Andreas Voss, M.D., Ph.D., Ingeborg van der Tweel, Ph.D., Alex van Belkum, Ph.D., Henri A. Verbrugh, M.D., Ph.D., and Margreet C. Vos, M.D., Ph.D.

## BACKGROUND

Nasal carriers of *Staphylococcus aureus* are at increased risk for health care–associated infections with this organism. Decolonization of nasal and extranasal sites on hospital admission may reduce this risk.

## METHODS

In a randomized, double-blind, placebo-controlled, multicenter trial, we assessed whether rapid identification of *S. aureus* nasal carriers by means of a real-time polymerase-chain-reaction (PCR) assay, followed by treatment with mupirocin nasal ointment and chlorhexidine soap, reduces the risk of hospital-associated *S. aureus* infection.

## RESULTS

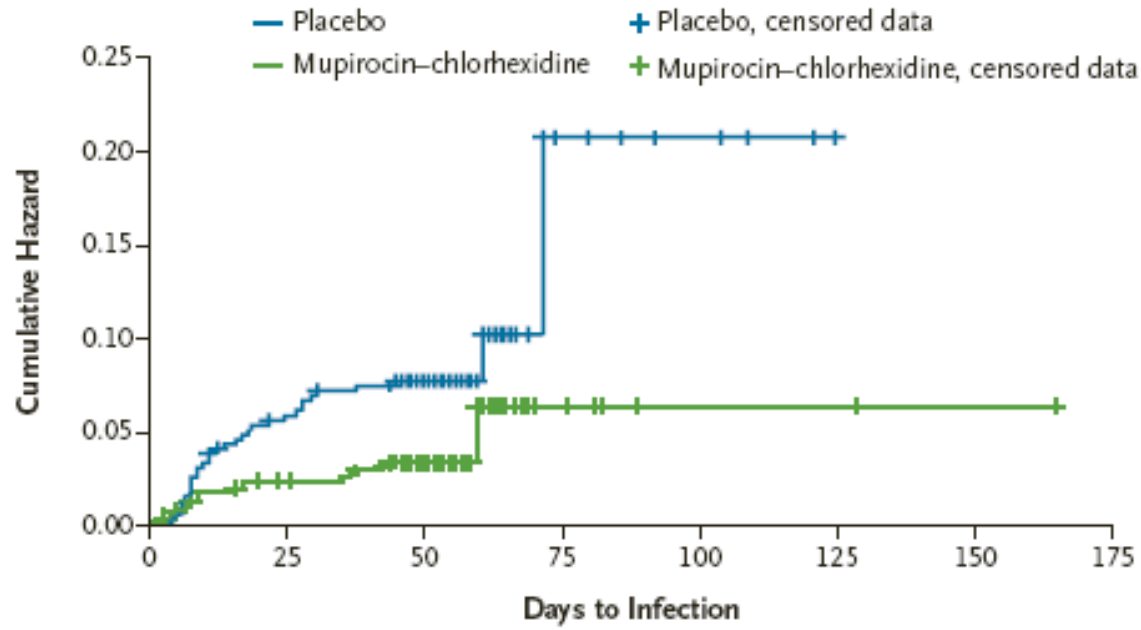
From October 2005 through June 2007, a total of 6771 patients were screened on admission. A total of 1270 nasal swabs from 1251 patients were positive for *S. aureus*. We enrolled 917 of these patients in the intention-to-treat analysis, of whom 808 (88.1%) underwent a surgical procedure. All the *S. aureus* strains identified on PCR assay were susceptible to methicillin and mupirocin. The rate of *S. aureus* infection was 3.4% (17 of 504 patients) in the mupirocin–chlorhexidine group, as compared with 7.7% (32 of 413 patients) in the placebo group (relative risk of infection, 0.42; 95% confidence interval [CI], 0.23 to 0.75). The effect of mupirocin–chlorhexidine treatment was most pronounced for deep surgical-site infections (relative risk, 0.21; 95% CI, 0.07 to 0.62). There was no significant difference in all-cause in-hospital mortality between the two groups. The time to the onset of nosocomial infection was shorter in the placebo group than in the mupirocin–chlorhexidine group ($P=0.005$).

## CONCLUSIONS

The number of surgical-site *S. aureus* infections acquired in the hospital can be reduced by rapid screening and decolonizing of nasal carriers of *S. aureus* on admission. (Current Controlled Trials number, ISRCTN56186788.)

**Table 2.** Relative Risk of Hospital-Acquired *Staphylococcus aureus* Infection and Characteristics of Infections (Intention-to-Treat Analysis).

| Variable | Mupirocin–Chlorhexidine (N=504) | Placebo (N=413) | Relative Risk (95% CI)* |
|---|---|---|---|
| | *no. (%)* | | |
| *S. aureus* infection | 17 (3.4) | 32 (7.7) | 0.42 (0.23–0.75) |
| Source of infection† | | | |
| Endogenous | 12 (2.4) | 25 (6.1) | 0.39 (0.20–0.77) |
| Exogenous | 4 (0.8) | 6 (1.5) | 0.55 (0.16–1.92) |
| Unknown | 1 (0.2) | 1 (0.2) | |
| Localization of infection | | | |
| Deep surgical site‡ | 4 (0.9) | 16 (4.4) | 0.21 (0.07–0.62) |
| Superficial surgical site‡ | 7 (1.6) | 13 (3.5) | 0.45 (0.18–1.11) |
| Lower respiratory tract | 2 (0.4) | 2 (0.5) | 0.82 (0.12–5.78) |
| Urinary tract | 1 (0.2) | 0 | |
| Bacteremia | 1 (0.2) | 1 (0.2) | |
| Soft tissue | 2 (0.4) | 0 | |




| No. at Risk | | | | | | |
|---|---|---|---|---|---|---|
| Mupirocin–chlorhexidine | 504 | 484 | 240 | 6 | 2 | 1 |
| Placebo | 413 | 386 | 204 | 7 | 4 | 0 |

**Figure 3. Kaplan–Meier Curves Showing Cumulative Hazard of Hospital-Acquired *Staphylococcus aureus* Infection in the Study Groups.**

Data were censored at the end of the follow-up period or at the time of death.

Institute *for* Healthcare Improvement

# Project JOINTS: **J**oining **O**rganizations **IN** **T**ackling **S**SIs

***Screen patients for Staph aureus (SA) carriage and decolonize SA carriers with five days of intranasal mupirocin and at least three days of CHG soap prior to surgery***

# Interventions to Prevent SSIs for Hip and Knee Arthroplasty

## New Practices:

- Use of an alcohol-containing antiseptic agent for pre-op skin prep
- Instruct patients to bathe or shower with chlorhexidine gluconate (CHG) soap for at least three days before surgery
- **Screen patients for *Staphylococcus aureus* (SA) and decolonize SA carriers with five days of intranasal mupirocin and bathing or showering with CHG soap for at least three days before surgery**

# Pre Operative Systemic Antibiotics

- Type of surgery
  - Clean contaminated
    - Transect mucosal surfaces
  - Clean with high risk of infection
    - Insertion of prosthesis
    - Cardiac/neurosurgery
- Choice of drug
- Timing of drug
- Duration of drug

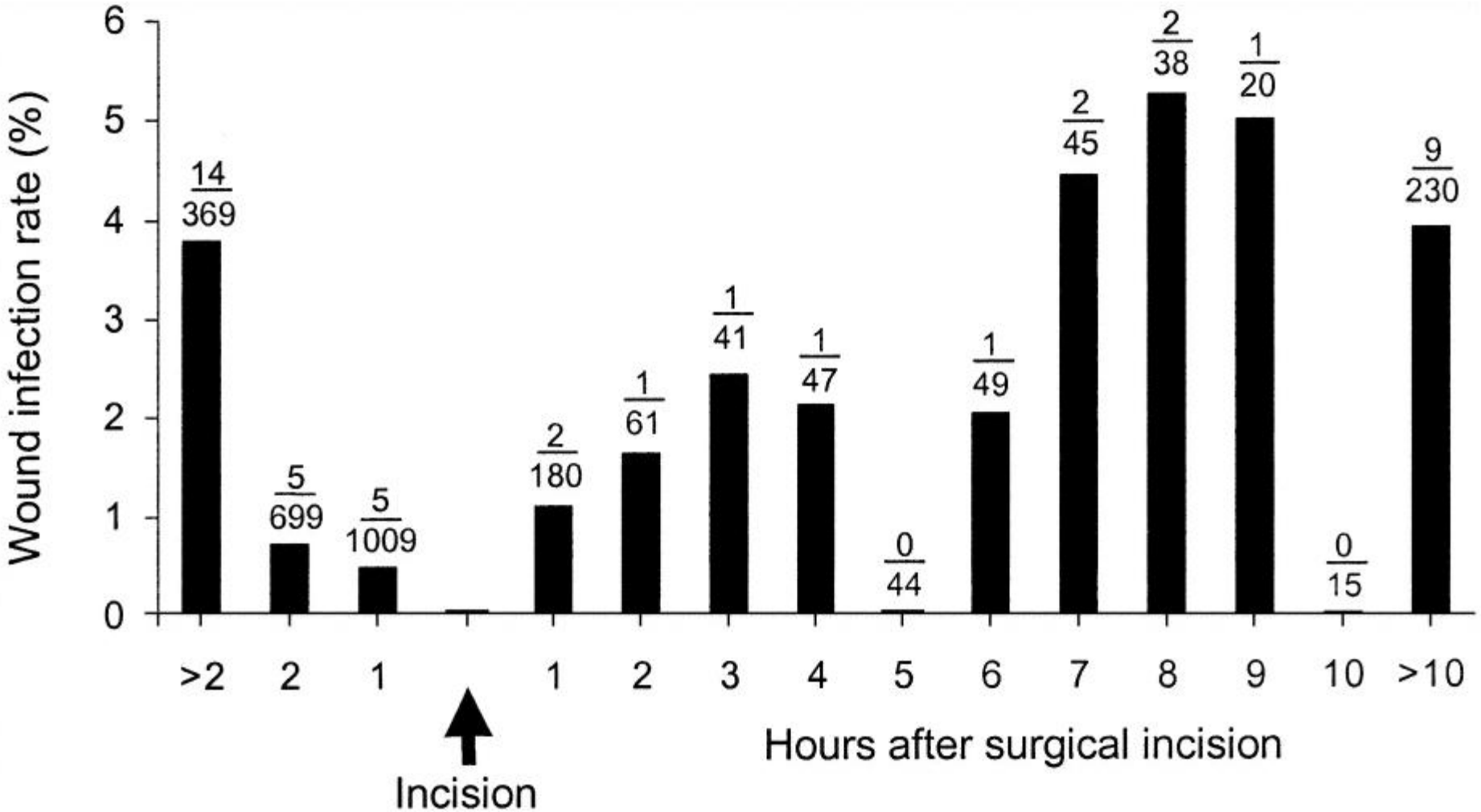
**Table 3. Summary of the Surgical Infection Prevention Guideline Writers Workgroup consensus positions.**

| Principle | Consensus position |
|---|---|
| General dosing | |
| Antibiotic timing | Infusion of the first antimicrobial dose should begin within 60 min before the surgical incision.[a] |
| Duration of prophylaxis | Prophylactic antimicrobials should be discontinued within 24 h after the end of surgery. |
| Screening for β-lactam allergy | For those operations for which cephalosporins represent the most appropriate antimicrobials for prophylaxis, the medical history should be adequate to determine whether the patient has a history of allergy or serious adverse antibiotic reaction. Alternative testing strategies (e.g., skin testing) may be useful for patients with reported allergy [36–38]. |
| Antimicrobial dosing | The initial antimicrobial dose should be adequate based on the patient's body weight, adjusted dosing weight, or body mass index. An additional antimicrobial dose should be provided intraoperatively if the operation is still continuing 2 half-lives after the initial dose.[b] |
| Antibiotic selection, by procedure | |
| Abdominal or vaginal hysterectomy | Cefotetan therapy is preferred; cefazolin or cefoxitin are alternatives. Metronidazole monotherapy is also used.[c] If the patient has a β-lactam allergy, use clindamycin combined with gentamicin or ciprofloxacin[d] or aztreonam; metronidazole with gentamicin or ciprofloxacin;[d] or clindamycin monotherapy. |
| Hip or knee arthroplasty | Use cefazolin or cefuroxime. If the patient has a β-lactam allergy, use vancomycin or clindamycin. |
| Cardiothoracic and vascular surgery | Use cefazolin or cefuroxime. If the patient has a β-lactam allergy, use vancomycin or clindamycin. |
| Colon surgery | For oral antimicrobial prophylaxis, use neomycin plus erythromycin base or neomycin plus metronidazole. For parenteral antimicrobial prophylaxis, use cefotetan, cefoxitin, or cefazolin plus metronidazole. If the patient has a β-lactam allergy, use clindamycin combined with gentamicin, ciprofloxacin, or aztreonam, or use metronidazole combined with gentamicin or ciprofloxacin.[d] |

[a] When fluoroquinolone or vancomycin are indicated, infusion of the first antimicrobial dose should begin within 120 min before the incision.
[b] See table 2.
[c] Metronidazole monotherapy is included in the Practice Bulletin of the American College of Obstetricians and Gynecologist as an alternative to β-lactams for patients undergoing hysterectomy, although it may be less effective as a single agent for prophylaxis [15].
[d] A single 750-mg dose of levofloxacin may be substituted for ciprofloxacin.

# Timing of Antibiotics

Classen et al. N Eng J Med 1992; 326:281-6



# Clinical practice guidelines for antimicrobial prophylaxis in surgery

Dale W. Bratzler, E. Patchen Dellinger, Keith M. Olsen, Trish M. Perl, Paul G. Auwaerter, Maureen K. Bolon, Douglas N. Fish, Lena M. Napolitano, Robert G. Sawyer, Douglas Slain, James P. Steinberg, and Robert A. Weinstein

**Am J Health-Syst Pharm.** 2013; 70:195-283

Table 1.
**Recommended Doses and Redosing Intervals for Commonly Used Antimicrobials for Surgical Prophylaxis**

| Antimicrobial | Recommended Dose | | Half-life in Adults With Normal Renal Function, hr[19] | Recommended Redosing Interval (From Initiation of Preoperative Dose), hr[c] |
|---|---|---|---|---|
| | Adults[a] | Pediatrics[b] | | |
| Ampicillin–sulbactam | 3 g (ampicillin 2 g/sulbactam 1 g) | 50 mg/kg of the ampicillin component | 0.8–1.3 | 2 |
| Ampicillin | 2 g | 50 mg/kg | 1–1.9 | 2 |
| Aztreonam | 2 g | 30 mg/kg | 1.3–2.4 | 4 |
| Cefazolin | 2 g, 3 g for pts weighing ≥120 kg | 30 mg/kg | 1.2–2.2 | 4 |
| Cefuroxime | 1.5 g | 50 mg/kg | 1–2 | 4 |
| Cefotaxime | 1 g[d] | 50 mg/kg | 0.9–1.7 | 3 |
| Cefoxitin | 2 g | 40 mg/kg | 0.7–1.1 | 2 |
| Cefotetan | 2 g | 40 mg/kg | 2.8–4.6 | 6 |
| Ceftriaxone | 2 g[e] | 50–75 mg/kg | 5.4–10.9 | NA |
| Ciprofloxacin[f] | 400 mg | 10 mg/kg | 3–7 | NA |
| Clindamycin | 900 mg | 10 mg/kg | 2–4 | 6 |
| Ertapenem | 1 g | 15 mg/kg | 3–5 | NA |
| Fluconazole | 400 mg | 6 mg/kg | 30 | NA |
| Gentamicin[g] | 5 mg/kg based on dosing weight (single dose) | 2.5 mg/kg based on dosing weight | 2–3 | NA |
| Levofloxacin[f] | 500 mg | 10 mg/kg | 6–8 | NA |
| Metronidazole | 500 mg | 15 mg/kg<br>Neonates weighing <1200 g should receive a single 7.5-mg/kg dose | 6–8 | NA |
| Moxifloxacin[f] | 400 mg | 10 mg/kg | 8–15 | NA |
| Piperacillin–tazobactam | 3.375 g | Infants 2–9 mo: 80 mg/kg of the piperacillin component<br>Children >9 mo and ≤40 kg: 100 mg/kg of the piperacillin component | 0.7–1.2 | 2 |
| Vancomycin | 15 mg/kg | 15 mg/kg | 4–8 | NA |
| *Oral antibiotics for colorectal surgery prophylaxis (used in conjunction with a mechanical bowel preparation)* | | | | |
| Erythromycin base | 1 g | 20 mg/kg | 0.8–3 | NA |
| Metronidazole | 1 g | 15 mg/kg | 6–10 | NA |
| Neomycin | 1 g | 15 mg/kg | 2–3 (3% absorbed under normal gastrointestinal conditions) | NA |

Table 2.
**Recommendations for Surgical Antimicrobial Prophylaxis**

| Type of Procedure | Recommended Agents[a,b] | Alternative Agents in Pts With β-Lactam Allergy | Strength of Evidence[c] |
|---|---|---|---|
| Cardiac | | | |
| Coronary artery bypass | Cefazolin, cefuroxime | Clindamycin,[d] vancomycin[d] | A |
| Cardiac device insertion procedures (e.g., pacemaker implantation) | Cefazolin, cefuroxime | Clindamycin, vancomycin | A |
| Ventricular assist devices | Cefazolin, cefuroxime | Clindamycin, vancomycin | C |
| Thoracic | | | |
| Noncardiac procedures, including lobectomy, pneumonectomy, lung resection, and thoracotomy | Cefazolin, ampicillin–sulbactam | Clindamycin,[d] vancomycin[d] | A |
| Video-assisted thoracoscopic surgery | Cefazolin, ampicillin–sulbactam | Clindamycin,[d] vancomycin[d] | C |
| Gastroduodenal[e] | | | |
| Procedures involving entry into lumen of gastrointestinal tract (bariatric, pancreaticoduodenectomy[f]) | Cefazolin | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] | A |
| Procedures without entry into gastrointestinal tract (antireflux, highly selective vagotomy) for high-risk patients | Cefazolin | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] | A |
| Biliary tract | | | |
| Open procedure | Cefazolin, cefoxitin, cefotetan, ceftriaxone,[k] ampicillin–sulbactam[h] | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]<br>Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j] | A |
| Laparoscopic procedure | | | |
| Elective, low-risk[l] | None | None | A |
| Elective, high-risk[l] | Cefazolin, cefoxitin, cefotetan, ceftriaxone,[k] ampicillin–sulbactam[h] | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]<br>Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j] | A |
| Appendectomy for uncomplicated appendicitis | Cefoxitin, cefotetan, cefazolin + metronidazole | Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]<br>Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j] | A |
| Small intestine | | | |
| Nonobstructed | Cefazolin | Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] | C |

Table 2 (*continued*)

| Type of Procedure | Recommended Agents[a,b] | Alternative Agents in Pts With β-Lactam Allergy | Strength of Evidence[c] |
|---|---|---|---|
| Obstructed | Cefazolin + metronidazole, cefoxitin, cefotetan | Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j] | C |
| Hernia repair (hernioplasty and herniorrhaphy) | Cefazolin | Clindamycin, vancomycin | A |
| Colorectal[m] | Cefazolin + metronidazole, cefoxitin, cefotetan, ampicillin–sulbactam,[h] ceftriaxone + metronidazole,[n] ertapenem | Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j], metronidazole + aminoglycoside[g] or fluoroquinolone[h-j] | A |
| Head and neck | | | |
| Clean | None | None | B |
| Clean with placement of prosthesis (excludes tympanostomy tubes) | Cefazolin, cefuroxime | Clindamycin[d] | C |
| Clean-contaminated cancer surgery | Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin–sulbactam | Clindamycin[d] | A |
| Other clean-contaminated procedures with the exception of tonsillectomy and functional endoscopic sinus procedures | Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin–sulbactam | Clindamycin[d] | B |
| Neurosurgery | | | |
| Elective craniotomy and cerebrospinal fluid-shunting procedures | Cefazolin | Clindamycin,[d] vancomycin[d] | A |
| Implantation of intrathecal pumps | Cefazolin | Clindamycin,[d] vancomycin[d] | C |
| Cesarean delivery | Cefazolin | Clindamycin + aminoglycoside[g] | A |
| Hysterectomy (vaginal or abdominal) | Cefazolin, cefotetan, cefoxitin, ampicillin–sulbactam[h] | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]<br>Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j] | A |
| Ophthalmic | Topical neomycin–polymyxin B–gramicidin or fourth-generation topical fluoroquinolones (gatifloxacin or moxifloxacin) given as 1 drop every 5–15 min for 5 doses[o]<br>Addition of cefazolin 100 mg by subconjunctival injection or intracameral cefazolin 1–2.5 mg or cefuroxime 1 mg at the end of procedure is optional | None | B |
| Orthopedic | | | |
| Clean operations involving hand, knee, or foot and not involving implantation of foreign materials | None | None | C |
| Spinal procedures with and without instrumentation | Cefazolin | Clindamycin,[d] vancomycin[d] | A |

Table 2 (*continued*)

| Type of Procedure | Recommended Agents[a,b] | Alternative Agents in Pts With β-Lactam Allergy | Strength of Evidence[c] |
|---|---|---|---|
| Hip fracture repair | Cefazolin | Clindamycin,[d] vancomycin[d] | A |
| Implantation of internal fixation devices (e.g., nails, screws, plates, wires) | Cefazolin | Clindamycin,[d] vancomycin[d] | C |
| Total joint replacement | Cefazolin | Clindamycin,[d] vancomycin[d] | A |
| Urologic | | | |
| Lower tract instrumentation with risk factors for infection (includes transrectal prostate biopsy) | Fluoroquinolone,[h-j] trimethoprim–sulfamethoxazole, cefazolin | Aminoglycoside[g] with or without clindamycin | A |
| Clean without entry into urinary tract | Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis]) | Clindamycin,[d] vancomycin[d] | A |
| Involving implanted prosthesis | Cefazolin ± aminoglycoside, cefazolin ± aztreonam, ampicillin–sulbactam | Clindamycin ± aminoglycoside or aztreonam, vancomycin ± aminoglycoside or aztreonam | A |
| Clean with entry into urinary tract | Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis]) | Fluoroquinolone,[h-j] aminoglycoside[g] with or without clindamycin | A |
| Clean-contaminated | Cefazolin + metronidazole, cefoxitin | Fluoroquinolone,[h-j] aminoglycoside[g] + metronidazole or clindamycin | A |
| Vascular[p] | Cefazolin | Clindamycin,[d] vancomycin[d] | A |
| Heart, lung, heart–lung transplantation[q] | | | |
| Heart transplantation[r] | Cefazolin | Clindamycin,[d] vancomycin[d] | A (based on cardiac procedures) |
| Lung and heart–lung transplantation[r,s] | Cefazolin | Clindamycin,[d] vancomycin[d] | A (based on cardiac procedures) |
| Liver transplantation[q,t] | Piperacillin–tazobactam, cefotaxime + ampicillin | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] | B |
| Pancreas and pancreas–kidney transplantation[r] | Cefazolin, fluconazole (for patients at high risk of fungal infection [e.g., those with enteric drainage of the pancreas]) | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] | A |
| | Cefazolin | Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] | A |
| Plastic surgery | | | |
| Clean with risk factors or clean-contaminated | Cefazolin, ampicillin–sulbactam | Clindamycin,[d] vancomycin[d] | C |

# Vancomycin Comment

- In patients with known MRSA infection or carriage, the *addition* of vancomycin to cefazolin is acceptable for cardiothoracic and orthopedic implant surgery
  - Physician, PA or pharmacist statement in chart is necessary
  - Vancomycin alone is less effective vs. OSSA
  - Vancomycin has no gram negative coverage
- Vancomycin must be started within two hours of the surgical incision
  - To reduce risk of “Red Man Syndrome”
  - To allow adequate distribution to tissues (long α)
  - Personal communication 8/22/07 Bratzler DW. Oklahoma Foundation for Medical Quality

# Antibiotic Stewardship

- Personnel
  - PharmD
  - ID physician
- Authority
  - Medical Board
  - Administration
- Surveillance
  - Data mining
- Credibility
  - Recommendations from evidence-based guidelines
- Visibility and Accountability
  - Report to QIPSI, Med Board and CMO

# Conclusions

- Not possible to prevent all SSI
- Preoperative and intraoperative processes can reduce the rate
- Antibiotics alone are not the answer
- Prolonging prophylactic antibiotics or mupirocin application are contraindicated
- Screening for MRSA colonization is Standard of Care for Hip/Knee implants and recommended for cardiac