Despite current preventive measures, SSIs remain a significant problem

- In the US (2006) there were ~ 80 million surgical procedures
- Between 2006-2009 approximately 1.9% developed SSI
- Between 2009-2010 SSIs accounted for 23% of 69,475 HAIs reported to NHSN

<table>
<thead>
<tr>
<th>Type of HAIs</th>
<th>No. (%) of HAIs</th>
<th>No. (%) of SSIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAUTI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Special Risk Population: Orthopedic Implants

- Hip or Knee aspiration
- If positive – irrigation and debridement
- Removal of hardware may be necessary
- Insertion of antibiotic spacers
- Revisions at future date
- Long term IV antibiotics in community or rehab
- Future worry about the joint
- In other words – DEVASTATING FOR THE PATIENT AND SURGEON

<table>
<thead>
<tr>
<th>Pathogen Involved with SSIs</th>
<th>No (%) of SSI Pathogens</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staph aureus (includes MRSA)</td>
<td>6425 (30.4)</td>
<td>1</td>
</tr>
<tr>
<td>Coagulase neg staph</td>
<td>2477 (11.7)</td>
<td>2</td>
</tr>
<tr>
<td>S. Cell</td>
<td>1981 (9.4)</td>
<td>3</td>
</tr>
<tr>
<td>Enterococcus fecalis</td>
<td>1240 (5.9)</td>
<td>4</td>
</tr>
<tr>
<td>Pseudomonas aerug</td>
<td>1156 (5.5)</td>
<td>5</td>
</tr>
<tr>
<td>Enterobacter spp</td>
<td>849 (4.0)</td>
<td>6</td>
</tr>
<tr>
<td>Klebsiella spp</td>
<td>844 (4.0)</td>
<td>7</td>
</tr>
<tr>
<td>Enterococcus spp</td>
<td>685 (3.3)</td>
<td>8</td>
</tr>
<tr>
<td>Proteus spp</td>
<td>667 (3.2)</td>
<td>9</td>
</tr>
<tr>
<td>Enterococcus faecium</td>
<td>517 (2.5)</td>
<td>10</td>
</tr>
<tr>
<td>Serratia spp</td>
<td>385 (1.8)</td>
<td>11</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>367 (1.7)</td>
<td>12</td>
</tr>
<tr>
<td>Acinetobacter baum</td>
<td>119 (0.6)</td>
<td>13</td>
</tr>
<tr>
<td>Other Candida spp</td>
<td>96 (0.5)</td>
<td>14</td>
</tr>
<tr>
<td>Other organisms</td>
<td>339 (1.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21,100 (100)</td>
<td></td>
</tr>
</tbody>
</table>


Mortality risk is high among patients with SSIs

- A patient with an SSI is:
  - 5x more likely to be readmitted after discharge
  - 2x more likely to spend time in intensive care
  - 2x more likely to die after surgery

- The mortality risk is higher when SSI is due to MRSA
  - A patient with MRSA is 12x more likely to die after surgery

### HAI

<table>
<thead>
<tr>
<th>Est Annual %</th>
<th>Est Direct Cost</th>
<th>Avg Length of Stay</th>
<th>Attributable Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Site Infection (SSI)</td>
<td>33.7%</td>
<td>$20,785</td>
<td>~11 days</td>
</tr>
<tr>
<td>MRSA SSI</td>
<td>18.9%</td>
<td>$42,300</td>
<td>~23 days</td>
</tr>
<tr>
<td>Central Line Associated Bloodstream Infection (CLABSI)</td>
<td>18.9%</td>
<td>$45,814</td>
<td>~10 days</td>
</tr>
<tr>
<td>MRSA CLABSI</td>
<td>31.5%</td>
<td>$40,144</td>
<td>~13 days</td>
</tr>
<tr>
<td>Ventilator Associated Pneumonia (VAP)</td>
<td>&lt;1%</td>
<td>$896</td>
<td>&lt;1 day</td>
</tr>
<tr>
<td>Catheter Associated Urinary Tract Infection (CAUTI)</td>
<td>15.6%</td>
<td>$11,285</td>
<td>~3 days</td>
</tr>
<tr>
<td>Clostridium difficile Infection (CDI)</td>
<td>&lt;1%</td>
<td>$896</td>
<td>&lt;1 day</td>
</tr>
</tbody>
</table>


---

**Cost of Surgical Site Infections**

- Cost of an SSI in a prosthetic joint implant can exceed $90,000
- Cost of an SSI can exceed more than $80,000 if it involves MRSA


---

**Pathogens survive on surfaces**

<table>
<thead>
<tr>
<th>Organism</th>
<th>Survival period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clostridium difficile</td>
<td>35-200 days,1,2</td>
</tr>
<tr>
<td>Methicillin-resistant Staphylococcus aureus (MRSA)</td>
<td>14-200 days,3,4</td>
</tr>
<tr>
<td>Vancomycin-resistant enterococci (VRE)</td>
<td>55-200 days,1,4</td>
</tr>
<tr>
<td>E. coli</td>
<td>&gt;150 days,1,5</td>
</tr>
<tr>
<td>Acinetobacter</td>
<td>150-1500 days,1,5</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>&gt;50-500 days,1,5</td>
</tr>
<tr>
<td>Salmonella</td>
<td>10 days-2 years,6</td>
</tr>
<tr>
<td>Mycobacterium tuberculosis</td>
<td>120 days,1</td>
</tr>
<tr>
<td>C. albicans</td>
<td>120 days,1</td>
</tr>
<tr>
<td>Viruses from the respiratory tract (eg: corona, coccovirus, influenza, SARs, rhino virus)</td>
<td>Few days,7</td>
</tr>
<tr>
<td>Viruses from the gastrointestinal tract (eg: astrovirus, rotavirus, noro)</td>
<td>60-90 days,8</td>
</tr>
</tbody>
</table>

---

Prior room occupancy increases risk

<table>
<thead>
<tr>
<th>Study</th>
<th>Healthcare associated pathogen</th>
<th>Likelihood of patient acquiring HAI based on prior room occupancy (comparing a previously 'positive' room with a previously 'negative' room)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martinez 2003</td>
<td>VRE – cultured within room</td>
<td>2.6x</td>
</tr>
<tr>
<td>Huang 2006</td>
<td>VRE – prior room occupant</td>
<td>2.6x</td>
</tr>
<tr>
<td></td>
<td>MRSA – prior room occupant</td>
<td>1.3x</td>
</tr>
<tr>
<td>Drees 2008</td>
<td>VRE – cultured within room</td>
<td>1.9x</td>
</tr>
<tr>
<td></td>
<td>VRE – prior room occupant</td>
<td>2.2x</td>
</tr>
<tr>
<td></td>
<td>VRE – prior room occupant in previous two weeks</td>
<td>2.0x</td>
</tr>
<tr>
<td>Shaughnessy 2008</td>
<td>A. baumannii – prior room occupant</td>
<td>1.8x</td>
</tr>
<tr>
<td></td>
<td>P. aeruginosa – prior room occupant</td>
<td>2.1x</td>
</tr>
</tbody>
</table>


A 7 S BUNDLE APPROACH TO PREVENTING SURGICAL SITE INFECTIONS

SAFETY – Is your OPERATING ROOM safe?

SCREEN – Are you screening for risk factors and presence of MRSA & MSSA?

SHOWERS – Do you have your patients cleanse their body the night before and morning of surgery with CHLORHEXIDINE (CHG)?

SKIN PREP – Are you prepping the skin with alcohol-based antiseptics such as CHG or iodophor?

SOLUTION – Are you irrigating the tissues prior to closure to remove exogenous contaminants? Are you using CHG?

SUTURES – Are you closing tissues with antimicrobial sutures?

SKIN CLOSURE – Are you sealing the incision or covering it with an antimicrobial dressing to prevent exogenous contamination?

7 “S” Bundle to Prevent SSI
#1 – Safe Operating Room

- traffic control, number staff in room
- air handling systems, filtration, grills
- SCIP: hair clipping, warmers, oxygenation, surgical prophylaxis, foley catheter removal 48 hrs
- room turnover and terminal cleaning
- surgical technique and handling of tissues
- instrument cleaning/sterilization process, biological indicators
- storage of supplies, clean supply bins, carts, tables, stationary equipment

Follow AORN Recommended Practices

- Preoperative Patient Skin Antisepsis. AORN, 2008:537-553.
- High-Level Disinfection. AORN 2014.
- Cleaning and Processing Anesthesia Equipment AORN.
- Sterilization in the Perioperative Setting. AORN.
- AORN Surgical attire 2013.

Antimicrobial prophylaxis

- Performance measures include the antibiotic being
  - given within 60 minute before incision
  - consistent with current published recommendations
  - re-dosed if the time since administration exceeds two half-lives of the medication
  - dose per BMI
  - discontinued within 24 hours of conclusion of procedure
Hair removal

- Shaving increases risk for SSI.
- Hair removal should be performed:
  - using a clipper
  - on the day of surgery
  - in a location outside of the procedure room
  - Assure clipper is cleaned between use
- Only interfering hair should be removed

Environmental strategies

- HVAC
  - HVAC systems dilute and remove contaminants
  - Air quality
  - Air volume exchanges
  - Airflow direction
  - Humidity should be maintained between 20% and 60%
    - Low humidity increases potential for dust
    - High humidity increases microbial growth
  - Temperature should be maintained between 68°F to 73°F

Environmental cleaning

- Evaluate between room cleaning procedures
- Terminal cleaning procedures on evening/night shift
- Sufficient staff to terminally clean all OR rooms?
New Technology for Operating Room Terminal Cleaning Being Used in Some Operating Rooms

- Ultraviolet C lights
- Disinfectant surface sprays
- Vaporized Hydrogen Peroxide Room Decontaminator

Surgical attire

- Normal individuals shed more than 10 million particles from their skin every day.
- Approximately 10% of skin squames carry viable microorganisms and it's estimated that individuals shed approximately 1 million microorganisms from their bodies each day.
- AORN "Recommended practices for surgical attire" section IV.a. states that:
  “A clean, low-lint surgical head cover or hood that confines all hair and covers scalp skin should be worn. The head cover or hood should be designed to minimize microbial dispersal. Skullcaps may fail to contain the side hair above and in front of the ears and hair at the nape of the neck.”

Boyce, Evidence in Support of Covering the Hair of OR Personnel AORN Journal Jan 2014

Laminar Flow and Exhaust Suits

No data to support reduction in SSIs

- Lipsett PA. Do we really need laminar flow ventilation in the operating room to prevent surgical site infections? Ann Surg 2008;248:701
Personal Items Don't Belong in the OR

• Items may harbor pathogens and be difficult to clean or disinfect adequately
  – Pathogens have been shown to survive on fabrics and plastics
  – Microorganisms may be transported from one location to another

AORN Journal • January 2012 Vol 95 No 1

Jewelry and Personal Clothing Doesn't Belong in OR

• Wearing jewelry increases bacterial counts on skin surfaces
  ▫ when jewelry is in place
  ▫ after removal

• Removing watches and bracelets allows for more thorough hand washing

• Personal clothing should be completely covered by surgical attire

AORN Journal • January 2012 Vol 95 No 1

Hot Topic due to recent outbreaks: Cleaning/Sterilization of Instruments

• Inspection of Instruments
  – Lumens, grooves, sorting, hand cleaning, disassembly required – massive kits
  – Many instruments cannot be disassembled
  – Correct use of Biologic Indicators

• Pre-soaking and rinsing of tissue and blood from the instruments in the operating room before sent to decontamination

Tosh et al. Outbreak of Pseudomonas aeruginosa Surgical Site Infections after Arthroscopic Procedures. Texas, 2009
Infect Control Hosp Epidemiol 2011;32(12):1179-1186
Most Important Control Measure

- **HAND HYGIENE** in the operating room
- Wash hands several times a shift – especially if you have had gloves on for more than 20 minutes – organisms multiply every 20 minutes

Communication between organisms to pass resistance factors

**Hand Contamination of Anesthesia Providers Is an Important Risk Factor for Intraoperative Bacterial Transmission**


![Image](https://example.com/image)

**Table 2. Baseline Provider Hand Contamination**

<table>
<thead>
<tr>
<th>Organism</th>
<th>Providers / total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>12/164 (7%)</td>
</tr>
<tr>
<td>MSSA</td>
<td>18/164 (12%)</td>
</tr>
<tr>
<td>VRE</td>
<td>4/164 (2%)</td>
</tr>
<tr>
<td>Enterococcus (non-vRE)</td>
<td>1/164 (0.6%)</td>
</tr>
<tr>
<td>Staph other</td>
<td>164/164 (100%)</td>
</tr>
<tr>
<td>Staph aureus</td>
<td>110/164 (67%)</td>
</tr>
<tr>
<td>C. difficile</td>
<td>54/164 (33%)</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>128/164 (78%)</td>
</tr>
<tr>
<td>Gram negative&lt;sup&gt;3&lt;/sup&gt;</td>
<td>85/164 (52%)</td>
</tr>
</tbody>
</table>

MRSA = methicillin-resistant Staphylococcus aureus; MSSA = methicillin-sensitive Staphylococcus aureus; VRE = vancomycin-resistant Enterococcus.<br>\(^3\) Samples taken upon entry to the patient environment but before patient contact and after an opportunity to perform hand hygiene.
Contaminated hands have the potential to leave biofilm on stopcocks and other devices

Abdominal Wound Protector/Retractor for Colon Surgery Shown to Reduce SSI

Horiuchi et al: A Wound Protector Shields Incision Sites from Bacterial Invasion  SURGICAL INFECTIONS Volume 11, Number 6, 2010

Reid et al: Barrier Wound Protection Decreases Surgical Site Infection in Open Elective Colorectal Surgery: A Randomized Clinical Trial  DISEASES OF THE COLON & RECTUM VOLUME 53: 10 (2010)
#2 SCREEN for Risk Factors and MRSA and MSSA Colonization

Evaluate Your Patient Risk Characteristics that might increase risk of SSI

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>Nutritional status</td>
<td>Obesity</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>Blood glucose level</td>
</tr>
<tr>
<td>Chronic tobacco use</td>
<td>Corticosteroid use</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>Alcoholism</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>Chronic lung disease</td>
</tr>
<tr>
<td>Chronic liver disease</td>
<td>Malignant disease</td>
</tr>
<tr>
<td>Preoperative chemotherapy</td>
<td>Anergy</td>
</tr>
<tr>
<td>Nasal colonization</td>
<td>Bacterial colonization</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Hematoma</td>
</tr>
<tr>
<td>Preoperative antibiotics</td>
<td></td>
</tr>
</tbody>
</table>

Risk Factors for Orthopedic Surgery

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current tobacco use</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
</tr>
<tr>
<td>Hypertension B</td>
<td></td>
</tr>
<tr>
<td>Malignant disease</td>
<td></td>
</tr>
<tr>
<td>Preoperative chemotherapy</td>
<td></td>
</tr>
<tr>
<td>Nasal colonization</td>
<td></td>
</tr>
<tr>
<td>Hyperglycemia</td>
<td></td>
</tr>
<tr>
<td>Preoperative antibiotics</td>
<td></td>
</tr>
</tbody>
</table>

Note: All of the variables listed are independent preoperative risk factors for surgical infections. Other risk factors include obesity, family history of infections, and smoking.
MRSA and MSSA Carriage and Infection – Evidence Based Practice

Patients who carry *Staph aureus* in their nares or on their skin are more likely to develop *Staph aureus* SSIs.

This is true for methicillin-resistant as well as methicillin-sensitive *Staph aureus*.


Decolonization Protocol – Evidence Based

*Staph aureus* carriers treated with five days of intranasal mupirocin and CHG washes before surgery have a 60% lower *Staph aureus* SSI rate than the placebo group.


Preoperative screening/decolonization was associated with fewer SSIs after elective Total Joint Arthroplasty


Does using mupirocin eradicate *Staph aureus* nasal carriage? – Evidence Based

- Short-term nasal mupirocin (4-7 days) is an effective method for *Staph aureus* eradication
- 90% success at one week
- 1% develop mupirocin resistance

Systematic review (Ammerlaan HS, et al. CID 2009): 8 studies comparing mupirocin to placebo
Implementation of a Screening Program For MRSA and Staph aureus Before Inpatient Orthopedic Surgery


Polymerase Chain Reaction (PCR) for Nasal Screens – Lab Challenges.

- Instructing staff on how to obtain a nares specimen with proper swabs
- Lab differentiation of the colonized screens from routine cultures.
- Molecular lab up and running in a short time frame with cross-training of staff of Cepheid’s GeneXpert System
- Reporting system for positive results

Implemented Decolonization Protocol

- 5-day application of intranasal 2% mupirocin - applied twice daily - for MRSA and Staph aureus positive patients
  - Prescription called in by Nurse Practitioner in prescreening unit
- Daily body wash with chlorhexidine (purchased by patient)
- MRSA Patients – Unique sticker system to notify Pre-surgery Unit of Vancomycin surgical prophylaxis
Institutional Prescreening for Detection and Elimination of Methicillin Resistant Staphylococcus aureus in Patients Undergoing Elective Orthopaedic Surgery

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>5293</td>
<td>7019</td>
<td></td>
</tr>
<tr>
<td>MRSA Infection</td>
<td>10 (0.18%)</td>
<td>4 (0.06%)</td>
<td>0.0315</td>
</tr>
<tr>
<td>MSSA Infection</td>
<td>14 (0.26%)</td>
<td>9 (0.13%)</td>
<td>0.0937</td>
</tr>
<tr>
<td>Total SSIs</td>
<td>24 (0.46%)</td>
<td>13 (0.18%)</td>
<td>0.0083</td>
</tr>
</tbody>
</table>


Pre-op MRSA and S. aureus Decolonization

• Results: % MRSA and S. aureus SSI

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Inpatient Surgeries</th>
<th># of Surgical Infections</th>
<th>%MRSA/MSSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY06</td>
<td>10/01/05-07/16/06*</td>
<td>5,293*</td>
<td>24*</td>
</tr>
<tr>
<td>FY07</td>
<td>07/17/06-09/30/07</td>
<td>7,019</td>
<td>6</td>
</tr>
<tr>
<td>FY08</td>
<td>10/01/07-09/30/08</td>
<td>6,323</td>
<td>7</td>
</tr>
<tr>
<td>FY09</td>
<td>10/01/08-09/30/09</td>
<td>6,164</td>
<td>11</td>
</tr>
<tr>
<td>FY10</td>
<td>10/01/09-09/30/10</td>
<td>6,437</td>
<td>6</td>
</tr>
</tbody>
</table>

*Historical Controls

#3 – Showers with CHG
OR Risk Factors: Bacteria on Patient’s Skin

• Pre-op Showers:
  – Liquid chlorhexidine shower
  – CHG impregnated washcloths

Pre-surgical Skin Preparations as a Pathway to Improving Surgical Outcomes – Evidence Based

- Reducing the risk of SSI in orthopaedic surgery
  - Standardized pre-cleansing initiative (CHG cloths) in total joint patients (night before/ morning of surgery)
  - SSI rate prior intervention – 3.2% (N=727)
  - SSI rate post intervention – 1.6% (N=824) 50% reduction \( p<0.01 \)

  Eiselt – Orthopaedic Nursing 2009;28:141-145

- Bundling risk reduction strategies – Quality initiative
  - MRSA prescreening in orthopaedic, obstetric, bariatric patients – decolonization
  - Pre-surgical antisepsis (CHG cloths) prior to surgery
  - Pre-intervention SSI rate 1.6% (N=17/1,095) vs post intervention SSI rate 0.57% (N=7/1,225) >60% reduction
  - MRSA SSI rate 0.73% vs 0.16% >75% reduction \( p<0.01 \)

  Lipke VL, Hyott AS. AORNJ 2010;62:288-296

Select Publications of Skin-Friendly, No-Rinse 2% CHG Impregnated CHG Prep Cloth

<table>
<thead>
<tr>
<th>Publication</th>
<th>CHG Prep Cloth Applications</th>
<th>Outcome</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson IE 2012</td>
<td>2</td>
<td>77% SSI reduction</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Kapadia JOK 2012</td>
<td>2</td>
<td>70% SSI reduction</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Lipke AORN 2010</td>
<td>2</td>
<td>82% SSI reduction</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Estell Orthop Nurs 2009</td>
<td>2</td>
<td>50% SSI reduction</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Murray SES 2011</td>
<td>2</td>
<td>66% reduction of MRSA colonization</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Thompson AHC 2013</td>
<td>2 preop + postop</td>
<td>72% SSI reduction</td>
<td>p&lt;0.005 (Cardio/Naucn)</td>
</tr>
<tr>
<td>Phillips IODE Week 2012 Poster of RCT (manuscript submitted)</td>
<td>2</td>
<td>0% SSI reduction</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Kapadia/Mont RCT interim data submitted to FDA hearing on Sterile Preps 12/2012</td>
<td>2</td>
<td>0% SSI reduction</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Bailey ICHS 2011</td>
<td>2</td>
<td>CHG Cloth product is cost effective for routine distribution even low patient compliance</td>
<td>N/A</td>
</tr>
<tr>
<td>Grating AORN 2013</td>
<td>1</td>
<td>77% SSI reduction</td>
<td>p&lt;0.01</td>
</tr>
</tbody>
</table>
#4 Skin Prep – Alcohol based surgical skin prep

Skin preparation

- FDA requires skin preparation antiseptics are
  - Fast acting (ie, within 10 minutes)
    - Two-log bacterial reduction on abdomen
    - Three-log bacterial reduction on groin
      - One log = microorganisms reduced 10 times
      - Two log = microorganisms reduced 100 times
      - Three log = microorganisms reduced 1000 times
  - Persistent
    - No return to baseline flora at six hours post application

Use an alcohol-containing antiseptic agent for preoperative skin preparation

Two types of preoperative skin preparations that combine alcohol (which has an immediate and dramatic killing effect on skin bacteria) with long-acting antimicrobial agents appear to be more effective at preventing SSI than povidone-iodine (an iodophor) alone:

- Chlorhexidine plus alcohol
- Iodophor plus alcohol

IHI: Prevention of SSI: Institute for Healthcare Improvement 2012
# Skin antiseptic agents

<table>
<thead>
<tr>
<th>Antiseptic agent</th>
<th>Rapidity of action</th>
<th>Persistent activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Excellent</td>
<td>None</td>
</tr>
<tr>
<td>CHG</td>
<td>Moderate</td>
<td>Excellent</td>
</tr>
<tr>
<td>PI</td>
<td>Moderate</td>
<td>Minimal</td>
</tr>
<tr>
<td>CHG w/alcohol</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>PI w/alcohol</td>
<td>Excellent</td>
<td>Moderate</td>
</tr>
<tr>
<td>PCMX</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

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## 5 Sutures – Antimicrobial Plus Sutures

### Risk Factor: Bacterial colonization of the suture

- Like all foreign bodies, sutures can be colonized by bacteria:
  - Implants provide nidus for attachment of bacteria\(^1\)
  - Bacterial colonization can lead to biofilm formation\(^2\)
  - Biofilm formation increases the difficulty of treating an infection\(^2\)

---

Why Antimicrobial Sutures?
OR Air Current Contamination

- In teaching hospitals:
  - Surgeon leaves room
  - Resident, Physician Assistant or Nurse Practitioner work on incision
  - Circulating Nurse counts sponges and starts room breakdown
  - Scrub Technician starts breaking down tables and preparing instruments for Central Processing
  - Anesthesia move in and out of room
  - Instrument representative might leave room and Visitors may leave room

Potential for Contamination of Sutures at End of Case


Antibacterial Suture Challenge

- Studied the “zone of inhibition” around the suture
  - A pure culture—0.5 MacFarland Broth—of S. aureus was prepared on a culture plate
  - An antibacterial suture was aseptically cut, planted on the culture plate, and incubated for 24 hrs — held at 5 and 10 days

Bacterial Adherence to Surgical Sutures: Can Antibacterial-Coated Sutures Reduce the Risk of Microbial Contamination?

Charles E Edmiston, MD, Gary R Suthekal, MD, FACS, Michael P Gifcone, MS, Candace J Kopel, MS, Christopher P Johnson, MD, FACS, Brian D Lewis, MD, FACS, Kelli R Brown, MD, FACS, Jonathan B Tower, MD, FACS

J Am Coll Surg 2006;203:481-489

Mean Microbial Recovery from Standard Polyglactin 910 Sutures (V) and Triclosan-Coated Polyglactin 910 Braided Sutures (VT)

Exposure Time 2 Minutes


Systematic review and meta-analysis of triclosan-coated sutures for the prevention of surgical-site infection

Z.X. Wang1,2, C.P. Jiang3, Y.C. Cai2 and Y.T. Ding1,2
1Department of Reproductive Medicine, Affiliated Dong Fang Hospital, School of Medicine, Nanjing University, Nanjing, Jiangsu, China
2Key Laboratory of Gynecology and Obstetrics, Ministry of Health, Nanjing, Jiangsu, China
3Department of Bacteriology, T.T. Ding, No. 612 Shao Hua Road, Nanjing, Jiangsu, China; E-mail: dingyin@163.com


Is there an evidence-based argument for embracing an antimicrobial (triclosan)-coated suture technology to reduce the risk for surgical-site infections?: A meta-analysis

Charles E Edmiston, MD, FACS, Bethany E. McLean, MD, and Matthew E. Lentnek, MD, MS

Edmiston et al: Surgery 2013;154:89-100
Evidence-Based Argument for Antimicrobial (Triclosan) Coated Sutures


#6 Solution – to Pollution is Dilution
Pulsatile Lavage Irrigation

- High-pressure pulsatile lavage and low-pressure pulsatile lavage result in higher rates of deep bacterial seeding in bone than does brush and bulb-syringe lavage.¹
- Higher irrigant pressures result in greater osseous damage and perhaps impairment of osseous healing.¹
- Kalteis et al. revealed that compared with brush and bulb-syringe lavage high and low-pressure pulsatile lavage resulted in significantly (p < 0.001) higher rates of deep bacterial seeding in bone.²
- No evidence that Bacitracin/Polymixin irrigations reduce rate of SSI²


New Chlorhexidine 0.05% Irrigation Solution

- Meets American College of Emergency Physicians (ACEP) guidelines for wound irrigation volume and pressure
- Proprietary SplatterGuard protects healthcare workers, patients and the environment from biohazard contamination
- Chlorhexidine Gluconate 0.05% has demonstrated antimicrobial efficacy and persistence in laboratory testing
- The mechanical action effectively loosens and removes wound debris
- Safe for mucous membranes – approved by FDA
- www.irrisept.com

Why CHG Irrigation: Environmental Contaminants in the Operating Room and at the End of Case
Molecular epidemiology of microbial contamination in the operating room environment: Is there a risk for infection?

Charles E. Edmiston Jr., MD; Gary R. Sixel, MD; Robert C. Carliner, MD; Belle R. Brown, MD; Bruce D. Levin, MD; Jay D. Semones, PhD; Carolann J. Bump, MS; Paul J. Wilcox, RN; Karen Stahl, RN; and Jonathan E. Toomey, MD, Milwaukee, Wis, and Brook, Ga

Intraoperative Recovery of Airborne Microbial Populations During Vascular Surgery (N=70)

Fig. 3. PFGE of clonally related strains of S. epidermidis and S. aureus recovered from members of the vascular surgery team and postoperative air samples. Lane 5A/B and 6A/I, 3 S epidermidis strains; lane 5C, 7% and 10/20/30/40, 3 S aureus isolates.

Impact of Intraoperative Irrigation on Resolution of Mesh Contaminated Animal Model

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Irrigation Fluid</th>
<th>Bacterial Isolates</th>
<th>Initial Challenge</th>
<th>Study Population, N = animals at 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Saline (Control)</td>
<td>MRSA</td>
<td>~3.7 log_{10} CFU</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>0.05% CHG</td>
<td>MRSA</td>
<td>~3.7 log_{10} CFU</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Positive Recovery at 7 days (log_{10} CFU)</th>
<th>Negative Recovery at 7 day (log_{10} CFU)</th>
<th>Biofilm Formation (log_{10} CFU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline</td>
<td>8/8, 4.26 log_{10} CFU</td>
<td>No, 0/8</td>
<td>8/8, 6.3 log_{10} CFU</td>
</tr>
<tr>
<td>0.05% CHG</td>
<td>1/8, 1.8 log_{10} CFU, p&lt;0.001</td>
<td>Yes, 7/8</td>
<td>2/8, 2.6 log_{10} CFU, p&lt;0.07</td>
</tr>
</tbody>
</table>

* Edmiston CE, et al., 2013 Am J Infect Control

#7 Skin Adhesive – Care of the Incision
Challenges in the Post-op Patient

- Incision collects fluid – serum, blood - growth medium for organisms – small dehiscences
- Spine fusions -incisions close to the buttocks or neck
- Body fluid contamination from bedpans/commodes
- Heavy perspiration common with obese patients
- Friction and sliding - skin tears and blisters
- Itchy skin - due to pain medications - skin breakdown

Cesarean Delivery: Sutures vs Staples

- Prospective, randomized study of 435 c-section patients
  - 197 patients: staples
  - 219 patients: 4-0 MONOCRYL™ (polyglaactin 25) Suture on PS2 needle
    - Wound separation rate: 17% (staples) vs. 5% (sutures)
    - Wound complication rate: 22% (staples) vs. 9% (sutures)
    - Staple closure was a significant independent risk factor for wound separation after adjustment for all other factors (GDM, BMI >30, incision type, etc)
- Meta-analysis of 6 studies with a total of 1487 c-section patients
  - 803 patients: staples
  - 684 patients: subcuticular suture closure
    - Staple closure was associated with a two-fold increase in risk of wound infection or separation


March 16 2010 issue of the BMJ
Innovative Technology: Topical Skin Adhesive

- Wounds are most vulnerable to infection in the first 48-72 hours. Until the epithelial barrier is complete (usually within 48 hours), wounds are solely dependent on the wound closure device to maintain integrity.
- The extent of microbial protection depends on barrier integrity. Effective barriers must maintain their integrity for the first 48 hours.
- Incisional adhesive provides a strong microbial barrier that prevents bacteria from entering the incision site.


Topical Skin Adhesive: Benefits Beyond Risk Reduction

- For Hospital Staff
  - No time spent removing staples or sutures
  - Reduces hospitalization costs
  - Reduces number of suture set ups
  - Simplifies post-op wound checks
  - Reduces number of wound dressings
  - Can reduce staff suture exposures

- For Patients
  - 7 days of wound healing strength in less than one minute of application
  - Shower immediately
  - Outstanding cosmesis
  - Reduced follow-up
  - Less pain and anxiety

Adhesive Border and Healing
6 Weeks Post-op and Beyond
Incisional Adhesive on Total Knee

Clinical Use of Incisional Adhesive in Orthopedic Total Joints

Which Would You Prefer???

Topical Incisional Adhesive (TSA)
Octyl Cyanoacrylate
OTHER OPTIONS
WHEN ADHESIVES ARE NOT USED

Antimicrobial (PHMB) Dressings with 
Hypoallergenic Fabric Tape

Spencer et al: The Use of Antimicrobial Gauze 
Dressing (AMG) After Orthopedic Surgery To 
Reduce Surgical Site Infections NAON 2010 Annual 
Congress - May 15-19, 2010

Antimicrobial Silver Dressings

Silver dressing and transparent dressing left on until 
discharge – seals the incision from exogenous 
contaminants

NAON – May 2006
Spencer et al: The Use of A Silver Gauze Dressing in Spine Surgery to Reduce the Incidence of 
MRSA Surgical Site Infections
IN CONCLUSION.....

What to DO? Establish a Multidisciplinary Team

The team representatives
OR nursing, CSS, Surgeons & Anesthesia, Managers from infection control, healthcare quality, facilities and environmental services

Evaluate
Procedures and Practices
Facility design and Environment of Care Issues
Patient Risk Factors
Infection Rates
Innovative Infection Prevention Products and Practices

Working Toward Zero Teams

• Senior leadership and surgeons – must be involved and lead the effort
• Clear goals
  – Structured program with clearly defined goal of zero tolerance for HAIs
• Communication – effective and consistent
• Ongoing and creative education
• Financial support to Infection Prevention program
• Use process improvement tools (fishbone, pareto, mind-mapping)

• Spencer M. et al. A Multidisciplinary Team working toward Zero Orthopaedic Infection Rate. Global Infectious Disease Conference, Tufts Medical School, Boston, MA October 2009
Risk is a Myriad Event
SSI Fishbone Diagram

Preoperative Factors

Intraoperative Factors

Postoperative Factors

Organizational and Management Factors

Preoperative Factors

Intraoperative Factors

Postoperative Factors

Organizational and Management Factors

Patient Factors

Surgeon Factors

Work Environmental Factors

Preoperative Factors

Intraoperative Factors

Postoperative Factors

Organizational and Management Factors

Patient Factors

Surgeon Factors

Work Environmental Factors

Preoperative Factors

Intraoperative Factors

Postoperative Factors

Organizational and Management Factors

Patient Factors

Surgeon Factors

Work Environmental Factors

The Joint Commission's Implementation Guide for NPSG.07.05.01 on Surgical Site Infections: The SSI Change Project

Elements of Performance

1. Educate staff and license physicians and pharmacists about surgical site infections and the importance of preventing them. This effort occurs upon hire, annually thereafter, and when involvement in surgical procedures is added to an individual's job responsibilities.

2. Educate patients, and their families, as needed, about surgical site infection prevention.

3. Implement policies and procedures aimed at reducing the risk of surgical site infections. These policies and procedures must be regulatory requirements and are aligned with evidence-based guidelines (for example, The Centers for Disease Control and Prevention [CDC] and/or other professional organizations' guidelines).

4. As part of this effort to reduce surgical site infections,
   - Conduct periodic risk assessments for surgical site infections in a time frame determined by the hospital,
   - Select surgical site infection measures using best practices or evidence-based guidelines,
   - Monitor compliance with best practices or evidence-based guidelines,
   - Evaluate the effectiveness of preventive efforts,
   - Note: Surveillance may be targeted to certain procedures based on the hospital's risk assessment.

5. Measure surgical site infection rates for the first 30 days following surgery and for the first year following procedures involving implantable devices. The hospital's measurement strategies follow evidence-based guidelines. Note: Surveillance may be targeted to certain procedures based on the hospital's risk assessment.

6. Provide process and outcome (for example, surgical site infection rates) measures to key stakeholders.

7. Administer antimicrobial agents for prophylaxis for a particular procedure or disease according to evidence-based practices.

8. When risk is not able to be easily identified, it is a matter that is often determined by evidence-based practices.

9. Use of staples
Unit Based Champions: Role Models, “Positive Deviance” Empowerment at Staff Level

- Role Models and Responsibilities enhance self-efficacy
- Participate in educational activities
- Hand hygiene observations
- Precaution Carts and direct care observations
- Communicate information to staff
- Assist in implementing practice change
- “Call-out” breaks in techniques
- Attend monthly meetings
- Contribute to an annual “Bug Beat Fair”
- Participate in Performance Improvement Studies
- Clinical ladder for professional advancement

National Association of Orthopedic Nurses (NAON), May 2006 Poster Presentation: The Bug Beat Fair: An Innovative Infection Control Educational Campaign in an Orthopedic Specialty Hospital

Engage Your Staff: Got Soap?

- Engaged the OR staff in a Got Soap? Campaign
  - OR Nurses
  - Surgeons
  - Administration
  - Used shaving cream for soap and used medical photographer

www.creativohandhygiene.com

Creative Themes and Posters

- Foam In - Foam Out
- www.creativohandhygiene.com
References


The End