Preventing Orthopedic Surgical Site Infections (SSI) through a Best Practice Bundle

Presenter
Jette R Hogenmiller, PhD, MN, APRN, FNP-BC, CDE, TNCCc

www.HealthInnovationandResearch.com

Background: Infection Preventionist, Family Nurse Practitioner, Oncology Clinical Nurse Specialist, & Healthcare Consultant

Contact: jette@jetteh.us

Disclosures: Health, Innovation & Research, LLC
Sponsor(s):
Learning Objectives

Identify:
• The impact of surgical site infection (SSI) on Orthopedic joint surgery outcomes (e.g. patient, financial)
• Potential sources of Orthopedic joint surgery SSI’s
• Scientifically based SSI prevention strategies & application to Orthopedic joint surgery
• Strategies that might be implemented in your setting to further reduce Orthopedic joint surgery SSI’s

Presentation Outline

1. Significance of SSI in Orthopedic joint surgeries

2. Is it time for a “SSI Prevention Bundle” in Orthopedics?

3. How does the APIC “Guide to the Elimination of Orthopedic Surgical Site Infections” provide us direction as Infection Preventionist’s? -> What is the evidence that guides us in SSI prevention?

4. Review of a bundle used to reduce Orthopedic surgeries & evidence for impact on outcomes

5. Next steps, what are they… on our journey to zero for SSI’s?
This is the face of our patients… health care consumer.
This is why we have a passion about Safety in the Surgery Suite (Infection Preventionist, Operating Room Nurse, Surgeon) …we want to protect those who enter our doors… they are innocent, no matter their age.

They & their families entrust their lives in our care.

---

**Healthcare-Associated Infections**

**Estimated Annual Hospital Cost of HAI by Site of Infection**

<table>
<thead>
<tr>
<th>Major Site of Infection</th>
<th>Total Infections</th>
<th>Hospital Cost per Infection</th>
<th>Total Annual Hospital Cost (in Millions)</th>
<th>Deaths per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical site infection</td>
<td>290,485</td>
<td>$25,546</td>
<td>$7421</td>
<td>13,088</td>
</tr>
<tr>
<td>Central line-associated bloodstream infection</td>
<td>248,678</td>
<td>$36,441</td>
<td>$9062</td>
<td>30,665</td>
</tr>
<tr>
<td>Ventilator-associated pneumonia (lung infection)</td>
<td>250,205</td>
<td>$9969</td>
<td>$2494</td>
<td>35,967</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infection</td>
<td>561,667</td>
<td>$1006</td>
<td>$565</td>
<td>8205</td>
</tr>
</tbody>
</table>

HAI = healthcare-associated infection, or HCAI
Pie Graph of Estimates of HAI’s in U.S. hospitals among adults & children outside of intensive care units, 2002

274,098 TOTAL
-967 HRN
-21 WBN
-28,725 Non-newborn ICU
244,385 = SSI


Surgical Site Infections (SSI)- All Cases

SSI’s Incidence:
• 15% to 20% of HAI’s
• ~500,000/yr SSIs (1 million some sources) among 44 million inpatient surgical procedures
• 2%-5% of patients undergoing inpatient surgery


Mortality
• 3% mortality
• 2-11 times higher risk of death
• 75% of deaths among patients with SSI are directly attributable to SSI
• ~8,205 deaths annually from SSI’s
• infected vs. uninfected cases
  (7.8% vs. 3.5%)

Significance of Surgical Site Infections (SSI) in Orthopedic Joint Surgeries

What does having an SSI mean to a person & society?

Orthopedic SSI Financial Costs

~1 million hip & knee surgeries per year

- Orthopedic SSI incidence
  - ~6,000-20,000 SSIs among hip and knee
  - ~31,000-35,000 SSIs for all orthopedic surgeries
    (estimates from NHSN data 2006-2008)

- Costs of infection/SSI
  - $38,000 vs $11,255 infected vs. noninfected hip fracture costs treated by fixation or hemi-arthroplasty
  - MRSA vs. MSSA more costly
  - $50,000 to tx infected arthroplasty
  - $250 million/yr U.S. cost of total joint replacement SSI's
    (Kuper, 2008)
  - Cost of infected hip revision is 4.8 X higher than primary total hip arthroplasty

MRSA = methicillin resistant staphylococcus aureus; MSSA = methicillin-susceptible staphylococcus aureus.
SSI Morbidity Costs


Total hip arthroplasty revision due to infection outcomes:

- more hospitalizations
- increased:
  - total length of stay (13 vs. 4 days, mean 9.31 days attributable to infection), incl. readmission w/ 90 days of surgery
  - # of operative procedures
  - outpatient visits & charges
  - cost

- substantial reduction in quality of life 1 yr later

APIC (2010), Lee (2006) & Whitehouse, et al. (2002) [orthopedic procedures, incl. open reduction of fracture, fusion, laminectomy & joint replacement; painwise matched (1:1) case-control study within a cohort (n=59 cases, 11/19% had joint replacement surgery)


Mortality & Orthopedic SSI’s

Higher 1-year postoperative mortality

Infected vs. noninfected

17% vs. 4%*

Compared to total other SSI’s

infected vs. uninfected cases

7.8% vs. 3.5%

* Lee et al. (2006) [Sample > 64 years of age, nested-case control; 15,218 -> hip & knee replacement, open reduction of fracture, other joint replacement, spinal fusion & laminectomy


Orthopedic Surgical Site Infection Rates

Incidence of SSIs

Pooled means of SSI rates by operative inpatient procedure and risk index categories, 2006 through 2008

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Index Category</th>
<th>Number of Procedures</th>
<th>Number of SSIs</th>
<th>Pooled Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip prosthesis</td>
<td>0</td>
<td>49,576</td>
<td>334</td>
<td>0.67</td>
</tr>
<tr>
<td>Hip prosthesis</td>
<td>1</td>
<td>65,046</td>
<td>938</td>
<td>1.44</td>
</tr>
<tr>
<td>Hip prosthesis</td>
<td>2,3</td>
<td>15,769</td>
<td>379</td>
<td>2.4</td>
</tr>
<tr>
<td>Knee prosthesis</td>
<td>0</td>
<td>70,675</td>
<td>409</td>
<td>0.58</td>
</tr>
<tr>
<td>Knee prosthesis</td>
<td>1</td>
<td>79,653</td>
<td>786</td>
<td>0.99</td>
</tr>
<tr>
<td>Knee prosthesis</td>
<td>2,3</td>
<td>20,855</td>
<td>333</td>
<td>1.60</td>
</tr>
</tbody>
</table>


Basic SSI Risk Index

The index used in NHSN assigns surgical patients into categories based on the presence of 3 major risk factors:

**Surgery time:** “Operation lasting more than the duration cut point hours, where the duration cut point is the approximate 75th percentile of the duration of surgery in minutes for the operative procedure, rounded to the nearest whole number of hours

**Wound class:** Contaminated (Class 3) or dirty/infected (Class 4) wound class

**ASA Class:** ASA classification of 3, 4, or 5

**Risk Index:** “The patient’s SSI risk category is simply the number of these factors present at the time of the operation”

ASA = American Society of Anesthesiologists.

---

Surgical Wound Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Wound Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>• An uninfected operative wound in which no inflammation is encountered and there is no entry into the respiratory, alimentary, genital, or urinary tract</td>
</tr>
<tr>
<td></td>
<td>• Clean wounds are closed primarily and, if necessary, drained with closed drainage</td>
</tr>
<tr>
<td>Clean-Contaminated</td>
<td>• Operative wounds in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination</td>
</tr>
<tr>
<td></td>
<td>• No evidence of infection is encountered or major break in technique occurs</td>
</tr>
<tr>
<td>Contaminated</td>
<td>• Open, fresh accidental wounds</td>
</tr>
<tr>
<td></td>
<td>• Operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract</td>
</tr>
<tr>
<td></td>
<td>• Incisions in which acute, non-purulent inflammation is encountered</td>
</tr>
<tr>
<td>Dirty or Infected</td>
<td>• Old traumatic wounds with retained devitalized tissue</td>
</tr>
<tr>
<td></td>
<td>• Existing clinical infection or perforated viscer is encountered</td>
</tr>
<tr>
<td></td>
<td>• This definition suggests that the organisms causing postoperative infection were present in the operative field prior to the procedure</td>
</tr>
</tbody>
</table>

NHSN & Standardized Infection Rate (SIR) Measurement

The Standardized Infection Ratio (SIR) is a measure that is used to compare how a hospital’s infection rate or unit’s infection rates compares to a national standard.

- Compares the actual number of HAIs reported with the number that would be expected, based on aggregate national data, adjusting for risk factors known to be significantly associated with differences in infection incidence.

\[
\text{SIR} = \frac{\text{Observed (O) HAIs}}{\text{Expected (E) HAIs}}
\]

- An SIR > 1 indicates that more HAIs were observed than expected.
- An SIR < 1 indicates that fewer HAIs were observed than expected.
- An SIR = 1 indicates that the number of HAIs observed was the same as the number expected.

NSHN SSI Report

Successful surgery means experiencing life to the fullest!
What Was “Our” Hip & Knee SSI rate?

ACTIONS TAKEN:

Stopped surgery
Performed comprehensive assessment
Convened multi-disciplinary team to:
Develop a focused bundle & intervention plan.

Significant “pain” provides for ability to take bold action!

Comprehensive Assessment

System Processes
- Antibiotic usage & timing
- Air system/HVAC
- Cleaning of OR
- MRSA colonization
- Patient temperature, pre, intra & postoperative
- Skin preparation
- Team work
- Blood glucose control
- Instrument/case opening
- OR apparel
- Sterilization
- Other

Client history/behaviors

- Diabetes
- Preop preparation/education
- Other
- Demographics
- Smoking
- Other
Seeking the Evidence

- **Clinical Experience**
  - For-profit, joint venture Orthopedic hospital (~5500+ cases annually & ~30 surgeons
  - Multi-state, multiple hospital system
  - Inner-city, safety-net, level I trauma center, multi-hospital system

- **Conferences – local, state, national & international**
  - APIC – IDSA – SHEA & others
  - E. Patchen Dellinger, MD. University of Washington
  - L. Prokuski, MD, University of Wisconsin
  - Others

- **Research Review/Professional Society Guidelines

The path is not always clear & change can be scary!
Guidelines for SSIs

Professional organizations & other resources


&

SHEA Practice Recommendations: Strategies to prevent surgical site infections in acute care hospital.

ICHE October 2008, vol. 29, supplement 1

APIC = Association for Professionals in Infection Control & Epidemiology
How-to Guide: *Prevent Surgical Site Infections*

*SSI Prevention: Four Components of Care*

1. Appropriate Use of Prophylactic Antibiotics
2. Appropriate Hair Removal
3. Controlled Postoperative Serum Glucose in Cardiac Surgery
4. Immediate Postoperative Normo-thermia in Colorectal Surgery

---

**GETTING TO ZERO**

Is there a SSI Ortho prevention bundle/path to get us to zero? **YES**
Preventing Orthopedic Total Joint Replacement Surgical Site Infections through a Comprehensive Best Practice Bundle/Checklist

Authors: Jette R. Hogenmiller, PhD, MN, APRN, CDE, James Hamilton, MD, Todd Clayman, RN, BSN, BernaSue Casper, MBA, Kathy Sparks, RN, BSN, Akin Cil, MD, James Stanford, MD, Sarah Darby, RN, BSN, MBA, Cheryl Pilsl, RN, DN, CRNA, Kara Settles, MD, Judy Kratz, RN, Steve DeGarmo, BS, Steve Williams, BA, Tendai Zinyemba, EVS; Hospital: Truman Medical Center, Kansas City, MO

Presented at: APIC National Conference; June 2011; Baltimore, MD. Poster 1683.

What do we know about the cause of Surgery/Orthopedic SSI’s?
Surgical Site Infection
Allan Morrison, Jr, MD, MSC, FACP, FIDSA, FSHEA

Sources of SSI

**Individual**
- Age
- Colonization with microorganisms
- Current infection, not at surgical site
- Diabetes
- Gender
- Nicotine use
- Nutritional status
- Obesity

**Hospital**
- Antibiotic prophylaxis not consistent with best practice
- Shaving vs clipping
- Skin preparation client/surgical team (CDC category IB)

SSI: Primary Risk Factors

- **Endogenous microorganisms**
  - Skin-dwelling microorganisms
    - Most common source
    - *Staphylococcus aureus* most common isolate

- **Exogenous microorganisms**
  - Surgical personnel
  - OR environment
  - All tools, instruments, and materials

OR = operating room.

SSI: Modifiable Risks

- Glucose control
- Preoperative CHG shower
- Appropriate hair removal
- Hand hygiene
- Skin antisepsis
- Antimicrobial prophylaxis
- Normothermia

CHG = chlorhexidine gluconate.
Table 2: Modifiable and Non-Modifiable Host- and Procedure-Related Orthopedic SSI Risk Factors

<table>
<thead>
<tr>
<th>Host-specific</th>
<th>Modifiable</th>
<th>Non-Modifiable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>Obese</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Current smoking</td>
<td></td>
<td>Male gender</td>
</tr>
<tr>
<td>Hematocrit &lt; 36</td>
<td></td>
<td>Rheumatoid arthritis</td>
</tr>
<tr>
<td>Elevated preoperative or postoperative serum glucose</td>
<td></td>
<td>ASA score of 3 or greater</td>
</tr>
<tr>
<td>Nasal carriage of Staphylococcus aureus (as risk factor for Staphylococcus aureus infection)</td>
<td></td>
<td>Recent weight loss</td>
</tr>
<tr>
<td>Procedure-specific</td>
<td>Estimated blood loss of &gt; 1 liter*</td>
<td>Disseminated cancer</td>
</tr>
<tr>
<td></td>
<td>Longer procedure time*</td>
<td>Admission from a healthcare facility</td>
</tr>
<tr>
<td></td>
<td>Suboptimal timing of prophylactic antibiotic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two or more surgical residents participating in procedure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prolonged wound drainage*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spiral procedure via the posterior or the anterior/posterior approach</td>
<td></td>
</tr>
</tbody>
</table>

A More Than Typical Scenario - Total Joint Replacement – What is the Risk?

High Risk Patient:
- Immunosuppressive meds - RA
- Diabetes
- Advanced age
- Prior surgery to same joint
- Psoriasis
- Malnourished
  - morbid obesity
  - sAlb<35
  - low sTransferrin
- Remote sites of infection
- Smokers
- ASA ≥3
Logistic Regression Analyses for Orthopedic Procedures

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Without Hospital Fixed Effects (n=107,825; C statistic=0.612)</th>
<th>With Hospital Fixed Effects (n=107,825; C statistic=0.831)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>P</td>
</tr>
<tr>
<td>Intercept</td>
<td>-4.9765</td>
<td></td>
</tr>
<tr>
<td>Patient severity</td>
<td>0.0911</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>0.3026</td>
<td>.0416</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.2589</td>
<td>.0011</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes without complication</td>
<td>0.5527</td>
<td>.1054</td>
</tr>
<tr>
<td>Diabetes with complication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complicated hypertension</td>
<td>0.0963</td>
<td>.6991</td>
</tr>
<tr>
<td>Heart failure</td>
<td>0.2212</td>
<td>.1928</td>
</tr>
<tr>
<td>Morbid obesity</td>
<td>0.6361</td>
<td>.0004</td>
</tr>
<tr>
<td>Hospital</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Transplant plant procedures and cases missing MediQual predicted death score were excluded.
†This is the reference value.
NA = not assessed
Distribution of Pathogens Related to Orthopedic Surgery

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Orthopedic Surgery (N=963)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulase-negative Staphylococcus</td>
<td>173 (15.3)</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>548 (48.6)</td>
</tr>
<tr>
<td>Enterococcus species</td>
<td></td>
</tr>
<tr>
<td>E. faecalis</td>
<td>57 (5.1)</td>
</tr>
<tr>
<td>E. faecium</td>
<td>13 (1.2)</td>
</tr>
<tr>
<td>Not specified</td>
<td>34 (3.0)</td>
</tr>
<tr>
<td>Candida species</td>
<td></td>
</tr>
<tr>
<td>Candida albicans</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Other or not specified</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>34 (3.0)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>38 (3.4)</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>14 (1.2)</td>
</tr>
<tr>
<td>Enterobacter species</td>
<td>37 (3.3)</td>
</tr>
<tr>
<td>Acinetobacter baumannii</td>
<td>10 (0.9)</td>
</tr>
<tr>
<td>Klebsiella oxytoca</td>
<td>5 (0.4)</td>
</tr>
<tr>
<td>Total number of pathogenic isolates by surgery type</td>
<td>1128</td>
</tr>
</tbody>
</table>


Review of a Variety of Well-Known and Less Well-Known Evidence

- Hair removal
- Skin preparation and microorganism affect
- Surgical instrument wraps
- Anesthesia work space
- Equipment (e.g. tourniquets)
  - Ultraviolet light
  - Head cover
  - Oxygen tension
  - Serum glucose
Hair Removal of the Surgical Site
Razor vs Clipper

<table>
<thead>
<tr>
<th></th>
<th>Percent SSI Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discharge</td>
</tr>
<tr>
<td>PM Razor</td>
<td>5.2%</td>
</tr>
<tr>
<td>AM Razor</td>
<td>6.4%</td>
</tr>
<tr>
<td>PM Clipper</td>
<td>4.0%</td>
</tr>
<tr>
<td>AM Clipper</td>
<td>1.8%</td>
</tr>
</tbody>
</table>


Activity of Antiseptic Agents Commonly Used for Pre-Operative Skin Preparation and Surgical Scrubs

<table>
<thead>
<tr>
<th>Agent</th>
<th>Gram-Positive Bacteria</th>
<th>Gram-Negative Bacteria</th>
<th>Mtb</th>
<th>Fungl</th>
<th>Virus</th>
<th>Rapidity of Action</th>
<th>Residual Activity</th>
<th>Toxicity</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>Most rapid</td>
<td>None</td>
<td>Drying</td>
<td>SP SS</td>
</tr>
<tr>
<td>Chlorhexidine</td>
<td>E</td>
<td>G</td>
<td>P</td>
<td>F</td>
<td>G</td>
<td>Intermediate</td>
<td>E</td>
<td>Ototoxicity</td>
<td>SP SS</td>
</tr>
<tr>
<td>Iodine/iodophors</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>Intermediate</td>
<td>Minimal</td>
<td>Absorption Skin initiation</td>
<td>SP SS</td>
</tr>
<tr>
<td>PCMX</td>
<td>G</td>
<td>F*</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>Intermediate</td>
<td>G</td>
<td>More data needed</td>
<td>SS</td>
</tr>
<tr>
<td>Triclosan</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>P</td>
<td>U</td>
<td>Intermediate</td>
<td>E</td>
<td>More data needed</td>
<td>SS</td>
</tr>
</tbody>
</table>

*Fair, except for Pseudomonas spp.; activity improved by addition of chelating agent such as EDTA.
SP = skin preparation; SS = surgical scrub.
Mechanism & spectrum of activity of antiseptic agents commonly used for pre-op skin preparation & surgical scrubs

Table E-1: Mechanism and spectrum of activity of antiseptic agents commonly used for preoperative skin preparation and surgical scrubs

<table>
<thead>
<tr>
<th>Agent</th>
<th>Mechanism of Action</th>
<th>Gram-Positive Bacteria</th>
<th>Gram-Negative Bacteria</th>
<th>Mts</th>
<th>Fungi</th>
<th>Virus</th>
<th>Rapidity of Action</th>
<th>Residual Activity</th>
<th>Toxicity</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Protein denaturation</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>None</td>
<td>Slow</td>
<td>None</td>
<td>Low</td>
<td>SP, SS</td>
</tr>
<tr>
<td>Chlorhexidine</td>
<td>Disrupts cell membrane</td>
<td>E</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>Intermediate</td>
<td>E</td>
<td>Obliterates, irritates</td>
<td>SP, SS</td>
<td></td>
</tr>
<tr>
<td>Iodophors</td>
<td>Oxidation/oxidation</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>Intermediate</td>
<td>Minimal</td>
<td>Absorption by free iodine from skin</td>
<td>SP, SS</td>
<td></td>
</tr>
<tr>
<td>POMX</td>
<td>Disrupts cell wall</td>
<td>G</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>Intermediate</td>
<td>G</td>
<td>More data needed</td>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>Trilidaun</td>
<td>Disrupts cell wall</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>P</td>
<td>Intermediate</td>
<td>E</td>
<td>More data needed</td>
<td>SS</td>
<td></td>
</tr>
</tbody>
</table>

Method

90 sterilization wraps divided into groups with
- no defect &
- with 6 sizes of defects ranging from 1.1mm to 10.0mm in diameter
- Puncture-type defects were created using nails of known diameter
- All wraps were evaluated by medical personnel for evidence of a breach

Sterilization wrap inspections do not adequately evaluate instrument sterility

- Orthopaedic procedures rely on strict sterilization techniques to prevent SSI
- Surgical instrument trays are wrapped for sterilization, and these wraps routinely are inspected by OR personnel to evaluate for breaches before use

Sterilization wrap inspections do not adequately evaluate instrument sterility

- Detection rates ranged from 6.7% to 96.7% from the smallest to largest defects, respectively
  - The potential for bacterial transmission through wrap defects also was evaluated, and contaminated nails of the smallest size transmitted bacterial contaminants through the wrap during the creation of puncture defects
  - Thus, substantial perforations in sterilization wraps frequently are missed when evaluated with commonly used techniques.

- Defects with a diameter approximately that of a pencil (6.7mm) were missed 18% of the time, although contamination can be transmitted by a nail with the diameter of a pin (1.1mm)

- These results raise questions about a common screening method


Study of surgical instruments contamination by bacteria from air during the operation

- Routinely sterilized surgical instruments were divided into 2 groups and put on the same instrument table
  - Group 1: Covered with dressing
  - Group 2: Exposed to air
- Samples collected at 30 minutes, 60 minutes, and 90 minutes, respectively after operation began and bacterium culture done

Results
- The general air contamination rate of the Group 2, exposed, was 1.18 times > Group 1, covered
- The exposure time had a positive correlation with bacterium contamination rate.

Time dependent contamination of opened sterile operating-room trays.

**Methods**: 45 trays opened in a positive-air-flow OR. Random assignment to 3 different treatments of trays/groups:

- **Group 1**: 15 opened & left uncovered in locked OR (e.g. no traffic/doors shut)
- **Group 2**: 15 identical to above, but 1 person traffic flow (walk briskly by trays & leave) in & out from exterior non-sterile corridor every 10 minutes
- **Group 3**: 15 opened, then immediately covered with sterile surgical towel & left in locked OR (e.g. no traffic)

**Results**: Interestingly, 3 of 30 trays were found to be contaminated immediately after opening (culture) & were eliminated from analysis.

**Remaining 27 uncovered trays contamination rate**
- 4% at 30 minutes
- 15% at 1 hr
- 22% at 2 hrs
- 26% at 3 hrs
- 30% at 4 hrs

Covered trays were not contaminated. “Culture positivity correlated directly with the duration of open exposure of the uncovered OR trays.”


---

**Organisms**

- 44% CNS
- 22% Corynebacterium
- 11% alpha-\textit{Streptococcus}
- 11% \textit{Bacillus} species
- 6% \textit{Micrococcus}
- 6% \textit{Moraxella} species

\textit{CNS} = coagulase-negative staphyloccus.

Blood contamination of anesthesia equipment & monitoring equipment.

- 19 definable surfaces were sampled in 22 operating rooms.
- 33% of surfaces were contaminated with blood
- Contaminated equipment included surfaces that are in continuous contact with patients e.g., blood pressure cuffs & pulse oximeter probes.
- Visual inspection was not a reliable means of detecting blood contamination.


Transmission of pathogenic bacterial organisms in the anesthesia work area

**RESULTS:** Bacterial contamination of the anesthesia work area increased significantly at the case conclusion, with a mean difference of 115 colonies per surface area sampled (95% CI: 62-169; P < 0.001).

- Transmission of bacterial organisms, including VRE to IV stopcock sets occurred in 32% (95% CI, 20.6-44.9%) of cases

**CONCLUSION:** Potentially pathogenic, multidrug-resistant bacterial organisms are transmitted during the practice of general anesthesia to both the anesthesia work area & intravenous stopcock sets.

Cl = confidence interval; VRE = vancomycin-resistant enterococcus; IV = intravenous.

**Microbial growth on the anesthesia machine**

**Part I**

*Purpose:* Determine the amount of microbial growth that develops on the anesthesia machine after a full day's use in OR

Descriptive bacteriology study relevant to anesthesia practice given *proximity of the oropharynx & multiple body fluids to anesthesia equipment & potential for cross-contamination to patients & staff*


**Microbial growth on the anesthesia machine**

**Part II**

*Results:* P value of 0.12 indicated that the observed CFU increase was not statistically significant at the .05 level. [Note: very close to 0.05—possibly underpowered]

- Organisms found on anesthesia machine tabletop:
  - CNS
  - *Bacillus*
  - alpha-*Streptococcus*,
  - *Acinetobacter*
  - *S. aureus* &
  - gram-negative rods

- Several were expected to be found; however, alpha-*Streptococcus*, *Acinetobacter*, *S. aureus*, and gram-negative rods are pathogenic organisms causing respiratory infections & bacteremia, especially in patients with compromised conditions

CFU = colony-forming units.

Microbial colonization of tourniquets used in orthopedic surgery

Part I

- Study analyzed -> **tourniquets** used for orthopedic surgery
  - **Group A** - main OR
  - **Group B** - ambulatory surgicenter
  - **Group C** - unused, prepackaged, sterile tourniquets from main OR
  - **Group D** - sterilely packed tourniquets from ambulatory surgicenter

- **Microbial growth on tourniquets:**
  - **Group A** – 100%
  - **Group B** – 40 %
  - **Group C** – 0 %
  - **Group D** – 0%


Microbial colonization of tourniquets used in orthopedic surgery

Part II

**Group A tourniquets (Main OR)**
- CNS 100%
- Bacillus 60%
- S. aureus 20%
  - Additionally -> 20% contaminated either with Streptococcus sanguis, Aerococcus viridans, or Corynebacterium species

**Group B tourniquets (Surgi-center)**
- CNS 40%
- Bacillus 30%

**Conclusion:** Tourniquet contamination may be a risk factor for the development of SSI in orthopedic surgery

CNS – coagulase negative staph
Ultraviolet lighting during orthopaedic surgery & the rate of infection
Part I

Purpose of study: Compare the infection rates following joint replacement procedures performed by 1 orthopaedic surgeon
- with &
- without the use of ultraviolet lighting

Methods
- July 1986 to July 2005, 1 surgeon performed 5980 total joint replacements at 1 facility
  - July 1986 to August 1991
  - September 1991 to July 2005; September 1991 ultraviolet lighting was installed in the ORs


Ultraviolet lighting during orthopaedic surgery & the rate of infection
Part II

Results
- Odds of infection were 3.1 times greater for procedures performed without ultraviolet lighting (& with laminar airflow) as compared with those performed with only ultraviolet lighting ($P<.0001$)
  - The infection rate associated with
    - Total hip replacement decreased from 1.03% to 0.72% ($P=.5407$)
    - Total knee replacement decreased from 2.20% to 0.50% ($P<.0001$)

Comment
- Number of limitations of study & subsequent studies with varying results

Surgical area contamination—comparable bacterial counts using disposable head & mask and helmet aspirator system, but dramatic increase upon omission of head-gear: An experimental study in horizontal laminar air-flow

**Purpose:** Effect of different head coverings on air-borne transmission of bacteria and particles in the surgical area—studied during 30 strictly standardized sham operations performed in a Horizontal LAF unit

The OR team wore disposable gowns plus either a
- Nonsterile head covering consisting of a squire type disposable hood & triple laminar face mask
- A sterilized helmet aspirator system
- No head cover at all

In the wound area both types of head cover resulted in
- low & comparable air (means of 8 & 4cfu/m³) &
- surface contamination (means of 69 & 126cfu/m²/hour) rates

LAF = laminar air flow.

---

Surgical area contamination—comparable bacterial counts using disposable head and mask and helmet aspirator system, but dramatic increase upon omission of head-gear: An experimental study in horizontal laminar air-flow

Omission of head-gear resulted in a 3- to 5-fold increase ($P > 0.01$), depending on site sampled air contamination rate (mean of 22cfu/m³) whereas the bacterial sedimentation rate in the wound area increased about 60-fold ($P > 0.0001$)

A proper head cover minimized the emission of apparently heavy particles that were not removed by the horizontal LAF & contained mainly *Streptococci*, presumably of respiratory tract origin

Dust particle counts revealed no differences between the 3 experimental situations

No correlation between air & surface contamination rates or between air contamination & air particle counts was found

RESULTS

I. Bacteriological point of view
   • disposable hoods of squire type & face masks are equally as efficient as a
   • helmet aspirator system &
   • both will efficiently contain the substantial emission of bacteria carrying droplets from the respiratory tract occurring when head cover is omitted.

II. Finally, the use of bacterial air counts to assess surgical site surface contamination in horizontal LAF units must be seriously questioned.


Influence of Oxygen on the Development of Wound Infection

Wound Oxygen Tension & SSI

Observed-Expected SSI Rate (%)

Subcutaneous Wound Oxygen Tension (mmHg)

n=14
n=25
n=33
n=24
n=19
n=15


FiO2 & SSI Three Studies

Number of Patients

Patients SSI at 30/35% SSI at 80%

Hyperglycemia & SSI

What is the evidence?

Perioperative Hyperglycemia in Noncardiac Surgical Patients: Does it Increase Postoperative Infections?

Postop inf = pneumonia, SSI, UTI, sepsis within 30 d

Variables = postop gluc, age, race, diabetes, ASA, emergent, op duration, transfusion

Significant: postop gluc > 180
O.R.=2.03

gluc increase of 40  O.R.=1.9
ASA & emergent

Rogers et al. Brigh & Womens, ASA, 24 Apr 08, NYC
Hyperglycemia & Risk of SSI after Cardiac Operations

No Increased Risk
- Elevated HbA1c
- Preoperative hyperglycemia

Increased Risk
- Diagnosed diabetes
- Undiagnosed diabetes
- Post-op glucose ≥200 mg % within 48 hours

Hyperglycemic
- Double risk of SSI
- 48% of diabetics
- 12% of non-diabetics
- 30% of all patients

47% of hyperglycemic episodes were in non-diabetic


SSIs & Glucose Levels

<table>
<thead>
<tr>
<th>Glucose Level (mg/dL)</th>
<th>Infected Patients (n=72)</th>
<th>Noninfected Patients (n=902)</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;200</td>
<td>35 (49%)</td>
<td>651 (72%)</td>
<td>1.00</td>
</tr>
<tr>
<td>200-249</td>
<td>21 (29%)</td>
<td>154 (17%)</td>
<td>2.54</td>
</tr>
<tr>
<td>250-299</td>
<td>11 (15%)</td>
<td>69 (8%)</td>
<td>2.97</td>
</tr>
<tr>
<td>≥300</td>
<td>5 (7%)</td>
<td>28 (3%)</td>
<td>3.32</td>
</tr>
</tbody>
</table>

Prevention of SSIs

Glucose Control

<table>
<thead>
<tr>
<th></th>
<th>Intermittent Insulin</th>
<th>Continuous Infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients</td>
<td>968</td>
<td>1499</td>
</tr>
<tr>
<td>Deep Sternal SSI</td>
<td>19</td>
<td>12 (<em>P</em>=.01)</td>
</tr>
<tr>
<td>Infection Rate</td>
<td>2.0%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>


Is it time for a “SSI Prevention Bundle for Orthopedic Surgery?”

Are we using the evidence we have?

“Excellence is a moving target”
With so many possibilities for sources of SSI’s what should the prevention focus be?

- 2% CHG Sage® Cloths: Night before & AM of surgery
- 3M™ Skin & Nasal Antiseptic: Preoperative
- Warming with 3M™ Bair Paws™ Gowns: Preop/intraop/postop
- Huddle – preoperative checklist & team review

Evidence supporting potential for positive impact on outcomes

REVIEW OF BUNDLE USED TO REDUCE ORTHOPEDIC SSI’S
Preventing Orthopedic Total Joint Replacement Surgical Site Infections through a Comprehensive Best Practice Bundle/Checklist


<table>
<thead>
<tr>
<th>TOPIC</th>
<th>ACTION</th>
<th>ACTION STATUS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical</td>
<td>Has medical clearance been obtained?</td>
<td>Yes/No</td>
<td>Date/Time</td>
</tr>
<tr>
<td>Dental</td>
<td>Has dental clearance been obtained?</td>
<td>Yes/No</td>
<td>Date/Time</td>
</tr>
<tr>
<td>Education</td>
<td>Preoperative education provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2% CHG</td>
<td>Preoperative shower CHG pack &amp; instructions given</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAT</td>
<td>PAT Visit 7-10 day prior to surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>Complete laboratory tests, assure results support surgery OK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative Call</td>
<td>Reinforce &amp; importance of preop 2% CHG showers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Remind patient to be NPO after midnight, NO gum or mints, Meds with a sip of water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Joint Surgery Checklist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal Clean</td>
<td>Verify OR room terminally cleaned prior to Ortho implant surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>Labs drawn by 7AM &amp; verify standards met to proceed with surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2% CHG</td>
<td>Verify showers completed (#1 soap/H2O; #2 PM; #3 pre-op area); Y=all done</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nares</td>
<td>Apply 3M product to nares, if pt not allergic to iodine. Use protocol.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warming</td>
<td>Warming 30 min in advance of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose of Antibx</td>
<td>Verify dosing based on current protocol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antibiotic</td>
<td>Antibiotic infusion begun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruments</td>
<td>Coordinate time start for table/instrument prep - doc open time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>Team huddle - SCOAP/WHO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraoperative</td>
<td>Incision surgery incision time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp</td>
<td>Patient temperature maintained at 36.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrument Sticker</td>
<td>NOT for explants or spacer revision</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Place initials of the individual verifying completion of the action in the appropriate “yes” or “no” location, and place the date and time the action occurred, where appropriate, in respective locations & include AM or PM.*

Skin Decontamination

Association of Perioperative Registered Nurses (AORN)

- Recommended Practices for Preoperative Patient Skin Antisepsis
  - “Patients undergoing open Class 1 surgical procedures below the chin should have 2 preoperative showers with CHG before surgery, when appropriate”

CDC

- Category 1B—“Require patients to shower or bathe with an antiseptic agent on at least the night before the operative day”
- Category B1—“Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies and strong theoretical rationale”

SHEA compendium of strategies to prevent HAI in acute care hospitals

- “To gain the maximum antiseptic effect of CHG, it must be allowed to dry completely and not be washed off”

Preoperative shower revisited: Can high topical antiseptic levels be achieved on the skin surface before surgical admission?

Background

- CHG skin concentrations were determined after preoperative showering/skin cleansing using 4% CHG soap or 2% CHG-impregnated polyester cloth

Study Design

- Subjects were randomized to 1 of 3 shower (4% soap)/skin cleansing (2% cloth) groups (n=20 per group)
  - Group 1 A/B evening
  - Group 2 A/B morning
  - Group 3 A/B evening and morning
- After showering or skin cleansing, volunteers returned to the investigator's laboratory where CHG skin surface concentrations were determined at 5 separate skin sites
- CHG concentrations were compared with CHG minimal inhibitory concentration that inhibits 90% (MIC90) of staphylococcal skin isolates

PPM = parts per million; MIC – minimum inhibitory concentration.

Can high topical antiseptic levels be achieved on the skin surface before surgical admission?

**Results** (CHG MIC<sub>90</sub> for 61 skin isolates was 4.8 ppm)

- **Evening only**
  - 17.2-31.6 ppm Group 1A, 4% CHG skin concentrations
  - 361.5-589.5 ppm Group 1B, 2% CHG (P<.0001)

- **Morning only**
  - 51.6-119.6 ppm Group 2A, 4% CHG
  - 848.1-1049.6 ppm in group 2B, 2% CHG (P<.0001)

- **Evening & morning**
  - 101.4-149.4 ppm Group 3A, 4% CHG
  - 1484.6-2031.3 ppm Group 3B 2% CHG cloth (P<.0001)

Effective CHG levels were not detected in the 4% CHG group in selected sites in 7 (35%) subjects in group 1A, 3 (15%) in group 2A, and 5 (25%) in group 3A.

PPM = parts per million; MIC – minimum inhibitory concentration.

Night before instructions on use of 2% Sage cloths.

Tested in inner-city sample after revised by ambulatory care nurses

Clean bed linens & pajamas also required.

Backside

1 & 2 packages night before

1 package AM of surgery
NASAL FLORA & SSI

Evidence & intervention used to address this as a source of SSI

Nasal Decontamination

Why consider decolonization of the nares?

SSI rates with

- CHG & mupirocin (3.4%) vs placebo (7.7%) preoperative surgery pts (n=917)
- Deep SSI RR 0.21 (0.07 to 0.62)

The number of SSI’s acquired in the hospital can be reduced by rapid screening & decolonization of nasal carriers of S aureus on admission (P=0.005)


Staph carriers had greater S aureus bacteremia than nonstaph carriers, 1.2% vs 0.4% RR 3.0, 95% CI (2.0-4.7).


RR = relative risk.

Nasal Decontamination

Why consider decolonization of the nares?

Other titles, full references available:

- **Preoperative elimination of nasal carriage using mupirocin nasal ointment significantly reduces the SSI rate in cardiothoracic surgery patients.** Klutmans, et.al. (1996) ICHE
- **Prophylactic intranasal mupirocin significantly reduced the rate of post-operative S aureus infections among surgical patients who were S. aureus carriers.** Van Rijen, MML, et al. (2008) J Antimicrob Chemother

TJA = total joint arthroplasty.
Why Avoid Mupirocin for Decolonization of the Nares?

Implications for SSI"s

Crisis in Antibacterial Resistance
Notice that as drug use increases resistant drug strains occur

Chart 1: Resistant Strains Spread Rapidly

MRSA = methicillin-resistant Staphylococcus aureus
VRE = Vancomycin-resistant enterococci
FQRP = Fluoroquinolone-resistant Pseudomonas aeruginosa

Source: Centers for Disease Control and Prevention
New Antibacterial Classes???

Antibacterial Drug Approvals in the United States

Mupirocin resistance in patients colonized with MRSA in a Surgical Intensive Care Unit.

**Background:** “Mupirocin resistance in pts with MRSA has been reported, usually in the context of widespread mupirocin use.”

**Methods:** “…nasal swab cultures for MRSA performed at admission, weekly, & at discharge…” > 48 hrs stay required. **This study occurred in a low use mupirocin hospital**, 6.08 tx days per 1000 patient days.

**Results:** “…of 302 MRSA isolates…,
- **13.2% were resistant to mupirocin with**
  - **8.6% having high-level resistance** (MIC, >512 ug/ml) &
  - **4.6% … low level resistance** (MIC, 8-256ug/ml).
- **72.5% of isolates contained staphylococcal cassette chromosome mec II.** ….PCR revealed that high-level mupirocin was present in multiple clonal groups.”


---

**Frequency of MRSA Colonization at Various Patient Body Sites**

- Forehead: 51%
- Nose: 54% (94%)
- Neck: 35%
- Axilla: 13%-28%
- Hands: 40%
- Groin: 38%

69% of positive patients were colonized at more than one extranasal site
95% of nasal carriers had MRSA at extranasal sites

MRSA Colonization Studies

<table>
<thead>
<tr>
<th>Population</th>
<th>Location</th>
<th>Year</th>
<th>Percent S. aureus</th>
<th>Percent MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHS clinics</td>
<td>Washington</td>
<td>2004</td>
<td>27.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>Atlanta</td>
<td>2003</td>
<td>21.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Homeless</td>
<td>San Francisco</td>
<td>2002</td>
<td>22.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Pediatric clinic</td>
<td>Chicago</td>
<td>2000</td>
<td>22.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Adult*/Pediatric</td>
<td>New York</td>
<td>2000</td>
<td>28*/34</td>
<td>0*/0.4</td>
</tr>
<tr>
<td>Students</td>
<td>Minneapolis</td>
<td>2000</td>
<td>36.2</td>
<td>7.4</td>
</tr>
<tr>
<td>Pediatric ER</td>
<td>Chicago</td>
<td>2000</td>
<td>26.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>Charlottesville</td>
<td>1999</td>
<td>NA</td>
<td>0.98</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>Boston</td>
<td>1998</td>
<td>24.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Pediatric clinic</td>
<td>Nashville</td>
<td>2004</td>
<td>36.4</td>
<td>9.2</td>
</tr>
</tbody>
</table>

IHS = Indian Health Service.

Mupirocin Resistance in Hip & Knee SSI's

It is of concern that Rotger M, Trampuz A, Piper KE, Steckelberg JM, Patel R.
found that 27% Phenotypic & genotypic
of MRSA isolates mupirocin resistance
causing hip or knee among staphylococci
prosthetic joint causing prosthetic joint
infection were resistant infection. J Clin Microbiol
to mupirocin.
Phenotypic and genotypic mupirocin resistance among Staphylococci causing prosthetic joint infection.

Method: Mupirocin MICs & mupA presence were determined in 108 staphylococci causing prosthetic joint infection.

0/35 isolates (0%) of methicillin-susceptible Staph (MSSA),
4/15 (27%) methicillin-resistant S. aureus (MRSA) isolates,
3/16 (19%) methicillin-susceptible coagulase-negative staph (MSSA),
11/42 (26%) methicillin-resistant coagulase-negative staphylococci (MRSA – CNS) were mupirocin resistant.

mupA was detected in all 5 high-level mupirocin-resistant staphylococci & 1 mupirocin-susceptible staphylococcus.


Use of perioperative mupirocin to prevent methicillin-resistant staphylococcus aureus (MRSA) orthopaedic SSI’s


Treatment: Pts received perioperative prophylaxis with:
- nasal mupirocin for 5 days & a
- bath or shower with 2% triclosan the day before surgery.

The control group consisted of pts undergoing similar procedures in the 6 months before the mupirocin/triclosan regimen was started.

Both groups received intravenous cephradine for 24 hours perioperatively.

There was a marked decrease in the incidence of MRSA nasal carriage in the group treated with mupirocin & triclosan. After introduction of the mupirocin/triclosan protocol, MRSA SSIs decreased from
- 23 per 1,000 to
- 3.3 to 4 per 1,000

Of the 11 MRSA SSIs that occurred in the mupirocin/triclosan group, only 1 patient received the Intervention correctly.

The number of SSIs caused by other pathogens was not affected by the intervention. The relative contributions of mupirocin & triclosan could not be determined.

Nevertheless, the authors stated that their results justify empirical, as opposed to targeted, usage of mupirocin prophylaxis because current health care practice makes it almost impossible to preoperatively assess for MRSA carriage and subsequently treat all patients undergoing orthopaedic surgery.

[this is an inappropriate conclusion]
# Skin & Nasal Antiseptic

Povidone-Iodine Solution 5% w/w [0.5% available iodine] USP

- **Skin & Nasal Antiseptic:** Only Product Designed for Presurgical Reduction of *S. aureus* in the Nares

<table>
<thead>
<tr>
<th>Effective</th>
<th>Reduces 99.5% of <em>S. aureus</em> in the Nares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Acting</td>
<td>Effective in as little as 1 hour</td>
</tr>
<tr>
<td>Persistent</td>
<td>Maintains this reduction for at least 12 hours</td>
</tr>
<tr>
<td>Safe</td>
<td>Active ingredient is an antiseptic, and has not been shown to lead to resistance</td>
</tr>
<tr>
<td>Assurance</td>
<td>Easily fits into facility’s preoperative process, so you know it has been applied and colonization of <em>S. aureus</em> in the nares has been reduced</td>
</tr>
</tbody>
</table>

3M™ Skin and Nasal Antiseptic

(Povidone-Iodine Solution 5% w/w [0.5% available iodine] USP)
Patient Preoperative Skin Preparation

1. Use a tissue to clean the inside of both nostrils including the inside tip of nostril. Discard.

2. Tilting the bottle slightly, dip one swab into solution and stir vigorously for 10 seconds. Withdraw the swab slowly to avoid wiping solution off during removal.

3. Insert swab comfortably into one nostril and rotate for 15 seconds covering all surfaces. Then focus on the inside tip of nostril and rotate for an additional 15 seconds. (swab 1)

4. Using a new swab: repeat steps 2 and 3 with the other nostril. (swab 2)

5. Repeat the application in both nostrils using a fresh swab each time. (swabs 3 & 4)

6. Do not blow nose. If solution drips out of nose, it can be lightly dabbed with a tissue.
Facts about Iodine and Iodophors

Iodine has been used to kill microorganisms for over 100 years. Iodine and iodophors have bactericidal activity against both gram-positive and gram-negative bacteria, as well as mycobacteria, viruses, and fungi. Iodine molecules rapidly penetrate the cell wall of microorganisms and inactivate cells by forming complexes with amino acids and unsaturated fatty acids, resulting in impaired protein synthesis and alteration of cell membranes, thus killing the microorganism.1

Iodine is a trace element essential to life and present throughout the body. True allergy to iodine does not exist. A very small number of patients who are extremely predisposed to allergy may exhibit sensitivity to various skin preparations.

According to the AOHN 2011 Recommended Practices for Preoperative Patient Skin Antiseptics, under Recommendation III it states:

1. The patient should be assessed for considerations affecting skin preparation.
   - II.a. The patient should be assessed for allergy or sensitivity to skin preparation agents.
   - II.a.1. Povidone-iodine can cause contact dermatitis or irritant reactions and does not indicate an allergy to iodine.
   - II.a.2. Anaphylaxis to povidone-iodine is extremely rare and has not been proven to be from the iodine.23 There is no correlation between reactions to povidone-iodine and allergy to seafood or fish and other sources.

2. Chlorhexidine glufosinate has triggered allergic reactions in sensitized individuals ranging from mild local symptoms to severe anaphylaxis. Mild symptoms may precede severe attacks.24

3. No increase in resistance to 3M™ Skin and Nasal Antiseptic has been shown in antibiotic-resistant strains of Staphylococcus aureus.2

Antimicrobial Effectiveness Against Resident Human Nasal Flora, Mainly Staphylococcus aureus, vs. a Saline Control(3)

Purpose: The purpose of this study (completed in 2009) was to assess the antimicrobial efficacy of 3M Skin and Nasal Antiseptic on the nasal flora of healthy volunteers versus a saline control. The study measured the reduction of S. aureus at 1, 6, and 12-h post treatment application. The reduction of total bacteria was also measured at these time points. Product acceptability data was collected from the subjects using a questionnaire.

Method: Thirteen to eighteen subjects (depending on time point) applied 3M Skin and Nasal Antiseptic following the instructions for nasal application. Seven to nine subjects (depending on time point) applied the 0.9% saline control.

One at a time, the foam-tipped applicators were saturated with the appropriate solution using a vigorous stir motion for at least 10 seconds. The subject’s nostrils were prepped for 30 seconds each using separate applicators. This process was then repeated using two additional applicators for a total application time of 1 minute per nare (2 minutes total). Post-prep samples were taken at 1-hour, 6-hours, and 12-hours from the nases. Baseline samples were taken before the application of the prep or control.

Results: 3M Skin and Nasal Antiseptic killed 99.5% of S. aureus within 1-hour and maintained the 99.5% kill for at least 12-hours post-prep (figure 2). 3M Skin and Nasal Antiseptic killed 99.2% of the total bacteria within 1-hour and maintained a 98.8% kill for at least 12-hours post-prep. The S. aureus count and the total bacterial count for 3M Skin and Nasal Antiseptic were significantly different from baseline using a paired t-test (P-value < 0.0004). 3M Skin and Nasal Antiseptic showed significantly more S. aureus reduction as well as more total bacterial reduction than control using a 2-sample t-test (P-value < 0.02).
Preoperative, Intraoperative, & Postoperative Warming

Why is it important?
What method did we chose and Why?
CMS core measures—postoperative measure

Prevention of SSIs

Temperature Control

<table>
<thead>
<tr>
<th></th>
<th>Temperature &gt;36.5</th>
<th>Temperature &gt;34.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients</td>
<td>104</td>
<td>96</td>
</tr>
<tr>
<td>Transfused Patients</td>
<td>23 (22%)</td>
<td>34 (35%) [P=.054]</td>
</tr>
<tr>
<td>SSIs</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Infection Rate</td>
<td>5.8%</td>
<td>18.8% [P=.009]</td>
</tr>
</tbody>
</table>

Inoperative Heat Transfer

Convection
Radiation
Evaporation
Conduction

SSI and Normothermia

N=200 randomized to

normothermia vs. hypothermia

- SSI developed in 6% vs. 19% (P=.009)

- Length of stay ↑2.6 days for hypothermia group (P=.001)

- Intraoperative normothermia can be maintained by blankets, warmed IV fluids

Temperature & SSIs

**Hypothermia reduces**
- Oxygen tension by vasoconstriction
- Leukocyte superoxide production

**Hypothermia increases**
- Bleeding & transfusion
- Duration of hospital stay even in uninfected patients

---


---

**3M™ Bair Paws™ System**

**Gown Basics**

*How does the Bair Paws Gown Work?*  
*When is the Bair Paws Gown used?*

*How does the Bair Paws gown work?*

There are two parts to the 3M™ Bair Paws™ system: the warming gown and the warming unit. The Bair Paws gown is worn like a traditional cotton gown (Figure 1). The gown ties on the right side (Figure 2) and behind the neck (Figure 3).

However, the Bair Paws gown has its own special features. There is a hose port on the gown. After you put on your Bair Paws gown, your doctor or nurse will connect the warming unit hose to the hose port on the gown and show you how to use the handheld controller for the warming unit (Figure 4). When the unit is turned ON, air will flow into the gown through tiny holes in the gown’s insert.
Bear Paw Warming Gown System

- Warming gown containing a warming unit
- Worn like traditional cotton gowns
- Hose port on gown which becomes connected to warming unit
  - Handheld controller for warmth adjustment
- When unit is on, air flows into gown through tiny holes in gown insert


---

The Bair Hugger patient warming system in prolonged vascular surgery: An infection risk?

Introduction: Use of the Bair Hugger forced-air patient warming system during prolonged abdominal vascular surgery may lead to increased bacterial contamination of the surgical field by mobilization of the pt's skin flora.

Methods: Bacterial content analyzed in air & wound specimens collected during surgery in 16 patients undergoing abdominal vascular prosthetic graft insertion procedure, using the Bair Hugger patient warming system. Bacterial colony counts from the beginning & the end of surgery were compared.

Results:
- No increase in bacterial counts at the study sites
- Decrease (P < 0.01) in air bacterial content around the patient & in the operating theatre after prolonged use of the patient warmer.
- No wound or graft infections occurred.

Antibiotics and Orthopedic SSI: Are there opportunities beyond the accepted?

Only 45% to 57% received the preoperative antibiotic 15-45 minutes before inflation of tourniquet of TKAs (N=114).

TKAs = total knee arthroplasties.
Timing of Prophylactic Antibiotic Administration for Total Hip Arthroplasty

Team Huddle
Surgical Checklist

Variety of Surgical Checklist exist

SCOAP
WHO
Others

SCOAP = Surgical Care and Outcomes Assessment Program; WHO = World Health Organization.
Implementing a pre-operative checklist to increase patient safety: a 1-year follow-up of personnel attitudes.

**BACKGROUND:** The OR is a complex work environment with a high potential for adverse events. We assessed personnel attitudes to a pre-operative checklist ('time out') immediately before start of the operative procedure.

**METHODS:** ‘Time out’ was implemented in December 2007 as an additional safety barrier in two Swedish hospitals. One year later, in order to assess how the checklist was perceived, a questionnaire was sent by e-mail to 704 persons in the operating departments, including surgeons, anesthesiologists, operation and anesthetic nurses and nurse assistants.

**RESULTS:** The questionnaire was answered by 331 (47%) persons
- 93% responded that ‘time out’ contributes to increased patient safety.
- 83% thought that ‘time out’ gave an opportunity to identify and solve problems. Confirmation of patient identity, correct procedure, correct side and checking of allergies or contagious diseases were considered ‘very important’ by 78-84% of the responders. Attitudes to checking of patient positioning, allergies and review of potential critical moments were positive but differed significantly between the professions. Attitudes to a similar checklist at the end of surgery were positive and 72-99% agreed to the different elements.

**CONCLUSION:** Staff attitudes toward a surgical checklist were mostly positive 1 year after their introduction in two large hospitals in central Sweden.

Be the kind of woman/man that when your feet hit the floor each morning the devil says…. “Oh Crap, She’s/He’s up!”

Impact of Surgery on Lives: Priceless!!!
Oral Decontamination

Overview of potential impact.

Oral Decontamination—Part of “Nose to Toes” Approach

Nose
• Skin and Nasal Antiseptic (Povidone-Iodine Solution 5% w/w [0.5% available iodine] USP)

Oral
• Chlorhexidine Gluconate 0.12%) Oral Rinse and Ultra-Soft Toothbrush
  • Provides antimicrobial activity during oral rinsing

Body to toes
• CHG Cloths
How might oral CHG based product impact outcomes in surgery?

Systematic Review of Prevention of VAP

**Purpose:** The aim of this review was to evaluate the evidence on the effectiveness of oral CHG in the prevention of VAP in critically ill adult mechanically ventilated patients in ICUs

**Results:** Eight randomized controlled trials met the inclusion criteria for this review
- 36% Higher chance of VAP in the control group compared with the chlorhexidine group (RR 0.64, 95% CI 0.44-0.91)
- The variation between the included studies was very small ($X^2=0.24$)

**Conclusion:** Treatment with CHG decreased the risk of VAP by 36%


Effectiveness of 0.12% Chlorhexidine Gluconate Oral Rinse in Reducing Prevalence of Nosocomial Pneumonia in Patients Undergoing Heart Surgery

**Background:** Decreasing the levels of bacteria in the oropharynx should reduce the prevalence of nosocomial pneumonia

**Objectives:** To test the effectiveness of 0.12% CHG oral rinse in decreasing microbial colonization of the respiratory tract and nosocomial pneumonia in patients undergoing open heart surgery

**Methods:** A prospective, randomized, case-controlled clinical trial design was used
- 0.12% CHG was the experimental drug and antiseptic mouthwash (phenolic mixture) was the control drug
- A total of 561 patients undergoing aortocoronary bypass or valve surgery requiring cardiopulmonary bypass were randomized to an experimental (n=270) or a control (n=291) group
- Nosocomial pneumonia was diagnosed by using the criteria established by the Centers for Disease Control and Prevention

Effectiveness of 0.12% Chlorhexidine Gluconate Oral Rinse in Reducing Prevalence of Nosocomial Pneumonia in Patients Undergoing Heart Surgery

**Results:** The overall rate of nosocomial pneumonia was reduced by 52% (4/270 vs 9/291; \( P = .21 \)) in the 0.12% CHG-treated patients.

- Among patients intubated for more than 24 hours who had cultures that showed microbial growth (all pneumonias occurred in this group), the pneumonia rate was reduced by 58% (4/19 vs 9/18; \( P = .06 \)) in patients treated with 0.12% CHG.
- In patients at highest risk for pneumonia (intubated >24 hours, with cultures showing the most growth), the rate was 71% lower in the 0.12% CHG group than in the antiseptic mouthwash group (2/10 vs. 7/10; \( P = .02 \)).

**Conclusions:** Although rates of nosocomial pneumonia were lower in patients treated with 0.12% CHG than in patients treated with antiseptic mouthwash, the difference was significant only in those patients intubated more than 24 hours who had the highest degree of bacterial colonization.


---

### Analysis of Ventilator-Associated Pneumonia per CHG 0.12%

<table>
<thead>
<tr>
<th>Study or Subcategory</th>
<th>CHG Events</th>
<th>Control Events</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Riso, et al (1996)</td>
<td>3</td>
<td>173</td>
<td>9</td>
<td>180</td>
<td>6.5%</td>
</tr>
<tr>
<td>Houston, et al (2002)</td>
<td>4</td>
<td>270</td>
<td>9</td>
<td>291</td>
<td>7.7%</td>
</tr>
<tr>
<td>Pobo, et al (2009)</td>
<td>18</td>
<td>73</td>
<td>15</td>
<td>74</td>
<td>19.0%</td>
</tr>
<tr>
<td>Scannapieco, et al (2009)</td>
<td>7</td>
<td>58</td>
<td>12</td>
<td>59</td>
<td>12.3%</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>574</strong></td>
<td><strong>604</strong></td>
<td><strong>45.5%</strong></td>
<td><strong>0.70 (0.39, 1.24)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total events:</strong></td>
<td><strong>32</strong></td>
<td><strong>45</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: \( \text{Tau}^2=0.13; \text{Chi}^2=4.74; \text{df}=3 (P=.19); I^2=37\% \)

Test for overall effect: \( Z=1.23 (P=.22) \)

Higher 1-year postoperative mortality
infected vs. non-infected

17% vs. 4%

Lee et al. (2006) [Sample > 64 years of age, nested-case control; 15,218 -> hip & knee replacement, open reduction of fracture, other joint replacement, spinal fusion & laminectomy]
### Orthopedic Total Joint Surgery Checklist

<table>
<thead>
<tr>
<th>TOPIC ACTION ACTION</th>
<th>ACTION STATUS* COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>Has medical clearance been obtained?</td>
</tr>
<tr>
<td>Dental</td>
<td>Has dental clearance been obtained?</td>
</tr>
<tr>
<td>Education</td>
<td>Preoperative education provided</td>
</tr>
<tr>
<td>2% CHG</td>
<td>Preoperative shower CHG pack &amp; instructions given</td>
</tr>
<tr>
<td>Preoperative Call</td>
<td>2% CHG Reinforce &amp; importance of preop 2% CHG showers</td>
</tr>
<tr>
<td>Education</td>
<td>Remind patient to be NPO after midnight, NO gum or mints, Meds with a sip of water. Ask about recent illness</td>
</tr>
<tr>
<td>PAT</td>
<td>PAT Visit 7-10 day prior to surgery</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Complete laboratory tests, assure results support surgery OK</td>
</tr>
<tr>
<td>2% CHG</td>
<td>Verify showers completed (#1 soap/H2O; #2 PM; #3 preoperative area); Y=all done</td>
</tr>
<tr>
<td>Educational</td>
<td>Apply 3M product to nares, if patient not allergic to iodine. Use protocol.</td>
</tr>
<tr>
<td>Warming</td>
<td>Warming 30 minutes in advance of surgery; time Bear Paws applied</td>
</tr>
<tr>
<td>Team</td>
<td>Team huddle - SGOAP/WHO</td>
</tr>
</tbody>
</table>

*Place initials of the individual verifying completion of the action in the appropriate “yes” or “no” location, and place the date and time the action occurred, where appropriate, in respective locations and include AM or PM.

PAT = preadmission testing; NPO = nothing by mouth.