Infection prevention in the OR: Establishing a safe operating room with a 7S bundle

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www.7sbundle.com
www.workingtowardzero.com
Objectives

• Understand the steps in the 7 S Bundle approach to prevent surgical site infections

• Describe the benefits of using a 0.05% chlorhexidine irrigation prior to incision to prevent contamination that may lead to a SSI.

• Identify how to collaborate with vendors who can compliment existing infection prevention initiatives in the operating room
7 “S” bundle to prevent SSI

- **SAFETY** – Safe Operating Room
- **SCREEN** – Screening pre-op for MRSA & MSSA
- **SHOWERS** – Showers with CHG night before and morning of surgery
- **SKIN PREP** – Skin Prep with alcohol based antiseptics (CHG, Iodophor)
- **SOLUTION** – Surgical Irrigation with 0.05% CHG
- **SUTURES** – Suturing with antibacterial sutures
- **SKIN CLOSURE** – Sealing the incision with incisional adhesive or covering it with an antimicrobial dressing to prevent exogenous contamination
#1 – Safe operating room
Is Your OR Safe?: Contamination risks in the operating room

- Traffic control, number of surgeons, staff, reps, visitors in the OR
- Improper surgical attire resulting in skin cells/organisms into environment from uncovered arms, hair, back of neck
- Improperly maintained air handling systems, filtration
- Hair clipping in the operating room
- Inadequate surgical prophylaxis (selection, dosing, timing)
- Inadequate room turnover and terminal cleaning procedures
- Inadequate surgical technique and handling of tissues
- Improper instrument cleaning/sterilization process, lack of use of enzymatic solution
- Improper use of biological indicators
- Contamination from storage of supplies, supply bins, carts, tables, stationary equipment
Follow AORN recommended practices
www.aorn.org – IPs should join and have access

- Preoperative Patient Skin Antisepsis
- Environmental Cleaning in the Perioperative Setting
- Surgical Tissue Banking
- Surgical Hand Antisepsis
- Cleaning and Care of Instruments and Powered Equipment
- Cleaning and Care of Surgical Instruments
- Cleaning and Processing of Flexible Endoscopes
- High Level Disinfection
- Cleaning and Processing Anesthesia Equipment
- Sterilization in the Perioperative Setting
- Hand Hygiene in the Perioperative Setting
- Prevention of Transmissible Infections in Perioperative Settings
- Surgical attire
- Sharps Safety
Surgical attire

• Typically, individuals shed more than 10 million particles from their skin every day

• Approximately 10% of skin squames carry viable microorganisms, causing a person to shed nearly 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.”
Scrubs and jackets in OR

- “Facility approved, clean, and freshly laundered surgical attire should be donned in a designated dressing area of the facility upon entry or reentry to the facility” ….AORN

- If scrubs are worn into the institution from outside, they should be changed before entering semi-restricted or restricted areas to minimize the potential for contamination (eg, animal hair, cross contamination from other uncontrolled environments)

- Home laundering of surgical attire is not recommended

- Non scrubbed personnel should wear long sleeved jackets that are buttoned or snapped closed during use. Complete closure of the jacket avoids accidental contamination of the sterile field. Long-sleeved attire is advocated to prevent bacterial shedding from bare arms and is included in the Occupational Safety and Health Administration (OSHA) regulation for the use of personal protective equipment (PPE)”
Environmental cleaning and disinfection

• Evaluate and observe between case cleaning procedures

• Bed should be the last thing cleaned – often it is the first!

• Terminal cleaning procedures on evening / night shift

• Sufficient staff to terminally clean all OR rooms each day?
New UV Technology for Operating Rooms

Air filtered through UV light unit that replaces fluorescent lighting “scrubs the air”

Ultraviolet-C room decontaminator

Narrow spectrum UV safe for patient and staff exposure during continuous use
Contact precautions in the OR

- AORN 2012 –Recommended Practices for Transmissible Infections in Perioperative Services
  - Contact precautions will be initiated in the OR for patients with:
    - MRSA colonization or infection
    - Vancomycin–resistant Enterococcus (VRE)
    - CRE
    - *C Difficile*
    - A large amount of wound drainage.
Cleaning / sterilization of instruments
www.aami.org – IPs should join and access standards

- Expect both TJC and CMS to spend a lot of time in Central Sterile Processing during Surveys
- Assure IFUs from manufactures are located in CSS (not the managers office) – online software best option
- Challenges with 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 with enzymatic
#5 – Chlorhexidine Irrigation

“The Solution to Pollution is Dilution”
Incisions are vulnerable to bacterial contamination before wound closure

- **OR activities during wound closure**
  - 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 & visitors might leave room

Air settling plates in the operating room at the last hour of a total joint case
Chlorhexidine Gluconate (CHG)

- CHG is a broad-spectrum biocide effective against Gram-positive bacteria, Gram-negative bacteria and fungi\(^1\)
- CHG inactivates microorganisms with a broader spectrum than other antimicrobials (e.g. antibiotics) – has a quicker kill rate than other antimicrobials (e.g. povidone–iodine, PI)\(^2\)
- It has both bacteriostatic and bactericidal mechanisms of action – kills by destabilizing the cell membrane within 20–30 second of application\(^3, 4\)
- Unlike PI, CHG is not affected by the presence of body fluids such as blood

5. Lim et al. *Anaesthesia Intensive Care* 2008;36:4
A) The positively charged Chlorhexidine molecule is attracted to the negatively charged phospholipids in the cell wall.

B) Chlorhexidine binds to the cell wall causing it to rupture

C) The rupturing of the cell wall causes fluid to leak leading to lysis and cell death.
Is 0.05% CHG an Effective Agent for Intraoperative Irrigation?

- Killing–curve analysis – MDRO surgical pathogens
- Log–reduction *in–vitro* mesh model – MDRO
- *In–vivo* abdominal mesh MRSA infection model
1. *In–Vitro* Time–Kill Kinetics

Methodology

- Clinical Gram–positive and Gram–negative multi–drug resistant surgical isolates were selected for study.
- A standardize microbial inoculum (8.1–9.2 log_{10} cfu/mL) was exposed to 0.05% CHG at 1, 5 and 30 minutes – At each interval, a neutralization agent was added to each tube and time–kill kinetics performed to assess cell viability
- Viable microbial cell counts were reported as log_{10} cfu/mL
- All testing was performed in triplicate and results averaged
Time–Kill Log Reduction – Selective Gram–Positive MDR Surgical Pathogens

- Vancomycin-resistant enterococci (VRE)
- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Methicillin-resistant *Staphylococcus epidermidis* (MRSE)
- Biofilm-forming *S. aureus* (MRSA)

Log$_{10}$ cfu/mL

1 Minute 5 Minutes

Post–Exposure

Edmiston et al. *Am J Infect Control* 2013;41:49
Time–Kill Log Reduction – Selective Gram–Negative MDR Surgical Pathogens

- **Pseudomonas aeruginosa**
- **E. coli (ESBL)**
- **Klebsiella pneumoniae (ESBL)**
- **Acinetobacter baumannii**

Log₁₀ cfu/mL vs. Post-Exposure:
- 1 Minute
- 5 Minutes

A. Edmiston et al. *Am J Infect Control* 2013;41:49
2. Impact of 0.05% Chlorhexidine Gluconate (CHG) on Microbial Adherence to Surgical Mesh

Methodology

• Clinical Gram-positive and Gram-negative surgical isolates were selected for study
• Selective mesh segments (1 cm²) were immersed in standardized suspension (8.0 Log₁₀ cfu/mL) for 5 minutes, followed by washing (2X)
• Test mesh placed in 0.05% CHG for 60 seconds and gently agitated, controls samples were placed in normal saline and agitated (60 seconds) – test segments were placed in neutralizing solution to inactivate CHG
• Test and control mesh segments were sonicated for 2 minutes, serially diluted, plated to TSA and incubated for 48 hrs (35°C)
• Microbial recovery expressed as Log₁₀ cfu/cm² – mesh segments were processed in triplicated and counts averaged

Time–Kill Log Reduction on Synthetic Mesh Following Contamination and 1–Minute Exposure to 0.05% Chlorhexidine Gluconate (CHG)

PS = polyester (soft)  DF = dual facing polyester and absorbable film
PR = polyester (rigid)  PP = polyester and polyglactin acid

MRSA – Biofilm producer

S. aureus (MRSA)

(p<0.01)
Time–Kill Log Reduction on Synthetic Mesh Following Contamination and 1–Minute Exposure to 0.05% Chlorhexidine Gluconate (CHG)

PS = polyester (soft)
PR = polyester (rigid)
DF = dual facing polyester and absorbable film
PP = polyester and polylactic acid

(p<0.001)

3. Impact of Intraoperative Saline and 0.05% CHG Irrigation on Resolution of MRSA Infected Animal Mesh Model

Methodology – Study approved by institutional animal welfare committee

- 1–cm x 2–cm abdominal (ventral midline) defect created in 16 Sprague–Dawley rats (Isoflurane/Rimadyl) followed by aseptic repair with polypropylene mesh – secured with 4 interrupted sutures
- Mesh segments contaminated (15–minutes) with 3.0 Log$_{10}$ cf/mL MRSA
- 8 segments irrigated 2X (60–sec) with normal saline / 8 segments irrigates (60–sec) with 0.05% CHG plus normal saline (60–sec) – irrigation volumes identical (200–mL)
- Incision closed (proline) and wound protected with coflex
- Animal observed daily – At 7–days animals were sacrificed (CO$_2$), mesh aseptically removed, segments sonicated, serially plated to TSA, incubated for 48–hrs at 35°C.
- Microbial recovery expressed as Log$_{10}$cfu/cm mesh
Impact of Intraoperative Saline and 0.05% CHG Irrigation on Resolution of MRSA Contaminated Polypropylene Mesh – Sprague–Dawley Animal Model

7 days Post Challenge – 3.0 log_{10} CFU/mL

Edmiston, ACS 2013
Irrigation of Incisions With 0.05% Chlorhexidine Reduces Surgical Site Infections in Colorectal Surgery

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1Tampa General Hospital; 2University of South Florida, Tampa, Florida

INTRODUCTION
Surgical site infections (SSIs) are the costliest hospital associated infections among hospitalized patients. In the US, approximately 300,000 SSIs occur yearly, representing 13% of healthcare associated infections. Surgical site irrigation is controversial and various solutions have been reported and used in an attempt to reduce infection. However, there is little clinical evidence to support use of antimicrobial agents in wound irrigation when other measures such as appropriate perioperative antibiotics are used. While there is a paucity of information on the effect of wound irrigation with chlorhexidine gluconate (CHG), much is known about its benefits for skin preparation. CHG has a wide range of activity against gram positive and negative bacteria, fungi, and viruses. Currently there is no formal recommendation or substantial evidence to support the practice of surgical wound irrigation prior to skin closure nor has the use of CHG irrigation in colorectal surgery been well investigated. Therefore the purpose of our study was to evaluate the effectiveness of 0.05% CHG irrigation in reducing abdominal surgical site infections in colorectal surgery.

STUDY DESIGN/SETTING
Retrospective review of abdominal operations performed by a group of three subspecialized colorectal surgeons at a large, tertiary, teaching hospital was performed.

METHODS
A consecutive 7 month trial period where 0.05% CHG solution was used to irrigate surgical incisions, as well as the consecutive 7 month period prior. The study extended from Jan 1, 2013 to Feb 28, 2014. One surgeon used CHG irrigation in all operations whereas the other two surgeons did not use CHG irrigation consistently. Procedures and SSIs were classified using NISN surgical procedure codes and infection event surveillance definitions. SSI rates for each surgeon were calculated and compared using student’s t-test.

RESULTS
A total of 196 qualifying cases were performed prior to CHG intervention and 197 during the trial period. A total of 27 SSIs occurred in each of the time periods. Table 1 demonstrates the number and rates of SSIs occurring during each time period and the difference between surgeons.

<table>
<thead>
<tr>
<th></th>
<th>Surgeon 1: Consistent Use of CHG</th>
<th>Surgeons 2 &amp; 3: Inconsistent Use of CHG</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-intervention Period</strong></td>
<td>13/67 (19%)</td>
<td>14/129 (11%)</td>
<td>0.32</td>
</tr>
<tr>
<td>SSIs/Cases (Rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CHG Trial Period</strong></td>
<td>7/58 (12%)</td>
<td>20/139 (14%)</td>
<td>0.0002</td>
</tr>
<tr>
<td>SSIs/Cases (Rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>p-value</strong></td>
<td>0.013</td>
<td>0.0137</td>
<td></td>
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</tbody>
</table>

American Society Colorectal Surgeons (ASCRS) June 2015
CONCLUSION

Our study demonstrates utility in the consistent use of 0.05% CHG irrigation for reducing SSIs in colorectal operations. A statistically significant decrease in SSIs was found for a surgeon using CHG in all cases during the intervention period. In addition, though there was no statistically significant difference between overall SSIs at baseline, there was a statistically significant decrease in SSIs for the surgeon using CHG in all cases during the intervention period when compared to the other surgeons. Although this was a small study, each participating surgeon served as their own control and could be compared across the group. A well powered prospective study should be performed to corroborate these preliminary findings.

REFERENCES

Conclusions

- *In–vitro* time–kill kinetics studies documented a >6-log reduction when selective drug–resistant surgical isolates were exposed for 1–5 minutes to 0.05% CHG.
- 0.05% CHG was effective (>5-log reduction, *p*<0.01) at resolving selective Gram–positive (biofilm–positive) and Gram–negative pathogens from the surface of synthetic mesh segments.
- 0.05% CHG was effective (82.5% reduction, *p*<0.001) in reducing the risk of an MRSA biofilm–mediated mesh infection in an *in–vivo* animal model.
- Current clinical experience has documented 0.05% to be safe in selective surgical practices.
- Clinical studies are warranted documenting its evidence–based benefit as an effective SSI risk reduction strategy.
Finally, an alternative to saline irrigation
The first and only FDA-cleared cleansing and debridement system, containing 0.05% Chlorhexidine Gluconate (CHG) in Water for Irrigation

IrriSept O.R. (sterile packaging)

Custom designed applicators facilitate cleansing for a variety of applications

SplatterGuard® LT SplatterGuard® IrriProbe®
IrriSept is indicated for use on wounds

Contraindications and Warnings:
Do not use on patients allergic to Chlorhexidine Gluconate (CHG)
Keep away from the eyes and ear canals; if there is contact with these areas, rinse out promptly and thoroughly with water or normal saline
Indications for Use

Surgical Wounds (as a final rinse before closure)

- Orthopedic Surgery
- General Surgery
- Plastics & Reconstructive Surgery
- Cardiothoracic Surgery
- Neurologic Surgery

- Surgical Site Infections (SSI)
- Skin & Soft Tissue Infections (SSTI)
- Delayed closures
- Abscesses
- Deep traumatic wounds

- Dehiscence
- Pilonidal cysts
- Puncture wounds
- Burns
- “Road rash” abrasions
- Lacerations
- Chronic Wounds
Collaborating with vendors
Instituted the use of the 7 S Bundle in 2012
2013 started implementing in facilities with high SSI rates
May 2015 – collaboration with Irrisept clinical specialists to visit facilities
Education done with surgeons on appropriate use of Irrisept
2016 – Collaboration with corporate Antimicrobial Stewardship Committee to explore the inappropriate use of antibiotic irrigations that could result in antimicrobial resistance and/or cases of anaphylaxis associated with Bacitracin irrigation
<table>
<thead>
<tr>
<th>1. Safe OR</th>
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<tbody>
<tr>
<td>EOC Rounds</td>
<td>75%</td>
</tr>
<tr>
<td>Wound Protectors</td>
<td>40%</td>
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<table>
<thead>
<tr>
<th>2. Screening for MRSA</th>
<th></th>
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<tbody>
<tr>
<td>Screening for MRSA</td>
<td>70%</td>
</tr>
<tr>
<td>Partial compliance</td>
<td>25%</td>
</tr>
<tr>
<td>Not screening (1)</td>
<td>5%</td>
</tr>
</tbody>
</table>

| 3. Chlorhexidine Showers | 95% |

<table>
<thead>
<tr>
<th>4. Alcohol Based Antiseptics</th>
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<tbody>
<tr>
<td>Chloroprep</td>
<td>95%</td>
</tr>
<tr>
<td>Duraprep</td>
<td>75%</td>
</tr>
</tbody>
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<thead>
<tr>
<th>5. Surgical Irrigation</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Bacitracin/Polymixin</td>
<td>70%</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>50%</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>30%</td>
</tr>
<tr>
<td>Irrisept (CHG)</td>
<td>75%</td>
</tr>
<tr>
<td>Other</td>
<td>40%</td>
</tr>
</tbody>
</table>

| 6. Antimicrobial Sutures | 70% |

<table>
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<th>7. Incisional</th>
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<tbody>
<tr>
<td>Adhesive/Dressings</td>
<td></td>
</tr>
<tr>
<td>Dermabond incisional adhesive</td>
<td>100%</td>
</tr>
<tr>
<td>Silver Dressing</td>
<td>65%</td>
</tr>
</tbody>
</table>
Many risk factors influence SSI

Pre-Operative Factors
- Lack of Hand Hygiene
- Patient Body Colonization
- Lack of Pre-Op Shower

Peri-Operative Team Factors
- Lack of Traffic Control - Too Many in room
- Improper Surgical Hand Antisepsis
- Improper Surgical Attire
- Unsterile Instruments
- Use of Staples or Steri-Strips
- Contaminated Environment
- Inadequate Surgical Prophylaxis
- Surgical Irrigation
- Non-Coated Sutures

Organizational and Management Factors
- Poor Communication Among Team
- Financial Constraints
- Poor Leadership
- Increase Hospitalization Days

Patient Factors
- MRSA or MSSA Nasal Colonization
- Infection at Another Site
- Obese
- Diabetic
- Smoker
- Immunosuppressive Agents

Surgeon Technique
- Use of Drains
- Lack of Re-Dosing of Antibiotic
- Poor Surgical Technique

Work Environment Factors
- Poor Staff levels
- Design, Availability and Maintenance of Equipment
- Workload and Shift Patterns
- Environment and Physical Plant Problems (Air Handling System)

Care Delivery Problems (CDP’s)
- Lack of Discontinuation of Antibiotics at 24 hrs
- Contaminated Environment
- Lack of Hand Hygiene
- Contamination of Incision Post-Op
- Inadequate Staffing for Post-Op Care
- Lack of Foley Catheter removal Within 48 hrs
Surgical infection prevention team

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