CHG Irrigation, Skin Antisepsis and Patient Bathing: Is There a Risk Reduction Benefit?

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“The Solution to Pollution is Dilution”

Evidence-Based Hierarchy

Systematic Reviews and Meta-analyses

Kinetics of Bacterial Growth in a Surgical wound

Randomized Controlled Double Blind Studies
Cohort Studies
Case Control Studies
Case Series
Case Reports
Ideas, Editorials, Opinions
Animal research
In vitro ('test tube') research

Q

10^6

Surgical procedure

3-5 days

10^2-3

2-6 hours

Period of contamination

Infection

Infection
Impact of Saline Lavage on Microbial Recovery from the Peritoneal Vault 24-hours Post-Gut Injury

Impact of Antibiotic Lavage on Microbial Adherence to Serosal Mesothelium

Topical Antibiotic Irrigation Literature by Service (1958-2009)

Ortho | 3 | 2,736
Neuro | 8 | 8,867
Gen  | 7 | 4,934
ENT  | 1 | 62
OB-GYN| 2 | 394
Vasc | 1 | 1,074
Transplant | 1 | 354
Plastics | 2 | 771
ER | 1 | 260
Total | 26 | 19,452
**Literature Review**

- Several well designed trials demonstrated no benefit in infection rates with prophylactic local antibiotic:
  - Simmons 2001 - IV Abx same as IV+local Abx
  - Moesga 1989 - IV Abx same as IV+local Abx
  - Anglen 2005 - Local Abx same as saline

<table>
<thead>
<tr>
<th>Strength of Analysis</th>
<th>Weak Study Design</th>
<th>Strong Study Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>Support Abx Irrigations</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Oppose Abx Irrigations</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**Antiseptic Irrigation**

  - Trend towards less SSI - Solution impairs wound healing
  - Dermacyn superior to povidone saline irrigation
  - Tetracyclin irrigation is not effective - similar to normal saline
- White RR. Pharmacokinetics of topical and intravenous cefazolin in patients with clean surgical wounds. *Plast Reconstr Surg* 2006;112:1773
  - Higher tissue concentration of cefazolin irrigation and IV than IV alone
  - Trend towards less SSI in non perforated appendicitis
Late-Onset Vascular Graft Infection

Slime-Forming Staphylococcus epidermidis

Microbial Recovery

Incubate 48 hours 35°C

0.45 μm Filter

Culture Media

Identification

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


Seabrook & Edmiston, Critical Care Infectious Diseases 2001; 875-888

Anastomotic femoral pseudoaneurysm: An investigation of occult infection as an etiologic factor

Gary R. Seabrook, MD; David D. Schonitz, MD; Dennis F. Randily, MD; Charles E. Edmiston, PhD; Condore J. Krapel, BS; MAISCF, and

Jocelin B. Tarroo, MD, Albuquerque, N.M.

Impact of Surgical Masks on Prevention of Microbial Nasopharyngeal Shedding in Healthy (N = 22) Individuals and Subjects with Symptoms of Rhinorrhea (N = 8)

Impact of Intraoperative Irrigation on Resolution of Mesh Contaminated Animal Model

The Surgical Wound

Stage 1 (initial response)
- Coagulation proteins
- Platelets
- Mast cells
- Complement
- Bradykinins

Stage 2 (>24-hours)
- Monocytes (scenarios)
  - wound healing
  - proinflammatory
- TNF –, IL-1, IL-6
- O2– – intermediates
- tissue injury

Mobilization of phagocytic cells
Impact of 0.05% (Irrisept®) CHG to Inhibit Bacterial Adherence To Prosthetic Device Surfaces

<table>
<thead>
<tr>
<th>Materials</th>
<th>Organisms (log₁₀ CFU/cm²)</th>
<th>E. coli</th>
<th>RP 62 A²</th>
<th>MRSA²</th>
<th>MSSA²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graft – PTFE</td>
<td>4.4 vs 0.8</td>
<td>6.8 vs 2.2</td>
<td>6.4 vs 1.2</td>
<td>6.6 vs 1.3</td>
<td></td>
</tr>
<tr>
<td>Graft – Dacron</td>
<td>6.5 vs 1.8</td>
<td>6.5 vs 1.6</td>
<td>6.4 vs 1.2</td>
<td>6.6 vs 1.3</td>
<td></td>
</tr>
<tr>
<td>Mesh – Polyester A²</td>
<td>6.3 vs 1.5</td>
<td>7.0 vs 2.1</td>
<td>6.8 vs 2.0</td>
<td>7.1 vs 2.2</td>
<td></td>
</tr>
<tr>
<td>Mesh – Polyester A²</td>
<td>6.1 vs 1.7</td>
<td>6.1 vs 2.2</td>
<td>7.1 vs 2.8</td>
<td>7.5 vs 2.6</td>
<td></td>
</tr>
<tr>
<td>Mesh – Polyester/ absorbable hydrophilic film</td>
<td>6.0 vs 0</td>
<td>5.6 vs 0</td>
<td>6.8 vs 1.5</td>
<td>6.0 vs 1.4</td>
<td></td>
</tr>
<tr>
<td>Mesh – Polyester/ polyactic acid</td>
<td>5.1 vs 1.8</td>
<td>6.1 vs 2.4</td>
<td>5.5 vs 1.0</td>
<td>5.9 vs 1.9</td>
<td></td>
</tr>
</tbody>
</table>

a.b.c.d RP 62 A, S. epidermidis; MRSA, methicillin-resistant S. aureus; MSSA, methicillin-sensitive S. aureus

e.f软; r = rigid

Local Antibacterial Administration
Clean Wounds

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Study</th>
<th>Benefit Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Praveen S. 2009</td>
<td>Local antibiotics are equivalent to intravenous antibiotics in the prevention of superficial wound infection in inguinal hernioplasty.</td>
<td>N</td>
</tr>
<tr>
<td>Musella M - 2001</td>
<td>Collagen tampons as aminoglycoside carriers to reduce postoperative infection rate in prosthetic repair of groin hernias.</td>
<td>Y</td>
</tr>
<tr>
<td>Bennett-Guerrero E - 2010</td>
<td>Gentamicin-collagen sponge for infection prophylaxis on sternal wound infections following cardiac surgery: a randomized trial.</td>
<td>N</td>
</tr>
<tr>
<td>Eklund AM - 2007</td>
<td>Prevention of sternal wound infections with locally administered gentamicin.</td>
<td>N</td>
</tr>
<tr>
<td>Friberg O - 2007</td>
<td>Local collagen-gentamicin for prevention of sternal wound infections: The LOGIP trial.</td>
<td>Y</td>
</tr>
<tr>
<td>Almdahl SM - 2011</td>
<td>Randomized prospective trial of saphenous vein harvest site infection after wound closure with and without topical application of autologous platelet-rich plasma.</td>
<td>N</td>
</tr>
<tr>
<td>Yetim I - 2010</td>
<td>Effect of local gentamicin application on healing and wound infection in patients with modified radical mastectomy: A prospective randomized study.</td>
<td>Y</td>
</tr>
</tbody>
</table>

Risk Reduction Begins on the Front End

Microbial Ecology of Skin Surface

- Scalp 6.0 Log₁₀ cfu/cm²
- Axilla 5.5 Log₁₀ cfu/cm²
- Abdomen 4.3 Log₁₀ cfu/cm²
- Forearm 4.0 Log₁₀ cfu/cm²
- Hands 4.0-6.6 Log₁₀ cfu/cm²
- Perineum 7.0-11.0 Log₁₀ cfu/cm²

Surgical Microbiology Research Laboratory 2008 – Medical College of Wisconsin

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**Note:**
- Impact of 0.05% (Irrisept®) CHG to Inhibit Bacterial Adherence To Prosthetic Device Surfaces
- Local Antibacterial Administration
- Clean Wounds
- Risk Reduction Begins on the Front End
- Microbial Ecology of Skin Surface

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**References:**
- Praveen S. 2009
- Musella M - 2001
- Bennett-Guerrero E - 2010
- Eklund AM - 2007
- Friberg O - 2007
- Almdahl SM - 2011
- Yetim I - 2010

**Notes:**
- **Materials:** Graft – PTFE, Graft – Dacron, Mesh – Polyester A², Mesh – Polyester/ absorbable hydrophilic film, Mesh – Polyester/ polyactic acid
- **Organisms:** E. coli, RP 62 A², MRSA², MSSA²
- **Bacterial suspension:** 8.0 log₁₀ cfu/ml
- **RP 62 A:** S. epidermidis
- **MRSA:** methicillin-resistant S. aureus
- **MSSA:** methicillin-sensitive S. aureus
- **Materials:** PTFE, Dacron, Polyester A²
- **Organisms:** E. coli, RP 62 A², MRSA², MSSA²
- **Bacterial suspension:** 8.0 log₁₀ cfu/ml
- **RP 62 A:** S. epidermidis
- **MRSA:** methicillin-resistant S. aureus
- **MSSA:** methicillin-sensitive S. aureus
Revisiting the Preadmission (Preoperative) Shower

- Study 1
- Study 2
- Study 3
- Study 4

Compared to MIC₉₀ (5 µg/ml) for Staphylococcal Surgical Isolates Including MRSA:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Groups</th>
<th>Chlorhexidine Gluconate (CHG) Skin Surface Concentrations (µg/ml±SD) Compared to MIC₉₀ (5 µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pilot 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>evening (15)</td>
<td>3.7±2.5</td>
</tr>
<tr>
<td></td>
<td>morning (15)</td>
<td>7.8±5.6</td>
</tr>
<tr>
<td></td>
<td>both (20)</td>
<td>9.9±7.1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>24.4±5.9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>436.1±92.2</td>
</tr>
<tr>
<td></td>
<td>[C₉₀/MIC₉₀] p-value</td>
<td>0.9 4.8 87.2</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.001</td>
<td>1.9 15.8 198.2</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.0001</td>
<td>2.5 25.3 349.1</td>
</tr>
</tbody>
</table>

Presurgical Skin Preparations as a Pathway to Improving Surgical Outcomes

- Reducing the risk of SSI in orthopaedic surgery:
  - Standardized prescreening initiative (CHG cloths) in total joint patients, right before morning of surgery.
  - SSI rate prior to intervention 3.2% (N=727).
  - SSI rate post intervention 1.6% (N=824) 16% reduction.
- Bundling risk reduction strategies — Quality initiative:
  - MRSA prescreening in orthopaedic, obstetric, bariatric patients — decolonization.
  - Presurgical antisepsis (CHG cloths) prior to surgery.
  - Preintervention SSI rate 1.6% (N=571,996)/vs postintervention SSI rate 0.87% (N=771,225) 49% reduction.
  - MRSA SSI rate 0.73% vs 0.16%.

Institutional Prescreening for Detection and CHG Eradication 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>7019</td>
<td>5293</td>
<td></td>
</tr>
<tr>
<td>MRSA Infection</td>
<td>4 (0.06%)</td>
<td>10 (0.18%)</td>
<td>0.0315</td>
</tr>
<tr>
<td>MSSA Infection</td>
<td>9 (0.13%)</td>
<td>14 (0.26%)</td>
<td>0.0937</td>
</tr>
<tr>
<td>Total SSIs</td>
<td>13 (0.18%)</td>
<td>24 (0.48%)</td>
<td>0.0093</td>
</tr>
</tbody>
</table>
Evidence Supporting Selected Uses of Chlorhexidine for Infection Control.

The Efficacy of Daily Bathing with Chlorhexidine for Reducing Healthcare-Associated Bloodstream Infections: A Meta-analysis

Mechanism and Spectrum of Activity for Commonly Used Antiseptics

<table>
<thead>
<tr>
<th>Agent</th>
<th>Mechanism of action</th>
<th>Gram positive bacteria</th>
<th>Gram negative bacteria</th>
<th>Rapidity of action</th>
<th>Residual activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Denature proteins</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Most rapid</td>
<td>None</td>
</tr>
<tr>
<td>Chlorhexidine</td>
<td>Disrupt cell wall</td>
<td>Excellent</td>
<td>Good</td>
<td>Intermediate</td>
<td>Excellent</td>
</tr>
<tr>
<td>Iodine/iodophors</td>
<td>Disrupt cell wall by free iodine</td>
<td>Excellent</td>
<td>Good</td>
<td>Intermediate</td>
<td>Minimal</td>
</tr>
<tr>
<td>PCMX</td>
<td>Disrupt cell wall</td>
<td>Good</td>
<td>Fair</td>
<td>Intermediate</td>
<td>Good</td>
</tr>
<tr>
<td>Triclosan</td>
<td>Disrupt cell wall</td>
<td>Good</td>
<td>Good</td>
<td>Intermediate</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

LISTER CARBOLIC ACID SPRAY AS ANTISEPTIC PRECAUTION

**Single-center, non-randomized, unblinded Phase IV Study of 3 Antiseptic Preparations**

- Sequential implementation design (6 month periods)
  - Period 1: Povidone-iodine scrub-paint combination (Betadine) with an isopropyl alcohol application between these steps
  - Period 2: 2% chlorhexidine/70% isopropyl alcohol (ChloraPrep)
  - Period 3: Iodine povacrylex in isopropyl alcohol (DuraPrep)

- SSIs tracked for 30 days
- Primary outcome was overall rate of SSIs by 6-month period performed in an intent-to-treat manner


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**SSIs and Wound Classifications by Antiseptic Preparation**

N=3,209 General Surgical Cases

**DESIGN:** A PROSPECTIVE, RANDOMIZED, MULTICENTER CLINICAL TRIAL OF 2% CHLORHEXIDINE GLUCONATE / 70% ISOPROPYL ALCOHOL (Alc-CHG) VS POVIDONE-IODINE (PI) FOR PREVENTION OF SSI

- Patients > 18 years, undergoing clean-contaminated procedures (gastrointestinal, thoracic, urologic and gynecologic)
- N = 849 surgical patients: 409 Alc-CHG vs 440 PI
- 1:1 randomization
- Patients monitored for 30 days post-op
- Overall rate of SSI was significantly reduced in Alc-CHG vs PI groups: 9.5% vs 16.1%, p=0.004
- No significant adverse events noted during the study in either group
- Alc-CHG superior to PI in reducing the risk of SSI in clean-contaminated procedures

**New England Journal of Medicine 2010;362:18-26**
Antimicrobial Sealants

  No benefit of applying cyanoacrylate prior to incision (N)
- Chambers A. Is skin closure with cyanoacrylate glue effective for the prevention of sternal wound infections? J Thorac Cardiovasc Surg 2010;139:793
  Significant benefit on superficial and deep wound infection if applied preoperatively or postoperatively (Y)
  Microbial sealant applied immediately before incision significantly reduced SSI (Y)
- von Eckardstein AS. A randomized trial of a skin sealant to reduce the risk of incision contamination in cardiac surgery. Ann Thorac Surg 2011;92:632
  Pretreatment with skin sealant protects against contamination and decreased SSI by 35% (Y)

No benefit of autologous platelet rich plasma placed on wounds post operatively