Target Zero: Mitigating Risk Factors for Preventing Hospital Acquired Infections

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Disclosures for Kathleen Vollman

- Consultant-Michigan Hospital Association Keystone Center
- Subject matter expert for CAUTI and CLABSI, HAPI, C-Diff and Sepsis for CMS/HIIN
- Consultant and speaker bureau:
  - Sage Products LLC
    - Will be addressing an off label use of a 2% CHG pre-op prep cloth
  - Eloquest Healthcare
  - Urology division of Medline Industries
Session Objectives

• Identify modes of transmission for the spread of microorganism in the healthcare environment

• Evaluate key evidence based care practices that can reduce bacterial load
INTERVENTIONAL PATIENT HYGIENE (IPH)

VAP/HAP

Oral Care/
Mobility

Catheter Care

Skin Care/
Bathing/Mobility

CA-UTI

CLA-BSI

SSI

Falls

HASI

HAI’s in Australia: One of The 10 National Quality and Safety Standards

• Systematic review from 2010-2016
  – 71,186 urinary tract infections
  – 4902 Clostridium difficile infections
  – 3946 surgical site infections
  – 1962 respiratory infections in acute stroke patients
  – 1100 hospital-onset Staphylococcus aureus bacteremia
  – Incomplete data on common infections such as pneumonia, gastroenterological and bloodstream infection,

Est 165,000 Australians contract infections in hospitals every year

60,037 hospital-acquired infections were diagnosed in Australian public hospitals,2 affecting one in every 74 hospitalisations (2015-2016).

HAIs are one of the most common complications affecting hospital patients; they increase the risk of morbidity, mortality & readmission within 12 months.
What is the Cost of HAC’s

- 2017–18, admissions associated with hospital-acquired complications (HACs) cost the public sector $4.1 billion or 8.9% of total hospital expenditure.
- 2018: Integration of HACs into funding model from July 2018
What If!!!

Around 61,862 healthcare-associated infections occur each year in Australian public hospitals

if we reduce the rate to the level of the best 25% of peer hospitals

IN PRINCIPAL REFERRAL HOSPITALS

IN PUBLIC ACUTE GROUP A

IN PUBLIC ACUTE GROUP B

138.4

84.9

52

this would result in

11,142 fewer healthcare-associated infections

with a possible value capture of

229,992 bed days

$459,984,691

Comparison of HAI’s between 2011 and 2015 in Acute care

<table>
<thead>
<tr>
<th>HAI</th>
<th>2011-11,282 patients</th>
<th>2015-12,299 patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>.98%</td>
<td>.89%</td>
</tr>
<tr>
<td>CDI</td>
<td>.54%</td>
<td>.54%</td>
</tr>
<tr>
<td>SSI</td>
<td>.97%</td>
<td>.56%</td>
</tr>
<tr>
<td>BSI</td>
<td>.44%</td>
<td>.41%</td>
</tr>
<tr>
<td>UTI</td>
<td>.58%</td>
<td>.32%</td>
</tr>
<tr>
<td>GI other</td>
<td>.22%</td>
<td>.25%</td>
</tr>
</tbody>
</table>

Patients at risk for an HAI is 16% lower in 2015 versus 2011

Magill SS et al. NEJM 2014;370:1198-208
Magill SS, et al. NEJM 2018;379:1732-1744
Declines in Hospital-Acquired Conditions

National efforts to reduce hospital-acquired conditions such as adverse drug events and injuries from falls helped prevent 20,500 deaths and saved $7.7 billion between 2014 and 2017.
MEET THE HOSPITAL STAPH

EMPLOYEES MUST WASH HANDS BEFORE RETURNING TO WORK.

STREP
MRSA

CONCEPT-MIKE ADAMS ART-DAN BERGER WWW.NATURALNEWS.COM
MDRO In Australia

Multi-resistant organism (MRO) refers to bacteria that are resistant to one or more classes of antimicrobial agents and usually are resistant to all but one or two commercially available antimicrobial agents.

Around 3,800 hospital-acquired MROs occur each year in Australian hospitals.

The cost associated with Multi-resistant organism (MRO) in Australia could cost the hospital an additional $61,390.

Patients with this HAC require 29.6 extra days in the hospital compared to those who don’t.
HAI in the ICU was the patients’ endogenous flora (40%-60%); cross-infection via the hands of health care personnel (HCP; 20%-40%); antibiotic-driven changes in flora (20%-25%); and other (including contamination of the environment; 20%). Weinstein RA. Am J Med 1991;91(Suppl):179S-184S.
Vertical vs. Horizontal

• Vertical approach refers to a narrow-based program focusing on a single pathogen (selective of the specific MDRO)
  – AST to identify carriers
  – Implementation of measures aimed at preventing transmission from carriers to other patients
    • Isolation
    • Hand hygiene

• Horizontal approach to infection prevention and control measures refers to broad-based approaches attempting reduction of all infections due to all pathogens
  – no screening
  – Universal nasal coverage
  – CHG bathing
  – No isolation
  – Limit lines/tubes
  – Hand hygiene

Reducing MDRO’s/HAI’s

- Hand Hygiene
- Decontamination of Environment
- Patient Decolonization
- Contact Precautions/Isolation
- Antibiotic Stewardship
- Practice Device Bundles

Reducing Bacterial Load on the Patient: A Horizontal Strategy

Evidence Based Bathing Practices
Polling question

- Based on the current evidence, what type of daily bathing should be performed with critically ill patients
  - Soap and water bath
  - Antisepsis CHG bath
  - Packaged bath cloths
  - Package cloths that are activated by water
Traditional Bathing

Why are there so many bugs in here?

Soap and water basin bath was an independent predictor for the development of a CLABSI

Bath Basins
Potential Source of Infection

Large multi-center study evaluates presence of multi-drug resistant organisms

- Contaminated: 686 basins/88 hospitals (62%)
- Colonized w/ VRE: 385 basins/80 hospitals (35%)
- Gram negative bacilli: 495 basins/86 hospitals (45%)
- MRSA: 36 basins/28 hospitals (3%)

Total hospitals: 88
Total basins: 1103

Mechanisms of Contamination

- Skin flora
- Multiple-use basins
  - Incontinence cleansing
  - Emesis
  - Product storage
- Bacterial biofilm from tap water

Biofilms are ubiquitous
Review

Opportunistic Premise Plumbing Pathogens: Increasingly Important Pathogens in Drinking Water

Joseph O. Falkinham, III 1,*, Amy Pruden 2 and Marc Edwards 2

Clinical Infectious Diseases

INVITED ARTICLE

HEALTHCARE EPIDEMIOLOGY: Robert A. Weinstein, Section Editor

Healthcare Outbreaks Associated With a Water Reservoir and Infection Prevention Strategies

Hajime Kanamori,1,2 David J. Weber,1,2 and William A. Rutala1,2
1Division of Infectious Diseases, University of North Carolina School of Medicine, and 2Hospital Epidemiology, University of North Carolina Health Care, Chapel Hill

Operating-room machines test positive for Legionella at UW Medicine

Originally published September 19, 2016 at 2:19 pm | Updated September 19, 2016 at 7:31 pm
Understanding Water

- All water with the exception of sterile water and filtered water is contaminated with microbes (e.g., potable water, tap water, showers, and ice).
- In healthy persons, contact or ingestion of such water rarely leads to infection.
- However, contact or ingestion of such water may cause infection in immunocompromised persons or when applied to non-intact skin.
- Transmission of these pathogens from a water reservoir may occur by direct and indirect contact, ingestion and aspiration of contaminated water, or inhalation of aerosols*


Presented at MSIPC October 6th, 2016, Lansing MI by Dorine Berriel-Cass
Waterborne Infection

Hospital Tap Water

- Bacterial biofilm
- Most overlooked source for pathogens
- 29 studies demonstrate an association with HAIs and outbreaks
- Transmission:
  - Drinking
  - Bathing
  - Rinsing items
  - Contaminated environmental surfaces
- Immunocompromised patients at greatest risk

Impact on UTI with Basin Bathing

UTI Rate - Removal of Prepackaged Bath Product QTR 3 FY05

### The Effect of Bathing with Basin and Water and UTI Rate, LOS and Costs

#### Unit Census: 14

<table>
<thead>
<tr>
<th>Phases</th>
<th>Product Cost/UTI</th>
<th>No. of UTI</th>
<th>Median(^4) LOS 17 Days</th>
<th>Median(^4) Cost (4857.00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I- Pre-Packaged Bathing Washcloths (9 months)</td>
<td>$10,530(^1) ($3.00)</td>
<td>25</td>
<td>175</td>
<td>$117,175</td>
</tr>
<tr>
<td>II- Basin/Water (9 months)</td>
<td>$3,510(^2) ($1.00)</td>
<td>48</td>
<td>336</td>
<td>$224,916</td>
</tr>
<tr>
<td>III- Additional Product Cost, UTI, LOS, COSTS</td>
<td>$7,020</td>
<td>23(^3)</td>
<td>151</td>
<td>$107,741</td>
</tr>
</tbody>
</table>

\(^1\) Based on 3 packages of 8 towels each  
\(^2\) Based on product cost of towels, soap, and basin  
\(^3\) Difference between phase I pre-package/phase II basin water  
Bathing with CHG Basinless Cloths

• Prospective sequential group single arm clinical trial
• 1787 patients bathed
  – Period 1: soap & water
  – Period 2: CHG basinless cloth bath*
  – Period 3: non-medicated basinless cloth bath

*2% CHG cloth for bathing is consider an off label use of the product.

Veron MO et al. Archives Internal Med 2006;166:306-312
26 colonization's with VRE per 1000 patients days vs. 9 colonization's per 1000 patient days with CHG bath
Impact on VRE with 2% CHG Cloth Bathing*

*2% CHG cloth for bathing is consider an off label use of the product.

Veron MO et al. Archives Internal Med 2006;166:306-312
The Efficacy of Daily Bathing with Chlorhexidine for Reducing Healthcare-Associated Bloodstream Infections: A Meta-analysis

John C. O’Horo, MD;¹ Germana L. M. Silva, MD;² L. Silvia Munoz-Price, MD;³ Nasia Safdar, MD, PhD⁴

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Experimental Events</th>
<th>Control Events</th>
<th>Total</th>
<th>Weight</th>
<th>Odds Ratio M–H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2.1 CHG Bathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borer et al, 2007</td>
<td>2</td>
<td>15</td>
<td>1600</td>
<td>3.3%</td>
<td>0.16 [0.04, 0.70]</td>
</tr>
<tr>
<td>Camus et al, 2005</td>
<td>6</td>
<td>7</td>
<td>1991</td>
<td>5.3%</td>
<td>0.84 [0.28, 2.52]</td>
</tr>
<tr>
<td>Climo et al, 2009</td>
<td>14</td>
<td>41</td>
<td>15472</td>
<td>10.5%</td>
<td>0.34 [0.18, 0.62]</td>
</tr>
<tr>
<td>Gould et al, 2007</td>
<td>171</td>
<td>264</td>
<td>6664</td>
<td>17.1%</td>
<td>0.66 [0.54, 0.80]</td>
</tr>
<tr>
<td>Munoz-Price et al, 2009</td>
<td>29</td>
<td>59</td>
<td>7532</td>
<td>13.1%</td>
<td>0.40 [0.25, 0.62]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>33359</td>
<td>32218</td>
<td>49.3%</td>
<td></td>
<td>0.47 [0.31, 0.71]</td>
</tr>
<tr>
<td>Total events</td>
<td>222</td>
<td>386</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.12; Chi² = 11.07, df = 4 (P = 0.03); I² = 64%
Test for overall effect: Z = 3.53 (P = 0.0004)

* 1.2.2 CHG Impregnated Cloths

<table>
<thead>
<tr>
<th></th>
<th>Experimental Events</th>
<th>Control Events</th>
<th>Total</th>
<th>Weight</th>
<th>Odds Ratio M–H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleasedale et al, 2007</td>
<td>9</td>
<td>22</td>
<td>2210</td>
<td>8.2%</td>
<td>0.39 [0.18, 0.85]</td>
</tr>
<tr>
<td>Dixon and Carver, 2010</td>
<td>8</td>
<td>27</td>
<td>3148</td>
<td>8.0%</td>
<td>0.31 [0.14, 0.69]</td>
</tr>
<tr>
<td>Evans et al, 2010</td>
<td>4</td>
<td>15</td>
<td>1785</td>
<td>5.2%</td>
<td>0.28 [0.09, 0.85]</td>
</tr>
<tr>
<td>Holder and Zellinger, 2009</td>
<td>2</td>
<td>12</td>
<td>2000</td>
<td>3.3%</td>
<td>0.28 [0.06, 1.24]</td>
</tr>
<tr>
<td>Montecalvo et al, 2010</td>
<td>27</td>
<td>57</td>
<td>13864</td>
<td>12.8%</td>
<td>0.43 [0.27, 0.68]</td>
</tr>
<tr>
<td>Popovich et al, 2009</td>
<td>2</td>
<td>19</td>
<td>5610</td>
<td>3.4%</td>
<td>0.13 [0.03, 0.54]</td>
</tr>
<tr>
<td>Popovich et al, 2010</td>
<td>17</td>
<td>19</td>
<td>5799</td>
<td>9.8%</td>
<td>1.14 [0.59, 2.19]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>34416</td>
<td>37399</td>
<td>50.7%</td>
<td></td>
<td>0.41 [0.25, 0.65]</td>
</tr>
<tr>
<td>Total events</td>
<td>69</td>
<td>171</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.19; Chi² = 12.80, df = 6 (P = 0.05); I² = 53%
Test for overall effect: Z = 3.78 (P = 0.0002)

Total (95% CI) 67775 69617 100.0% 0.44 [0.33, 0.59]

Heterogeneity: Tau² = 0.13; Chi² = 26.12, df = 11 (P = 0.006); I² = 58%
Test for overall effect: Z = 5.39 (P < 0.00001)
Test for subgroup differences: Chi² = 0.19, df = 1 (P = 0.66), I² = 0%

*2% CHG cloth for bathing is considered an off label use of the product

Infect Control Hosp Epidemiol 2012;33(3):257-267
The Evidence: Impact of 2% CHG Cloth Baths*
Evaluate effect of daily bathing with CHG on acquisition of MDRO’s and incidence of CLABSI

9ICU’s & Bone Marrow Transplant unit
Randomly assigned 7727 patient:
  a. No-rinse, 2% CHG impregnated washcloths*
  b. Non-antimicrobial, no-rinse bath cloths

Results of 2% CHG bathing
- 23% reduction
- 28% reduction
- 50% reduction
- 90% reduction


*2% CHG cloth for bathing is considered an off-label use of the product
Impact of 2% CHG Cloth Baths*
Study to determine the best method for reducing spread of MRSA & MDROs

3 protocols tested:

a) Swab for MRSA on admission to ICU
   - Isolate if positive
   - Nasal mucopiricin x 5 days
   - 2% CHG cloth* bathing for entire ICU stay

b) Swab for MRSA on admission to ICU
   - Isolate if positive
   - Nasal mucopiricin x 5 days
   - 2% CHG cloth* bathing for entire ICU stay

c) No swab
   - Nasal mucopiricin x 5 days
   - 2% CHG bath* for entire ICU stay

*2% CHG cloth for bathing is considered an off-label use of the product

Results: No Swab Group Universal Decolonization Demonstrated

37% reduction in MRSA
44% reduction in CLABSIs

# Chlorhexidine Bathing and Health Care-Associated Infections

## A Randomized Clinical Trial

<table>
<thead>
<tr>
<th>Setting</th>
<th>5 ICUs at 1 academic center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Studied</td>
<td>2% CHG washcloths</td>
</tr>
<tr>
<td>Study period/design</td>
<td>13 months/”Pragmatic Cluster Crossover” RCT</td>
</tr>
<tr>
<td>N</td>
<td>9,340 patients; 39,922 pt days</td>
</tr>
<tr>
<td>Outcome(s) Studied</td>
<td>Composite of CLABSI, CAUTI, VAP (new VAE definition), and <em>C. difficile</em>; Secondary: HA-BSI, clinical MDRO cultures, blood culture contamination</td>
</tr>
<tr>
<td>Results</td>
<td>Non-significant: 2.86 vs. 2.90 per 1000 pt days</td>
</tr>
<tr>
<td>Industry Support?</td>
<td>None</td>
</tr>
</tbody>
</table>

---

**Figure 2.** Effect of Chlorhexidine Bathing on Primary and Secondary Outcomes

- Analyses of primary composite outcome
- Intention-to-treat
- As treated
- Adjusted
- Secondary outcomes
- CDI
- CLABSI
- CAUTI
- VAP
- MDRO
- Blood culture contamination
- HA-BSI
- In-hospital mortality

---

## Difference Between Climo & Noto Study

<table>
<thead>
<tr>
<th></th>
<th>Climo</th>
<th>Noto</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcomes</strong></td>
<td>Hospital-acquired MDROs and hospital-acquired BSI</td>
<td>Composite (CLABSI, CAUTI, VAP, C. diff)</td>
</tr>
<tr>
<td><strong>Multicenter Study</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Active surveillance for MDRO acquisition</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Audit of Bathing Compliance</strong></td>
<td>Yes (product usage data)</td>
<td>No</td>
</tr>
<tr>
<td><strong>Training on Bathing</strong></td>
<td>Yes at study start</td>
<td>No</td>
</tr>
<tr>
<td><strong>Analysis Concerns</strong></td>
<td>Adequate adjustment for clustering?</td>
<td>Patient-level analysis; Adequate power with crossover design?</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td>Oral CHG in place for VAP prevention</td>
</tr>
</tbody>
</table>

CHG vs. Routine Bathing to Prevent MDRO and CLABSI in General Medical & Surgical Units

- 53 hospitals in 14 states
- Compared routine bathing (non-medicated disposable cloth or showering) to decolonization with universal chlorhexidine and targeted nasal mupirocin in non-critical-care units.
- 12-month baseline period, 2 month phase, 21 month intervention

Decolonization with universal chlorhexidine bathing and targeted mupirocin for MRSA carriers did not significantly reduce multidrug-resistant organisms in non-critical-care patients.

Patients with medical devices had a 32% greater reduction in all cause bacteremia and a 37% greater reduction in MRSA or VRE clinical cultures compared with the routine care group.

*2% CHG cloth for bathing is considered an off-label use of the product.

Huang SS, et al. Lancet. 2019; March 5th online
Universal Decolonization in an Australian Quaternary ICU

(Dawkins J, et al. Presented at AAACN Annual Scientific Meeting, 2018 Gold Coast)

- Royal Adelaide Hospital ICU
- Prior to 2014 experience stagnating CLABSI rates in ↑In MDRO’s
- Implementation: Sept 2014 2% CHG cloth bathing & first 5 days mupirocin in the nose
- Change practice from CHG soap and water to CHG cloths
- Routine screening procedures for MRSA & VRE (admission and weekly screening)

<table>
<thead>
<tr>
<th></th>
<th>% Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total BSI (including S. aureus)</td>
<td>↓41%</td>
</tr>
<tr>
<td>S. aureus BSI</td>
<td>↓81%</td>
</tr>
<tr>
<td>Total MRO Infections</td>
<td>↓20%</td>
</tr>
<tr>
<td>Acquisitions</td>
<td>↓42%</td>
</tr>
<tr>
<td>MRSA Infections</td>
<td>↓28%</td>
</tr>
<tr>
<td>Acquisitions</td>
<td>↓68%</td>
</tr>
<tr>
<td>VRE Infections</td>
<td>↓36%</td>
</tr>
<tr>
<td>Acquisitions</td>
<td>↓43%</td>
</tr>
<tr>
<td>MRGN Infections</td>
<td>↓13%</td>
</tr>
<tr>
<td>Acquisitions</td>
<td>↓24%</td>
</tr>
</tbody>
</table>
Differential Effects of Chlorhexidine Skin Cleansing Methods


- Prospective, randomized 2-center study with blinded assessment.
- To determine whether 3 different CHG skin cleansing methods yield similar residual CHG concentrations and bacterial densities on skin.

Method A- 2% CHG cloth
Method B- 4% CHG liquid poured onto non-medicated cloth
Method C-4% CHG liquid on cotton wash cloth
CHG Bathing Process

2% CHG Bathing Protocol
- 6 cloths used in the following order:
  - neck, shoulders, and chest (clean neck well, even if it is not visibly soiled).
  - arms, hands, web spaces, and axilla.
  - abdomen, groin/perineum.
  - right leg, right foot, and web spaces.
  - left leg, left foot, and web spaces.
  - back of neck, back, and buttocks.
  - Additional cloths should be used for larger patients.

Cleansing of Perineum/vagina
- The perineum and vagina are a critical area for cleaning and decolonization.
- CHG is safe to use on the perineum and external mucosa of vagina.
- Do not use CHG inside of the vagina.
- Important to use 2% CHG cloth after incontinence care.

Key Points
- Not to be used above the jawline.
- To be firmly massaged into skin with CHG cloths.
- Do not rinse, wipe off, or dry with another cloth or towel. Let skin air dry for 2 minutes.
- Tubing from foleys, drains, G-tubes/J-tubes, rectal tubes and chest tubes should be cleaned within 6 inches of patient.
- Use only CHG compatible products with CHG wipes.
- Do not save, reheat or reuse bags.

Monitor for compliance by assessing amount of CHG on the skin (Assay).
Prevent sub-optimal concentrations


*2% CHG cloth for bathing is consider an off label use of the product.

For Successful Banning of Basins for Patient Care

- We need to provide alternatives for the other functions:

<table>
<thead>
<tr>
<th>Current</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emesis</td>
<td>Emebags being installed in every adult and ped pt. room, ACU, PACU</td>
</tr>
<tr>
<td>Storage of patient items</td>
<td>Clear plastic “baggies”</td>
</tr>
<tr>
<td></td>
<td>Trial of “Concierge List” to decrease waste of unused/unneeded</td>
</tr>
<tr>
<td></td>
<td>products</td>
</tr>
<tr>
<td>Foot soaks</td>
<td>Shampoo caps, prepackaged</td>
</tr>
<tr>
<td>Shampoo patient’s hair</td>
<td>Shampoo caps par’d on all units</td>
</tr>
<tr>
<td>24 hour urine, ice</td>
<td>Store some basins in lab to be dispensed with each 24 hour jug.</td>
</tr>
<tr>
<td>Bath cloths with no insulation,</td>
<td>Bath cloths with insulation to stay warm longer</td>
</tr>
<tr>
<td>cold halfway through bath.</td>
<td></td>
</tr>
</tbody>
</table>

Quinn B, et al. Presented at NACNS National Conference, March 5-7th, 2015, San Diego CA
Australian SSI Data

Surgical site infection refers to an infection that occurs in the region of the body where prior surgery has been performed. It may or may not be associated with an indwelling device, such as a surgical drain.

Around 5,600 hospital-acquired surgical site infections occur each year in Australian hospitals.

The cost associated to Surgical Site Infections in Australia could cost the hospital an additional $42,102.

Patients with this HAC require 20.3 extra days in the hospital compared to those who don’t.

- Highest rate at Principal Referral Hospitals: 32.9
- Aggregate rate at Principal Referral Hospitals: 13.9
- If all hospitals reduced their rate to less than 13.9 per 10,000 hospitalisations, it would prevent at least 786 surgical site infections.
Prevention: What Can We Do Using the Basics

- Pre-op antisepsis-skin decontamination
- Nasal decontamination
- Oral decontamination
Hair removal, skin prep, hand hygiene, nasal decolonization, oral decontam, OR environment, patient management, abx prophy, surgical technique

Process Variability

\[
\left( \frac{\text{Dose of Bacteria}}{\text{Contamination}} \right) \times \left( \frac{\text{Virulence}}{\text{Resistance}} \right) = \text{Risk}
\]

Resistance of the Host
(Patient)

Patient Variability

Age, diabetes, obesity, nicotine, steroids, nutrition, etc.

CDC Guideline For Prevention Of Surgical Site Infection, 1999  
http://www.cdc.gov/ncidod/dhqp/gl_surgicalsite.html
Meet Your Microbiome
the microorganisms that call you home and where they live

Nose
Mouth
Gut
Vagina
Skin

37 Trillion Human Cells
100 Trillion Microbial Cells

Kinds of cells in the human body

- Human
- Bacterial
- Fungal

Risk of Infection

According to the CDC’s conceptual formula for SSI Risk, SSIs are impacted by the number of microbes that contaminate an incision during surgery

- **Most surgical site infections are caused by contamination of an incision with microbes from the patient’s own skin**
- The skin can contain over 1,000,000 bacteria per sq. cm
- It can take as few as 10 microbes per sq. cm* to cause a surgical site infection

*Risk of Infection

If we can reduce the number of microorganisms, we can reduce the risk of infection.
## Distribution of Top Ranking Pathogens 2009-2010

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>30.4%</td>
</tr>
<tr>
<td>Coagulase negative staphylococci (CNS)</td>
<td>11.7%</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>9.4%</td>
</tr>
<tr>
<td>Enterococcus faecalis</td>
<td>5.9%</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>5.5%</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td>4%</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>4%</td>
</tr>
<tr>
<td>Enterococcus spp.</td>
<td>3.2%</td>
</tr>
<tr>
<td>Proteus spp.</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Chlorhexidine Gluconate (CHG)

Skin antisepsis

- Used for disinfection of hands
  - Surgical scrub
  - Hand hygiene
- Pre-op skin disinfection of patients undergoing surgery
  - Cumulative effect with repeated applications
- Combined with alcohol for skin disinfection
  - Effective in the presence of blood or serum protein
  - Effective against vegetative Gram negative and positive organisms, some yeasts and viruses
# Preoperative Bathing

## Recommended Practice

### CDC – Guideline for Prevention of Surgical Site Infections, 2017

- “Before surgery, patients should shower or bathe (full body) with soap (antimicrobial or non-antimicrobial) or an antiseptic agent on at least the night before the operative day” (*Category IB-strong recommendation; accepted practice.*)

### SHEA/IDSA* – Strategies to Prevent Surgical Site Infections, 2014

- “Preoperative bathing with chlorhexidine-containing products” (Unresolved issue). To gain the maximum antiseptic effect of chlorhexidine, adequate levels of CHG must be achieved and maintained on the skin.

### AORN – Perioperative Standards and Recommended Practices, 2018

- “The collective evidence supports that preoperative patient bathing may reduce the microbial flora on the patient’s skin before surgery.”
- “The patient should be instructed to bathe or shower before surgery with either soap or a skin antiseptic on at least the night before or the day of surgery.”
- Although many studies support the use of 2% CHG cloths for preoperative bathing, additional research is needed before a practice recommendation can be made.”

---

3. AORN. Guidelines for Perioperative Practice, Denver, Colorado: AORN, Inc : 2018
The patient’s endogenous flora is the leading cause of SSI and antiseptics decrease bacteria present on the skin.

Preoperative bathing with CHG is effective in reducing skin flora, the same effect is not achieved with the use of soap alone.

Review by Webster did not show a statistically significant reduction in SSI, the studies included were limited to use of 4% CHG.

Use of a non-rinseable form of CHG (2% impregnated cloths) results in a significantly increased reduction in skin flora compared to 4% CHG showers. This reduction was greater with repeated application.

References:
CHG bathing

- **Meta-analysis by Chlebicki, et al** did not find a significant reduction in SSI rates
  - Varying/lack of application protocols (multiple vs. single application) and CHG concentrations

- **Additional studies specifically examining the effect of 2% CHG cloths demonstrate an appreciable impact on SSI**
  - Recent systematic review that included studies with consistent bathing protocols of two preoperative baths, found that the use of 2% CHG cloths significantly reduced SSI risk
  - Low risk and low-cost intervention that has shown effective in reducing bacteria on the skin, a risk factor for SSI

Preoperative bathing and SSI

  - Compare SSI incidence in THA patients using 2% CHG protocol the night before and morning of procedure (n=557), to pts undergoing only in-hospital skin prep (n=1901)
  - Infections in CHG protocol group = 0.5% vs 1.7% in group not using protocol (p=0.0428)
  - The benefits of an effective chlorhexidine cloth protocol have the potential to decrease periprosthetic infections
Summary - Preoperative Wipes or Showers

- Reduces the bacterial burden on the patient’s skin prior to surgical incision
- Practical problems: patient compliance, patient’s ability to bath/shower, and consistency in method of preparation
- 2% CHG impregnated cloth shown to be more effective than 4% CHG liquid detergent in multiple studies

Patient information regarding CHG

- Inactivated by soaps and shampoos
  - Keep out of eyes and ears
- Do not use lotions, powders, or creams after application
MRSA carriage

Patients at high risk

- History of MRSA colonization
- Intensive care units (ICUs)
- Immunocompromised
- Residents of long-term care facilities
- Hemodialysis
- Hospitalized in the previous 12 months
- Received antibiotic therapy in the last three months
- Skin or soft tissue infection at admission
Nasal Decolonization

- S. aureus colonization
  - Carriage is the most important independent risk factor for developing an SSI\(^2\)
  - Usually associated with the nares (~70%)
  - Other sites includes the skin, axilla, groin / perineal space
  - Carriers of high numbers of S. aureus have 3-6 times the risk of HAI\(^1\)
- Swabbing the nares identifies 80%-90% of MRSA carriers\(^2\)
- Patients may have S. aureus on the skin and other sites and not in the nose
- Decolonization of nasal and extranasal sites may reduce infection risk\(^4\)
  - ASHSP report - mupirocin should be used intranasally for all patients with documented colonization with Staph aureus (Strength of evidence for prophylaxis = A)\(^3\)

Guidelines and Recommendations

- **2014 SHEA/IDSA Practice Recommendation**
  - If unacceptably high SSI rates exist for surgical populations despite implementation of the basic SSI prevention strategies, then applying standard infection control methods for outbreak investigation and management are recommended, including:
    - Screen surgical patients for S. aureus and decolonize preoperatively for high risk procedures, including some orthopedic and cardiac procedures
    - Routine preoperative decolonization with mupirocin without screening and targeted use is not currently recommended due to concerns about evolving resistance.
Guidelines and Recommendations

2017 World Health Organization (WHO)

- Nasal decolonization with mupirocin for Cardio or Ortho surgeries: Patients with known nasal carriage of S. aureus should receive intranasal application of mupirocin ointment. (Strong recommendation)
- Nasal decolonization with mupirocin for other surgeries: Use of nasal mupirocin ointment is suggested (Conditional recommendation)

2017 Wisconsin Division of Public Health Supplemental Guidance for Preventions of SSIs

Decolonizing the Nares for MSSA and MRSA:
Although the optimal suppression regimen is unclear, the following is recommended:
- Standardized regimen of topical mupirocin (twice a day for 5-7 days) or,
- An alternative approach involving the use a nasal swab containing 5% or 10% povidone iodine applied to the nares 1 to 2 hours prior to surgery,
- Along with a 2% or 4% CHG body cleansing/shower (once a day for 2 days) prior to surgical admission.

1. Benedet et al. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. The Lancet. Published online November 2, 2016 http://dx.doi.org/10.1016/S1473-3099(16)30398-X
Options for Pre-surgical Nasal Decolonization

– Intranasal mupirocin has been used historically to decolonize the nares and is associated with compliance burdens and antibiotic resistance

– 5% povidone iodine formulated specifically for intranasal application is an option that provides directly observed, just in time application with demonstrated efficacy in helping reduce the risk of SSI
Do iodine-based solutions differ in their effectiveness for decolonizing intranasal Staphylococcus aureus?

Investigator initiated, prospective randomized controlled trial comparing nasal S. aureus cultures at baseline, 4 and 24 hours after treatment with off the shelf 10% povidone iodine, 3M™ Skin and Nasal Antiseptic (5% povidone iodine) or saline (control)

- 429 patients were randomized, of which 95/429 (22.1%) were positive at baseline for S. aureus and 13.6% of these were MRSA
- 5% PI formulation demonstrated significantly more effective intranasal decolonization of S. aureus over the 4 hour time interval (p=0.003)
- 10% PI no different than saline (control)

Summary of Clinical Evidence

– One time application of a specially formulated 5% PVP-I Nasal Antiseptic helps reduce the risk of SSI when part of a preoperative protocol¹,²,³

– It is cost effective¹,²,³

– It has better antimicrobial efficacy in the nose than 10% PVP-I⁴


- Staphylococci found in the oral flora
  - Carriage rates for Staphylococcus aureus – 24% - 84% in healthy adult oral cavities
  - Incidence in denture wearers – 48%
- Chlorhexidine gluconate used in low doses in the oral cavity
  - Eliminates plaque
  - Antimicrobial activity
- Conclusion
  - These findings suggest that S. aureus continues to be a frequent isolate in the oral cavity and perioral regions. The oral cavity should be considered a source of S. aureus in terms of cross-infection and dissemination to other body sites.
Effect of a Preoperative Decontamination Protocol


- Intervention: CHG + Oral Rinse + Nasal Povidone-Iodine Solution

Conclusion and Relevance:

- Study demonstrates that preoperative MRSA decontamination with chlorhexidine washcloths and oral rinse and intranasal povidone-iodine decreased the SSI rate by more than 50% among patients undergoing elective orthopedic surgery with hardware implantation.

<table>
<thead>
<tr>
<th>Population</th>
<th>Total # Patients</th>
<th>SSI Rate</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decolonized Patients</td>
<td>365</td>
<td>1.1% (4/365)</td>
<td>P=.02</td>
</tr>
<tr>
<td>Control</td>
<td>344</td>
<td>3.8% (13/344)</td>
<td>P=.02</td>
</tr>
</tbody>
</table>

Multivariate logistic regression identified MRSA decontamination as an independent predictor of not developing an SSI (adjusted odds ratio, 0.24 [95% CI, 0.08-0.77]; p=.02).
Optimize SSI Prevention – 3Cs

Do not leave it up to the patient

- Did the patient absorb the SSI prevention message and do what is expected?
- Caregivers need to take CONTROL of the process
- Maintain CONTINUITY of prevention strategies
  - Apply 2% CHG in Pre-Op Holding
  - Apply nasal antiseptic in Pre-Op Holding
- Ensure COMPLIANCE
  - Takes 3 - 4 minutes
Summary – Keys to Success

- Weigh the risk vs. benefit and the cost vs. benefit based on your institution’s goals for process improvement to reduce SSIs.
- Properly and consistently applied prevention strategies can reduce the risk of surgical site infections and ensuing morbidity and mortality.
- Prevention requires multiple interventions applied as part of a horizontal strategy:
  - Pre-operative antiseptic shower
  - Skin antisepsis before incision
  - Management of the oral and nasal flora
- Chlorhexidine gluconate plays a key role in the risk reduction of SSIs.
- Synergism
  - Effective team work and communication will improve patient outcome.
Australian Pneumonia Data

Pneumonia refers to an infection of the lungs.

Around 17,900 hospital-acquired episodes of pneumonia occur each year in Australian hospitals.

167.4
High rate at Principal Referral Hospitals

46.6
Aggregate rate at Principal Referral Hospitals

Per 10,000 hospitalisations

If all hospitals reduced their rate to less than 46.6 per 10,000 hospitalisations, it would prevent at least 2,830 episodes of pneumonia.

The cost associated with Hospital Acquired Pneumonia in Australia

Could cost the hospital an additional $39,406

Patients with this Pneumonia require 19.0 extra days in the hospital compared to those who don’t have a Pneumonia.
Source Control: The Oral Cavity as a Risk Factor in NV-HAP and VAP
VAP Data in the US

• VAP is associated with ↑ MV days and ↑ ICU & hospital LOS

• Attributable mortality estimated to be 4.0–13.5%

• Financial cost of a VAP episode has been estimated as approximately $20,000 to $40,000

Building Blocks to Best Practice in Caring for Mechanically Ventilated Patients

Ventilator Bundle: HOB 30, Deep Vein Thrombosis (DVT) prophylaxis, Peptic Ulcer Disease (PUD) prophylaxis, Sedation interruption, Spontaneous breathing trial, daily care with chlorhexidine

VAP Bundle: HOB 30, Sedation interruption, Spontaneous breathing trial, oral care 6x per day, CHG rinse 2x per day, subglottic secretions drainage if expected to be ventilated > 72hrs

http://www.ihi.org/resources/PagesTools/HowtoGuidePreventVAP.aspx
www.ICUliberation.org
Risk Factor Categories for Hospital Acquired Pneumonia

- Factors that increase bacterial burden or colonization
- Factors that increase risk of aspiration
Comprehensive Oral Care
Oral Cavity & VAP

- 89 critically ill patients
  - Examined microbial colonization of the oropharynx through out ICU stay
  - Used pulse field gel electrophoresis to compare chromosomal DNA

Results:
- Diagnosed 31 VAPs
  - 28 of 31 VAPs the causative organism was identical via DNA analysis

- 49 elderly nursing home residents admitted to the hospital
  - Examined baseline dental plaque scores & microorganism within dental plaque
  - Used pulse field gel electrophoresis to compare chromosomal DNA

Results
- 14/49 adults developed pneumonia
  - 10 of 14 pneumonias, the causative organism was identical via DNA analysis


El-Solh AA. Chest. 2004;126:1575-1582
This attachment structure requires mechanical removal with a good toothbrush.
What Does the Evidence Tell Us?

Brush
CHG rinse alone
CHG rinse in combination
Swab/Clean/Moisturize
Suction

All of the above

Comprehensive Oral Care Program
Literature Review: Oral Care Impact of VAP

Comprehensive Oral Care:

• Reduction in VAP from 5.6 to 2.2 (Schleder B. et al. J Advocate Health 2002;4(1):27-30)
• Reduction in VAP from 4.10 (2005) to 2.15 (2006) with addition of CPC & comprehensive oral care. Vent bundle & rotational therapy already being performed
• Reduction in VAP from 12.0 to 8.0 (p=.060) with 80% compliance, vent bundle already being preformed, 1538 patients randomized to control or study group. Additional outcomes: ↓ vent days (p=.05), ↓ ICU LOS (p=.05), ↓ time to VAP (p= <.001), & reduction in mortality (p=.05) (Garcia R et al AJCC, 2009;18:523-534)
Literature Review: Oral Care Impact of VAP

Comprehensive Oral Care & CHG:

- Reduction in VAP to zero for 2 years, vent bundle, mobility, oral care & CHG with comprehensive education preformed (Murray TM et al. AACN Advanced Critical Care. 2007;18(2):190-199)

Dickinson S et al. SCCM Critical Connections, 02/2008

Type of Oral Care Impacted on VAP

- Multi-center prospective RCT (6 month trial)
- 1716 admitted to the ICUs; 219 fulfilled the criteria for inclusion and 213 were analyzed
- 108 were randomized to control group and 105 to intervention group (Tooth brushing with 0.12% CHG or 0.12% CHG alone q 12 hrs)
- Examine impact on VAP, time on vent & LOS

<table>
<thead>
<tr>
<th>Events</th>
<th>Control group (n = 108)</th>
<th>Intervention group (n = 105)</th>
<th>RR</th>
<th>CI(95%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>80 (47.6%)</td>
<td>88 (52.4%)</td>
<td>1,0</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>28 (62.2%)</td>
<td>17 (37.8%)</td>
<td>1.81</td>
<td>0.93 – 3.57</td>
<td>0.084</td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>81 (48.8%)</td>
<td>85 (51.2%)</td>
<td>1,0</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>27 (57.4%)</td>
<td>20 (42.6%)</td>
<td>1.41</td>
<td>0.73 – 2.70</td>
<td>0.296</td>
</tr>
<tr>
<td>Duration of mechanical ventilation^b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± sd</td>
<td>11.1 ± 7.6</td>
<td>8.7 ± 5.0</td>
<td>1.063</td>
<td>1.011 – 1.120</td>
<td>0.018</td>
</tr>
<tr>
<td>Categorization^b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 5 days</td>
<td>13 (37.1%)</td>
<td>22 (62.9%)</td>
<td>1.0</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>6 to 10 days</td>
<td>40 (48.8%)</td>
<td>42 (41.2%)</td>
<td>1.61</td>
<td>0.71 – 3.70</td>
<td>0.249</td>
</tr>
<tr>
<td>11 days and more</td>
<td>28 (57.1%)</td>
<td>21 (42.9%)</td>
<td>2.27</td>
<td>0.93 – 5.55</td>
<td>0.073</td>
</tr>
<tr>
<td>Length of ICU^b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± sd</td>
<td>13.9 ± 8.6</td>
<td>11.9 ± 7.77</td>
<td>1.032</td>
<td>0.999 – 1.065</td>
<td>0.064</td>
</tr>
<tr>
<td>Categorization^b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 5 days</td>
<td>11 (39.3%)</td>
<td>17 (60.7%)</td>
<td>1.0</td>
<td>0.64 – 3.70</td>
<td>0.333</td>
</tr>
<tr>
<td>6 to 10 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 days and more</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RR of Death 41% > in Control Group
## Impact of Oral CHG on Frequency of VAP

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Chlorhexidine Events</th>
<th>Control Events</th>
<th>Risk Ratio IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.1 Single Dose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grap, 2004</td>
<td>4</td>
<td>11</td>
<td>2.79 [0.75, 10.37]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>11</td>
<td>23</td>
<td>2.79 [0.75, 10.37]</td>
</tr>
<tr>
<td>Total events</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 1.53 (P = 0.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.2 1x/day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scannapieco, 2009</td>
<td>7</td>
<td>58</td>
<td>0.59 [0.25, 1.40]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>58</td>
<td>59</td>
<td>0.59 [0.25, 1.40]</td>
</tr>
<tr>
<td>Total events</td>
<td>7</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 1.19 (P = 0.23)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.3 2x/day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berry, 2011</td>
<td>4</td>
<td>71</td>
<td>4.39 [0.50, 38.39]</td>
</tr>
<tr>
<td>Scannapieco, 2009</td>
<td>7</td>
<td>58</td>
<td>0.59 [0.25, 1.40]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>129</td>
<td>137</td>
<td>1.25 [0.19, 8.31]</td>
</tr>
<tr>
<td>Total events</td>
<td>11</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 1.30; Chi² = 2.83, df = 1 (P = 0.09); I² = 65%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.23 (P = 0.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.4 3x/day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belissimo-Rodrigues, 2009</td>
<td>16</td>
<td>64</td>
<td>1.01 [0.56, 1.83]</td>
</tr>
<tr>
<td>Cabov, 2010</td>
<td>1</td>
<td>17</td>
<td>0.23 [0.03, 1.70]</td>
</tr>
<tr>
<td>Fourrier, 2000</td>
<td>5</td>
<td>30</td>
<td>0.29 [0.12, 0.69]</td>
</tr>
<tr>
<td>Fourrier, 2005</td>
<td>13</td>
<td>114</td>
<td>1.08 [0.52, 2.27]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>225</td>
<td>236</td>
<td>0.64 [0.31, 1.31]</td>
</tr>
<tr>
<td>Total events</td>
<td>35</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.31; Chi² = 7.87, df = 3 (P = 0.05); I² = 62%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 1.22 (P = 0.22)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.5 4x/day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koeman, 2006</td>
<td>13</td>
<td>127</td>
<td>0.58 [0.31, 1.09]</td>
</tr>
<tr>
<td>Ozgarka, 2012</td>
<td>12</td>
<td>32</td>
<td>0.58 [0.35, 0.97]</td>
</tr>
<tr>
<td>Tantipong, 2008</td>
<td>5</td>
<td>102</td>
<td>0.43 [0.16, 1.17]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>261</td>
<td>269</td>
<td>0.56 [0.38, 0.81]</td>
</tr>
<tr>
<td>Total events</td>
<td>30</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.00; Chi² = 0.30, df = 2 (P = 0.66); I² = 0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 3.11 (P = 0.002)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 4.** Effect of chlorhexidine frequency of use on ventilator-associated pneumonia rates.
Does Compliance Make A Difference?

Oral care compliance & use of the ventilator bundle resulted in a 89.7% reduction in VAP.

Impact of a New Bundle/2 State Collaborative

- 38 hospitals, 56 ICU’s in 2 states from October 2012 to March 2015
- Evidence based interventions, teamwork & safety culture
- Head-of-bed elevation, use of subglottic secretion drainage endotracheal tubes, oral care, chlorhexidine mouth care, and daily spontaneous awakening and breathing trials.

- VAE: 7.34 to 4.58 cases per 1,000 ventilator-days (p = 0.007)
- IVAC 3.15 to 1.56 per 1,000 ventilator days (p = 0.018)
- PVAP 1.41 to 0.31 cases per 1,000 ventilator-days (p = 0.012)

TRUST THE PROCESS
Non-Vent Pneumonia: Addressing Risk Factors

Some slides courtesy of Barb Quinn
Build the Will: NV-HAP?

• HAP 1st most common HAI in U.S
• Increased morbidity → 50% are not discharged back home
  – Increased mortality → 18%-29%
  – Extended LOS → 4-9 days
  – Increased Cost → $28K to $109K
  – 2x likely for readmission <30 day

## Relative Harm: Most Common HAIs

<table>
<thead>
<tr>
<th>Type</th>
<th>% Prevalence</th>
<th>% Mortality</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUTI</td>
<td>13%</td>
<td>1.5%</td>
<td>$1,108</td>
</tr>
<tr>
<td>CLABSI</td>
<td>5-10%</td>
<td>12%</td>
<td>$33,618</td>
</tr>
<tr>
<td>SSI</td>
<td>22%</td>
<td>3%</td>
<td>$19,305</td>
</tr>
<tr>
<td>HAP</td>
<td>22%</td>
<td>19%</td>
<td>$40,000</td>
</tr>
</tbody>
</table>

# Current Literature:
**NV-HAP is a National Problem in Hospitals**

<table>
<thead>
<tr>
<th>Study</th>
<th>Incidence</th>
<th>Mortality</th>
<th>+LOS</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. Davis (2012)</td>
<td>5,600 /3 yrs</td>
<td>18.9%</td>
<td>Not queried</td>
<td>$28,000</td>
</tr>
<tr>
<td>HCUP National database (P)</td>
<td>2/100 pts</td>
<td>14.5%</td>
<td>4 days</td>
<td>$36,400</td>
</tr>
<tr>
<td>Magill et al. CDC (2014)</td>
<td>13% of all HAIs</td>
<td>19%</td>
<td>4-9 days</td>
<td>$40,000</td>
</tr>
<tr>
<td>Micek, Chew, Hamptom &amp; Kollef (2016)</td>
<td>Matched controls 174 cases NV-HAP</td>
<td>15.5% vs. 1.6% 8.4 more likely to die</td>
<td>15.9 days vs. 4.4</td>
<td></td>
</tr>
<tr>
<td>See, et al. (2016).</td>
<td>Retrospective review 8 hospitals in PA 2011-2012 VAP excluded 30% of 838</td>
<td>30.9%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hospital-Acquired Pneumonia: Non-Ventilated versus Ventilated Patients in Pennsylvania

• Purpose:
  – Compare VAP and NV-HAP incidence, outcomes

• Methods:
  – Pennsylvania Database queried
  – All nosocomial pneumonia data sets (2009-2011)

Results:

### Table 1. Pennsylvania Nosocomial Pneumonia and Related Deaths

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NO. OF NV-HAP CASES</th>
<th>NO. OF NV-HAP DEATHS</th>
<th>% OF NV-HAP CASES CONTRIBUTING TO DEATH</th>
<th>NO. OF VAP CASES</th>
<th>NO. OF VAP DEATHS</th>
<th>% OF VAP CASES CONTRIBUTING TO DEATH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>1,976</td>
<td>363</td>
<td>18.4 (95% CI: 16.5 to 20.3)</td>
<td>922</td>
<td>163</td>
<td>17.7 (95% CI: 15.0 to 20.5)</td>
</tr>
<tr>
<td>2010</td>
<td>1,848</td>
<td>366</td>
<td>19.8 (95% CI: 17.8 to 21.8)</td>
<td>737</td>
<td>144</td>
<td>19.5 (95% CI: 16.3 to 22.7)</td>
</tr>
<tr>
<td>2011</td>
<td>1,773</td>
<td>315</td>
<td>17.8 (95% CI: 15.8 to 19.7)</td>
<td>640</td>
<td>127</td>
<td>19.8 (95% CI: 16.4 to 23.3)</td>
</tr>
<tr>
<td>Total</td>
<td>5,597</td>
<td>1,044</td>
<td>18.7 (95% CI: 17.5 to 19.8)</td>
<td>2,299</td>
<td>434</td>
<td>18.9 (95% CI: 17.1 to 20.7)</td>
</tr>
</tbody>
</table>

Note: NV-HAP refers to nonventilator-hospital-acquired pneumonia and VAP refers to ventilator-associated pneumonia.

- Mortality
- Incidence
- Total deaths
- Total cost
- Wide-spread

NV-HAP SMCS Research Findings: 2010

24,482 patients and 94,247 patient days

Incidence:
- 115 adults
- 62% non-ICU
- 50% surgical
- Average age 66
- Common comorbidities:
  - CAD, COPD, DM, GERD
- Common Risk Factors:
  - Dependent for ADLs (80%)
  - CNS depressant meds (79%)

Cost:
- $4.6 million
- 23 deaths
- Mean Extended LOS 9 days
- 1035 extra days

HAPPI-2 Incidence of Non-Ventilator Hospital Acquired Pneumonia

- Multicenter retrospective chart review
- Extracted NV-HAP cases as per the 2014 ICD-9-CM codes for pneumonia not POA and the 2013 CDC case definition
- 21 hospitals completed data collection
- Measured nursing care missed 24hrs before diagnosis
- Non-vent HAP occurred on every unit

Baker D, Quinn B, Amer J of Infect Control, 2018;46:2-7
HAPPI-2 Incidence of Non-Ventilator Hospital Acquired Pneumonia

Missed nursing care 24 hours prior to Non-Vent HAP dx.

*No reflects oral care 0–1 times; **Excludes cases where mobility was not allowed (n=1093)

Baker D, Quinn B, Amer J of Infect Control, 2018;46:2-7
HAPPI-2 Incidence of Non-Vent Hospital Acquired Pneumonia

Results:
• 1300 NV-HAP (0.12-2.28 per 1000 pt days)
  – 18.4% mortality
  – 50% < 66 yrs old
  – 63% non-surgical
  – 70.8% outside the ICU
  – 27.3 % in ICU
  – 18.8% transferred to ICU
  – 37.3% LOS >20 days
  – 57.7% LOS > 15 days
  – 40.6% admitted from home were discharged back to home
  – 19.3% readmitted within 30 days
  – $36.4 -$52.56 million in extra costs

Med-Surg (43.1%; n = 560)
Telemetry (8.5%; n = 111)
Progressive (7.2%; n = 93)
Oncology (4.9%; n = 64)
Orthopedic (2.8%; n = 37)
Neurology (1.5%; n = 19)
Obstetric (0.2%; n = 3)
Epidemiology of Non-Ventilator Hospital Acquired Pneumonia in US

• The 2012 US National Inpatient Sample dataset was used to compare an NV-HAP group to 4 additional group cohorts:
  – pneumonia on admission
  – general hospital admissions
  – matched on mortality & disease severity
  – ventilator-associated pneumonia (VAP)

• Secondary outcome: compare HLOS, total hospital charges, and mortality between the NV-HAP group and the 4 I group cohorts

Epidemiology of Non-Ventilator Hospital Acquired Pneumonia in US

- Incidence of NV-HAP was 1.6%, (3.63 per 1,000 pt days)
- NV-HAP was associated with:
  - Increased total hospital charges
  - Longer hospital length of stay
  - Greater likelihood of death

Compared to all groups except patients with VAP

ICU-Acquired pneumonia: VAP vs. NV-HAP

• **Methods:**
  - Prospective study of 135 consecutive episodes over 3 years of adults with ICU-acquired pneumonia
  - Compared clinical and microbiological characteristics of VAP and NV-HAP

• **Results** for VAP & NV-HAP were not statistically different:
  - Pathogens
  - Comorbid conditions,
  - Severity parameters,
  - Mortality, and
  - Hospital length of stay

• Among NV-HAP patients, 79 (52%) needed subsequent intubation

Slide courtesy of Barb Quinn
Where is the Highest Risk for NV-HAP?

Rate of Nonventilator Hospital-Acquired Pneumonia

NV-HAP per 1000 patient days

Slide courtesy of Barb Quinn
Preventing NV-HAP Through Evidence Based Fundamental Nursing Care Strategies
Pathogenesis → Prevention

Germs in Mouth
- Dental plaque provides microhabitat
- Bacteria replicate 5X/24 hrs

Aspirated into Lungs
- Most common route
- 50% of healthy adults micro-aspirate in sleep

Weak Defenses
- Poor cough
- Immunosuppressed
- Multiple co-morbidities

Micro Aspiration During Sleep in Healthy Subjects

- Prospective duplicate full-night studies
- 10 normal male’s 22-55 yrs of age
- Methods:
  - Radioactive $^{99m}$Tc tracer inserted into the nasopharynx
  - Lung scans conducted immediately following final awakening
  - No difference in sleep efficacy between 2 study nights
- Results:
  - 50% of subjects had tracer in the pulmonary parenchyma upon final awakening
  - No difference in age, time spent in bed, efficacy of sleep, apnea-hypopnea index, arousal plus awakening index or % sleep in the supine position between subjects that aspirated and those that did not.

Body Position: Supine versus Semi-recumbent (30-45 degrees)

Methodology

• 19 mechanically ventilated patients
• 2 period crossover trial
• Study supine and semirecumbent positions over 2 days
• Labeled gastric contents (Tc 99m sulphur colloid)
• Measured q 30 min content of gastric secretions in endobronchial tree in each position
• Sampled ET secretions, gastric juice & pharyngeal contents for bacteria

Body Position: Supine versus Semi-recumbent (30-45 degrees)

Results

- Radioactive contents higher in endobronchial secretions in supine patients
- Time dependent:
  - Supine: 298cpm/30min vs. 2592cpm/300min
  - HOB: 103cpm/30min vs. 216cpm/300min
- Same microbes cultured in all 3 areas 32% with HOB vs. 68% supine

Hospital Variation in Missed Nursing Care

Figure 2. Elements of care most and least frequently missed. The solid bars represent the means across all 10 hospitals, and the range lines indicate the standard deviations.

Patient Perceptions of Missed Nursing Care

<table>
<thead>
<tr>
<th></th>
<th>Fully Reportable</th>
<th>Partially Reportable</th>
<th>Not Reportable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently Missed</td>
<td>Mouth care</td>
<td>Ambulation</td>
<td>Patient assessment</td>
</tr>
<tr>
<td></td>
<td>Listening</td>
<td>Discharge planning</td>
<td>Surveillance</td>
</tr>
<tr>
<td></td>
<td>Being kept informed</td>
<td>Patient education</td>
<td>IV site care</td>
</tr>
<tr>
<td>Sometimes Missed</td>
<td>Response to call lights</td>
<td>Medication administration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Response to alarms</td>
<td>Repositioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meal assistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pain medication and follow-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rarely Missed</td>
<td>Bathing</td>
<td>Vital signs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hand washing</td>
<td></td>
</tr>
</tbody>
</table>

* IV, intravenous.

AACN Procedural Manual-7th ed

• Procedure 4: Endotracheal Tube Care and Oral Care
• Authors:
  – Kathleen M Vollman
  – Mary Lou Sole
  – Barbara Quinn
Impact of Oral Care on HAP

**Figure 2.** Effects of oral care on preventing non-ventilator-associated pneumonia (non-VAP).

**Figure 3.** The effect of mechanical oral care on non-ventilator-associated pneumonia (non-VAP).

SMCS HAP Prevention Plan

Phase 1: Oral Care

- Formation of new quality team: Hospital-Acquired Pneumonia Prevention Initiative (HAPPI)
- New oral care protocol to include non-ventilated patients
- New oral care products and equipment for all patients
- Staff education and in-services on products
- Ongoing monitoring and measurement
  - Monthly audits

## Gap Analysis

<table>
<thead>
<tr>
<th>Best Practice</th>
<th>Our Gaps</th>
<th>Action To Take</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive oral care for all (CDC, SHEA)</td>
<td>ICU vent patients only</td>
<td>Develop inclusive oral care protocol</td>
</tr>
<tr>
<td>Oral CHG (0.12%) periop adult CV surgery and vent pts. (CDC, ATS, IHI).</td>
<td>Not using CHG on these patients.</td>
<td>Added to preprinted orders, and to protocol</td>
</tr>
<tr>
<td>Therapeutic oral care tools (ADA)</td>
<td>Poor quality oral care tools. Absence of denture care supplies.</td>
<td>New tools and supplies.</td>
</tr>
</tbody>
</table>

# Protocol – Plain & Simple

<table>
<thead>
<tr>
<th>Patient Type</th>
<th>Tools</th>
<th>Procedure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self Care / Assist</td>
<td>Brush, paste, rinse, moisturizer</td>
<td>Provide tools</td>
<td>4 X / day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brush 1-2 minutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rinse</td>
<td></td>
</tr>
<tr>
<td>Dependent / Aspiration Risk</td>
<td>Suction toothbrush kit (4)</td>
<td>Package instructions</td>
<td>4 X / day</td>
</tr>
<tr>
<td>Dependent / Vent</td>
<td>ICU Suction toothbrush kit (6)</td>
<td>Package instructions</td>
<td>6 X / day</td>
</tr>
<tr>
<td>Dentures</td>
<td>Tools + Cleanser Adhesive</td>
<td>Remove dentures &amp; soak</td>
<td>4X / day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brush gums, mouth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rinse</td>
<td></td>
</tr>
</tbody>
</table>

Provide Meaningful Data

- Ortho Unit had ZERO HAP cases in the last 4 months of 2013!!
- Great WORK!!
- Remember, the goal is to provide and document oral care after each meal and before bedtime.

Used with permission from Barbara Quinn
NV-HAP Incidence
50 % Decrease from Baseline

Control chart for NV-HAP
January 2010 to December 2013

Open Heart Surgery Patients: NV-HAP Reduced 75%

Oral chlorhexidine periop started

Used with permission from Barbara Quinn
Return on Investment

- 60 NV-HAP avoided Jan 1 – Dec. 31 2013
- $2,400,000 cost avoided
- - 117,600 cost increase for supplies
- $2,282,400 return on investment

- 8 lives saved

PRICELESS

NV-HAP 70% from Baseline!

Control chart for non-ventilator HAP
January 2010 to December 2014

- Oral care for all adult pts
- Documentation
- NGT standards revised
- Pharmacy starts PPI protocol
- Started oral care prior to surgery
- Mandatory Education for Nurse Assistants

Number of non-ventilator HAP cases

- UCL
- Mean
- LCL
Post operative NV-HAP (all adult inpatient surgery) Incidence 6 months Pre Oral Care vs. 6 months After

Quinn B, Presented at AACN NTI, Houston, Tx, 2017
Building Blocks to Best Practice in Caring for Mechanically Ventilated Patients

Ventilator Bundle: HOB 30, Deep Vein Thrombosis (DVT) prophylaxis, Peptic Ulcer Disease (PUD) prophylaxis, Sedation interruption, Spontaneous breathing trial, daily care with chlorhexidine.

VAP Bundle: HOB 30, Sedation interruption, Spontaneous breathing trial, oral care 6x per day, CHG rinse 2x per day, subglottic secretions drainage if expected to be ventilated > 72hrs.

ABCDE Bundle: Assess & manage pain, Both Spontaneous awakening trial (SAT) & spontaneous Breathing trial (SBT), Choice of Sedation, Delirium Assessment and management, Early Mobility, Family and Patient Engagement.

http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventVAP.aspx
www.ICUliberation.org
ASSESS, PREVENT & MANAGE PAIN
BOTH SAT & SBT
CHOICE OF SEDATION
DELIRIUM
EARLY MOBILITY
FAMILY/PATIENT ENGAGEMENT

COMPREHENSIVE ORAL CARE
It is not enough to do your best; you must know what to do, and THEN do your best.

~ W. Edwards Deming
Bugging Out
Contact Kathleen Vollman at kvollman@comcast.net
www.Vollman.com

HAI prevention courses by Kathleen Vollman
https://www.medbridgeeducation.com/certificate_programs/20336-healthcare-acquired-infections-prevention-is-key