Innovations in Hand Hygiene

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Deb Medical Hand Hygiene
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Skin As A Barrier
- Stratum corneum composed of ~15 layers of flattened dead cells
- New layer formed daily
- Completely replaced every 2 wks
- Horny protective layer of bricks and mortar

From healthy skin....
- $10^7$ particles shed daily
- 10% contain viable bacteria
- Acidic pH is antibacterial
- Lipids prevent dehydration

Effects of Soap on Skin
- Increased pH
- Reduced lipids
- Increased transepidermal water loss
- Increased shedding of squamous cells

Effect of Scrubbing on Skin Shedding
- CFU reduced satisfactorily with either surgical scrub or alcohol
- No increase in shedding after alcohol
- 18-fold increase in shedding after scrub

Studies of Hand Flora

Meers & Yeo, 1978
Factors affecting skin condition
(Seitz, Newman, AJIC, 1988)

- Nurses in Arizona and Wisconsin
- Winter, northern locale, age >30 yrs increased risk of dry, chapped hands
- Washing only 1-2 times/hour increased severity of dry skin

Survey 1

- To describe prevalence and correlates of skin damage on hands of nurses
- Four hospitals: two in mid-Atlantic, two in northern U.S.
- 410 nurses working 30+ hr/week in acute care

Assessing Skin Damage: Irritant Contact Dermatitis

- Visual exam at 30X magnification by trained investigators
- Self-report questionnaire
- Reliability and validity confirmed with dermatologist assessment
- Diagnosed conditions (eczema, atopic dermatitis, psoriasis) excluded

Results

- Approximately one-fourth (106/410) had measurable, current skin damage
- 85.6% reported ever having problems
- Damage not correlated with age, sex, skin type, soap used at home, duration of handwashing, glove brand

Correlates of Damage

- Type of soap used at work (CHG<plain soap<other antimicrobial soap, p=.01)
- Frequency of handwashing (p=.0003)
- Frequency of gloving (p=.008)
- Study site (both community hospitals < both academic health centers, p=.009)

Logistic Regression

- Dependent variable: skin damage
- Independent variables: type of soap, frequency of handwashing and gloving, study site
- Independent correlates of damage:
  Soap used at work (p=.03)
  Frequency of gloving (p=.01)
Survey 2

- Compare microbial flora of hands of nurses with healthy and damaged skin
- Examine relationships between hand care practices, skin condition, and skin flora
- Subjects: 20 nurses with healthy skin, 20 nurses with damaged skin

Methods

- Prospective data collection for 3 work weeks over a 3-month time period
- Subjects kept detailed diary of hand care

Microbiologic Methods

- Samples plated on general nutrient medium and six selective media
- Representative colonies gram-stained and identified with API systems or standard techniques
- Antimicrobial susceptibilities tested by disk diffusion

Results: Hand Care Practices

- Mean handwashes/hr: 2.1 (.68-4.8)
- 57.5% used non-antimicrobial soap
- Mean glovings/hr: 1.3 (.25-3.2)
- 87.5% used powdered gloves only
- 97.4% used hand lotion

Hand Flora

- Mean CFUs: Undamaged 5.63
  Damaged 5.60 p=.63
- # Species: Undamaged 6.2
  Damaged 8 p=.11
- Colonizers Undamaged 2.6
  Damaged 3.3 p=.03
Hand Flora

• Twice as many with damaged hands were colonized with *S. hominis* (p=.02) and *S. aureus* (p=.11)

• Twice as many carried gram-negative bacteria, enterococci, *Candida*

Comparison with Previous Studies

• 1986, oncology nurses
  Mean CFU: 4.79

• 1992, nurses in Peru
  Mean CFU: 5.74

• 1997, nurses in acute care
  Mean CFU: 5.61

Comparison with Previous Studies:CNS

• Resistant to methicillin
  1986 (n=50 isolates)  68.0%
  1988 (n=81 isolates)  50.7%
  1992 (n=163 isolates) 46.6%
  1997 (n=123 isolates) 58.5%

• Resistant to tetracycline
  1986 (n=50 isolates) 23.0%
  1988 (n=81 isolates) 30.7%
  1992 (n=163 isolates) 47.8%
  1997 (n=123 isolates) 10.5%

Differences in Flora by Clinical Area

Horn, et al., ICHE, 1988

• BMT Staff (n=28)
  – Lower CFUs
  – Significantly more resistance in CNS
  – Significantly more JK coryneforms, GNBs, *Candida*

• Dermatology Staff (n=35)
  – Higher CFUs
  – Significantly more *S. aureus*
**Differences by Discipline**

Horn, et al., ICHE, 1988

- Physicians had higher counts than nurses
- Nurses had higher rates of antimicrobial-resistant CNS flora than physicians
- Rank order of antimicrobial resistance:
  - BMT staff
  - Patients hospitalized 30+days
  - Dermatology staff
  - Normal controls

**Conclusions**

- Colonizing hand flora of staff reflects patient population contacted
- Efforts to improve hand condition are warranted, since skin damage is associated with changes in flora
- Efforts should include monitoring of hand care practices, adoption of protectant products in policy, increased use of powderfree, hypoallergenic, and/or non-latex gloves

**5 min PI vs. 1 min PI/Alc**

- 28 OR volunteers
- Mean CFU, 1 hr post: 1.5 and .83 (p=.59)
- Mean CFU, 2 hr post: 4.0 and 1.5 (p=.33)
- Conclusion: no significant difference

Mil Med 1998; 163:145

**Comparison of Five Protocols**

Pereira, JHI, 1997; 36:49

- 23 OR nurses, all protocols random order
- Protocols Tested:
  - CHG 5/3.5 min
  - CHG 3/2.5 min
  - PI Ti 3/2.5 min
  - CHG PA 2/0.5 min
  - CHG EA 2/0.5 min

**Results…**

- CHG-5 and ALC had lowest post-scrub counts
- No difference between CHG-5 and ALC at day 1, but ALC significantly lower post-scrub counts at day 5 (p=0.003)
- No significant difference in skin condition

**Effect of Brush on Skin**

Acta Derm Ven 1999; 79:230

- Compared brush scrub with wash for 11 days in different seasons
- TEWL, conductance, pH measured
- Significantly higher TEWL for brush in autumn
Antiseptic Scrub With or Without Brush

- 15 volunteers did 5 min scrub using CHG/ALC with and without brush (crossover design)
- No significant differences in CFU
- But, up to twice the number of subjects without a brush had greater CFU reductions

Alcohol Vs. Traditional Scrub: 30-Day SSI Rates

- Clean and clean-contaminated surgery
- Protocols: 75% propanol, 4% PI, 4% CHG
- Infection rates: 2.44% (55/2252) in alc group; 2.48% (53/2135) in other groups
- Compliance significantly better with alc (p=0.008), and hands were less dry with less skin irritation

- Parienti, JAMA 2002; 288:722-7

Time Tests

- Single wash with 10% PI failed to provide lasting CFU reductions
- 30 sec wash as effective as longer washes
- Conclusion: “prolonged vigorous pre-operative scrubbing is unnecessary”

Effect of Fingernails on Counts

- Natural, Artificial, Polished

What About the Time?

- 25 OR staff, randomized crossover
- 2 vs. 3 min scrub
- Difference <0.5 log
- Conclusion: clinically equivalent
Effect of Fingernails on GNBs

*Nurs Res* 1998; 47:54

![Bar chart showing percentage recovery of GNBs](chart.png)

<table>
<thead>
<tr>
<th>Recovery of GNBs</th>
<th>Natural (n=31)</th>
<th>Artificial (n=27)</th>
<th>Polished (n=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>45</td>
<td>0</td>
</tr>
</tbody>
</table>

*p* < 0.05

Cleaning with artificial and natural nails

*McNeil, CID, 2001; 32:367*

- 21 nurses with, 20 without artificial nails
- Before cleaning, 85% with and 35% without had gnb, yeast or *S. aureus* (p=.003)
- For those with artificial nails, 14% cleared these organisms after cleaning with soap, 80% after alcohol

Prolonged outbreak traced to staff fingernails.....

Over 15 months, 10.5% of 439 neonates acquired *P. aeruginosa*, 35% died;
Significant association with two nurses: one with long natural nails and one with artificial nails;
“Requiring short natural fingernails..is a reasonable policy”

Moolenaar, et al. ICHE, 2/00

Candida osteomyelitis and diskitis

- Three post-laminectomy patients got deep wound infection with identical strain of *C. albicans*
- Case-control study found significant relationship with one OR tech who wore artificial nails and carried *C. albicans* in nose

CID 2001; 32:352.

*S. marcesens* wound infections

- 7 cardiovascular infections
- Risk factor: exposure to a nurse with artificial nails
- Exfoliant cream removed from nurse’s home

Passare, JID 1997; 175:992

Percentage free of *S. aureus*, gnbs, yeast

*CID, 2001; 32:367*

![Percentage graph](chart2.png)

Before HW | After Soap | After Alc
---|---|---
**Pilot Study, NICU**

- **Purpose:** Compare traditional antiseptic wash (CHG) and mild soap wash + alcohol rinse
- **Outcomes:** Microbial flora, skin condition
- **Random assignment (n=8 in each group)**

**Hand Hygiene Practices**

<table>
<thead>
<tr>
<th></th>
<th>Traditional Wash</th>
<th>Soap/alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean Washes:</strong></td>
<td>21.2</td>
<td>23.8</td>
</tr>
<tr>
<td><strong>Mean Glovings:</strong></td>
<td>12.4</td>
<td>12.4</td>
</tr>
</tbody>
</table>

**Microbiology**

- NS differences in mean CFU counts at baseline, 2, 4 wks
- NS differences in types of organisms isolated
- All p >0.44

**Skin Condition**

- By week 4, significant improvement in skin condition of alcohol group
  - by observer assessment (p=0.001)
  - by subject assessment (p=0.007)

Larson, Heart and Lang, 2000

**Sequential Trial of ALC and CHG**

- **Two products:**
  - Detergent w/4%CHG (TSS)
  - 61% ethyl ALC, 1% CHG, and emollients (HP)
- **20 OR staff used each product for 3 weeks sequentially**

**Background**

- **Our study design**
  - Prospective single center clinical trial
  - 3 Operating Suites of the Hospital
- **Sample Size**
  - required 20
  - recruited 27
- **22 Randomly Assigned to Treatment**
- **5 Randomly Assigned to Reference**
  - Drop-outs 2
- **25 Completed Entire Study**
**Background cont.**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THUR</th>
<th>FRI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hand Prep (HP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Traditional Surgical Hand Scrub</td>
<td></td>
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</tr>
</tbody>
</table>

**Outcomes….**

- Skin condition
- Time required
- Hand microbiology
- Preference

**Data Collection**

- Measurement Tools for Skin Condition
  - VSS, Erythema

  **VSS:**
  - 1=extensively scaly
  - 2=very scaly
  - 3=scaly
  - 4=slightly scaly
  - 5=very slightly scaly
  - 6=normal

  **Erythema:**
  - 0=severe erythema
  - 1=marked erythema
  - 2=moderate pinkness
  - 3=mild erythema
  - 4=normal

  **HSA:**
  - Appearance
  - Abnormal
  - Normal

**INVESTIGATORS**

- [Investigators]

**SUBJECTS**

- [Subjects]

**Data Collection: Scrub Practices**

61 Random Observations

**Data Collection**

- Microbiological Assay Diary Card

**Skin Condition**

- Nine ratings during each phase for self-assessment, scaling and erythema
- Skin damage significantly reduced during HP testing period (p=0.0005)
**Time Required**

- 61 observations of scrub technique (31 for HP, 30 for TSS)
- Direct contact time less for HP product (79.1 vs. 146.6 secs, \( p=0.000 \))
- Protocol deficiencies fewer for HP (6.5% vs. 50%, \( p=0.0001 \))

**Hand Microbiology**

- Pre- and post-scrub cultures obtained on Day 1, 5, and 19 during both phases
- 33 isolates of GNB (83.7% *Acinetobacter, Enterobacter, Klebsiella*), 1 *S. aureus*, 11 yeast
- No MRSA or VRE

**Post-Scrub Microbial Counts**

![Bar chart showing microbial counts](chart.png)

**Preferences**

![Bar chart showing preferences](chart.png)

**Costs for Scrubbing**

* Larson, AORN J, 2001; 73:412 *

- Traditional Scrub
  - ~$60.40/application
  - Mean time required: 6 mins total
- Alcohol Preparation
  - ~$20.50/application
  - Mean time required: 2 mins total

**Alc vs. Soap**

* Zaragoza, AJIC, 1999; 27:258 *

- Mean reduction in counts:
  - plain handwashing: 49.6%
  - alcohol: 88.2% (\( p<.001 \))
- Staff acceptance rate “good”:
  - plain handwashing: 9.3%
  - alcohol: 72%
Log Counts, 50 MICU Staff
Larson, CCM, 2001

Mean Skin Scaling Scores, 50 MICU Staff
Larson, CCM, 2001

Improvement in Skin Condition
Boyce, ICHE, 2000; 21:442

- After 2 wk use, with soap and water
  - more skin irritation (p=.001)
  - more transepidermal water loss (p=.003)
- “Newer alcoholic hand gels that are
tolerated better than soap may be more
acceptable to staff and may lead to
improved hand-hygiene practices.”

Improvement in Practice
Bischoff, Arch Intern Med 2000; 160:1017

Time and Costs
Voss & Widmer, ICHE, 1997; 18:205

- 100% compliance with handwashing
  consumes 16 hr nursing time/day shift,
  whereas AHD requires 3 hr (p = .01)
- “AHD, with its rapid activity, superior
efficacy, and minimal time commitment,
allows 100% healthcare- worker
compliance without interfering with the
quality of patient care”
Conclusions

- Prolonged scrubbing unnecessary and damaging
- Brush unnecessary and damaging
- Alcohol products warrant greater use
- Link with outcomes absent

What About Moisturizers/Lotions?

- Prevent dehydration, damage to barrier properties, skin shedding, loss of skin lipids
- Restore water-holding capacity of keratin layer
- Increase width of corneocytes

Moisturizers may even...

- Prevent cross-infection by improving barrier properties of skin, reducing shedding of viable bacteria, creating a mechanical or chemical barrier

Therefore...

- Use lotions
- Recommend lotions
- But choose wisely

Participants were....

- About 97% Hispanic
- About half born outside U.S.
- Living in multi-unit apartment buildings in upper Manhattan
- 99% female heads of households

Comparison of mean pre and post handwash CFU counts between groups
**Hand Hygiene Guideline For Healthcare Settings**

- Published 10/25/02
- MMWR
- http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5116a1.htm

**New emphases**

- Skin health, including moisturizers
- Alcohol hand rinses
- Compliance issues
- Preoperative surgical hand preparation
- Fingernails

**Next Challenges**

- Adverse reactions?
- Fire hazards?
- Plain vs. antimicrobial soap?
- Skepticism
- Dispensers
- Selecting among products

**Just Because It Feels Good, Doesn’t Mean It’s Bad**

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