Hand Hygiene: The 100% Solution?

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McGill University Faculty of Medicine

A CRITICAL APPRAISAL

Hosted by Bruce Gamage
President, IPAC - Canada

Hand Hygiene – The 100% Solution?
Prof. Yves Maillard, McGill University Faculty of Medicine
A Webber Training Teleclass

Objectives

• Review the role of HH to prevent health care associated infections (HAI)
  – State of knowledge

• Explore the relative contribution of hands and other vectors of transmission in hospitals

• Try to “go beyond the usual pep talk on HH”...

Morbidity and Mortality

• Risk of acquiring a HAI when hospitalized
  – 5-10% (developed countries)
    • USA
      – 4.5%
      – 1,700,000 cases
      – 100,000 deaths
    – >25% developing countries?

Morbidty and Mortality

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause of death (based on the 9th Revision International Classification of Diseases, ninth)</th>
<th>Percent of total deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diseases of heart</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>2</td>
<td>Malignant neoplasms</td>
<td>100.0-20.9</td>
</tr>
<tr>
<td>3</td>
<td>Cardiovascular diseases</td>
<td>100.0-20.9</td>
</tr>
<tr>
<td>4</td>
<td>Chronic kidney diseases</td>
<td>100.0-20.9</td>
</tr>
<tr>
<td>5</td>
<td>Deaths (unmentionable)</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>6</td>
<td>Diabetes mellitus</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>7</td>
<td>Infections and parasites</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>8</td>
<td>Atherosclerosis</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>9</td>
<td>Injuries, adverse effects of drugs and poisons</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>10</td>
<td>Intestinal diseases</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>11</td>
<td>Intestinal diseases</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>12</td>
<td>Chronic liver diseases</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>13</td>
<td>Alcoholic liver diseases</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>14</td>
<td>Deaths (unmentionable)</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td>15</td>
<td>Deaths (unmentionable)</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
<tr>
<td></td>
<td>All other causes</td>
<td>100-90.0, 91.0-95.9</td>
</tr>
</tbody>
</table>

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A dogma in medicine?
- Justifies colossal investments
- Assumes that any level of improvement is beneficial
- Assumes that resources invested in HH promotion does not divert funds from other evidence-based strategies

Most frequent sites of infection and their risk factors

<table>
<thead>
<tr>
<th>Site of Infection</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary tract infections</td>
<td>Neonatal urinary presentaion, infection, inopportune medications, diabetes</td>
</tr>
<tr>
<td>Lower respiratory tract infections</td>
<td>Intubation, aspiration, respiratory care, contact with infected patients</td>
</tr>
<tr>
<td>Surgical site infections</td>
<td>Inappropriate surgical site preparation, infection, inopportune medications,</td>
</tr>
<tr>
<td>Blood infections</td>
<td>Neonatal age, critical care, underlying disease, neutropenia, immunosuppression, lack of training and supervision</td>
</tr>
</tbody>
</table>

Most common sites of health care associated infections and their risk factors underlying the occurrence of infections

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Surgical site infections

- Most SSI are acquired during surgery.
- Sources:
  - Direct inoculation of exogenous flora during surgery
  - Exogenous contamination is possible but infrequent
    - Ex: contamination with GAS from a HCW
    - Ex: Contaminated bandages

Ventilator-associated pneumonia

- Micro-aspiration is believed to be the most important route for healthcare-associated pneumonia

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Central-line associated infections
Migration of skin organisms at the insertion site into the cutaneous catheter tract with colonization of the catheter tip is the most common route of infection for central catheters (2) catheter hub contributes substantiation of long-term catheters (23).

Catheter-associated urinary-tract infections
Pathogenesis.

Endogenous flora
• Critical aspect of 4 most common HAI...

• Even with perfect HH compliance, these HAI would still occur...

Most frequent sites of infection and their risk factors

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BACK TO HAND HYGIENE

HH indications do not have the same « protective effect » against HAI

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HH indications do not have the same « protective effect » against HAI

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Efficacy of hand hygiene

- Many studies have showed that different interventions can improve hand hygiene compliance
  - Especially if pre-intervention compliance is low!
- However, there are much less studies linking hand hygiene compliance and the risk of modern HAI!

Published articles, hand hygiene and selected healthcare-associated infections

<table>
<thead>
<tr>
<th>HAI</th>
<th>n</th>
<th>Pubmed search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator associated pneumonia</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Bloodstream infection</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>77</td>
<td></td>
</tr>
</tbody>
</table>
Why so few studies on HH efficacy?

- Efficacy is implicitly accepted?
- Lack of interest from scientists?
- Publication bias?
- Logistically near-impossible?
  - Sample size
  - Cost
  - Study design
  - Lack of reliable process and outcome indicators
  - Etc.

Hand Hygiene and ventilator-associated pneumonia

HH and VAP

- Before-and-after study
  - 12-month control and 12-month intervention
- ICU of a single institution
- Main outcomes
  - VAP/1 000 ventilator-days
  - CLA-BSI/1 000 catheter-days
  - HH compliance (direct observation)

HH and VAP

Results

- Moderate increase in HH compliance
  55% → 73% (P=0.05)
- 50% Decrease in VAP rate (!)
- No significant change in CLA-BSI rates

VAP bundle had NO impact on VAP rates, while a <20% increase in HH compliance halved VAP rates???
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HH and modern HAI

- Overall, there are very few data to support the hypothesis that HH can prevent modern HAI
  - Let alone be the most important preventive measure!
- Some researchers are highly motivated to prove that HH can prevent HAI
  - Especially if your entire career depends on HH!

HH and modern HAI

- Bigger, more rigorous studies are bound to be conducted in the future
  - This should help resolve the uncertainty

Methodology for studies on hand hygiene

The "ultimate" study will probably never be conducted

Hand Hygiene and nosocomial pathogen transmission

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Plausibility of the role of HH to prevent germ dissemination

Hand Hygiene and Germ Dissemination

- Objective of every HH campaign = 100% compliance
- Consequence:
  - >40 HH/h in the ICU
  - Up to 12 minutes/hr devoted to HH

MRSA transmission

- For MRSA to be transmitted from one patient to another, a succession of errors must occur:
  1. Patient A must be colonized by MRSA (and contagious)
  2. The HCW must acquire MRSA (despite glove use if patient A is a known carrier)
  3. HH must be suboptimal or omitted entirely
  4. The HCW must touch a non-colonized patient B
  5. Patient B must acquire MRSA

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  5. Patient B must acquire MRSA

The entire sequence occurs relatively infrequently!!!

Number needed to harm

<table>
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<th>Number of beds</th>
<th>400 beds</th>
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<tbody>
<tr>
<td>Number of HH opportunities per patient per day</td>
<td>Approx. 10/patient/day</td>
</tr>
<tr>
<td>Number of HH opportunities per day hospital-wide</td>
<td>Approx 4000 HH</td>
</tr>
<tr>
<td>Number of HH opportunities per month hospital-wide</td>
<td>120 000 HH opportunities</td>
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1Assuming that HH is the only source of transmission of pathogens

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<td>Number of HH opportunities per month hospital-wide</td>
<td>120 000 HH opportunities</td>
</tr>
<tr>
<td>Actual HH compliance</td>
<td>Approx 50%</td>
</tr>
<tr>
<td>N missed HH opportunities hospital-wide</td>
<td>60 000 per month</td>
</tr>
<tr>
<td>N new MRSA cases</td>
<td>1-3 per month</td>
</tr>
<tr>
<td>N new MRSA cases per missed HH opportunity</td>
<td>20 000-40 000 missed HH case</td>
</tr>
</tbody>
</table>

1Assuming that HH is the only source of transmission of pathogens

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Optimal Hand Hygiene Compliance

What is the optimal HH compliance rate?

A) 20%
B) 50%
C) 80%
D) 100%
E) It depends...

Modeling of transmission

Assumptions of model

• Computations assuming:
  • Hypothetical typical medical ward
  • Transmission only through HCWs’ hands

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>20</td>
</tr>
<tr>
<td>Number of HCW</td>
<td>3</td>
</tr>
<tr>
<td>Contact rate</td>
<td>2/day</td>
</tr>
<tr>
<td>HH opportunities/day</td>
<td>14/t/day</td>
</tr>
<tr>
<td>Efficacy of HH</td>
<td>50%</td>
</tr>
<tr>
<td>Proportion of MRSA patients</td>
<td>1%</td>
</tr>
</tbody>
</table>

Numerous other variables including detection rate, contagiousness...

Theory of decreasing returns

• HH is very effective to prevent MRSA transmission

• However...
  – The benefits are potentially highest when compliance is 20-40%
  – Above a certain level of compliance, the return on investment decreases gradually...

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#### Potential Explanations

1. **Hawthorne effect**  
   - Your compliance rate is not actually 40%

2. **Admission of colonized patients**  
   - Regardless of R0, there will always be some ongoing transmission

3. **Environmental contamination**  
   - HCPs’ hands are not the only way to transmit pathogens

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#### Potential Explanations

1. **Hawthorne effect**  
   - Your compliance rate is not actually 40%

2. **Admission of colonized patients**  
   - Regardless of R0, there will always be some ongoing transmission

3. **Environmental contamination**  
   - HCPs’ hands are not the only way to transmit pathogens
   - The alternative routes may have even lower rates of interruption

---

#### Environmental Contamination

![Environmental Contamination Image](image)

#### How can we say that hands are the main route?

![Diagram of Hands as the main route](image)

- Proven

#### Medical Equipment

![Medical Equipment Image](image)

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Privacy curtains

- Cleveland Veterans’ Hospital
  - Curtains cleaned q 4 months or if visibly soiled
  - 50 curtains sampled on every unit
  - Culture of curtains (contact plates and swabs)
  - Glove culture after touching the curtains

Sphygmomanometers

- 203 BP cuffs sampled
- 45% inner cuffs with levels of contamination >100cfu/25cm²
- 13% contaminated with pathogenic microorganisms
  - A. baumannii 2%
  - MSSA 6%
  - MRSA 5%
  - Pseudomonas 1%
  - Enterobacteriaceae 1%

Privacy curtains

- 2 important factors to consider
  - Frequency of manipulation
  - Cleaning schedule

- Can curtains be a source of cross-transmission?
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Privacy curtains
- Contamination of 200 curtains evaluated for MRSA
  - University Hospital, Nottingham, UK
  - Different units in hospital
  - Contact plates, chromogenic media
  - "Point prevalence" study

Results
- 15% (31/200) contaminated by MRSA
- Median 1CFU, range 1-13CFU

Patient’s charts

What about scissors? ...

- Point prevalence study
  - 232 scissors sampled
  - Swab, quantitative culture
  - Disinfection and sampling post-disinfection

Scissors: A Potential Source of Nosocomial Infection
John M. Emble, MD, George G. Zhouel, PhD, Pierre J. Plouffe, MD, Darryl Hobson, PhD

Results
- 182/232 (78.4%) contaminated by bacteria
  - 68% shared scissors
  - 89% nurses’ personal scissors

| Table 1: Distribution of Contaminants from Regular and Shared Scissors |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|                             | Regular Scissors | Shared Scissors | Total Scissors | Total CFU |
|                             | CFU             | CFU             | CFU            | CFU           |
| Escherichia coli            | 10             | 10             | 20            | 25           |
| Pseudomonas                 | 5              | 5              | 10            | 12           |
| Staphylococcus              | 1              | 1              | 2             | 3            |
| Other pathogens             | 1              | 1              | 2             | 3            |
| Total                       | 12             | 12             | 24            | 30           |

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Phlebotomy Tourniquets

- A. baumannii and MRSA contamination on reusable phlebotomy tourniquets.
  - 200 Tourniquets sampled at the end of a regular day in a test center or at the end of a day on a hospital ward
  - Tourniquets used 11-33 times per day on average
  - Contamination
    - A. baumannii
      - 17% testing center
      - 3% medical ward
    - S. aureus
      - 2% testing center
      - 2% medical ward
      - No MRSA

The stethoscope
A potential vector of pathogens?

Cross-sectional studies
- Stethoscopes are selected “randomly” to assess contamination
- Results:
  - 40 articles identified
  - >2800 stethoscopes sampled
  - Significant variation in contamination levels

Cross-sectional studies

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### Cross-sectional studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal</th>
<th>Year</th>
<th>Etiology</th>
<th>Setting</th>
<th>Design</th>
<th>Handwash</th>
<th>Duration</th>
<th>Wound Care</th>
<th>Equipment</th>
<th>Medical Personnel</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith</td>
<td>Journal1</td>
<td>2005</td>
<td>Bacteria</td>
<td>Hospital</td>
<td>Survey</td>
<td>Yes</td>
<td>5 min</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Limited</td>
</tr>
<tr>
<td>Jones</td>
<td>Journal2</td>
<td>2006</td>
<td>Virus</td>
<td>Community</td>
<td>Random</td>
<td>No</td>
<td>2 min</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Brown</td>
<td>Journal3</td>
<td>2007</td>
<td>Fungi</td>
<td>Hospital</td>
<td>Case</td>
<td>Yes</td>
<td>3 min</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**These studies suggest that medical equipment**

A) Is an important source of transmission  
B) Is NOT an important source of transmission  
C) All of the above

### Cross-sectional studies

- Multiple limitations
  - Material selection not randomized
  - The "pest" of cannot be evaluated
    - How many times used today? This week?
    - Microbiological status of patients it touched? (MRSA? C. difficile?)
    - Exact use?  
      - Contains physical examination? BP?
    - If bacteria recovered, so what? Is it relevant?  
      - Medical equipment does not have to be sterile

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METHODS
- Study design: Structured observational study
- Convenience-based sampling (internal medicine and orthopedics)
- Performance of standardized P/E
- Sampling
  - Stethoscope and dominant hand
- Assessment of bacterial contamination CFU count
  - Total Aerobic Colony Count (Total CFU)
  - MRSA CFU Count

RESULTS

ASSESSMENT OF TOTAL CFU

ASSOCIATION BETWEEN DIAPHRAGM CFU AND FINGERTIPS CFU

ASSOCIATION BETWEEN DIAPHRAGM MRSA & FINGERTIPS MRSA

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Disinfection of small medical equipment

2007 guideline for isolation precautions: preventing transmission of infectious agents in health care settings

“Noncritical equipment, such as commodes, intravenous pumps, and ventilators, must be thoroughly cleaned and disinfected before being used on another patient”

Do HCWs disinfect their stethoscopes?

Frequency of disinfection
- 15 articles identified
- 1038 respondents
- Pooling of results not possible
  - Variation on multiple-choice answers
  - Proportion of respondents who declared never disinfecting their stethoscope
    - From 10% (15/154) to 90% (29/32)

Disinfection practices
- 4/82 (4%) of MDs and RNs disinfect their scissors after each use

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Audit of disinfection small medical equipment

- 28 different HCWs observed
- Global compliance:
  - 18% (6/33)
  - 20% (1/5) when leaving isolation room
- Disinfection per type of equipment
  - BP machine: 33% (6/18)
  - Glucometer: 0/2
  - Stethoscope: 0/2
  - Thermometer: 0/6
  - Oxiimeter: 0/5

Electronic medical equipment: Trojan Horses?

Glucose meter and opportunities for cross-transmission

  - 11 glucose meters
  - 11,560 glucose measurements
  - 95.1% done sequentially on same patient
  - 6% done sequentially on different patients
  - 3% done sequentially on same patient but in separate hours
- Intervention phase: 2 interventions to decrease sharing
  1) Increase in number of glucose meters (number increase from 22 to 47)
  2) Overall increase in number of glucose meters (number increased from 10 to 28)
- Results
  - Dedicated equipment: decrease sequential use by 20%
  - Non-dedicated equipment: decrease sequential use by 17%

Sphygmomanometers

- Historically, 1 per patient bed
  - Risk of cross-transmission was low
  - Disinfection required only once at patient d/c
- New electronic ones
  - More convenient (HCWs do not use manual ones)
  - But also more expensive
  - 5-6 per ward only
    - Is it really cost saving?

Non-dedicated sphygmomanometers

- Cost-saving strategy on the short term
  - Less equipment to buy initially (lower up-front cost)
- Potential risk for patients
  - Potential for cross transmission
  - Low disinfection rate
- Costly on long term
  - Loss of productivity due to repeated disinfection
  - Cost of healthcare associated infections

Disinfection of BP machine

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Costs of disinfection

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursing hourly wage (7hr)</td>
<td>36</td>
</tr>
<tr>
<td>Nursing hourly wage ($/minute)</td>
<td>0.5</td>
</tr>
<tr>
<td>Time required to disinfect BP machine (minutes)</td>
<td>1</td>
</tr>
<tr>
<td>Cost of wipe ($)</td>
<td>0.1</td>
</tr>
<tr>
<td>Cost of BP machine disinfection</td>
<td>0.6</td>
</tr>
<tr>
<td>Number patients in hospital requiring VS</td>
<td>569</td>
</tr>
<tr>
<td>Number of VS per day</td>
<td>3</td>
</tr>
<tr>
<td>Proportion of VS done with non-dedicated BP machine</td>
<td>0.5</td>
</tr>
<tr>
<td>Number of VS per day with non-dedicated BP machine</td>
<td>759</td>
</tr>
<tr>
<td>Cost of BP machine disinfection per day (assuming 100% compliance)</td>
<td>469</td>
</tr>
<tr>
<td>Cost BP machine disinfection per week ($)</td>
<td>$3,150.00</td>
</tr>
</tbody>
</table>

Modeling of transmission
Medical Equipment

Does fomite-mediated transmission follow the same model as hands?

Conclusion

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Conclusion

- The role of hand hygiene to prevent modern HAI is still debatable
- The role of hand hygiene to prevent cross-transmission is more plausible
  - But the potential role of fomites should also be acknowledged
  - The relative contribution of each potential route should be better studied
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February 12 (South Pacific Teleclass)
PREVENTING CATHETER ASSOCIATED URINARY TRACT INFECTIONS:
WHAT’S NEW
Prof. Paul A. Tambyah, National University of Singapore

February 13 (Free Teleclass)
ELIMINATING PREVENTABLE HARM THROUGH BUILDING A
RELIABLE CULTURE OF SAFETY
Dr. Denise M. Murphy, Main Line Health System, Pennsylvania

February 27 RAPID BACTERIAL DIAGNOSTICS – IMPACT ON PATIENT AND
INFECTION CONTROL
Dr. Stephen M. Brecher, VA Boston Health Care System

March 6 HEALTHCARE LAUNDRY: EPIDEMIOLOGY AND MICROBIOLOGY ISSUES
Dr. Lynne Schublter, Centers for Disease Control

www.webbertraining.com/schedulepl.php

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