Quality of Hand Washing Among BSL-2 Laboratory Workers

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Microbiological Containment

- Achieved through:
  - Primary Barriers (Safety Equipment & PPE)
  - Secondary Barriers (Facility Safeguards)
  - Microbiological Practices

“In the last analysis, however, biological safety depends on the attitude and conduct of the individual worker.”

Robert Pike, 1978 (p. 336)
Evidence for Hand Transmission

- Procedure-generated aerosols
  - Inhalation hazard
    - < 10 µm penetrate to bronchi
    - < 5 µm penetrate to the alveoli
  - Hand, skin and surface contamination
    - > 50 µm settle out quickly

- “The respirable component is relatively small and does not vary widely; in contrast hand and surface contamination is substantial and varies widely” (BMBL, 5th ed. p. 14)

- “The potential risk from exposure to droplet contamination requires as much attention in a risk assessment as the respirable component of aerosols” (BMBL, 5th ed. p. 14)
### Comparison of 10 most common symptomatic laboratory-acquired infections (1979 – 2004)

<table>
<thead>
<tr>
<th>Agent</th>
<th>No. of cases</th>
<th>No. of deaths</th>
<th>Primary Route(s) of Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mycobacterium tuberculosis</em></td>
<td>199</td>
<td>0</td>
<td>Inhalation</td>
</tr>
<tr>
<td>Arboviruses</td>
<td>192</td>
<td>3</td>
<td>Injection/contact/inhalation</td>
</tr>
<tr>
<td><em>Coxiella burnetii</em></td>
<td>177</td>
<td>1</td>
<td>Inhalation</td>
</tr>
<tr>
<td>Hantavirus</td>
<td>155</td>
<td>1</td>
<td>Inhalation/mucous membranes</td>
</tr>
<tr>
<td><em>Brucella</em> spp.</td>
<td>143</td>
<td>4</td>
<td>Inhalation/mucous membranes</td>
</tr>
<tr>
<td>Hepatitis B virus</td>
<td>82</td>
<td>1</td>
<td>Mucous membranes</td>
</tr>
<tr>
<td><em>Shigella</em> spp.</td>
<td>66</td>
<td>0</td>
<td>Ingestion</td>
</tr>
<tr>
<td><em>Salmonella</em> spp.</td>
<td>64</td>
<td>2</td>
<td>Ingestion</td>
</tr>
<tr>
<td>Hepatitis C virus</td>
<td>32</td>
<td>1</td>
<td>Mucous membranes</td>
</tr>
<tr>
<td><em>Neisseria meningitidis</em></td>
<td>31</td>
<td>11</td>
<td>Mucous membranes/inhalation</td>
</tr>
</tbody>
</table>

*Adapted from Harding & Byers (2006, p. 55)*
Evidence for Hand Transmission

- Generally no barrier between hands and face at BSL-2
- Hand-to-face contact (HFC)
  - 72% of BSL-2 lab workers touch face while in lab
  - HFC rates range from 0 – 17.5 times per hour
  - Mean HFC = 3.4/hr.
- Type of contact
  - Nose (49.4%)
  - Forehead (31.6%)
  - Cheek/chin (11.5%)
  - Mouth (5.2%)
  - Eye (2.3%)
Evidence for Hand Transmission

- **Case Studies**
    - Ocular Vaccinia Infection
    - 4 days of hospitalization, several weeks of recovery
  - Spina et al. (2005)
    - Four isolated cases of E. coli O157:H7
    - Suspected low compliance with gloves & hand hygiene
  - Mermel, et al. (1997)
    - Hospital lab Shigella outbreak (6 people)
    - Acute bloody diarrhea
    - 73 days away from work
    - $10,000 in lost wages
Hand Washing & Hand Disinfection

- Effective for removing/inactivating microbes
- Effectiveness depending on:
  - Agent used
  - Contact time
  - Surfaces covered
- Antiseptic handwashing & alcohol-based hand sanitizers are superior to traditional soap & water handwashing

CDC, (2002) *MMWR* 51(RR-16)
Hand Washing & Hand Disinfection

- Duration of Scrubbing
  - Plain soap and water (15 sec.)
    Decreased bacterial counts
    0.6 – 1.1 Log_{10} reductions
  - Plain soap and water (30 sec.)
    Decreased bacterial counts
    1.8 – 2.8 Log_{10} reductions

- Log Reductions
  - 1 Log_{10} (90% Reduction)
  - 2 Log_{10} (99% Reduction)
  - 3 Log_{10} (99.9% Reduction)
  - 4 Log_{10} (99.9% Reduction)

Log_{10} [Initial] – Log_{10} [Final] = Log Reduction

CDC, (2002) *MMWR* 51(RR-16)
Hand Washing & Hand Disinfection

- **Alp, Haverkate, & Voss (2006)**
  - Observational study of clinical lab workers
  - Focus: Hand hygiene behaviors and compliance with a no-jewelry policy (rings, wrist watches, bracelets)
  - Findings:
    - No-jewelry policy: 36.7% compliance rate ($n=49$)
    - Potential pathogens were cultured exclusively from skin underneath jewelry

- **Trick et al. (2003)**
  - Hand hygiene (both soap & water and alcohol gel) less effective when rings are worn
Hand Washing & Hand Disinfection

- Vesley et al.
  A. Wet hands with warm water
  B. Dispense soap or antiseptic cleansing agent
  C. Spread soap or cleansing agent around hands and between fingers, adding water as needed
  D. Vigorously rub hand, finger, and wrist surfaces for at least 30 seconds – working downward toward fingers and fingernails
  E. Rinse under warm water working from the wrist downward
  F. Dry hands with paper towels, and use paper towels to turn off faucet
Hand Washing & Hand Disinfection

- Purpose of this study:
  - Evaluate quality of hand washing among BSL-2 Lab workers
  - Evaluate extent of jewelry use among lab workers
Study Design

- Cross-sectional study
  - May – December 2009
    - Informed consent
    - Behaviors measured by direct observation
      - Frequency of HW
      - Quality of HW
      - Rate of HFC
      - Jewelry use
Subjects & Setting

- **Subjects**
- 93 participants (56% male)
  - Research professors
  - Post-doctoral students
  - Research associates
  - Graduate students
  - Laboratory technicians
  - Medical doctors
Subjects & Setting

- Participating Labs ($n = 21$)
  - BSL-2 (17)
  - BSL-2+ (4)
- Staffing
  - Range 1 – 9 workers ($mean = 4.4/lab$)
- Approved Agents
  - Viral only (14)
  - Bacterial and viral (4)
  - Bacterial only (2)
  - Bacterial and parasitic (1)
Measurement

- Instrumentation
  - Laboratory behavior observation tool (LBOT)
    - Developed from 2 existing tools
      - Handwashing assessment tool (HAT; Brock, 2002)
      - WHO HH assessment tool (Haas, 2007)
  - Standardized measurement tool
    - Amount of observation time
    - Procedure being performed
    - Agent in use
    - HH behaviors (including hand washing quality tool)
    - Situational factors within labs
• HAT (Brock, 2002) also includes components for splashing, friction, and hand position. These were removed to bring tool into conformance with hand washing protocol recommended by Vesley et al. (2000).
• Drying weighted here as 2 rather than 1 based on risk of recontamination from faucet handles.
Results

- Overall HW Compliance
  - 118 hours of observation
  - 604 HW opportunities
  - 62 HW Events (1 w/hand sanitizer)
  - Overall compliance rate = 10.3%

- Compliance by lab
  - 336 opportunities in 12 labs with zero compliance
  - 268 opportunities in 9 labs: 3 – 85% compliance
Quality of HW

- 61 soap and water HW performed by 23 subjects (24.7%) from 9 labs
- 49 HW scored, 12 not scored ($n=22$)
- Average score = 11.3 (range = 2 – 18 points)
- Scrubbing 9 seconds or less (84% of cases)
- Soap use (92%)
- Lathering not visible to observer (51% of cases)
- Turned off faucet with bare hands (59% of cases)
- Foot operated (27%)
- Turned off with paper towel (14%)
# Quality of HW by Gender and Job Title

<table>
<thead>
<tr>
<th>Gender</th>
<th>Time Scrubbing</th>
<th>Soap</th>
<th>Surfaces Covered</th>
<th>Rinse</th>
<th>Dry</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n=8)</td>
<td>1.0</td>
<td>2.3</td>
<td>1.9</td>
<td>1.4</td>
<td>2.7</td>
<td>9.3</td>
</tr>
<tr>
<td>Male (n=14)</td>
<td>2.1</td>
<td>2.5</td>
<td>2.0</td>
<td>1.6</td>
<td>2.8</td>
<td>11.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Time Scrubbing</th>
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<th>Surfaces Covered</th>
<th>Rinse</th>
<th>Dry</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>PostDoc/RA (n=10)</td>
<td>1.7</td>
<td>2.4</td>
<td>2.0</td>
<td>1.3</td>
<td>2.4</td>
<td>9.7</td>
</tr>
<tr>
<td>Lab Tech (n=6)</td>
<td>1.9</td>
<td>2.4</td>
<td>2.3</td>
<td>1.7</td>
<td>3.1</td>
<td>11.4</td>
</tr>
<tr>
<td>PI/MD (n=2)</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.5</td>
<td>3.0</td>
<td>8.5</td>
</tr>
<tr>
<td>GradStudent (n=4)</td>
<td>2.0</td>
<td>2.8</td>
<td>1.9</td>
<td>1.9</td>
<td>3.0</td>
<td>11.5</td>
</tr>
</tbody>
</table>

| Total Points Possible | 6.0 | 4.0 | 4.0 | 2.0 | 4.0 | 20.0 |
Jewelry

- 93 Subjects
- 60 (65%) observed wearing ring, wrist watch, bracelet or combination
  - 29 Males (56%)
  - 31 Females (76%)

<table>
<thead>
<tr>
<th></th>
<th>Ring(s)</th>
<th>Wrist Watch</th>
<th>Bracelet(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>16 (31%)</td>
<td>15 (29%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>Female</td>
<td>17 (41%)</td>
<td>10 (24%)</td>
<td>14 (34%)</td>
</tr>
</tbody>
</table>
Discussion

- Rate and quality of HW is suboptimal
- BSL-2 containment may be routinely and pervasively violated by poor hand hygiene
- Hand sanitizers may be appropriate for routine hand decontamination when supported by risk assessment
- Additional research and policy review needed regarding wearing of jewelry in BSL-2 labs