



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
 - $< 10 \mu\text{m}$ penetrate to bronchi
 - $< 5 \mu\text{m}$ penetrate to the alveoli
 - Hand, skin and surface contamination
 - $> 50 \mu\text{m}$ 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*)

Evidence for Hand Transmission

Comparison of 10 most common symptomatic laboratory-acquired infections (1979 – 2004)

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

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

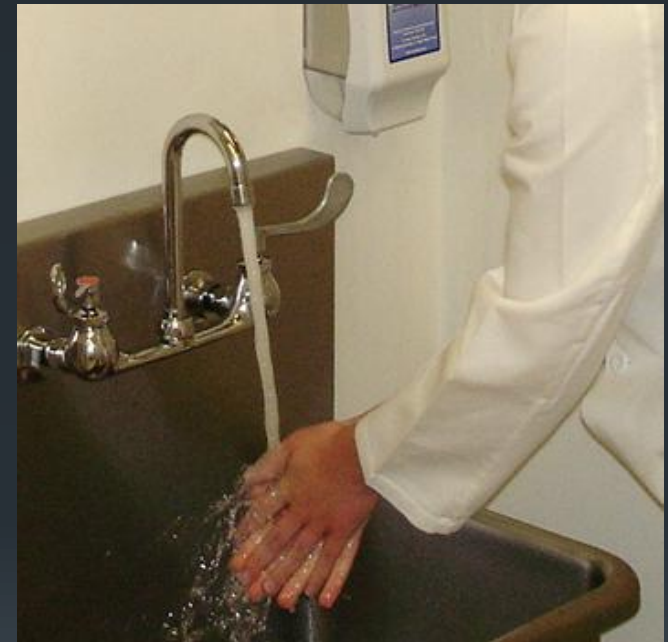
■ Case Studies

- Lewis, et al. (2006)
 - 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



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)

$$\text{Log}_{10} [\text{Initial}] - \text{Log}_{10} [\text{Final}] = \text{Log Reduction}$$



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

Measurement

| Duration of Scrubbing | Soap | Surfaces Covered | Rinse | Drying | Alcohol-based Hand Sanitizer Used? |
|---|--|---|---|--|------------------------------------|
| ≥ 15 sec. [3] 10-14 sec. [2] 5-9 sec. [1] < 5 sec. [0] | Visible [2] Not vis. [1] No soap [0] | Dorsal, wrist, palm [2] interdigital areas Two of the above [1] One surface only [0] | All surfaces [2] Partial [1] No rinsing [0] | Dried, used [2] towel to turn off faucet Dried, turned [1] off with hands Did not dry [0] | Y N |
| Weight [2] Score | Weight [2] Score | Weight [2] Score | Weight [1] Score | Weight [2] Score | Total Score: |

$(\text{Score})(\text{Weight}) = \text{Subject's Score}$

$\text{Maximum Score} = 20$

- 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

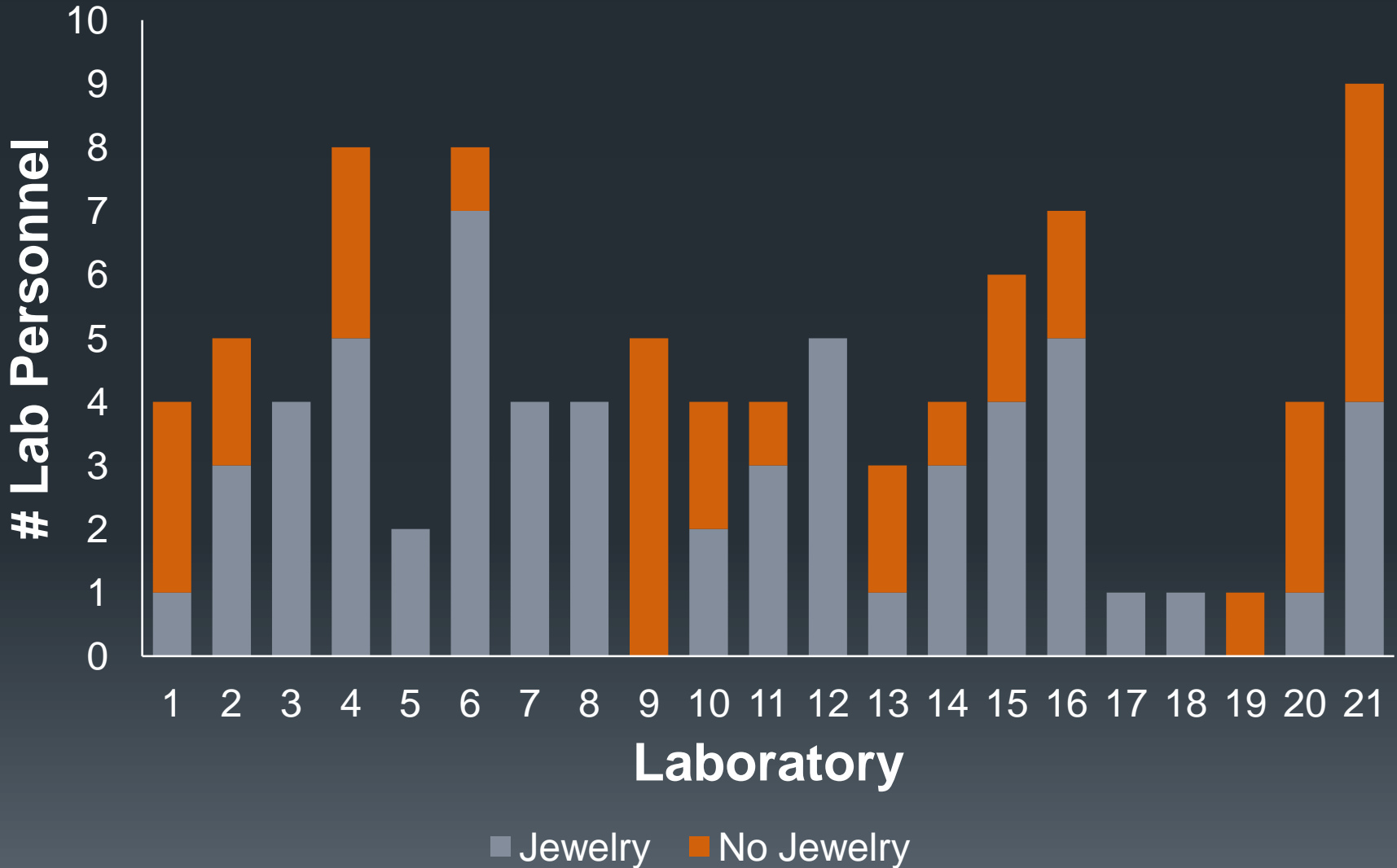
| | Time Scrubbing | Soap | Surfaces Covered | Rinse | Dry | Mean Score |
|----------------------------|----------------|------|------------------|-------|-----|------------|
| Gender | | | | | | |
| Female (<i>n</i> =8) | 1.0 | 2.3 | 1.9 | 1.4 | 2.7 | 9.3 |
| Male (<i>n</i> =14) | 2.1 | 2.5 | 2.0 | 1.6 | 2.8 | 11.0 |
| Job Title | | | | | | |
| PostDoc/RA (<i>n</i> =10) | 1.7 | 2.4 | 2.0 | 1.3 | 2.4 | 9.7 |
| Lab Tech (<i>n</i> =6) | 1.9 | 2.4 | 2.3 | 1.7 | 3.1 | 11.4 |
| PI/MD (<i>n</i> =2) | 1.0 | 2.0 | 1.0 | 1.5 | 3.0 | 8.5 |
| GradStudent (<i>n</i> =4) | 2.0 | 2.8 | 1.9 | 1.9 | 3.0 | 11.5 |
| 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%)

| | Ring(s) | Wrist Watch | Bracelet(s) |
|--------|----------|-------------|-------------|
| Male | 16 (31%) | 15 (29%) | 4 (8%) |
| Female | 17 (41%) | 10 (24%) | 14 (34%) |

Jewelry use by Lab





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