Laboratory-Acquired Infections: An APHL Training Webinar

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Faculty Disclosure

The Association of Public Health Laboratories adheres to established standards regarding industry support of continuing education for healthcare professionals. The following disclosures of personal financial relationships with commercial interests within the last 12 months as relative to this presentation have been made by the speaker(s):

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Nothing to disclose
Objectives

• Summarize the presented cases of well-documented infections that have occurred in clinical laboratories.
• Explain how laboratorians are exposed to LAIs and how this knowledge can reinforce prevention programs.
• List the recommended vaccinations for personnel in laboratories.
Chain of Infection

- Pathogen
- Source
- Susceptible Host
- Entry
- Mode
Guidelines for Safe Work Practices in Human and Animal Medical Diagnostic Laboratories
Recommendations of a CDC-convened, Biosafety Blue Ribbon Panel

MMWR Supplements
January 6, 2012 / 61(01);1-101

Excellent tables for review of lab safety policies.

http://www.cdc.gov/mmwr/preview/mmwrhtml/su6101a1.htm
5 Routes of LAI infection

50% obvious cause
- parenteral;
- spills and splashes onto skin and mucous membranes;
- Ingestion*

50% cause not known
- worked with or in proximity
  (*Includes touching mouth or eyes with contaminated fingers or objects)
- Infectious aerosols (and droplets) –

*Includes touching mouth or eyes with contaminated fingers or objects

References:
MMWR Supplements
January 6, 2012 / 61(01);1-101

Definitions

• Cut off for aerosols: <5 μm

• Droplet particles >10–20 μm will settle rapidly, and will not be deposited in the lower respiratory tract.

• “In theory, influenza viruses can be transmitted through aerosols, large droplets, or direct contact with secretions (or fomites). These 3 modes are not mutually exclusive”

http://wwwnc.cdc.gov/eid/article/12/11/06-0426_article.htm
Role of aerosols/droplets
LAI – a problem in clinical labs?


Reports from 88 hospital microbiology laboratories and 3 national reference laboratories.

33% of labs reported at least 1 LAI.

Incidence of infection for clinical lab staff vs. general population (aged 30-59)

Lower for clinical microbiologists than the general population for: *Salmonella*, *C. difficile*.

About the same for *Shigella* and *Coccidioides* species.

Higher for: *Brucella* (641 per 100,000 vs. 0.8)

*N. meningitidis* (25.1 per 100,000 vs. 0.6)

*E.coli* 0157H7 (83 versus 0.96).

Results of 2002-2004 online survey

Forty-one bacterial LAI were reported:  *Shigella* (15),

*Bruceella* (7),

*Salmonella* spp. (6),

*Staphylococcus aureus* (6) with 5 of these being methicillin-resistant resistant,

*N. meningitidis* (4),

*E. coli 0157:H7* (2) and *C. difficile* (1)

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Case studies: 4 Shigella LAI

2004-3 staff at one hospital ill; cultures yield S. sonnei. patient isolate from 1 wk earlier. Pulsed-field electrophoresis – same. 1 had worked with; 2 had not.

- Handwashing sink faucet contaminated.

2005- LAI-staff member helped to clean biosafety cabinet where cultures manipulated.

- Cleanup counts!

Shigella case study

Micro lab in 719 bed hospital; 16 technologists and 3 students.

6 became ill with S. sonnei; identical antibiograms.

Year before: footpedal sink removed.

Student stuck gloved finger in well with heavy suspension during typing; also used handwashing sink, instead of prep sink, to discard culture

- Contaminated handwashing sink faucet.

Human *Salmonella typhimurium* Infections Associated with Exposure to Clinical and Teaching Microbiology Laboratories

http://www.cdc.gov/salmonella/typhimurium-laboratory/011712/index.html
2nd investigation Surveyed labs with and without LAI

- Essentially same facilities, safety policies, procedures in labs that had LAIs and those that did NOT.
- Monitoring and enforcing NO handheld electronics is difficult.
- Lesson Learned: Labs without LAI included symptoms in their training, and their students were more familiar with biosafety materials. Specific advice written for students and for supervisors.
Lesson Learned:
Training Tool Target to Students

Supervisor
Responsibilities listed:
Advice to Laboratory Directors, Managers, and Faculty Involved with Clinical and Teaching Microbiology Laboratories

7 infections w/ S. typhi in staff who worked in micro labs. 5 had no travel history. 1 had received typhoid fever vaccine.

22-year-old student infected while working with Salmonella typhi for laboratory practice. (not vaccinated).

Keep children out of laboratory. 0157 has a small infectious dose…

- 6-year old child visiting lab, shown open plate--touched it.
- mother immediately washed hands with lab soap.
- child hospitalized 3 days later—colitis, haemolytic uremic syndrome.
- Plate was *E.coli* 0157.
- Required dialysis for 2 weeks, multiple transfusions.
- 1 year later—normal renal function, blood pressure, no proteinuria.

Glove, handwashing policy advice

E. coli 0157

4 cases of LAI that would have been prevented with adherence to glove zone/no glove zone policy, buttoned lab coat policy.

No touching phones, keyboards, etc. in no glove zone without glove removal and handwashing.

Difficulty in maintaining practices during a foodborne outbreak.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1151895/
Careful routine procedures are critical…

Case study: Lab trainee is ill - Bloody diarrhea, haemolytic uraemic syndrome (HUS).

• *E. coli* 0157 isolated from fecal specimen; unusual phage type--54.

Strange – this phage type did not match any recent isolates.
So what happened?

• The lab had one 0157 QC strain with the same phage type.

• Cultures were transposed at some point…

the 0157 was being used for \textit{E.coli} antibiotic sensitivity testing. Not recognized – 0157 also fully sensitive.
Reminder: laboratory-acquired infections with 0157 have occurred with no accidents or breaches in practice. Infectious dose is very small: 50 to 100 organisms, retains infectivity on surfaces.
Remove PPE Carefully

Salmonella, E. coli 0157, Shigella—contamination of the hands directly or indirectly

Glove removal procedure – importance has been documented with fluorescent bacteriophage, contamination could be visualized on staff and on surfaces.

Casanova, 2008 Emerg Infect Dis, 14(8), 1291-129
www.cdc.gov/eid/content/14/8/pdfs/1291.pdf
Removing PPE

SEQUENCE FOR REMOVING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Except for respirator, remove PPE at doorway or in anteroom. Remove respirator after leaving patient room and closing door.

1. GLOVES
   - Outside of gloves is contaminated!
   - Grasp outside of glove with opposite gloved hand; peel off
   - Hold removed glove in gloved hand
   - Slide fingers of ungloved hand under remaining glove at wrist
   - Peel glove off over first glove
   - Discard gloves in waste container

2. GOGGLES OR FACE SHIELD
   - Outside of goggles or face shield is contaminated!
   - To remove, handle by head band or ear pieces
   - Place in designated receptacle for reprocessing or in waste container

3. GOWN
   - Gown front and sleeves are contaminated!
   - Unfasten ties
   - Pull away from neck and shoulders, touching inside of gown only
   - Turn gown inside out
   - Fold or roll into a bundle and discard

4. MASK OR RESPIRATOR
   - Front of mask/respirator is contaminated — DO NOT TOUCH!
   - Grasp bottom, then top ties or elastics and remove
   - Discard in waste container

PERFORM HAND HYGIENE IMMEDIATELY AFTER REMOVING ALL PPE
CDC inquiry: LAI w/ *N. meningitidis*

- 2 reports in 2002: MMWR 51(07):141-144.

- Isolated approx. 3,000x/year in the US.

- CDC sent query to professional organizations to inquire about laboratory-acquired infections.

- **Conclusion:** LAI rare event, but with serious consequences

N. meningitidis (Sejvar, 2005)

• 16 cases cases of probable laboratory-acquired meningococcal disease occurring worldwide between 1985 and 2001 were identified, including six U.S. cases between 1996 and 2000.

• Nine cases (56%) were serogroup B; seven (44%) were serogroup C.

• Eight cases (50%) were fatal. All cases occurred among clinical microbiologists.

• 50% fatality rate for LAI compared to community fatality rate of 10%.

• [Link to more information](http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=16145146)
N. meningitidis vaccine

• Immunization recommended – decreases risk of A, C, Y and W-135 (not B).

• Experience of infected staff varies:
  • 1 fatality- first isolate in that lab in 4 years.
  • 1 fatality-state lab worker who worked with approx. 4 isolates/month.

Clinical Laboratory procedures…bench or bsc?

CDC advice:
START in the biosafety cabinet with cultures from sterile sites—

Blood, cerebrospinal fluid, inner ear.

J. Clin Micro. 43(9) 4811-4814.
DROPLET Transmission

43 cases of LAI *N. meningitidis* in literature—

• **ONLY** 1 microbiologist infected in each case

• 40 worked on the open bench (catalase assays, made suspensions, etc.) 2 worked behind a plastic shield; 1 in a defective biosafety cabinet.

• None were immunized.
Biosafety Cabinet for culture of sterile sites: blood, CSF, inner ear.
Followup- *N. meningitidis* LAI

- Following standard procedure for that lab, experienced tech was transferring frozen stock cultures with a glass Pasteur pipet.
- Laboratory reviewed procedures: use of bsc, soft cotton swabs used for transfer, offered vaccine, published event and follow-up.
- Ideal response.

Case studies: Brucella

• Most frequent LAI

• Aerosol transmission, low dose required for infection.

• From: sniffing plates, spilling blood-culture bottle, mucocutaneous exposure to spray, aerosol from broken tube in centrifuge

• routine work outside of biosafety cabinet.

MMWR, 57(02) 39-42.
Monitoring Select Agent Theft, Loss, and Release Reports in the United States-2004-2010

- 11 LAI with BSAT
- 10,000 individuals with access.
- No fatalities
- No secondary infections.

Applied Biosafety. 2012. 17(4) 171-180

## LAIs from BSATs

<table>
<thead>
<tr>
<th>Type of Lab</th>
<th>Organism</th>
<th># cases</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exempt (Clinical)</td>
<td><em>B. melitensis</em></td>
<td>1</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td><em>B. suis</em></td>
<td>2</td>
<td>2010</td>
</tr>
<tr>
<td>Registered (Research)</td>
<td><em>F. tularensis</em></td>
<td>3</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2009</td>
</tr>
<tr>
<td></td>
<td><em>B. melitensis</em></td>
<td>3</td>
<td>2004</td>
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<td></td>
<td>2007</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>2008</td>
</tr>
<tr>
<td></td>
<td><em>Coccidioides</em></td>
<td>1</td>
<td>2004</td>
</tr>
</tbody>
</table>

*Applied Biosafety. 2012. 17(4) 171-180*

Analysis and recommendation for Timely post-exposure prophylaxis

Reports of *B. abortus* minimized or prevented:


(3) Robichaud, 2004 Clin Infec Dis **38**:e199-e122.

Excellent review of Brucella exposures, treatment, outcomes: *Laboratory Exposures to Brucellae and Implications for Bioterrorism*  
http://www.cdc.gov/ncidod/EID/vol11no08/04-1197.htm
Brucella exposure-HIGH Risk

HIGH:

1. Having direct personal exposure to Brucella (sniffing bacterial cultures, direct skin contact, pipetting by mouth, inoculation, or spraying into the eyes, nose, or mouth.)

2. Performing work on the open bench (outside of BL3) with an open culture plate or being in close proximity to such work (across an open bench top or within 5 feet)

3. Presence in the laboratory during any procedure on a Brucella isolate that might result in generation of aerosolized organisms and inhalational exposure (e.g. vortexing or catalase testing)
Brucella Exposure-Low risk

LOW RISK

• Present in the laboratory during workup and identification of a Brucella isolate

• Present from the time the culture is first isolated until all culture isolates are removed or destroyed from the laboratory.

• Not meeting criteria (1,2,3) for high-risk.
Update: Potential Exposures to Attenuated Vaccine Strain *Brucella abortus* RB51 During a Laboratory Proficiency Test --- United States and Canada, 2007

January 18, 2008 / 57(02);36-39

- http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5702a2.htm
2007 Laboratory Proficiency Exercise for clinical labs

- Category B pathogen sent to 1,316 labs in US and Canada.

- **Sent w/ letter directing handling in class II biosafety cabinet using BL3 primary barriers and safety equipment.**

- Mislabeled sample sent to NYSDOH, handled on bench, 17 exposed.

- Prompted survey of NY labs.
No Plate Sniffing..

A potentially unsafe laboratory practice that has been associated with LAI. Some incidents from the MMWR:

**Imported Melioidosis --- South Florida, 2005**
*Burkholderia pseudomallei*
[Los Angeles:](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5532a1.htm)

**Laboratory-Acquired Brucellosis --- Indiana and Minnesota, 2006**
[http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5702a3.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5702a3.htm)
2 separate LAI.

**Laboratory Exposure to *Burkholderia pseudomallei* --- Los Angeles, California, 2003**
[http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5342a3.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5342a3.htm)

**Update: Potential Exposures to Attenuated Vaccine Strain *Brucella abortus* RB51 During a Laboratory Proficiency Test --- United States and Canada, 2007**
[http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5702a2.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5702a2.htm),
LAI Brucellosis- 2013 review

18 (11%) - lab accidents
147 (88%) - aerosols from routine identification
2 (1%) - unknown.

167 exposed; 71 LAI; 12 relapses.

Hepatitis – Acute vs. Chronic

Hepatitis B

Acute infection

chronic-1 in 10 adults*

Hepatitis C

Acute infection

8 in 10 chronic

* Age-dependent: 90% for perinatal infections.
Hepatitis B-Reported Risk 2001-2007

HEPATITIS B VACCINE WORKS!!
Hepatitis C – Reported Risk 2001-2007

Perinatal (mother to child) transmissions also occur with BBP infections.
Hepatitis C

Up to 75% of people living with Hepatitis C DO NOT KNOW THEY ARE INFECTED

Many people can live with HEPATITIS C for DECADES WITH NO SYMPTOMS
Reason for reporting BBP exposures

http://www.cdc.gov/features/vitalsigns/hepatitisc/
US-HIV Occupationally Acquired

Clinical lab staff total from CDC

- 24 documented
- 17 possible

2009- last documented case-few under investigation

- Safety –engineered needles
- Post-exposure prophylaxis

Needlestick Risk: BBP

- HBV infection ranges from 1% to 30% depending on the presence of hepatitis e antigen.
- HCV infection following a needlestick is 1.8%.
- HIV infection following a needlestick is 0.3%

- [http://www.cdc.gov/niosh/stopsticks/bloodborne.html](http://www.cdc.gov/niosh/stopsticks/bloodborne.html)
Failure to use droplet barrier

Droplets from opening a Vacutainer -- caused an HIV seroconversion in clinical laboratory work in Germany.

Clinical laboratory worker did not use eyewash after incident, despite training 6 months earlier.

Eberle. AIDS 14(2)206-207.
Procedures with Potential for generating aerosols and droplets

Partial list:
Subculturing positive blood culture bottles, making smears
Manipulating inoculation needles, loops, and pipettes
Filtering specimens under vacuum
Preparing isolates for automated identification/susceptibility testing
Performing catalase test
Performing serology, rapid antigen tests, wet preps, and slide agglutinations
Throwing contaminated items into biohazardous waste
Cleaning up spills

MMWR Supplements
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3 + PPD tests at the same time in micro lab.

• Chest X-rays taken, INH offered.

• Investigation: “faulty” biosafety cabinet-continuous re-circulation; no exhaust.

• One staff member refused post-exposure treatment; was later diagnosed with endometrial tuberculosis.

Example: occupational exposure to *Burkholderia mallei* not mentioned

- Infected microbiologist hospitalized for 2 months before organism correctly identified.

- [1st US case since 1945].

- Antibiogram of lab strain provided answers for treatment that cured infection.

- **Message for all microbiologists: tell your physician about possible occupational exposure to microorganisms.**

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4924a3.htm
Vaccination Advice

All Healthcare workers, adults, recommendations for specific medical conditions.

Immunization of Health Care Personnel. 2011. MMWR 60(RR07); 1-45.

http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6007a1.htm
Clinical and research microbiologists who might be exposed routinely to isolates of *N. meningitides* should receive a single dose of MCV4 and receive a booster dose every 5 years if they remain at increased risk”. Aged >55 with risk factors for meningococcal disease should be vaccinated with MPSV4 (305).

Factors indicating vaccination for all HCW: Asplenia or persistent complement deficiencies.

Work in countries where it is endemic.
Diseases for Which Vaccination Might Be Indicated in Certain Circumstances

- Microbiologists and others who work frequently with *S. typhi* should be vaccinated with either of the two licensed and available vaccines. Booster vaccinations should be administered on schedule according to the manufacturers' recommendations.

Immunization of Health Care Personnel. 2011. MMWR 60(RR07); 1-45.
http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6007a1.htm
Root cause analysis requires of exposure incidents

**GOAL:** Determine if steps can be taken to prevent re-occurrence?

**THANK YOU FOR YOUR INTEREST IN LAI!**
Questions