LESSONS LEARNED TO IMPROVE BIOSAFETY

SEPTEMBER 23, 2024

Shoolah Escott, MS, MLS(ASCP)
Biosafety, Biosecurity, and Bioterrorism Preparedness Trainer
Lexington, MA

NORTHEAST ASSOCIATION FOR CLINICAL MICROBIOLOGY AND INFECTIOUS DISEASE
37TH ANNUAL CONFERENCE

Speakers

Shoolah Escott, MS, MLS (ASCP), Independent Biosafety, Biosecurity, and Bioterrorism Preparedness Trainer, retired Biosafety Manager and ARO MA State Public Health Laboratory and CDC Laboratory Training Branch

Michael Pentella, PhD, D(ABMM) is a Clinical Professor at the University of Iowa, College of Public Health and Director of the Iowa State Hygienic Laboratory

Group Discussion

ATTENDEE INTRODUCTIONS…PLEASE INTRODUCE YOURSELF!

- Where are you from?
- What do you do?
- What do you hope to get from this course?

WORKSHOP AGENDA

Time	Topic	Presenter(s)
8:00 AM	Introductions, how biosafety started and overview of the ABSA LAI Database	Colleen Dolan Shoolah Escott
8:30 AM	Overview of exercise tools emphasizing how Risk Assessment, Exposure Assessment, and Root Cause Analysis work together in preventing LAIs	Shoolah Escott
9:00 AM	Break - 60 minutes in the Exhibit Hall	
10:00 AM	Deep Dive into a Paper to Review how to apply the tools	Michael Pentella
10:30 AM	Exercise - Breakout into small groups - apply the tools to a case: a. Use the exposure assessment tool for the selected exposures, b. Perform analysis of data to determine root cause for the selected exposures, c. Complete the RA for select exposures and mitigate the gaps.	Michael Pentella Shoolah Escott
11:00 AM	Groups will discuss their findings	Attendees
11:15 AM	How to apply past events to an emerging pathogen	Michael Pentella
11:45 AM	Concluding session: summarize the lessons learned and final Q&A	Michael Pentella Shoolah Escott
12:00 PM	Adjourn and Lunch in the Exhibit Hall	Colleen Dolan

WORKSHOP OBJECTIVES

At the end of the workshop, you will be able to:

- Describe how the ABSA LAI database can be used for biosafety training and determining how to safely work with emerging pathogens.
- Utilize an exposure assessment tool to assess real-life laboratory incidents for potential exposures and to help guide prophylaxis if indicated.
- Analyze actual laboratory incidents to determine the root cause and what steps are necessary to mitigate future incidents.

INTRODUCTION OBJECTIVES

- Describe the beginning of biosafety under Dr. Wedum
- Explain how to search the ABSA LAI Database
- Discuss how to use the ABSA LAI Database as a training tool to prevent incidents in the laboratory

HISTORY OF LABORATORY ACQUIRED INFECTIONS

- Biowarfare research in the U.S. began in 1941. In 1972, it became the biodefense program. These years taught us about laboratory acquired infections thanks to Arnold Wedum!
- Wedum learned that recognized accidents only accounted for 16% if the infections. Many never knew that they were infected.

Journal of the American Biological Safety Association, 1(1) p. 6 ©ABSA 1996

IN CELEBRATION OF
DR. ARNOLD G. WEDUM'S LEGACY

W. Emmett Barkley, Ph.D.

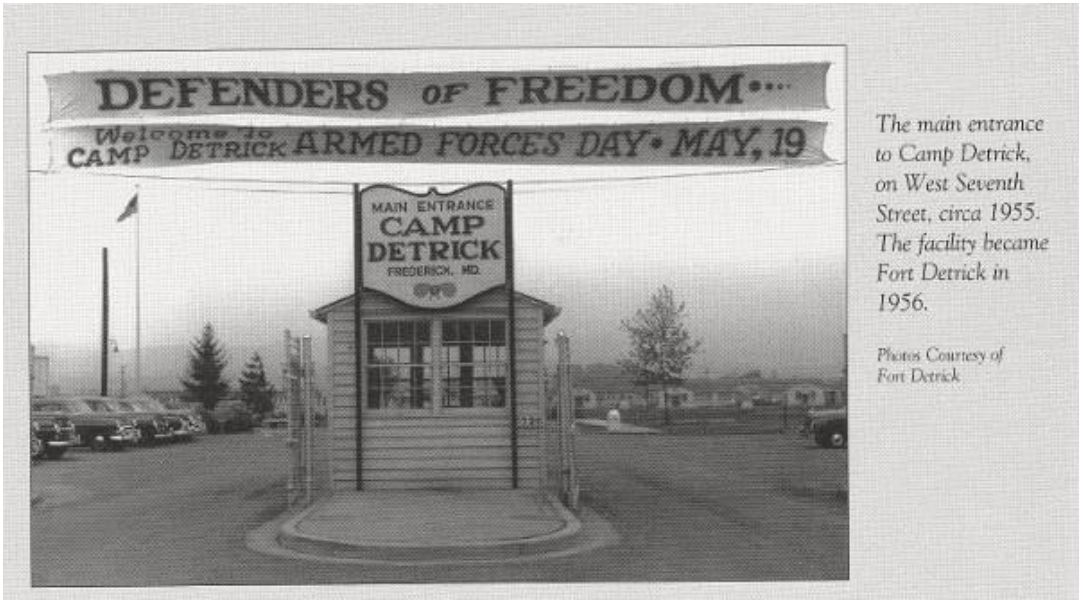
DR. WEDUM IS CONSIDERED THE "FATHER OF MODERN BIOLOGICAL SAFETY"

Arnold G. Wedum is revered as the person most responsible for creating the biosafety profession. He was a caring and wonderful mentor for many of the early leaders of ABSA. His traits of determination and persistence served biosafety well. He was one of the first to publish papers on how infectious aerosols were created in the lab and how to control those aerosols. He was a brilliant man whose knowledge of biological safety was sought by the leaders of the United State's biological research community. The NIH Advisory Committee valued his council regarding safety practices appropriate to recombinant DNA research.

Dr. Wedum's intellect, his deliberate and careful style in assessing hazards, and his vast experience remain instructive to all of us today. He brought to light the fundamental concepts of our profession. His lifelong efforts promoted occupational health and safety in infectious disease research and gave our profession credibility and a valid scientific relevance.

- Arrived at Camp Detrick as the Director of Industrial Health and Safety in the mid-1940s.
- Pioneered modern principles of biosafety and biocontainment at Camp Detrick starting with his arrival and continued until he left in 1972.
- He helped plan and hosted the 1st Biological Safety Conference on April 18, 1955.
- He gave the opening keynote address: "The Role of Safety in the Biological Warfare Effort."
- The annual ABSA Wedum Distinguished Achievement Award was established in 1976.

Camp Detrick – where the biosafety profession began under Dr. Arnold Wedum's leadership



The main entrance to Camp Detrick, on West Seventh Street, circa 1955. The facility became Fort Detrick in 1956.

Photos Courtesy of Fort Detrick

U.S. Army Biological Warfare Labs late 1940's

- Biowarfare research in the U.S. began in 1943. In 1972, it became the biodefense program.
- During WW II, researchers worked with dangerous pathogens on the open bench top until these cabinets were designed and created under the direction of Dr. Wedum. But they were initially only in one building.

ARNOLD WEDUM AND LABORATORY-ACQUIRED INFECTIONS

- 1943-1950, there were 145 confirmed LAIs. These years taught us a lot about LAIs.
- Dr. Wedum learned that recognized accidents only accounted for 16% if the infections. Many never knew that they were infected.
- Estimates are that 13%-48% of employees became infected.
- He meticulously investigated every infection reported.
- Wedum's research identified who and why they were getting infected.
- The work revealed the kinds of activities most likely to cause exposures.
- Wedum learned that keeping workers safe in microbiology labs was far more difficult than in chemistry, radiation, or engineering labs.
- He faced a pervasive culture of self-sacrifice and resistance to safety measures among the researchers who did not want safety to get in the way of science.

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Go to: ABSA.ORG
Scroll down to Biosafety/Biosecurity Resources

my.ABSA.org

For the Biosafety and Biosecurity Professional

Log in

Home | Groups | Journal | Riskgroups | LAI Db | Help

Laboratory-Acquired Infection (LAI) Database

Search Tips

A searchable laboratory-acquired infection database.

Gillum, David, Partha Krishnan, and Karen Byers. *Applied Biosafety 21.4 (2016)*: 203-207.

You can search partial terms using the asterisk (*)
example: pseud*
results: Pseudoalteromonas, pseudomycoides, Pseudallescheria, etc.

You can use Boolean operators OR, AND
syringe AND gloves
student OR teacher

input any term that might appear in a report *(examples: 2014, virus, goggles, texas, dengue, etc.)*

Search LAI Database

Search

- **N=590 LAI**
- **Clinical Laboratories = 120**
- **Articles About Fatal Cases = 22**

Tips for using the database for safety training

Why?

- Real-life examples:
  - hit home harder
  - provide strong engagement
  - Bridge the gap between theoretical knowledge and application
- Made-up ones are easily dismissed

How?

- Key word search:
  - Organism
  - Place
  - By type of work being performed e.g., research, diagnostic
  - Outcome
- Review case in database
- Look up original article

Next steps?

- Initial risk assessment (RA)
- Root cause analysis
- Exposure assessment
- Follow-up RA and determine appropriate mitigation steps
- Case presentation:
  - Immediately catch their attention
  - What, how and why it happened
  - How it applies to them
  - Why doing it right is so important

Date(s) of LAI / exposure: 04/27/2012	**Location where LAI / exposure occurred:** San Francisco, CA, USA
Occupation(s) of affected personnel: Research Associate	**Age(s) of affected personnel:** 25
Agent(s) involved: *Neisseria meningitidis* serogroup B	

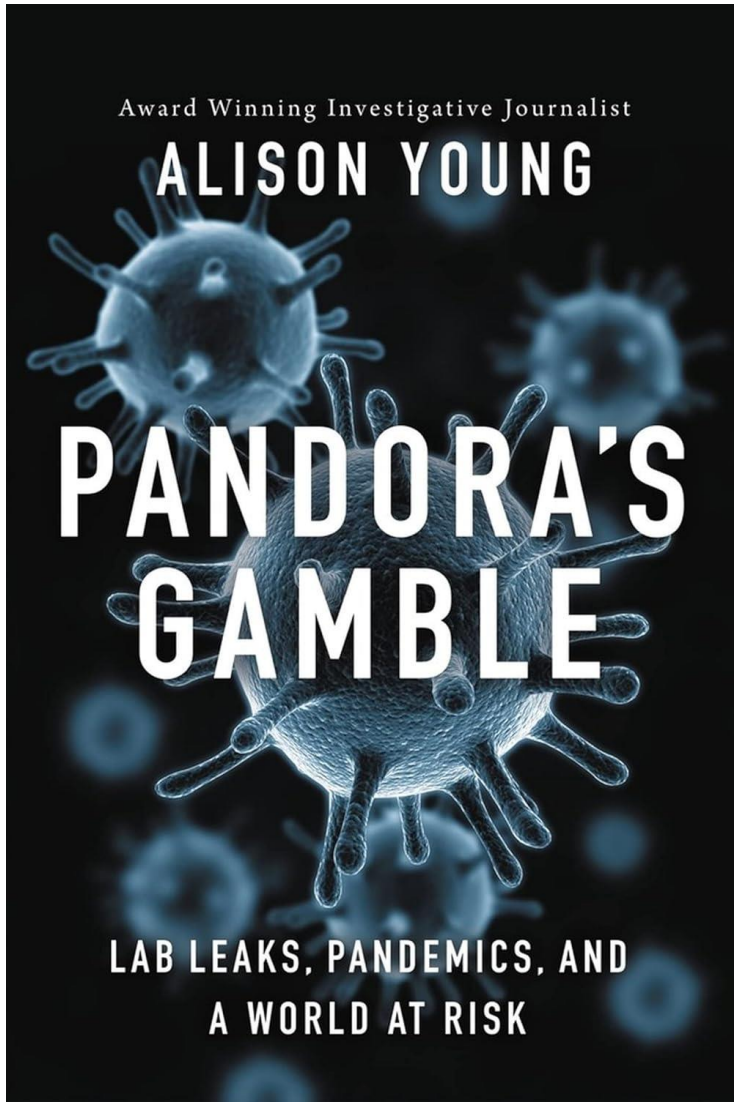
Biological Safety Level (BSL) for work being performed?: BSL-2	**Setting in which LAI / exposure occured:** Research laboratory
Device or equipment involved: plate spreader, plate scraper, flaming loops, pipettor	**Procedure being performed:** performing culture procedures on the open laboratory bench

How LAI / exposure occurred: Multiple breaches in recommended laboratory safety practices were identified as common practice in this laboratory. These include the manipulation of *N. meningitidis* isolates on the open laboratory bench. This un-safe practice can result in aerosol transmission of the bacteria. It is presumed this is how the LAI occurred. It was also noted that laboratory personnel lacked adequate safety training.

PPE worn at the time of LAI / exposure: Lab coat, Single pair of protective gloves, Other PPE
Engineering controls used at the time of the LAI / exposure: None

Follow-up procedures taken: Follow-up procedures RECOMMENDED (but not necessarily taken): Perform all open manipulation of infectious material inside a biosafety cabinet (BSC). Replace open flames (for transfer loops) with disposable transfer loops used in a BSC. Properly handle and dispose of waste generated in the BSC. Follow BSL-2+ practices including: - Use disposable closed-front laboratory coats. - Double glove: removing the outer-layer inside the BSC - Wear wrap-around eye protection, goggles, or face shield - Wear a fit-tested N95 respirator, particularly when culturing large volumes. Employer should ensure laboratory staff are trained and adhere to biosafety practices. Laboratory staff should be offered recommended vaccines.

Actions that may have been taken to prevent exposure: The actions taken by the patient to prevent exposure were minimal: - wearing a cloth lab coat - wearing a single layer of gloves
Post-exposure prophylaxis provided: The patient was suspected of having meningococcal disease and was treated at the hospital with ceftriaxone. He died approximately 3 hours after arrival (approximately 17 hours after the first onset of symptoms).
Agency(ies) LAI / exposure reported to: The institution where the incident occurred, Local governmental agency (e.g., city or county health department), State governmental agency (e.g., state public health laboratory), Federal government agency (e.g., CDC, OSHA),
References Fatal Meningococcal Disease in a Laboratory Worker — California, 2012 Morbidity and Mortality Weekly Report September 5, 2014 / 63(35);770-772 https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6335a2.htm



Fatal Meningococcal Disease in a Laboratory Worker — California, 2012

Channing D. Sheets, MSEd[1], Kathleen Harriman, PhD[1], Jennifer Zipprich, PhD[1], Janice K. Louie, MD[1], William S. Probert, PhD[1], Michael Horowitz, MS[2], Janice C. Prudhomme, DO[2], Deborah Gold, MPH[2], Leonard Mayer, PhD[3] (Author affiliations at end of text)

Occupationally acquired meningococcal disease is rare (*1*). Adherence to recommendations for safe handling of *Neisseria meningitidis* in the laboratory greatly reduces the risk for transmission to laboratory workers (*2*). A California microbiologist developed fatal serogroup B meningococcal disease after working with *N. meningitidis* patient isolates in a research laboratory (laboratory A). The California Department of Public Health (CDPH), the local health department, the California Division of Occupational Safety and Health (CalOSHA), and the federal Occupational Safety and Health Administration (OSHA) collaborated on an investigation of laboratory A, which revealed several breaches in recommended laboratory practice for safe handling of *N. meningitidis*, including manipulating cultures on the bench top. Additionally, laboratory workers had not been offered meningococcal vaccine in accordance with Advisory Committee on Immunization Practices (ACIP) recommendations and CalOSHA Aerosol Transmissible Diseases Standard requirements (*3,4*). In accordance with OSHA and CalOSHA regulations, laboratory staff members must receive laboratory biosafety training and use appropriate personal protective equipment, and those who routinely work with *N. meningitidis* isolates should receive meningococcal vaccine.

Case Report

On the evening of Friday, April 27, 2012, a microbiologist aged 25 years had onset of headache, fever, neck pain, and stiff-

postexposure chemoprophylaxis. Laboratory A voluntarily closed on April 30. No additional cases of meningococcal disease were identified among emergency department or laboratory staff members. The local health department identified other close contacts of the patient and ensured that they received postexposure chemoprophylaxis.

Blood and tissue specimens from the patient were sent to the CDPH Microbial Diseases Laboratory for isolation and serogroup identification. *N. meningitidis* serogroup B was identified in the clinical specimens by polymerase chain reaction. The patient had worked with *N. meningitidis* serogroup B isolates in the weeks and days before his death.

Investigation Findings

CalOSHA, OSHA, and CDPH initiated an investigation. Laboratory A was inspected, and employees were interviewed about their training as well as laboratory practices and protocols and were asked to demonstrate how procedures were performed. Multiple breaches in recommended laboratory safety practices were identified (Tables 1 and 2), including manipulation of *N. meningitidis* isolates on an open laboratory bench (*2,5*). The inspection team made recommendations for safe handling of *N. meningitidis* isolates and use of appropriate personal protective equipment. Laboratory A microbiologists working with *N. meningitidis* isolates had not been offered quadrivalent meningococcal vaccine, as recommended by

The year is 2012

Evening April 27, California microbiologist, 25 y/o onset of headache, fever, neck pain, and stiffness

Morning April 28, while being transported via ambulance to the ER he lost consciousness

Upon arrival, noted petechial rash, and treated with ceftriaxone, went into respiratory arrest and died 3 hours later

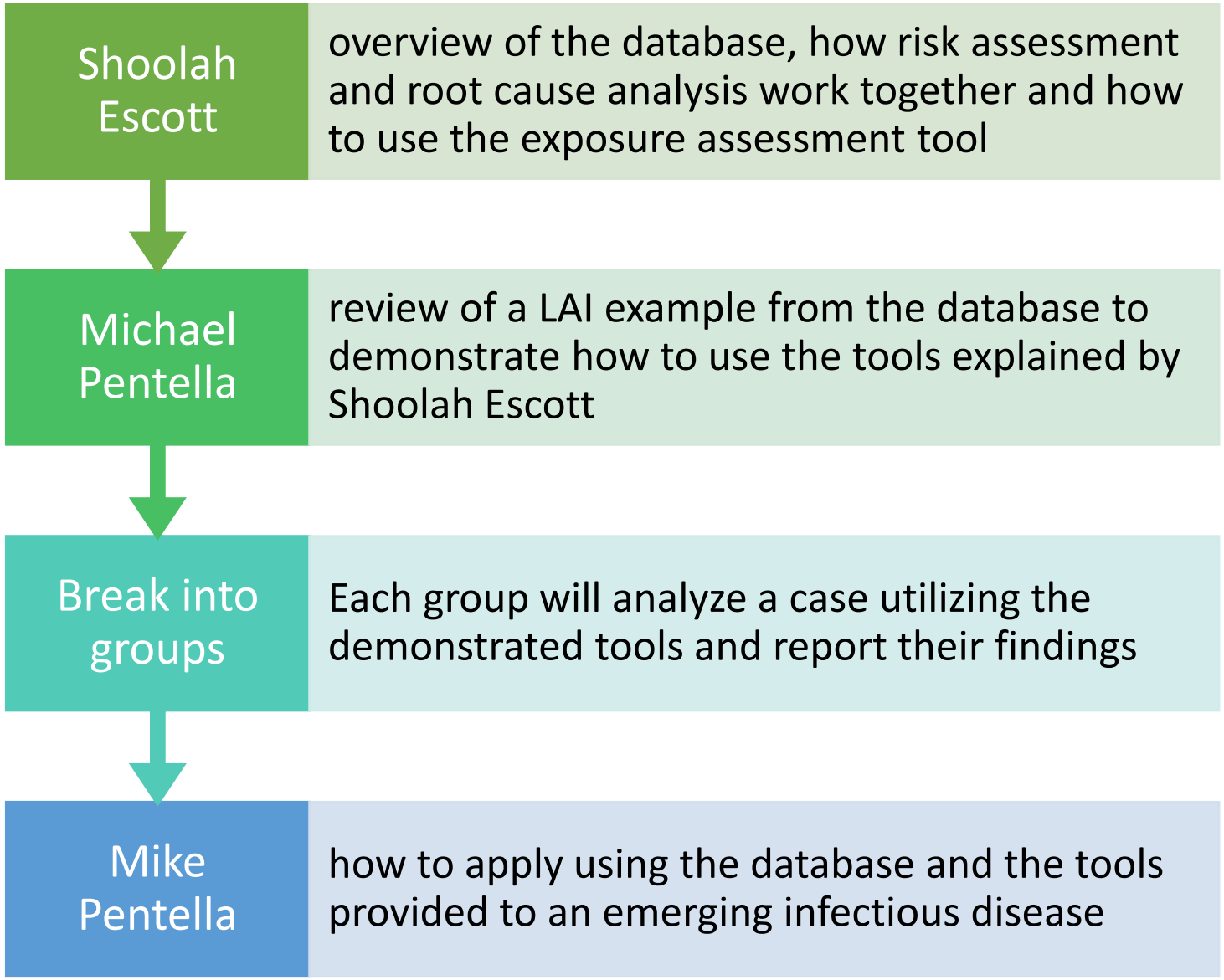
Cause???...

Neisseria meningitidis

WHAT TO LOOK FOR FROM CASES OF LAI?

- What the exposure event is?
- What type of lab setting did this exposure occur?
- What equipment were involved in the exposure event?
- What PPE were in use during the exposure?
- What type of exposure occurred (aerosol, dermal, oral, needle stick, etc.)?
- What was the root cause analysis (if completed)?
- Was the LAI reported, and to whom?
- Number of individuals exposed and infected?
- Was there any follow-up? If yes, what was it and was it sufficient?

Overview of the Workshop



What Tools Are Available to Help Me?

Erin Bowles, BS, MLS(ASCP)
Wisconsin State Laboratory of Hygiene,
Communicable Disease Division
Presented by Shoolah Escott

Wisconsin State Laboratory of Hygiene
UNIVERSITY OF WISCONSIN–MADISON

Tools Every Laboratory Must Have and Utilize

- **Biosafety Plan:**
  - Vaccinations
  - Biosafety Training
  - Competency Assessment
  - **Risk Assessment and Mitigation Steps Tool**
  - **Exposure Assessment Tool**
  - Incident Report
  - Names and contact information for Occupational Health/Incident response team
  - **Root Cause Analysis Tool**

(Bold print indicates tools we will use in today's workshop)

Begin With a Risk Assessment

- Things to consider:
  - What are you working with?
  - How hazardous is the specimen?
  - Where will you be working?
  - Will others be working nearby?
  - What are the testing steps and how will you manipulate the specimen?
  - What is your immune status?
  - What is your mental status?
- Who performs the risk assessment?
- Risk assessment requires continual re-assessment

Let Me Tell You a Story

How Do You Determine Whether or Not You've Had Lab Exposures?

Partners change based on mission

Connect and Communicate with Partners

- How will you communicate
- Look at the big picture
- Ask questions
- Provide guidance
- Determine action plan for follow-up treatment or prophylaxis
- Discuss disposal of any remaining organism
- Determine who is responsible for what actions
- Evaluate and determine what changes need to be made to prevent further occurrences

Complete Exposure Assessment

- Determine who will do the exposure assessment
- General questions:
  - When did this occur?
  - Where was the organism worked with?
  - Who else was within 5 feet?
  - What PPE was worn?
  - What is the immune status of the individual working with the specimen and others who were within 5 feet?
- Specific Activities and Manipulations:
  - Answer yes or no to a list of common laboratory activities that are performed on specimens
- Based on answers determine whether there was an exposure and what it the level of risk.
- Determine what post-exposure follow up steps will be taken

Exposure Assessment and Monitoring Tool

CLINICAL LABORATORY BIOLOGICAL EXPOSURE EVALUATION TOOL

Potential Exposure Event Summary

Date of Potential Exposure: _____ **Exposure Location(s):** _____

Multiple people exposed? ☐ No ☐ Yes. *Complete this form for each person to determine individual exposure risk.*

Name/Identifier of Person Potentially Exposed: _____

Individual's Predispositions: ☐ Pregnant ☐ Immunocompromised ☐ Other: _____

Interactions with Organism

Individual worked with organism: ☐ Within BSC ☐ Outside BSC ☐ Did not work directly with organism

Individual did not work with organism, but was: ☐ Within five feet ☐ M

Individual wore: ☐ Gloves ☐ Lab coat/gown ☐ Safety glasses

Individual performed the following activities or types of manipulation wit

- ☐ Removed caps or swabs from culture containers, opened lyophilized cultures or cryotubes
- ☐ Manipulated needles, syringes or sharps
- ☐ Flamed a loop
- ☐ Wet preps
- ☐ Rapid antigen testing
- ☐ Blood culture bottle
- ☐ Exa mec
- ☐ Snif
- ☐ Cat

What work was done by whom, where and what PPE was worn? Who else was present and how close were they?

Exposure Event Follow-up

Treatment and Monitoring

Post Exposure Prophylaxis (PEP): ☐ Will begin PEP ☐ Declined PEP ☐ N/A

Serological Monitoring: ☐ Will begin serological monitoring ☐ Declined ☐ N/A

Fever Watch: ☐ Yes ☐ No ☐ N/A

Other Notes:

Corrective Actions and Mitigations

Use the risk assessment determinations above to evaluate the overall risk of exposure according to the likelihood of occurrence and severity of consequences.

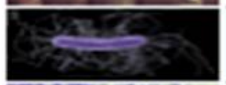
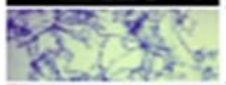
What treatment is needed and who will be monitoring the treatment?

[Laboratory Exposure Assessment and Symptom Monitoring Guide]

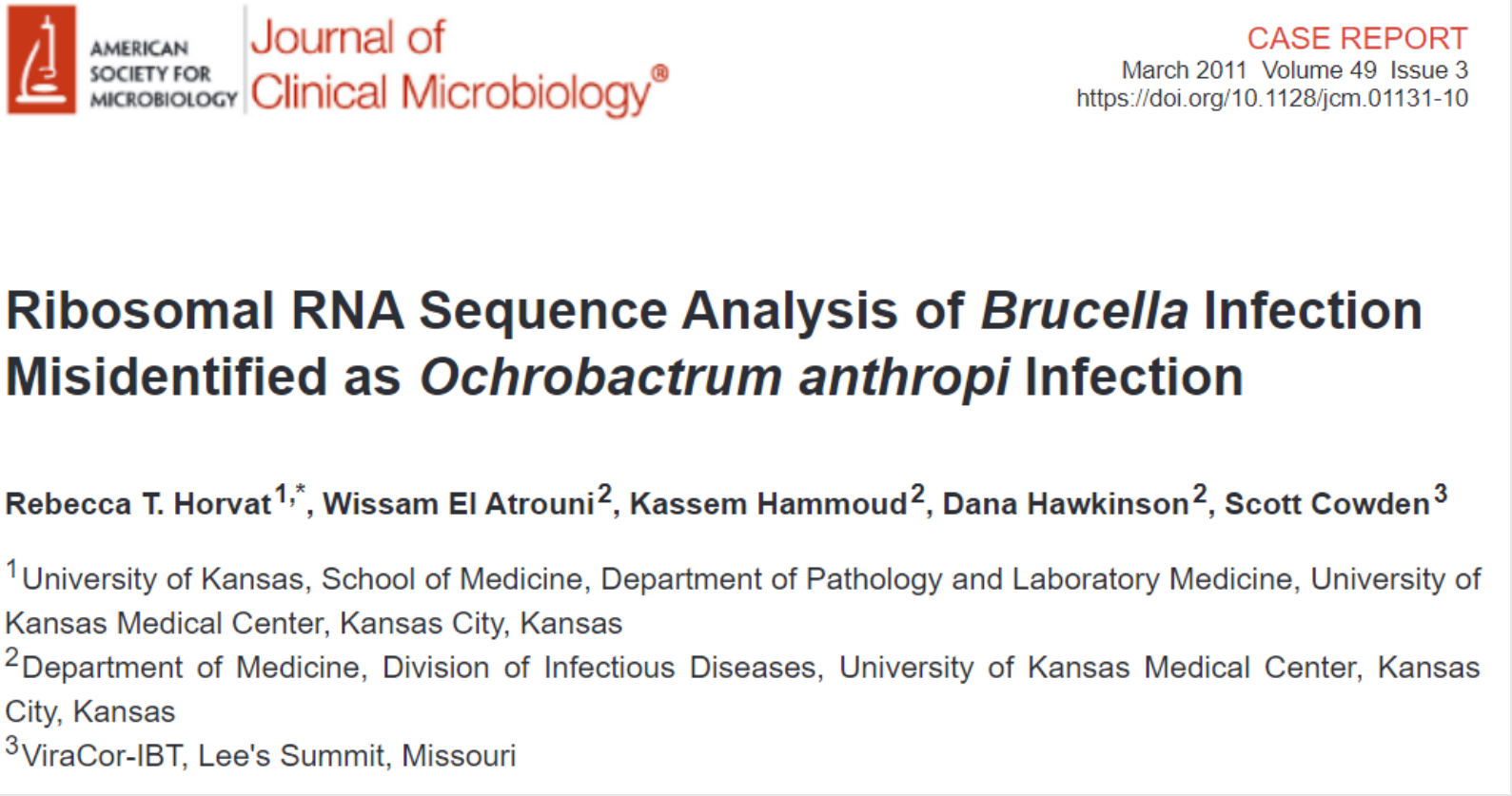
Exposure Monitoring Guide

[PHPR_Clinical_Laboratory_Biological_Exposure_Monitoring_Guide.pdf (aphl.org)]

CLINICAL LABORATORY BIOLOGICAL EXPOSURE MONITORING GUIDE

Disease (Organism/Agent)	Notes	Exposure Risks and Routes of Transmission in the Laboratory Setting*	Incubation Period	Symptoms (Will depend on route of transmission)
 Anthrax, Woolsorter's disease (Bacillus anthracis)	1, 5*, 8, 14	Direct and indirect contact of broken skin with cultures and contaminated laboratory surfaces, accidental parenteral inoculation, exposure to infectious aerosols. LD50 is 2,500-55,000 for spores and will depend on the route of exposure. < 10 spores necessary for cutaneous anthrax infection.	Typically 1–6 days, with a range up to 60 days	Cutaneous: painless sore with black eschar. Inhalational: Fever and chills, chest discomfort, body aches. Gastrointestinal: Fever, chills, swelling of neck and neck glands, sore throat, painful swallowing, stomach pain, fainting, abdominal swelling. Injection anthrax: Fever, chills, blisters or bumps that may itch, painless skin sore with black eschar, swelling around sore.
 Blastomycosis (Blastomyces dermatitidis)	3, 14	Accidental parenteral inoculation with infected tissues or cultures of yeast form. Pulmonary infections from inhalation of conidia from mold-form cultures.	3 weeks – 3 months	Flu like symptoms, fever, cough, night sweats, myalgia (muscle pain) and arthralgia (joint pain), weight loss and anorexia, chest pain, fatigue.
 Brucellosis, Undulant fever, Malta fever, Mediterranean fever (Brucella abortus, B. suis, B. melitensis)	1, 5, 14	Brucella spp. have a very low infectious dose and are easily aerosolized. Ingestion, inhalation, accidental parenteral inoculation or contact with broken skin or mucosa. Direct exposure to samples or cultures (outside containment). ID is 10-100 organisms by aerosol or subcutaneous exposure.	5 days – 5 months	Initial symptoms: fever, sweats, malaise, anorexia, headache, pain in muscles, joint, and/or back, fatigue. Chronic symptoms: recurrent fevers, arthritis, swelling of the testicle and scrotum area, swelling of the heart (endocarditis), neurologic symptoms (in up to 5% of all cases), chronic fatigue, depression, swelling of the liver and/or spleen.
 Glanders (Burkholderia mallei)	1, 5*, 14	Ingestion, inhalation, accidental parenteral inoculation, and contact with broken skin or mucosa with cultures and infected tissues, purulent drainage, blood and sputum. There is increased risk for individuals with diabetes.	1–14 days	Fever with chills and sweating, muscle aches, chest pain, muscle tightness, headache, nasal discharge, light sensitivity (sometimes with excessive tearing of the eyes), ulceration at the site of localized infection, lymphadenopathy, abscess formation.
 Melioidosis, Whitmore's disease (Burkholderia pseudomallei)	1, 5*, 14	Ingestion, inhalation, inoculation, and direct contact via skin abrasions and mucous membranes.	1 day – years	Localized: Localized pain or swelling, fever, ulceration, abscess. Pulmonary: Cough, chest pain, high fever, headache, anorexia. Bloodstream: Fever, headache, respiratory distress, abdominal discomfort, joint pain, disorientation. Disseminated: Fever, weight loss, stomach or chest pain, muscle or joint pain, headache, seizures.
 Psittacosis (Chlamydia psittaci)	1, 14	Infectious aerosols in the handling, care, or necropsy of naturally or experimentally infected birds, mice and eggs.	5–14 days	Abrupt onset of fever and chills, headache, muscle aches, nonproductive cough, splenomegaly, rash.
 Botulism (Clostridium botulinum toxin)	1, 5*, 13	Exposure to toxin, and especially associated with activities that have high potential for aerosol or droplet formation. 0.7-0.9 µg of inhaled aerosolized toxin is likely enough to kill a 70 kg / 150 lb person.	6 hours – 10 days	Double vision, blurred vision, drooping eyelids, slurred speech, difficulty swallowing, difficulty breathing, thick-feeling tongue, dry mouth, muscle weakness.
 C. diff (Clostridioides difficile)	1, 14	Infectious aerosols are the most likely route of laboratory-associated infections (LAI) and could serve as a reservoir for vegetative cells and spores.	2–3 days	Severe diarrhea, fever, stomach tenderness or pain, loss of appetite, nausea.
 Coccidioidomycosis, Valley Fever (Coccidioides immitis, C. posadasii)	3, 14	Inhalation of spores. Rarely, contact with broken skin can cause cutaneous infection.	1–3 weeks	Fatigue, cough, fever, shortness of breath, headache, night sweats, muscle aches or pains, rash on upper body or legs.
 Q fever (Coxiella burnetii)	1, 5, 9, 14	Inhalation of infectious aerosols. Accidental parenteral inoculation. Exposure to experimentally or naturally infected animals, their tissues, or body fluids. ID by inhalation is ~10 organisms.	9–39 days	Acute: Fever, chills, myalgia, arthralgia, headache, pneumonia, hepatitis.
 Dermatophytosis, Ringworm (Microsporum, Epidermophyton and Trichophyton)	3, 14	Contact with skin, nail lesions, contact with contaminated surfaces.	4–14 days after skin comes in contact with fungus	Ringworm can affect skin on almost any part of the body as well as fingernails and toenails. The symptoms of ringworm often depend on which part of the body is infected, but they generally include itchy skin, ring-shaped rash, red, scaly, cracked skin and hair loss.
 Encephalitis, EEE (Eastern Equine Encephalitis virus)	2, 5, 6, 12	Inhalation of infectious aerosols, accidental parenteral inoculation. Exposure to infected animals and mosquitoes in the lab.	1–10 days	Sudden onset of headache, high fever, chills, and vomiting; severe cases may progress to disorientation, seizures, or coma.
 Ebola virus disease, EVD (Ebola virus)	2, 5*, 12	Direct contact of infectious material with mucous membranes, accidental parenteral inoculation.	2–21 days	Fever, severe headache, muscle pain, weakness, fatigue, diarrhea, vomiting, abdominal pain, unexplained hemorrhage.

Review Literature for Similar Incidents



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CASE REPORT
March 2011 Volume 49 Issue 3
https://doi.org/10.1128/jcm.01131-10

Ribosomal RNA Sequence Analysis of *Brucella* Infection Misidentified as *Ochrobactrum anthropi* Infection

Rebecca T. Horvat[1,*], Wissam El Atrouni[2], Kassem Hammoud[2], Dana Hawkinson[2], Scott Cowden[3]

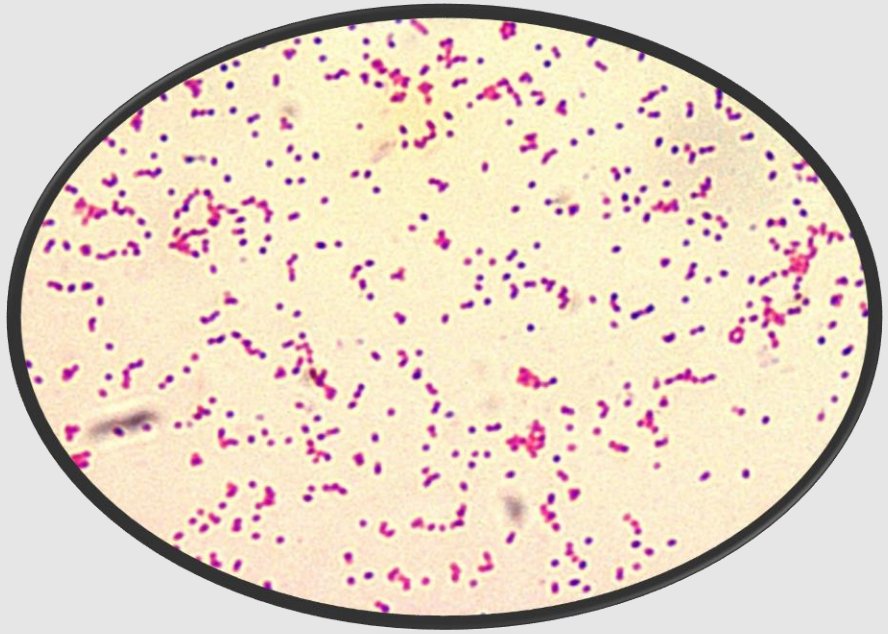
[1]University of Kansas, School of Medicine, Department of Pathology and Laboratory Medicine, University of Kansas Medical Center, Kansas City, Kansas
[2]Department of Medicine, Division of Infectious Diseases, University of Kansas Medical Center, Kansas City, Kansas
[3]ViraCor-IBT, Lee's Summit, Missouri

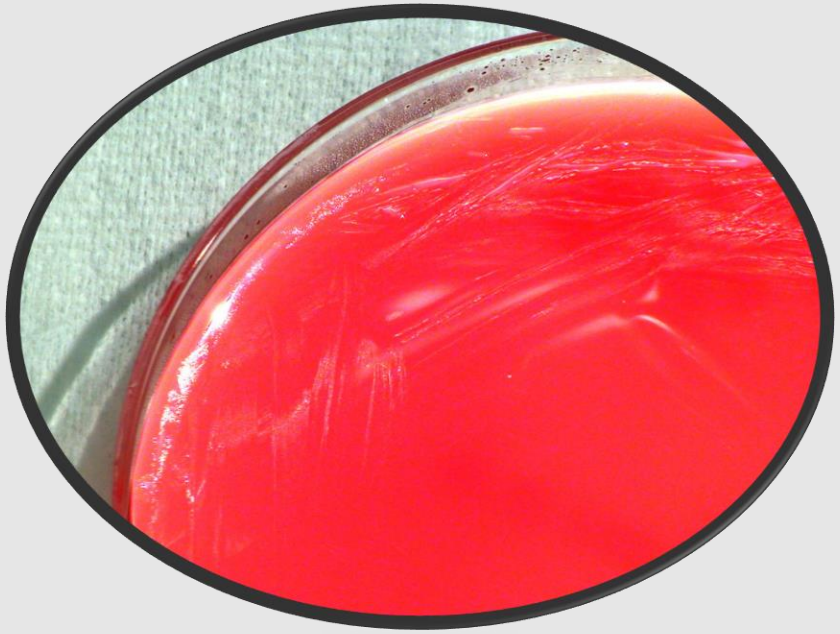
https://journals.asm.org/doi/epub/10.1128/jcm.01131-10

- 62 y/o F, Medical Technologist
- employed in hospital microbiology lab >20 yrs
- *Brucella* isolate was identified from purulent material collected during a hip surgery.
- Two previous blood cultures from the same patient yielded *Ochrobactrum anthropi*.
- After rRNA sequencing, all the isolates were identified as *Brucella* species and subsequently serotyped as *Brucella suis*.
- Misidentification of *Brucella* species remains a problem with bacterial identification systems.
- Pt had no risk factors or foreign travel experiences.

Brucella spp.

- Highly infectious; frequent cause of LAI
- Containment BSL-3 facility and practices required
- BSC use is prudent for clinical samples or proficiency test cultures
- PEP after lab exposure (MMWR 57: 39-42. 2008. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5702a3.htm)





Demographics of Lab-Acquired Brucellosis

Occupation or facility	No. exposed (*n* = 167)	No. with LAB (*n* = 71)
Occupation:		
Microbiologist	158	62
Researcher	3	3
Clinician	3	3
Administrator	2	2
Unknown	1	1
Facility:		
Clinical	142	46
Reference	2	2
Research	15	15
Vaccine production	2	2
Unknown	6	6

Traxler, R.M. etal. A Literature Review of Laboratory-Acquired Brucellosis. JCM 2013

Determine Root Cause

- **Ask 5 "whys" to get to the underlying root cause?**

Problem:

Why was there an exposure?

Why?

Aerosol created when spotting isolate for Maldi-TOF ID on open bench

Why?

Trying to get rapid results to physician for patient care and no Gram stain performed on isolate

Why?

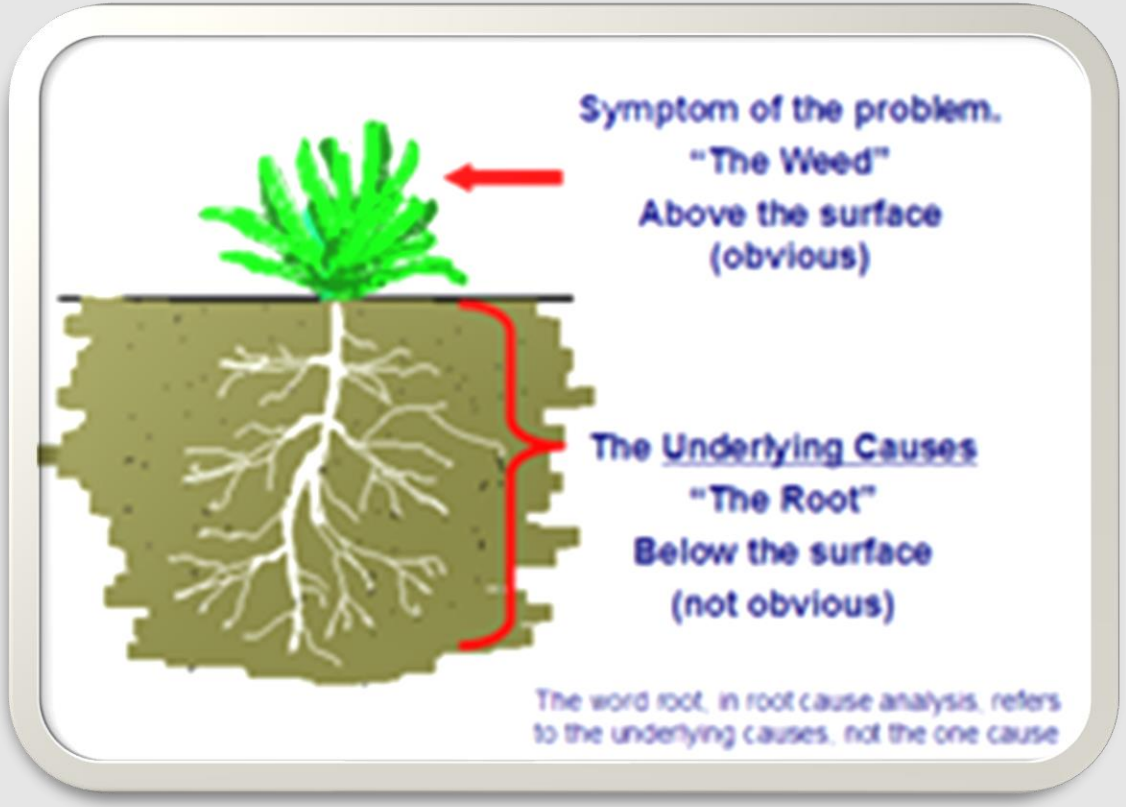
Didn't suspect a BT agent from a synovial fluid inoculated into a blood culture bottle

Why?

No policy in place to do a Gram stain routinely before performing Maldi-TOF

Why?

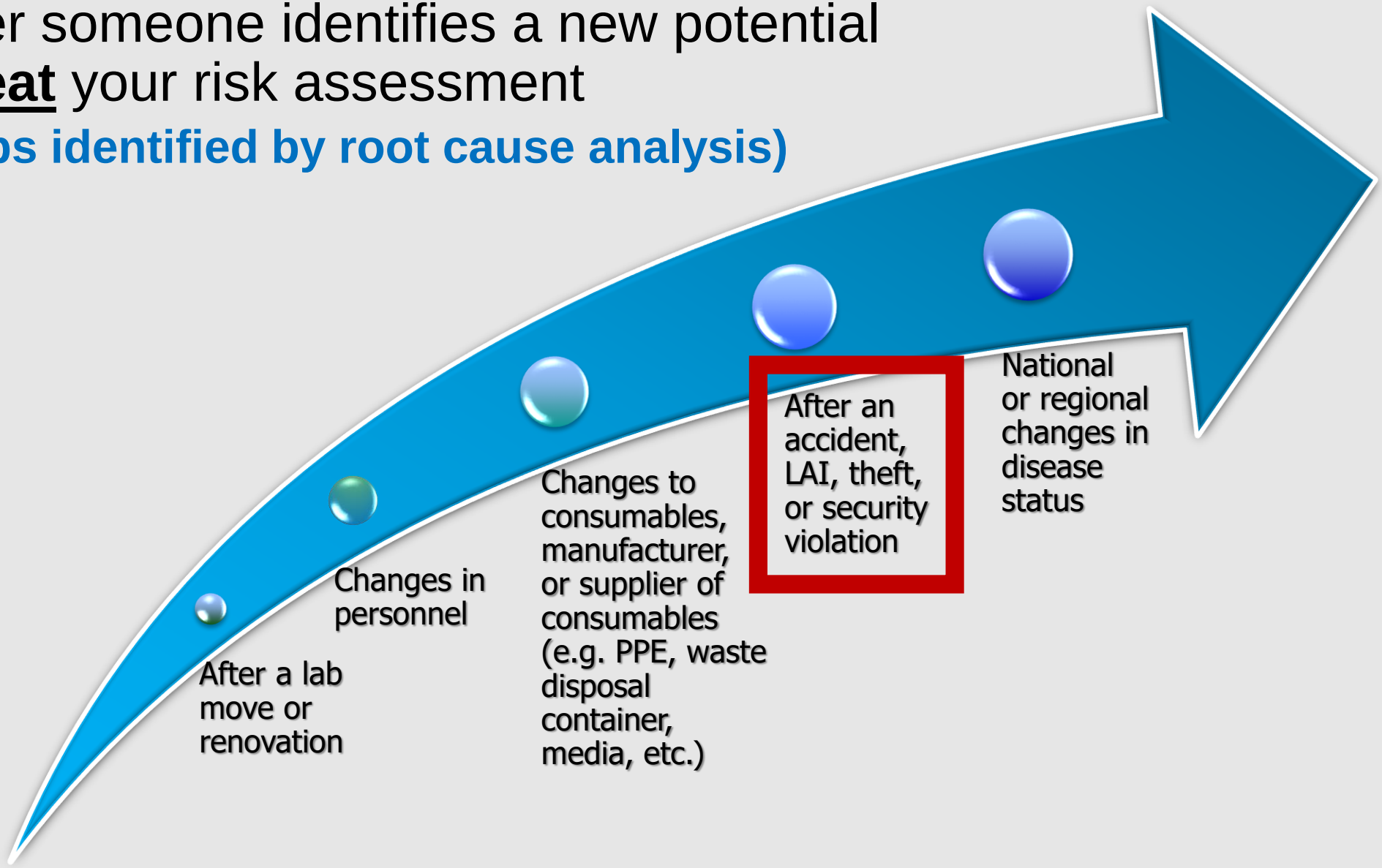
Missed clues of slow growth and never checked patient history



Root Cause: Speed more important than safety?

When Do You Repeat a Risk Assessment?

- Whenever someone identifies a new potential risk, **repeat** your risk assessment
  (e.g. Gaps identified by root cause analysis)



Repeat Risk Assessment

- What new hazards were identified in the root cause analysis?
  - Speed!
  - High volume!
  - Robotic! Not thinking about source and growth time.
- Evaluate the risk
  - High risk
- What else can be done to mitigate the risk?
  - Slow grower spot MALDI plates in BSC
  - Prepare and dry Gram stain in BSC
  - Read the Gram stain before running Maldi
  - Provide training
- Implement controls
- Review effectiveness and continue to adjust as needed

Applying risk assessments to laboratory accidents - *Salmonella*

Michael A. Pentella, PhD, D(ABMM),

Clinical Professor, University of Iowa, College of Public Health

Laboratory Director, University of Iowa, State Hygienic Laboratory

Objectives

- Review the article considering biosafety in the clinical lab
- Determine the role of the risk assessment in the biosafety program
- Discuss the cost of exposures and lab acquired infections

Review Article

ABSA INTERNATIONAL

The Culture of Biosafety, Biosecurity, and Responsible Conduct in the Life Sciences: A Comprehensive Literature Review

Applied Biosafety:
Journal of ABSA International
1-12

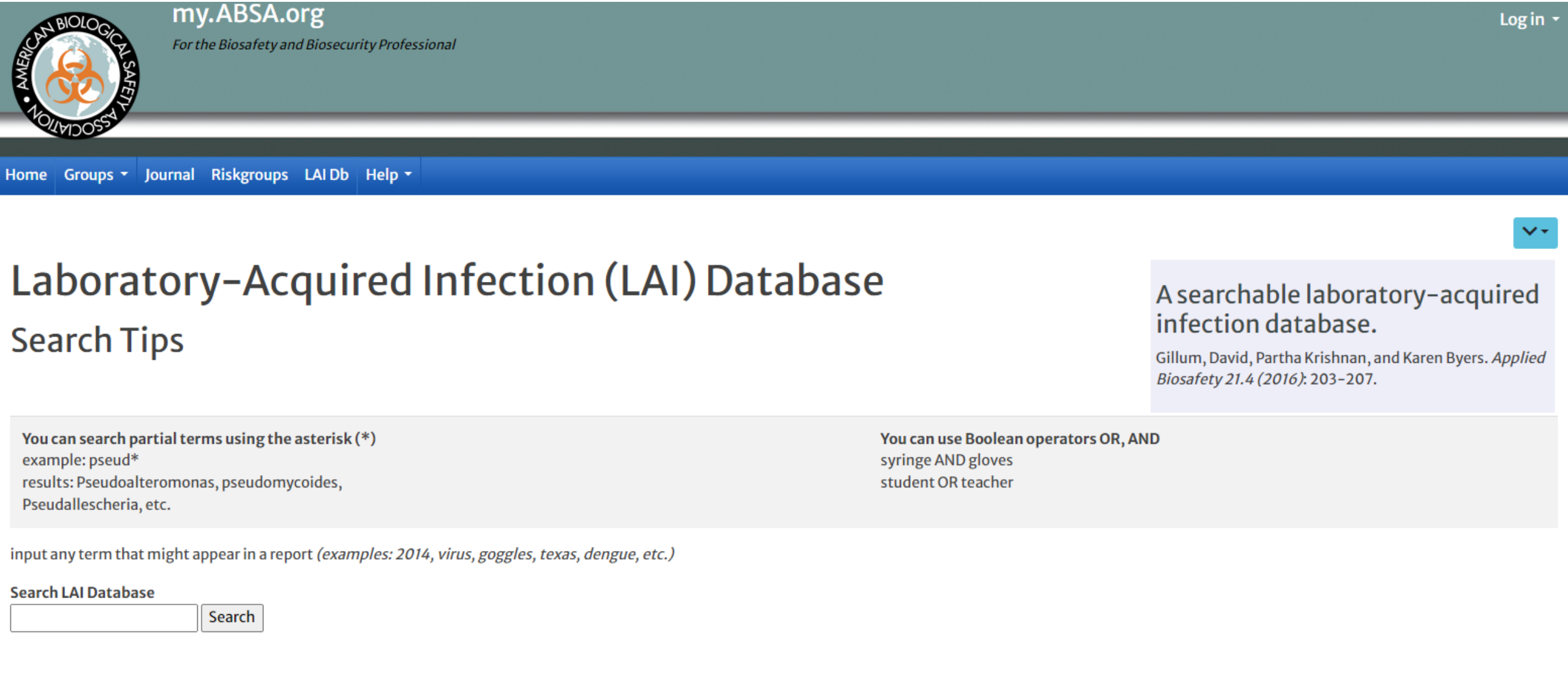
DOI: 10.1177/1535676018778538
journals.sagepub.com/home/apb
SAGE

Dana Perkins[1], Kathleen Danskin[1], A. Elise Rowe[1], and Alicia A. Livinski[2]

"We (the authors) concluded that life scientists seeking to foster a culture of biosafety and biosecurity should learn from the substantial literature in analogous areas such as nuclear safety and security culture, high-reliability organizations, and the responsible conduct of research, among others."

Excellent Resource

- **N=590 LAI**
- **Clinical Laboratories = 120**
- **Salmonella = 36**



Published in final edited form as:
Appl Biosaf. 2015 ; 20(2): 72–74.

Nontyphoidal *Salmonella*: An Occupational Hazard for Clinical Laboratory Workers

Anna Barker[1], **Megan Duster**[1], **Sarah Van Hoof**[2], and **Nasia Safdar**[2,*]

[1]University of Wisconsin-Madison, Madison, Wisconsin

[2]University of Wisconsin Hospital and Clinics, Madison, Wisconsin

Abstract

Laboratory-acquired infections due to nontyphoidal *Salmonella* are rare. Yet, recent outbreaks in microbiology teaching laboratories show that these species are still an appreciable occupational hazard for laboratory employees. This article presents two cases of nontyphoidal *Salmonella* that occurred at the authors' institution—an infected patient and a clinical laboratory worker who acquired the infection by handling this patient's specimens.

Let's use this published paper to think through the risk assessment

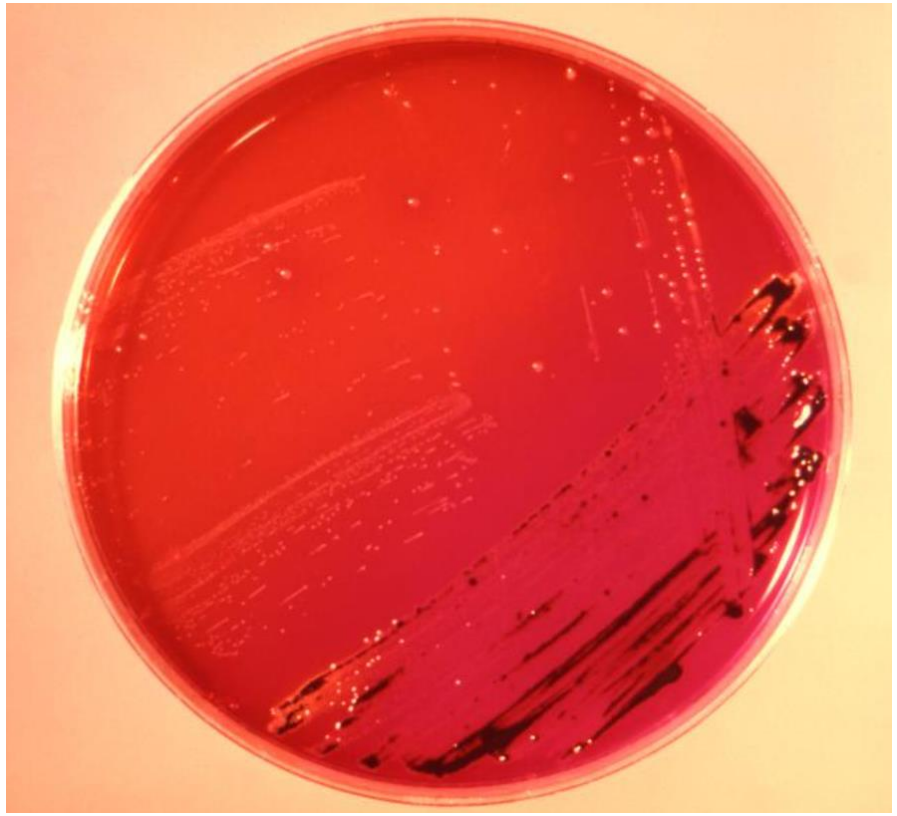
Salmonella case study

- What is known:
  - 45 y/o F clinical technician previously healthy
  - Symptoms appeared one week after index case
  - Worked with index case positive blood cultures
  - Technician's stool grew Salmonella enterica Enteritidis identical to index cases by PFGE
  - 20 y experience, no previous LAI

- Occupational Practices
  - Consistently wears gloves and generally washes hands when exiting lab
  - No known exposure
  - Swabbed bacterial colonies from a culture plate, put the swab into a buffer, the shook solution on bench top
  - Disinfect surfaces once daily with a quat, also decontaminate visible spills
  - Brought cell phone into lab, use unknown
  - Biosafety training provided

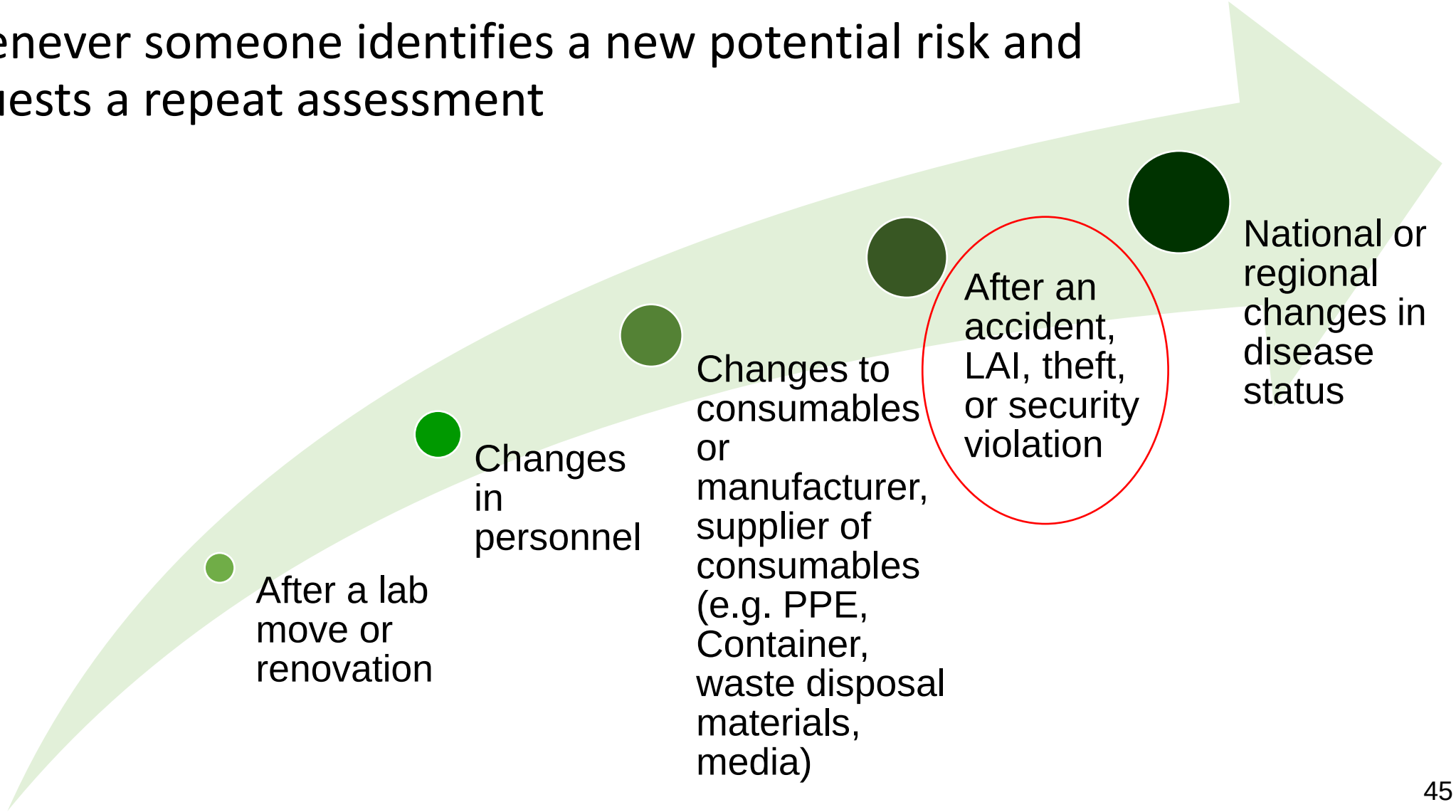
Poll: What are the likely risks?

- Select the most probable risk:
    1. Lack of handwashing
    2. Splash/splatter from swab in broth
    3. Shaking tube on open bench top
    4. Ineffective disinfectant
    5. Cell phone use in the lab



When Do You Repeat a Risk Assessment?

- Whenever someone identifies a new potential risk and requests a repeat assessment



Risk Assessment Matrix for *Salmonella* Hazards*

Risk factors	**Degree of Laboratory Risk**		
Agent Hazards	**Low to Moderate**	**Moderate to High**	**High**
Pathogenicity	Mild to moderate disease (***Salmonella***)		
Virulence	Mild to moderate disease or low infectivity		
Infective dose			<1 organism
Transmission	Indirect contact (contact with contaminated surfaces)	Direct contact (droplet, tissue, fluid, secretion contact with mucous membranes; ingestion)	

*adapted from D.O. Fleming ,personal communication

Risk Assessment Matrix for Protocol Hazards

Protocol Hazards	**Low Risk**	**Moderate Risk**	**High Risk**
Agent Concentration		10^3 – 10^6 IU/ml	
Suspension Volume	<1 ml		
Generate droplets & droplet nuclei	Streaking “smooth” agar		
Protocol Complexity	Standard repetitive procedures		

Performing a risk assessment

Walk through the APHL Risk Assessment Best Practices Document and Iowa RA

- Provide resources including WHO RA and CDC Webpage

Table A. Likelihood of hazard occurrence.

Hazard Likelihood	Description of Likelihood
1. Rare	Will only occur in exceptional circumstances
2. Unlikely	Not likely to occur within the foreseeable future
3. Possible	May occur within the foreseeable future, sporadic exposure is possible
4. Likely	Likely to occur within the foreseeable future, routine exposure is likely
5. Highly Likely	Almost certain to occur within the foreseeable future, consistent exposure is highly likely

Table B. Consequence of hazard occurrence.

Hazard Consequence	Description of Consequence
1. Insignificant	No treatment required
2. Minor	Minor injury requiring First Aid treatment (e.g. minor cuts, bruises, bumps)
3. Moderate	Injury requiring medical treatment or lost time
4. Major	Serious injury (injuries) requiring specialist medical treatment or hospitalization
5. Critical	Loss of life, permanent disability or multiple serious injuries

Table C. Based on the likelihood and consequence determined above, identify the risk level of each hazard using the Risk Assessment Matrix below.

Risk Assessment Matrix		Hazard Consequence				
		Insignificant	Minor	Moderate	Major	Critical
Hazard Likelihood	Highly likely	Medium	Medium	High	Extreme	Extreme
	Likely	Low	Medium	High	High	Extreme
	Possible	Low	Medium	High	High	High
	Unlikely	Low	Low	Medium	Medium	High
	Rare	Low	Low	Low	Medium	Medium

Table D. Based on the assessed risk level for each hazard, determine whether additional control measures should be implemented.

Assessed Risk Level		Description of Risk Level	Actions
☐	Low	If an incident were to occur, there would be little likelihood that an injury would result.	Undertake the activity with the existing controls in place.
☐	Medium	If an incident were to occur, there would be some chance that an injury requiring First Aid would result.	Additional controls are advised.
☐	High	If an incident were to occur, it would be likely that an injury requiring medical treatment would result.	Control will need to be in place before the activity is undertaken.
☐	Extreme	If an incident were to occur, it would be likely that a permanent, debilitating injury or death would result.	Consider alternatives to doing the activity. Significant control measures will need to be implemented to ensure safety.

Mitigation Control Measures

- **Engineering Controls**: Physical changes to workstations, equipment, materials, production facilities, or any other relevant aspect of the work environment that reduce or prevent exposure to hazards
- **Administrative Controls**: Policies, standards and guidelines used to control risks
- **Practices and Procedures**: Processes and activities that have been shown in practice to be effective in reducing risks
- **Personal Protective Equipment**: Devices worn by the worker to protect against hazards in the laboratory

- Use a biosafety cabinet when suspending swab in broth
- Policy against cell phone use
- Strictly enforce handwashing
- Relook at disinfectant product coverage
- Adjust frequency of surface disinfection

After an exposure, consider the after-action steps

Appendix B. Risk Management Hotwash Worksheet

To be completed by laboratory staff during and/or after they perform work with control measures in place.	***Yes***	***No***
1. Are the planned control measures sufficient and effective in minimizing the level of risk?	☐	☐
2. Have there been any changes to the planned control measures?	☐	☐
3. Are any changes and/or additional control measures required in the future?	☐	☐
DETAILS: Please provide any additional information here.		

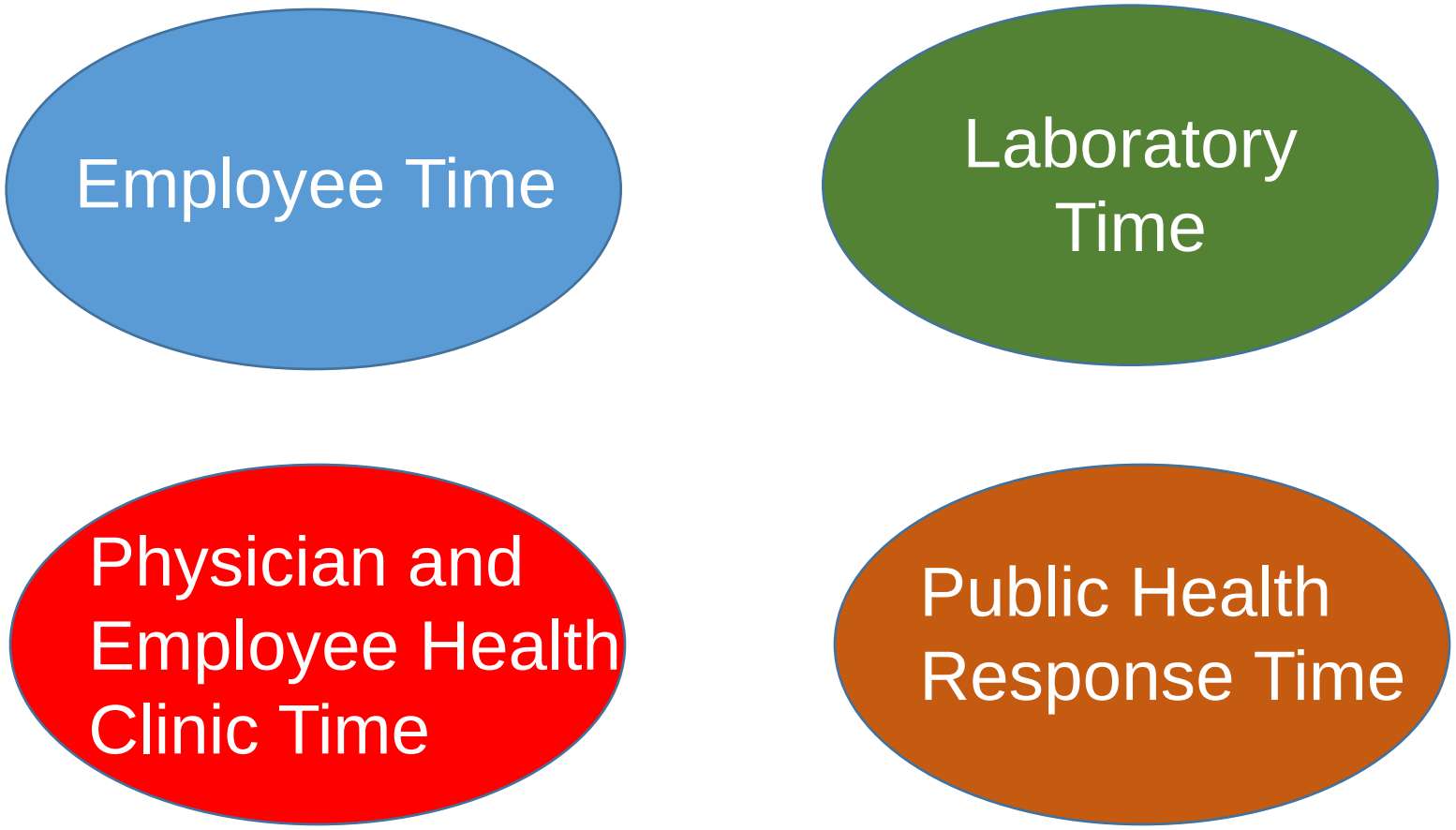
What can you learn from this published LAI?

- The importance of performing a risk assessment
- The value of the root cause analysis
- Building critical thinking skills
- Establishing the culture of safety

Incident Responders

- Facility
  - Lab directors
  - Supervisors
  - Occupational health
  - Infection prevention
  - ID specialists
- Public Health
  - State epidemiologist
  - State PHL
  - CDC lab scientists
  - CDC epidemiologists

Cost of Lab Exposures: TIME



Cost of Time to Consider for Lab Exposures

Employee Time

- Time to notify and document incident
  - Notify supervisor and Biosafety Officer of exposure
  - Complete report of injury
- Travel time
  - Travel to occupational health, medical clinic, or ER
  - Travel to Pharmacy
  - Travel to follow-up appointments
- Wait time
  - Doctor's appointment
  - Pharmacy pick up
  - Follow-up appointments
- Symptom monitoring
  - Regular completion of symptom monitoring logs
  - Reporting symptoms

Cost of Time to Consider for Lab Exposures

Laboratory Time

- Time to document incident
  - First report of injury by safety committee (Director, biosafety officer, lab supervisor)
- Decontaminate lab area
- Perform laboratory risk assessment
- Select agent exposure form
- Time spent covering employee absences

Cost of Time to Consider for Lab Exposures

Physician/Employee Health Clinic Time

- Initial appointment
  - Exposure review
  - Identify treatment
- Complete paperwork
- Follow up and patient monitoring

Cost of Time to Consider for Lab Exposures

Public Health Response Time

- Patient interview
- Laboratory walkthrough
  - Document lab layout, workflow, and location of incident
- Exposure and contact investigation
- Post exposure monitoring

Cost of Lab Exposures: Resources

Exposure	*Incident Occurs*	Average Time (Minutes)	Average Costs ($USD)
Laboratory Staff Time and Costs			
Decontamination	**Decontaminate area following exposure incident**	**75**	**$77.87**
Documentation	**Review: First report of Injury by safety committee (Director, biosafety officer, supervisor)**	**180**	**$479.49**
Risk Assessment	**Laboratory risk assessment (Laboratory manager)**	**60**	**$49.50**
Select Agent Report Form	**Completion of Select Agent Program Report Form**	**25**	**$20.63**
Reallocated Work Time	**Time lab workers spent away from regular position to cover for absent lab workers**	**2400**	**$2,056.40**
	Total Laboratory Staff Time and Costs	**2740**	**$2,683.89**

Employee Impact from Exposure to Salmonella

Lost Resources from an Exposure to Salmonella		Average Time (Minutes)	Average Costs ($USD)
Exposed Worker Time and Costs			
Notification	Notify Employee Health, HR, supervisor, biosafety officer, laboratory director	37.5	$32.13
Documentation	Initiate & complete first report of injury, including witnesses (25 min, 5 min)	60	$51.41
Travel	Travel to Employee Health Clinic site	35	$29.99
Patient Appointment	Emergency room or healthcare facility wait time	37.5	$32.13
Patient Appointment	Physician review of exposure, review history, identify treatment	60	$51.41
Travel	Travel to pharmacy/Rx pick-up	35	$29.99
Documentation	Costs of Rx (Doxycycline 100mg 2x daily + Rifampin 600mg 1x daily for 3-6 weeks)	0	$37.64
Patient Time	Treatment (5-10 min @ 7 days)-Rx	52.5	$44.98
Travel	Travel to Employee Health follow-up appointment	35	$29.99
Follow-up Appointment	Review: Follow-up with Employee Health Clinic	60	$44.98
Symptom Monitoring	Completion of symptom monitoring logs (5-10 minutes, 7 days/week for 4 weeks)	210	$179.94
Missed Work Time	Days absent due to exposure (Max time based on acute infection, 2 weeks missed work)	2400	$2,056.40
	Total Exposed Worker Time and Costs	3022.5	$2,620.99

Physician/Employee Health Clinic Impact from an Exposure to *Salmonella*

Lost Resources from an Exposure to *Salmonella*		Average Time (Minutes)	Average Costs ($USD)
Healthcare Provider or Occupational Health Time and Costs			
Treat Patient	Physician review of exposure, review history, identify treatment	60	$108.3
Documentation	Complete patient paperwork/documentation, Treatment: Rx written/called in	45	$81.23
Patient Review	Review: Employee Health Clinic follow-up	60	$146.05
	Total Healthcare Provider Time and Costs	165	$335.58

Public Health Response Costs of Lab Exposure to *Salmonella*

Cost of Laboratory Exposure to *Salmonella*		Average Time (Minutes)	Average Costs ($USD)
Public Health Response Time and Costs			
Patient Interview	Conduct interview with exposed worker	60	$33.49
Laboratory Walkthrough	Document lab layout and workflow, location of incident, proximity of employees to incident	180	$100.47
Exposure and contact investigation	Assess if contact investigations are necessary	75	$41.86
Post Exposure Monitoring	Post exposure monitoring and incident follow-up	90	$50.24
	Total Public Health Response Time and Costs	405	$226.06

Total Cost of Laboratory Exposure to *Salmonella*

Exposure	*Incident Occurs*	Average Time (Minutes)	Average Costs ($USD)
Laboratory Staff Time and Costs			
Decontamination	Decontaminate area following exposure incident	75	$15.99
Documentation	Review: First report of Injury by safety committee (Director, biosafety officer, supervisor)	180	$421.17
Risk Assessment	Laboratory risk assessment (Laboratory manager)	60	$41.73
Select Agent Report Form	Completion of Select Agent Program Report Form	25	$17.39
Reallocated Work Time	Time lab workers spent away from regular position to cover for absent lab workers	2400	$1,606.40
	Total Laboratory Staff Time and Costs	**2740**	**$2,102.68**
Exposed Worker Time and Costs			
Notification	Notify Employee Health, HR, supervisor, biosafety officer, laboratory director	37.5	$32.13
Documentation	Initiate & complete first report of injury, including witnesses (25 min, 5 min)	60	$51.41
Travel	Travel to Employee Health Clinic site	35	$29.99
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Exposure and contact investigation	Assess if contact investigations are necessary	75	$41.86
Post Exposure Monitoring	Post exposure monitoring and incident follow-up	90	$50.24
	Total Public Health Response Time and Costs	**405**	**$226.06**
	Subtotal (minutes)	**6332.5**	**$4,732.94**
	Subtotal (hours)	**105.54**	

Total Cost for all Exposed	# of Exposed Lab Workers
$5,984.85	1

Average Lab Worker Salary ($USD/hr)	
Lab Scientist	$32.99
Lab Manager	$41.73
Lab Director	$56.93

2019 National Average Lab Worker Salary ($USD/hr)
$40.16

Average Physician Salary ($USD/hr)	
Internal Medicine Physician	$117.00

2019 National Average Epidemiologist Salary
$33.49

Key
Laboratory Staff
Exposed Worker
Healthcare Provider
Epidemiologist

https://www.aphl.org/programs/preparedness/_layouts/15/WopiFrame.aspx?sourcedoc=/programs/preparedness/Documents/2022%20Calculating%20the%20Cost%20of%20Avoidance%20Tool.xlsx&action=default&DefaultItemOpen=1

Post Salmonellosis exposure lab risk mitigation

- Install a new BSC dedicated to blood cultures?
- Automate an alert into the LIMS for suspect highly infectious pathogen?
- Additional training for staff on biosafety practices

Epidemiol. Infect. (2015), **143**, 1333–1351. © Cambridge University Press 2014
doi:10.1017/S0950268814002829

REVIEW ARTICLE
Systematic review and meta-analysis of the proportion of non-typhoidal *Salmonella* cases that develop chronic sequelae

J. KEITHLIN[1,2], J. M. SARGEANT[1,2]*, M. K. THOMAS[3] AND A. FAZIL[4]

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[2] *Department of Population Medicine, Ontario Veterinary College, Guelph, Ontario, Canada*
[3] *Centre for Food-borne, Environmental and Zoonotic Infectious Diseases, Public Health Agency of Canada, Guelph, Ontario, Canada*
[4] *Laboratory for Foodborne Zoonoses, Public Health Agency of Canada, Guelph, Ontario, Canada*

Received 23 April 2014; Final revision 28 August 2014; Accepted 30 September 2014; first published online 30 October 2014

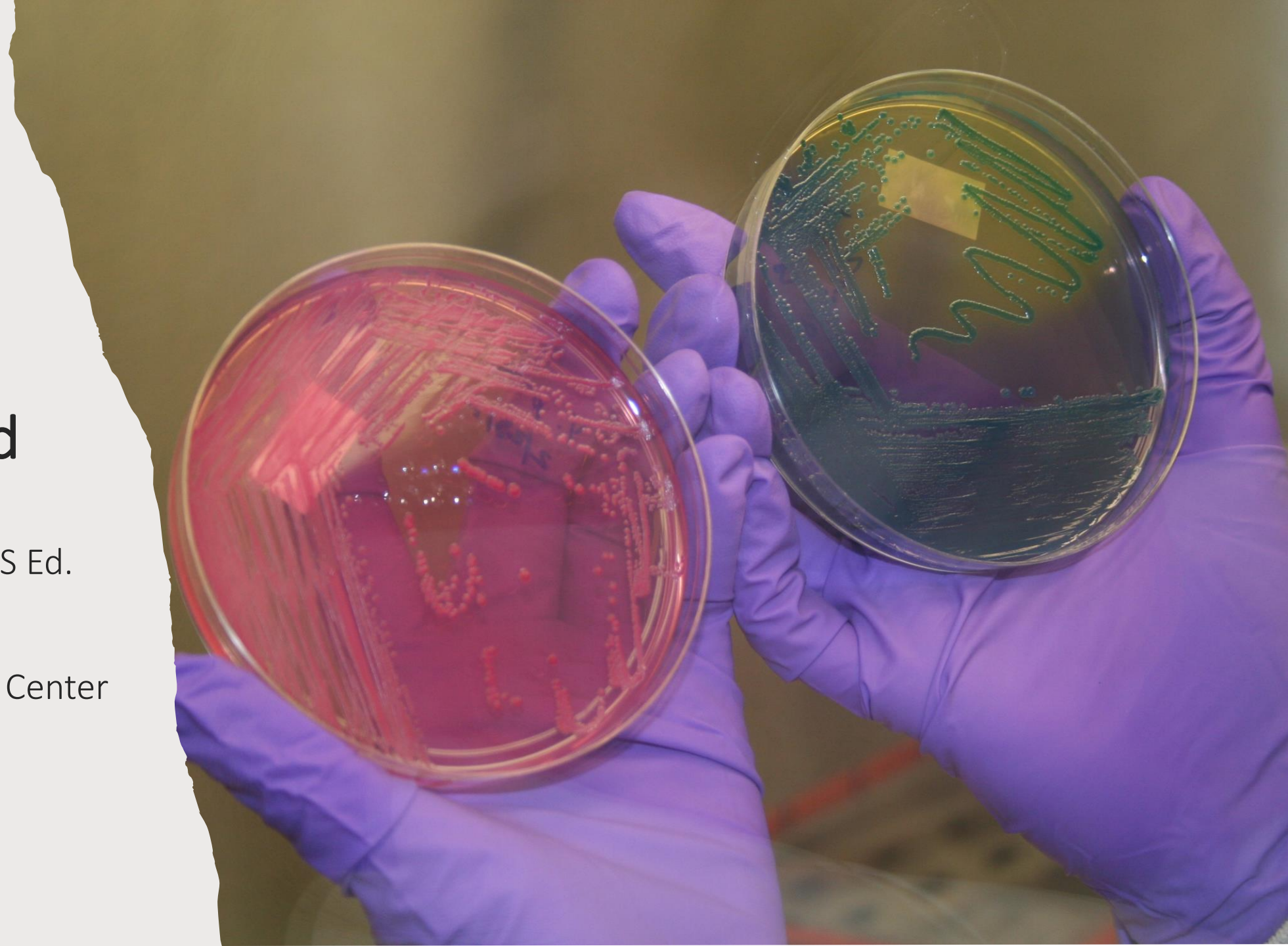
SUMMARY

The objective of this systematic review and meta-analysis was to estimate the proportion of cases of non-typhoidal salmonellosis (NTS) that develop chronic sequelae, and to investigate factors associated with heterogeneity. Articles published in English prior to July 2011 were identified by searching PubMed, Agricola, CabDirect, and Food Safety and Technology Abstracts. Observational studies reporting the number of NTS cases that developed reactive arthritis (ReA), Reiter's syndrome (RS), haemolytic uraemic syndrome (HUS), irritable bowel syndrome (IBS), inflammatory bowel disease (IBD) or Guillain–Barré syndrome (GBS), Miller–Fisher syndrome (MFS) were included. Meta-analysis was performed using random effects and heterogeneity was assessed using the I^2 value. Meta-regression was used to explore the influence of study-level variables on heterogeneity. A total of 32 studies were identified; 25 reported on ReA, five reported on RS, seven reported on IBS, two reported on IBD, two reported on GBS, one reported on MFS, and two reported on HUS. There was insufficient data in the literature to calculate a pooled estimate for RS, HUS, IBD, GBS, or MFS. The pooled estimate of the proportion of cases of NTS that developed ReA and IBS had substantive heterogeneity, limiting the applicability of a single estimate. Thus, these estimates should be interpreted with caution and reasons for the high heterogeneity should be further explored.

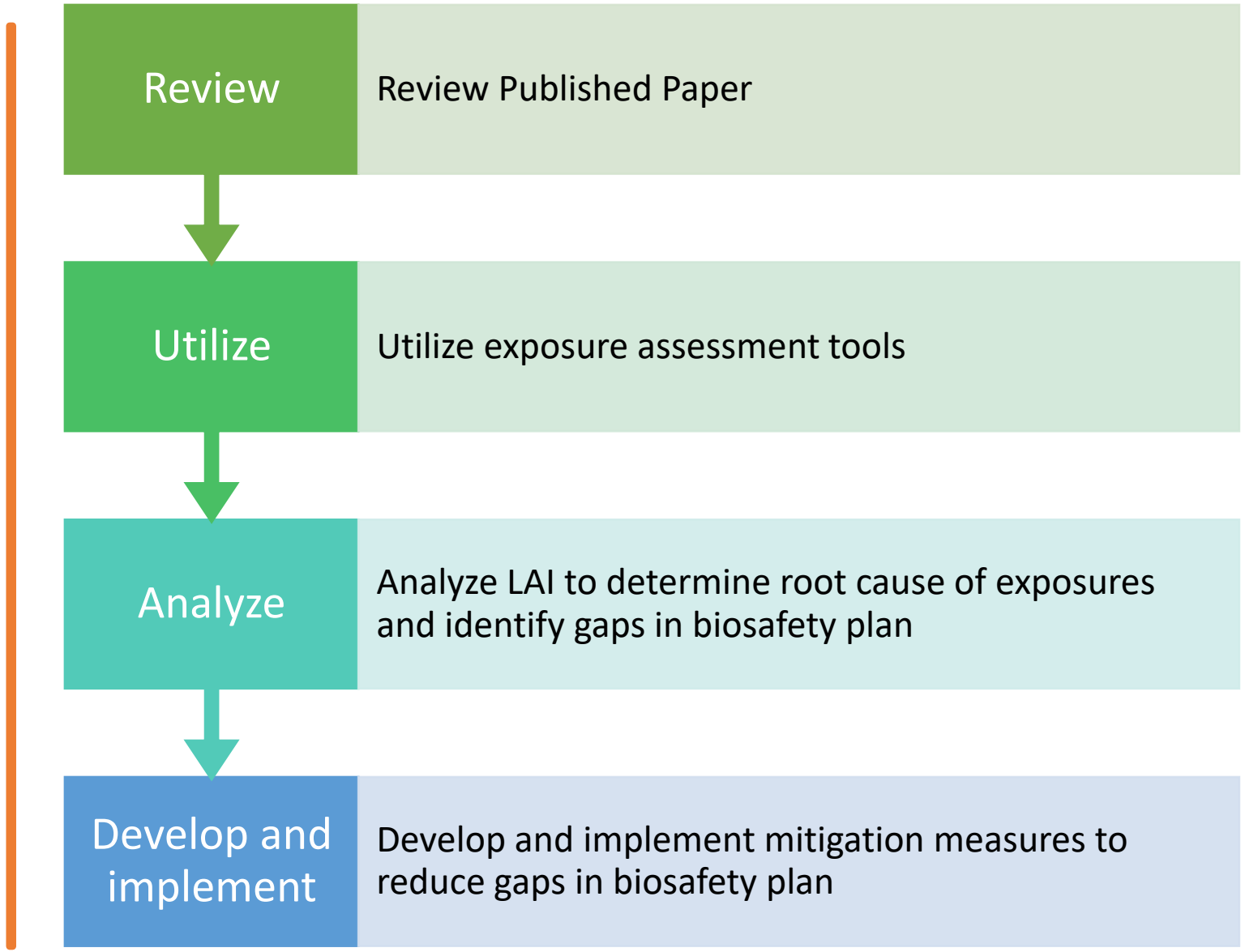
- **Reactive Arthritis**
- **Reiter's Syndrome**
- **Hemolytic Uremic Syndrome**
- **Irritable Bowel Syndrome**
- **Inflammatory Bowel Disease**
- **Guillain-Barre Syndrome**
- **Miller-Fisher Syndrome**

Are Attenuated Strains Safe?

Michael J. Perry, MS, MS Ed.
Associate Director,
Biodefense Laboratory
NYS DOH – Wadsworth Center



Outline


Review
Review Published Paper
Utilize
Utilize exposure assessment tools
Analyze
Analyze LAI to determine root cause of exposures and identify gaps in biosafety plan
Develop and implement
Develop and implement mitigation measures to reduce gaps in biosafety plan

Laboratory-Acquired Infection (LAI) Database

Search Tips

input any term that might appear in a report *(examples: 2014, virus, goggles, texas, dengue, etc.)*

Search LAI Database

Yersinia pestis Search

A searchable laboratory-acquired infection database.

Gillum, David, Partha Krishnan, and Karen Byers. *Applied Biosafety 21.4 (2016)*: 203-207.

Date(s) of LAI / exposure: **18/09/2009**	Location where LAI / exposure occurred: **Chicago, IL. U.S.A.**
Occupation(s) of affected personnel: **Researcher**	Age(s) of affected personnel: **60-y-old**
Agent(s) involved: **Yersinia pestis** find in Risk Group Database > (NOTE: you may have to edit search to be more specific)	
Biological Safety Level (BSL) for work being performed?: **unknown**	Setting in which LAI / exposure occured: **Research laboratory**
Device or equipment involved: **Unknown**	Procedure being performed: **Pigmentation-negative attenuated Y. pestis strain**
How LAI / exposure occurred: **The patient, a researcher in a university laboratory, had been working along with other memebers of the laboratory group with a pigmentation-negative (pgm-) attenuated Y. pestis strain (KIM D27).**	
PPE worn at the time of LAI / exposure: **Unknown,**	
Engineering controls used at the time of the LAI / exposure: **Unknown**	
Follow-up procedures taken: **After the notification of the Chicago Department of Public Health (CDPH) an investigation was conducted by the university, CDPH, the Illinois Department of Public Health and the CDC. A review of attendance records for university biosafety training identified deficiencies in staff attendance (including the patient) at a number or required biosafety courses.**	
Actions that may have been taken to prevent exposure: **It is recommended that researchers should adhere to recommended biosafety practices when handling live bacterial cultures, even attenuated strains. Institutional biosafety committees should implement and maintain effective surveillance systems to detect and monitor unexpected acute illness in laboratory workers.**	
Post-exposure prophylaxis provided: **Fatal laboratory-acquired infection. The patient initially was treated with diuretics for suspected congestive heart failure and later with intravenous antibiotics (vancomycin and piperacillin/tazobactam).**	
Agency(ies) LAI / exposure reported to: **Local governmental agency (e.g., city or county health department), Federal government agency (e.g., CDC, OSHA),**	
References Fatal Laboratory-Acquired Infection with an Attenuated Yersinia pestis Strain-Chicago, Illinois, 2009. MMWR/Vol.60/No.7. 201-205.	

MMWR from Feb 2011

Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 60 / No. 7
February 25, 2011

Fatal Laboratory-Acquired Infection with an Attenuated *Yersinia pestis* Strain — Chicago, Illinois, 2009

On September 18, 2009, the Chicago Department of Public Health (CDPH) was notified by a local hospital of a suspected case of fatal laboratory-acquired infection with *Yersinia pestis*, the causative agent of plague. The patient, a researcher in a university laboratory, had been working along with other members of the laboratory group with a pigmentation-negative (pgm-) attenuated *Y. pestis* strain (KIM D27). The strain had not been known to have caused laboratory-acquired infections

Case Report

On September 10, 2009, the researcher, a man aged 60 years with insulin-dependent diabetes mellitus, was evaluated at an outpatient clinic for fever, body aches, and cough of approximately 3 days duration. A clinic physician suspected influenza or other acute respiratory infection and referred the patient to an emergency department (ED) for further evaluation; however, the patient did not seek further care

Fatal Case - *Yersinia pestis*

Synopsis

- Chicago DPH – Notified of suspected fatal LAI with *Yersinia pestis*
- Researcher was in a university laboratory
- Researcher was working with pigmentation-negative (pgm-) attenuated *Y. pestis* strain (KIM D27)
- Other researchers in a separate part of the building were working with virulent *Y. pestis* strain (CO92)
- Investigation determined unrecognized occupational exposure (route unknown) to *Y. pestis*, leading to septic shock

Case Report

Researcher, man, 60 years old, insulin-dependent diabetes mellitus

September 10, 2009 – evaluated at outpatient clinic for fever, body aches, and cough of ~ 3 days.

Physician suspected influenza or other acute respiratory infection

Referred to emergency department (ED) but did not seek further care.

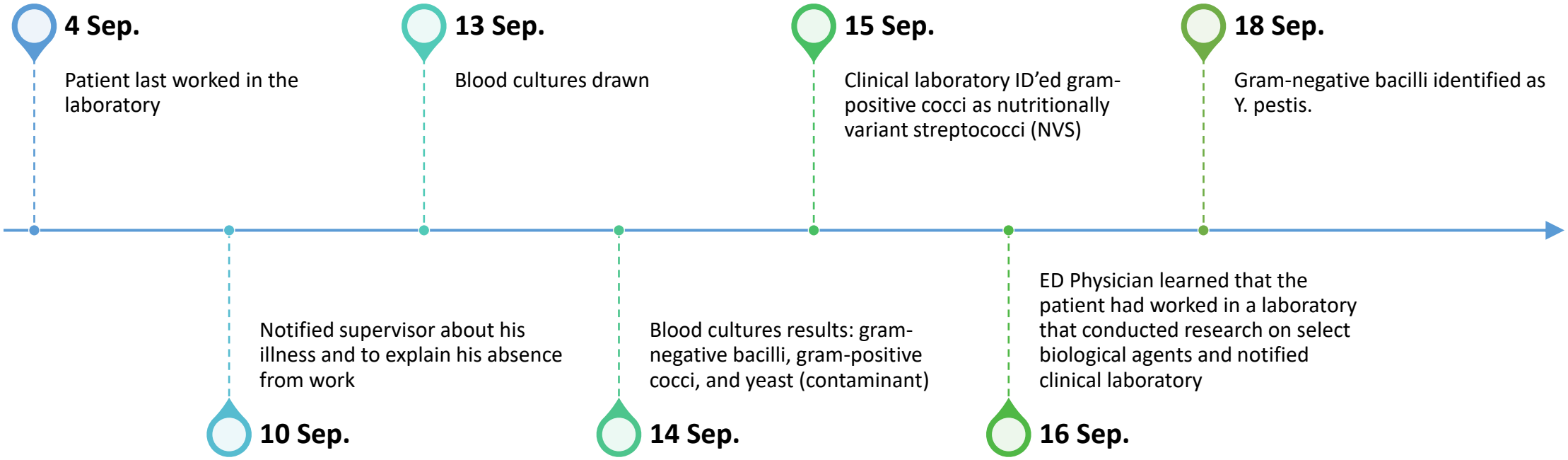
September 13, 2009 – brought back to ED with worsening symptoms

O_2 Saturation (92%), Temperature (100.9°F), pulse (106 bpm), respiratory rate (42 breaths per min), Blood Pressure (106/75 mmHg)

Patient initially treated with diuretics but later with intravenous antibiotics (vancomycin and piperacillin/tazobactam) once infection suspected

~12 hrs after presentation, patient had worsening respiratory distress, was intubated, and died 1 hr later of cardiac arrest

Timeline


4 Sep.
Patient last worked in the laboratory
10 Sep.
Notified supervisor about his illness and to explain his absence from work
13 Sep.
Blood cultures drawn
14 Sep.
Blood cultures results: gram-negative bacilli, gram-positive cocci, and yeast (contaminant)
15 Sep.
Clinical laboratory ID'ed gram-positive cocci as nutritionally variant streptococci (NVS)
16 Sep.
ED Physician learned that the patient had worked in a laboratory that conducted research on select biological agents and notified clinical laboratory
18 Sep.
Gram-negative bacilli identified as Y. pestis.

Step 1 – Prior to Work Starting
Risk Assessment

Task/Procedure	Hazard	Initial Risk Level	Mitigation Measure	Residual Risk Level
Describe the task or procedure steps	Describe the hazards	Select the risk level	Describe the appropriate mitigation measures	Select the residual risk level

Risk Assessment Matrix		Hazard Consequence				
		Insignificant	Minor	Moderate	Major	Critical
Hazard Likelihood	Highly likely	Medium	Medium	High	Extreme	Extreme
	Likely	Low	Medium	High	High	Extreme
	Possible	Low	Medium	High	High	High
	Unlikely	Low	Low	Medium	Medium	High
	Rare	Low	Low	Low	Medium	Medium

Assessed Risk Level		Description of Risk Level	Actions
☐	Low	If an incident were to occur, there would be little likelihood that an injury would result.	Undertake the activity with the existing controls in place.
☐	Medium	If an incident were to occur, there would be some chance that an injury requiring First Aid would result.	Additional controls are advised.
☐	High	If an incident were to occur, it would be likely that an injury requiring medical treatment would result.	Control will need to be in place before the activity is undertaken.
☐	Extreme	If an incident were to occur, it would be likely that a permanent, debilitating injury or death would result.	Consider alternatives to doing the activity. Significant control measures will need to be implemented to ensure safety.

Step 1 – Prior to Work Starting
Risk Assessment

Task/Procedure	Hazard	Initial Risk Level	Mitigation Measure	Residual Risk Level
Making suspensions and culturing *Yersinia pestis*	Risk or aerosols, splashes, and splatter when culturing, vortexing, and pipetting	High	• Use the pigmentation-negative attenuated *Yersinia pestis* strain (KIM D27) • Work in a BSC • Wear gloves	Low

Step 2 – Exposure Assessment Tool/Form

Exposure Assessment:

- Conducted by Chicago DPH, Illinois DPH, CDC, and University

When did this occur?

- Early September 2009

Where was the organism worked with?

- University research laboratory

Who else was within 6 feet?

- Exposure considered a close contact anyone within 6 feet of the patient or who had handled his blood or tissue samples during Sept 7-18, 2009.
- 65 exposed –1 household contact and 64 other close contacts (medical, laboratory, and pathology personnel)

What PPE was worn?

- Patient inconsistently complied with lab policy to wear gloves

What is the immune status of the individual working with the specimen and others who were within 6 feet?

- Patient is hemochromatosis-induced iron overload

Post-Exposure Follow up

- Review of Occupational Safety and health Administration Form logs for recent work-related injuries or illnesses among workers in the laboratory
- Review of attendance records for university biosafety training
- Prophylaxis
  - 7-day course of doxycycline

Step 3 –Biological Exposure Monitoring Guide

CLINICAL LABORATORY BIOLOGICAL EXPOSURE MONITORING GUIDE

Disease (Organism/Agent)		Notes	Exposure Risks and Routes of Transmission in the Laboratory Setting [8]	Incubation Period	Symptoms (Will depend on route of transmission)
	**Plague** **(Bubonic Plague, Black Death)** *(Yersinia pestis)*	**1, 5*, 14**	Direct contact with cultures and infectious materials and inhalation of infectious aerosols or droplets. accidental autoinnoculation, ingestion.	1–7 days, 1–4 for primary pneumonic plague	Often associated with a characteristic periodic electroencephalogram.

Step 4 - Root Cause Analysis Tool

Root Cause Analysis Form

Describe the problem:

1. **Why?**

2. **Why?**

3. **Why?**

4. **Why?**

5. **Why?**

Root Cause:

Step 4 – Root Cause Analysis Tool

The why's?

1. Why was there a fatality?
2. Why was there an exposure
3. Why were these practices not followed
4. Why were training courses not attended?
5. Why was there no follow up

The Problems?

1. There was an exposure to *Yp*
2. Biosafety practices were not followed including the use of gloves
3. Staff did not attend required biosafety courses
4. Staff did not think it was necessary and no oversight in attendance or following SOP's
5. Root Cause: Staff did not follow SOP and Facility Staff did not enforce training policy

Step 5 – Gaps in Biosafety Plan

Problems Identified:

- Lack of Biosafety Training
- Enforcement of Biosafety Training
- Lack of Competency Assessment
- Not following written policies and procedures:
  - Incident Reporting
  - Physical health

Step 6 – Additional Mitigation Measures

☣**Engineering Controls**: Physical changes to workstations, equipment, materials, production facilities, or any other relevant aspect of the work environment that reduce or prevent exposure to hazards.

☣**Administrative Controls**: Policies, standards and guidelines used to control risks.

☣**Practices and Procedures**: Processes and activities that have been shown in practice to be effective in reducing risks.

☣**Personal Protective Equipment**: Devices worn by the worker to protect against hazards in the laboratory.

- Implement a system to ensure staff are taking required biosafety training courses – Track attendance and completion.
- Implement a policy for what happens when someone doesn't take required courses/trainings.
- Ensure staff have access to required PPE (gloves) and are using them regularly and consistently. Incorporate spot checking to ensure use.
- Retrain staff on incident and medical reporting policies. Follow up/train yearly as well as when new staff are hired. List important contact information, phone numbers and reporting scenarios in the laboratory and/or easily accessible areas.
- Include a yearly drill or exercises that tests these procedures and staff knowledge.

Step 7 – Assess Impact of Additional Mitigation Measures

Mitigation Measures	Impact of Mitigation Measures
1. Implement a system to ensure staff are taking required biosafety training courses – Track attendance and completion	1. Will ensure staff understand biosafety risks of procedures, PPE requirements, and pathogen(s).
2. Implement a policy for what happens when someone doesn't take required courses/trainings	2. Will force staff to take accountability (e.g., if you do not take this training, you might not be able to continue your research, it will take you longer to graduate, and might cost you more money).
3. Ensure staff have access to required PPE (gloves) and are using them regularly and consistently. Incorporate spot checking to ensure use.	3. Even just one instance of not using PPE, can result in illness or injury
4. Retrain staff on incident and medical reporting policies. Follow up/train yearly as well as when new staff are hired. List important contact information, phone numbers and reporting scenarios in the laboratory and/or easily accessible areas	4. Engraining the policy into staff, ensures that they stay up-to-date and knowledge. When an event does occur, they will know how to quickly react and respond. Time can make a huge difference!
5. Include a yearly drill or exercises that tests these procedures and staff knowledge.	5. A yearly test is useful to see how staff will react in various situations.

What Was Learned?

An initial risk assessment cannot predict every potential scenario; however, this is why it needs to be constantly re-evaluated, reviewed, and revised.

It is important to drill down and determine the root cause.

A lapse in multiple safety policies can be fatal given the right conditions.

Often overlooked, reporting and notifications are an important part of biosafety.

Respect what is being worked with, even attenuated strains!

Directions for Breakout Session

- Read about the exposure scenario – 3 cases
  - Burkholderia
  - Brucella
  - SARS-CoV-1
- Discuss what occurred
- Use the exposure tool and post exposure follow up
- Root cause analysis
- Report to group what the findings are from the root cause
- Repeat the risk assessment
- Mitigation steps to reduce the risk
- Report final considerations

Applying risk assessments to laboratory accidents – Emerging Pathogens

Michael A. Pentella, PhD, D(ABMM),

Clinical Professor, University of Iowa, College of Public Health

Laboratory Director, University of Iowa, State Hygienic Laboratory

Objectives

- Review the article considering biosafety in the public health lab
- Determine the role of the risk assessment in the biosafety program
- Discuss the role of the risk assessment for emerging pathogens

The Scenario

- Oropouche virus is emerging
- Florida is seeing cases of a new viral illness in travelers from Cuba
- Preliminary epidemiology indicates it is similar to, chikungunya, yellow fever, and dengue

Oropouche virus (OV)

- OV is spread to people primarily by the bite of infected biting midges.
  - Some mosquitoes can also spread the virus.
- OV has been reported in parts of South America, Central America, and the Caribbean.
  - In June 2024, Cuba reported its first confirmed Oropouche case.
- OV disease typically presents as an abrupt onset of fever, severe headache, chills, myalgia, and arthralgia.
- Clinical presentation is commonly mistaken for other arboviruses such as dengue, chikungunya, and Zika viruses, and malaria.
- There are no vaccines to prevent or medicines to treat Oropouche.
- Prevention relies on personal protective measures to avoid bites.

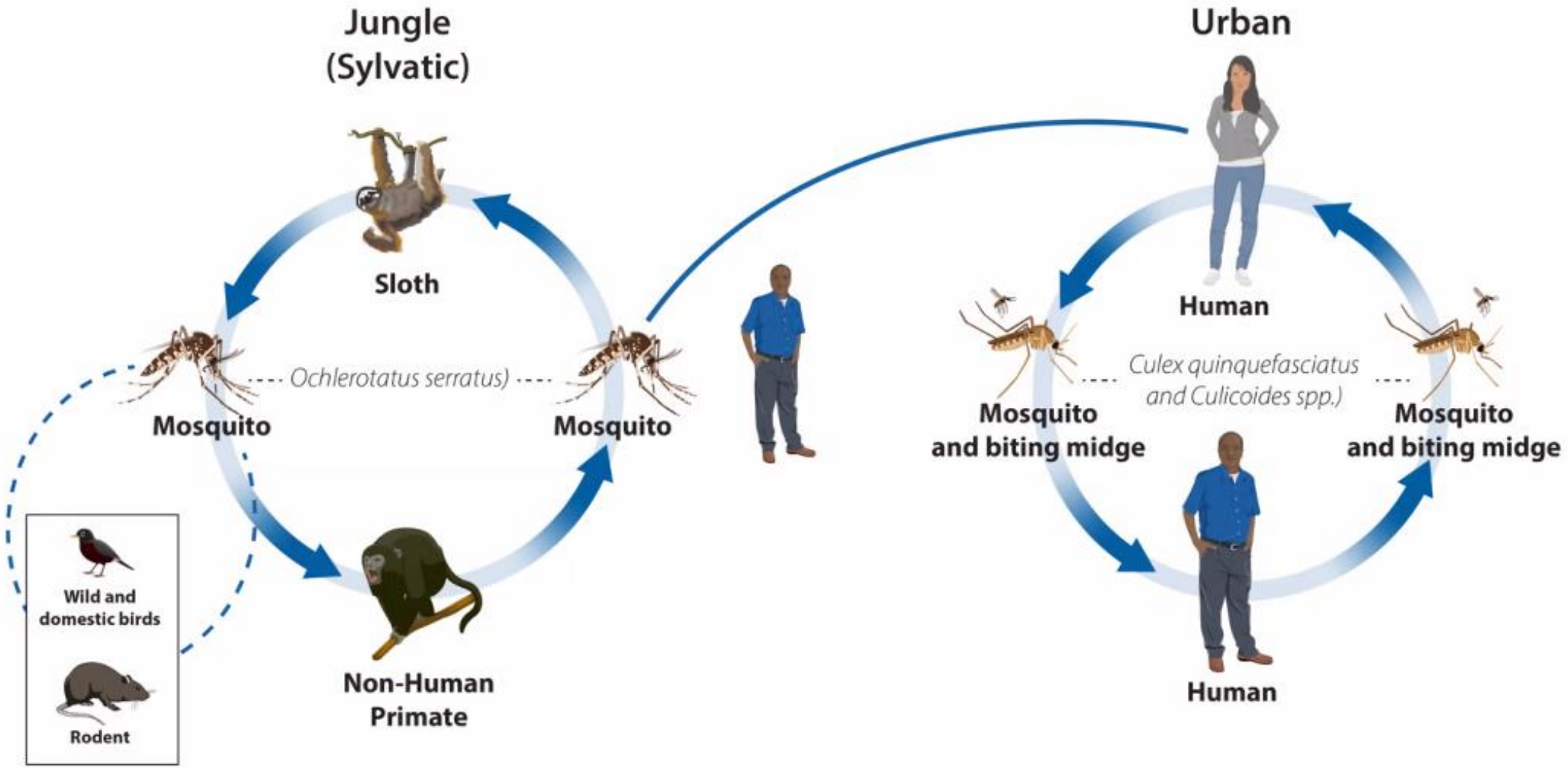
OROV Infection

Clinical illness similar to other arboviral pathogens in the Americas

- **Most (~60%) people become symptomatic; incubation period about 3-10 days**
- **Initial clinical presentation similar to infections caused by dengue, Zika, and chikungunya viruses**
  - Acute onset of fever, chills, headache, myalgia, and arthralgia
  - Other symptoms can include retroorbital pain, photophobia, vomiting, diarrhea, fatigue, maculopapular rash, conjunctival injection, and abdominal pain
- **Clinical laboratory findings can include lymphopenia and leukopenia, and slightly elevated liver enzymes**
- **Initial symptoms resolve after few days, but high proportion (~70%) experience recurrent symptoms within days to weeks after resolution of initial illness**

Slide Courtesy of CDC – Lyle Petersen

Oropouche Virus (OROV)



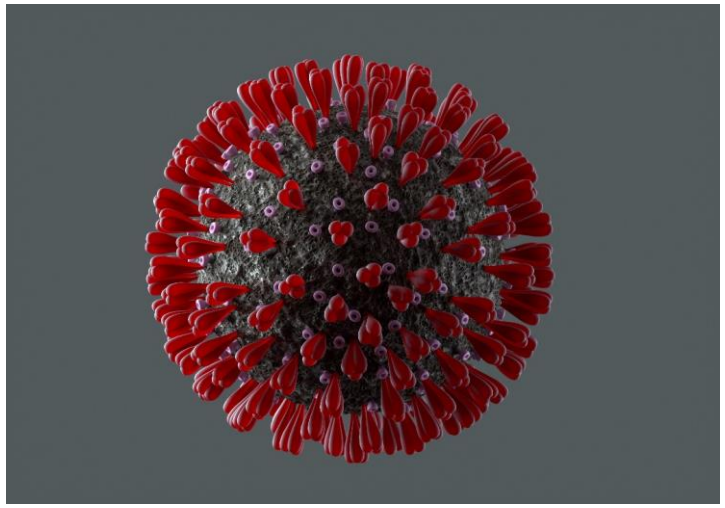
OROV Regional Epidemiology Update

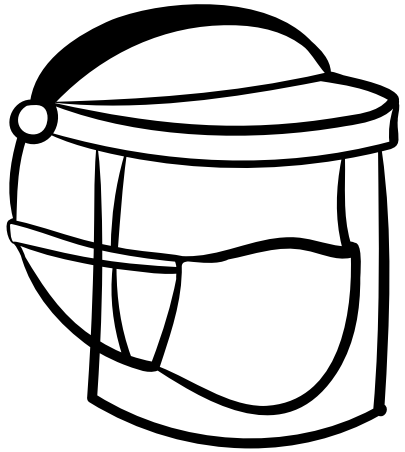
- **PAHO Region (Aug 3 Risk Assessment: Overall Risk to the Region - HIGH)**
  - 8,078 cases: Bolivia (356), Brazil (7,248), Colombia (74), Cuba (74), Peru (290)
- **Brazil**
  - 2 deaths, 5 cases of vertical transmission
- **Europe (ECDC Risk assessment, August 8)**
  - 19 imported cases in June and July
    - Spain (12), Italy (5), Germany (2)
      - Travel history: Cuba (18), Brazil (1)
- **U.S.**
  - 20 imported cases from Cuba (8/22)

Slide Courtesy of CDC – Lyle Petersen

Question: What do we know about oropouche virus and LAI?

- Consider risk from this emerging pathogen
- Samples to be tested: Blood, serum, CSF
- Is there a viremic phase of the unknown illness? **YES**
- Most probable risk of lab exposure
  1. Needlestick/sharp injury
  2. Splash and splatter





What does a literature search provide?

- Search for a closely related agent to the emerging agent.
- ABSA LAI database no oropouche virus found
- Search for dengue virus:
  - 10 articles on LAI caused by dengue virus
    - 8 LAI occurred in research labs
    - 1 LAI occurred in the field
    - 1 LAI occurred in the healthcare lab

Date(s) of LAI / exposure: **November 2002**	Location where LAI / exposure occurred: **Cambridge, Massachusetts, USA**
Occupation(s) of affected personnel: **health care worker**	Age(s) of affected personnel: **37**
Agent(s) involved: **dengue virus** find in Risk Group Database (NOTE: you may have to edit search to be more specific)	
Biological Safety Level (BSL) for work being performed?: **-none-**	Setting in which LAI / exposure occured: **health care**
Device or equipment involved: **syringe, blood culture bottle**	Procedure being performed: **transfer of blood from syringe to blood culture bottle**

How LAI / exposure occurred: **While transferring blood from the syringe to the blood culture bottle, the needle dislodged from the syringe, and blood was splashed onto the healthcare worker's face, including eye, nose, and mouth. This article also provides a table of known dengue LAIs, including references.**

PPE worn at the time of LAI / exposure: **Not described,**

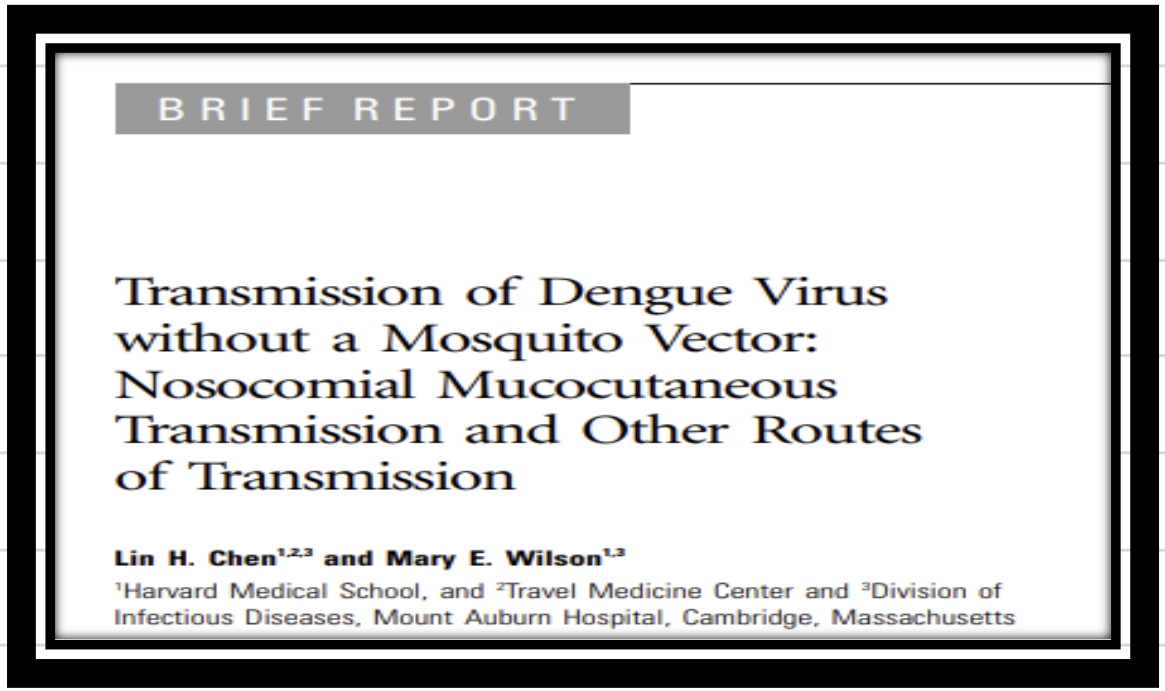
Engineering controls used at the time of the LAI / exposure: **Unknown**

Follow-up procedures taken: **unknown**

Actions that may have been taken to prevent exposure: **unknown**

Post-exposure prophylaxis provided: **unknown**

Agency(ies) LAI / exposure reported to: **The institution where the incident occurred,**


BRIEF REPORT

Transmission of Dengue Virus without a Mosquito Vector: Nosocomial Mucocutaneous Transmission and Other Routes of Transmission

Lin H. Chen[1,2,3] and Mary E. Wilson[1,3]

[1]Harvard Medical School, and [2]Travel Medicine Center and [3]Division of Infectious Diseases, Mount Auburn Hospital, Cambridge, Massachusetts

References

Chen, L.H. and M.E. Wilson. 2004. "Transmission of dengue virus without a mosquito vector: nosocomial mucocutaneous transmission and other routes of transmission." Clin. Infect. Dis. 39:e56-60.

Dengue virus case study

What is known:

- 37 y/o handling of blood sample from patient later confirmed to be infected with dengue virus: eye pain, nosebleeds, and decreased appetite.
- On 12/19/2002 - fatigue, myalgia, headache, and low-grade fever
- Serum sample day 8, IgM positive and IgG negative
  - Convalescent IgG 1:2560

Exposure and Root Cause:

- Transferring blood from syringe to blood culture bottle, needle dislodged, splash to face.
- Root cause was lack of face protection – no policy
- "In summary, health care workers should be aware that nosocomial transmission of dengue virus can occur by mucocutaneous exposures, as well as by needlestick exposures."

Start with a Risk Assessment Matrix for *Dengue Virus* as a proxy for oropouche virus Hazards*

Risk factors	Degree of Laboratory Risk		
Agent Hazards	**Low to Moderate**	**Moderate to High**	**High**
Pathogenicity	Asymptomatic cases	Moderate to high disease - hemorrhagic fever	Severe disease – dengue shock disease
Virulence	Mild to moderate disease or low infectivity		
Infective dose			10-100 organisms
Transmission	Typically spread through mosquito bite	Splash/Splatter	Needlestick/Sharps injury

Comments:

- Dengue can range from asymptomatic to severe disease
- Virulence may depend on the type/strain of dengue virus
- Typical needlestick exposure is 1.4 microliter of blood
- Difficult to determine since where dengue is endemic workers are also exposed to mosquitoes

*adapted from D.O. Fleming ,personal communication

Risk Assessment Matrix for Protocol Hazards for Dengue as a proxy for oropouche virus

Protocol Hazards	Low Risk	Moderate Risk	High Risk
Agent Concentration			10^7 – 10^9 IU/ml
Suspension Volume	<50 ul		
Generate droplets & droplet nuclei	Working with pipettes		Working with syringe, needle
Protocol Complexity			Standard repetitive procedures

Comments

- In acute phase, high concentration of virus expected
- Volume needed for testing is usually low
- Typical needlestick exposure is 1.4 microliter of blood
- Considering that this will be standard PCR procedure with manual methods

Agent FL Mitigation Control Measures

- **Engineering Controls**: Physical changes to workstations, equipment, materials, production facilities, or any other relevant aspect of the work environment that reduce or prevent exposure to hazards
- **Administrative Controls**: Policies, standards and guidelines used to control risks
- **Practices and Procedures**: Processes and activities that have been shown in practice to be effective in reducing risks
- **Personal Protective Equipment**: Devices worn by the worker to protect against hazards in the laboratory

- Use BSL-2 (BMBL 6th)
- Work in a BSC
- Use a safety device for needle
- Determine if disinfectant product coverage is sufficient
- Strictly enforce handwashing
- Wear face shield to protect mucous membranes/eyes

CNN + Follow 914.4K Followers

Dengue cases top 5.2 million in the Americas as outbreak passes yearly record, PAHO says

Story by Michael Rios, CNN • 3d • 3 min read

2024: Dengue virus is spreading to new areas of the world because of global warming , changing mosquito habitats and potential social disruption!

The New York Times

GLOBAL HEALTH

The Push for a Better Dengue Vaccine Grows More Urgent

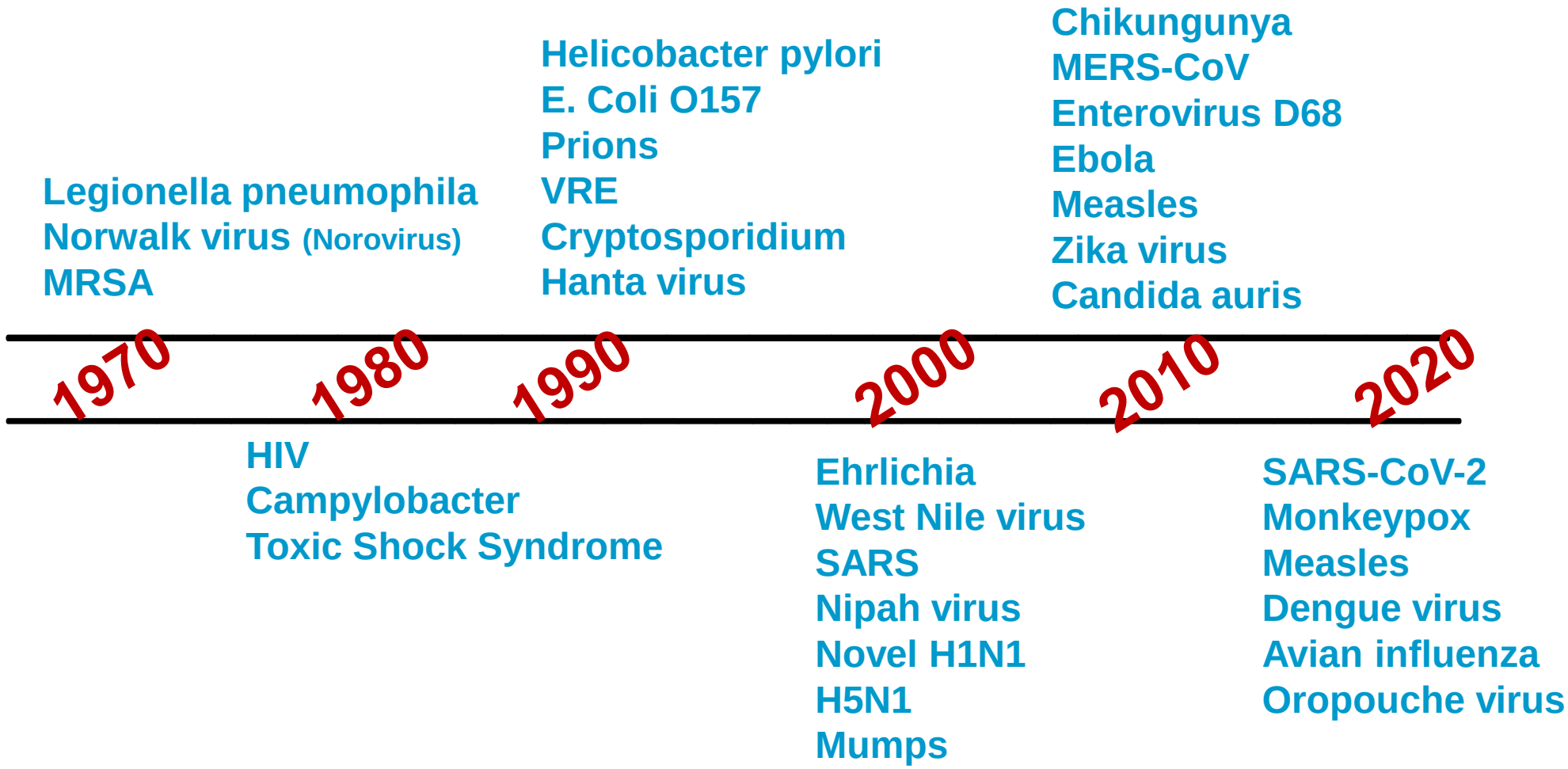
A public research institute in Brazil has proved a new shot protects against the disease, but can't make it fast enough to stop the huge outbreak sweeping Latin America.

Dengue cases reported to ArboNET from other states and territories (non-PR) as of Aug 21

State/Territory	Total Cases	Locally Acquired	Travel Associated
USVI	82	79	3
Florida*	296	16	280
New York	175	0	175
California	88	0	88
Massachusetts	80	0	80

*Note: reports posted from states include higher case counts that have not yet been entered in ArboNET. As of Aug 17, a total of 23 locally acquired and 378 travel associated dengue cases were included in local report numbers from Florida.

Other emerging pathogens associated with LAIs



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MMWR

Weekly

December 20, 2002 / 51(50);1133-1135
Weekly

December 20, 2002 / 51(50);1133-1135

Laboratory-Acquired West Nile Virus Infections --- United States, 2002

West Nile virus (WNV), a mosquito-borne flavivirus introduced recently to North America, is a human, equine, and avian neuropathogen (*1*). The majority of human infections with WNV are mosquito-borne; however, laboratory-acquired infections with WNV and other arboviruses also occur (*2--4*). This report summarizes two recent cases of WNV infection in laboratory workers without other known risk factors who acquired infection through percutaneous inoculation. Laboratory workers handling fluids or tissues known or suspected to be WNV-infected should minimize their risk for exposure and should report injuries and illnesses of suspected occupational origin to their supervisor.

- **Case 1**, microbiologist in public health laboratory performing a necropsy on a blue jay
  - Worked in BSC under BSL-2 conditions
  - Lacerated thumb while using a scalpel to remove bird's brain
  - Superficial thumb wound, cleansed and bandaged
  - Four days post symptoms of headache, myalgias, and malaise followed by chills, sweats,
  - Six days post maculopapular rash lasting 3 days
  - Sought medical care 7 days post exposure
  - Serial serum samples collected 13 days and 21 days post exposure positive for WNV-IgM antibody
  - Brain of blue jay positive for WNV RNA by PCR

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MMWR

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- **Case 2**, microbiologist in a US laboratory harvesting WNV-infected mouse brains
  - Worked in BSC under BSL-3 conditions
  - Punctured finger with a contaminated needle
  - Wound was cleansed and bandaged
  - Post exposure temperature monitoring several times each day
  - 3 days after injury UIR symptoms
  - 4 days 100.9 degree temp malaise fatigue, chills
  - URI symptoms and a dry cough persisted for >1 week.
  - Patient had had dengue fever, and vaccinated for yellow fever and JEV
  - At 10 days post exposure, serum antibody WNV-IgM specific detect

Conclusions from 2 WNV cases

- Two microbiologist infected from exposure through percutaneous inoculation
- Both illnesses mild and self-limited
- Lab workers at risk for occupationally acquired WNV
- Labs handling live WNV need to use BSL-3 lab facilities, however, this would limit the number of labs capable of detecting WNV infections in a timely manner. BSL-2 facilities can be modified to achieve an acceptable level of safety
- Training that reinforces awareness of potential hazards and risks that stresses the importance of timely reporting of injuries and suspected exposures is needed

Risk Assessment Matrix for *West Nile virus* Hazards*

Risk factors	**Degree of Laboratory Risk**		
Agent Hazards	**Low to Moderate**	**Moderate to High**	**High**
Pathogenicity	Mild to moderate disease (***West Nile virus***)		
Virulence	Mild to moderate disease or low infectivity		
Infective dose			<1 viral unit (via intramuscular route)
Transmission	Primarily: mosquito bite Laboratory: Indirect contact (contact with contaminated surfaces)	Direct contact (droplet, tissue, fluid, secretion contact with mucous membranes; ingestion)	Needle stick or other sharps injury

*adapted from D.O. Fleming ,personal communication

Risk Assessment Matrix for Protocol Hazards

Protocol Hazards	**Low Risk**	**Moderate Risk**	**High Risk**
Agent Concentration			10^1 – 10^6 viral units
Suspension Volume	<1 ml		
Generate droplets & droplet nuclei	Fecal secretions of infected birds	Pipetting	Needle stick injuries, droplets, and aerosols
Protocol Complexity	Standard repetitive procedures		

Post *West Nile virus* exposure lab risk mitigation

- Avoid sharps?
- Install a new BSC dedicated to blood cultures?
- Automate an alert into the LIMS for suspect highly infectious pathogen?
- Additional training for staff on biosafety practices

Mitigation Control Measures

- **Engineering Controls**: Physical changes to workstations, equipment, materials, production facilities, or any other relevant aspect of the work environment that reduce or prevent exposure to hazards
- **Administrative Controls**: Policies, standards and guidelines used to control risks
- **Practices and Procedures**: Processes and activities that have been shown in practice to be effective in reducing risks
- **Personal Protective Equipment**: Devices worn by the worker to protect against hazards in the laboratory

- Use a biosafety cabinet when working with dead birds
- Use safety devices or strictly limit sharps
- Strictly enforce handwashing
- Move testing to BSL-3
- Train staff on reporting exposures

After an exposure, consider the after-action steps

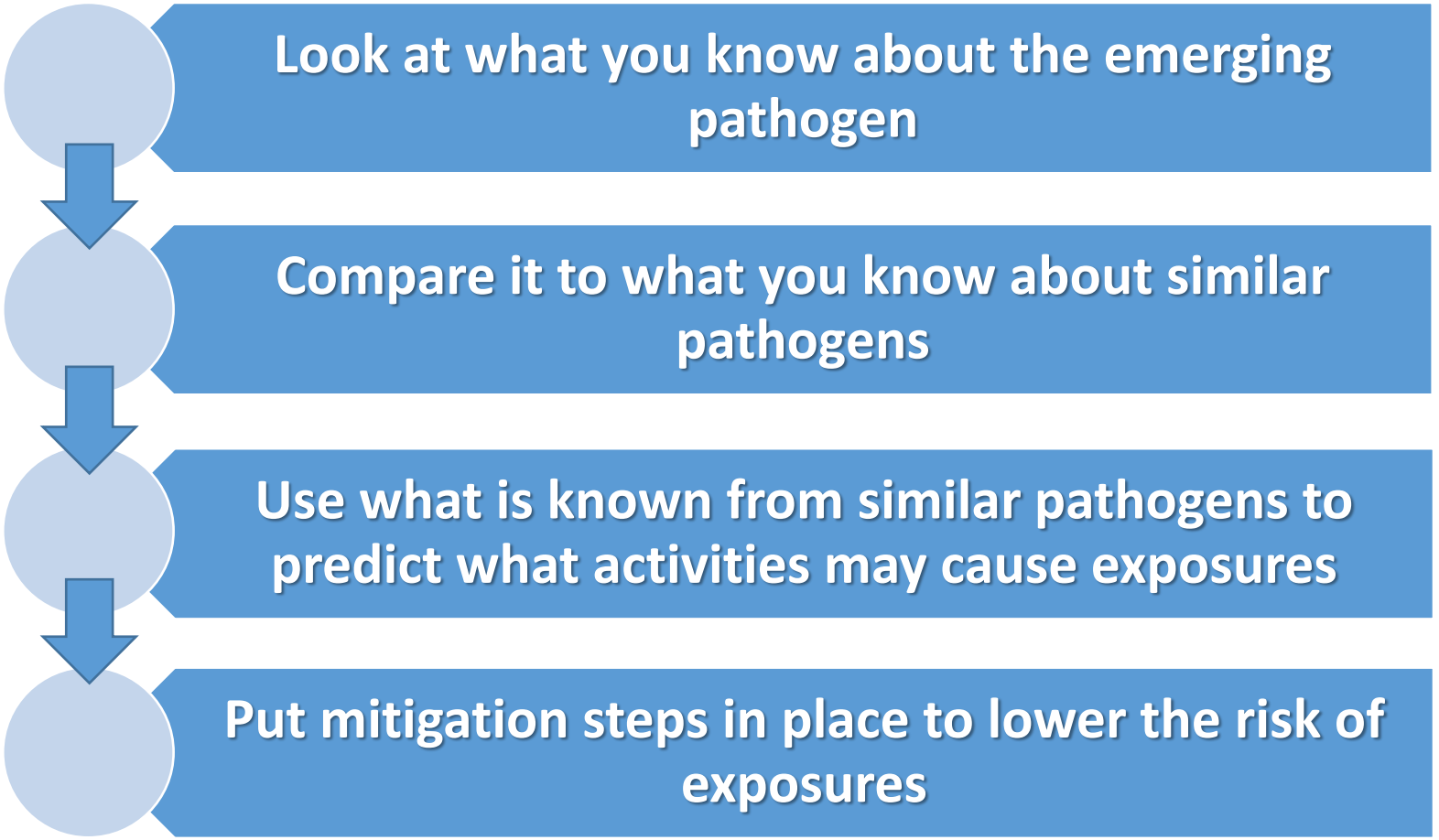
Appendix B. Risk Management Hotwash Worksheet

To be completed by laboratory staff during and/or after they perform work with control measures in place.	***Yes***	***No***
1. Are the planned control measures sufficient and effective in minimizing the level of risk?	☐	☐
2. Have there been any changes to the planned control measures?	☐	☐
3. Are any changes and/or additional control measures required in the future?	☐	☐
DETAILS: Please provide any additional information here.		

What can you learn from this published LAI?

- The importance of performing a risk assessment
- The value of the root cause analysis
- Building critical thinking skills
- Establishing the culture of safety

What Was Learned?



What pathogen has you most concerned?

- Steps to follow
  - Do a risk assessment!
  - Use what is published of similar agents
    - ABSA LAI database is an amazing resource and other resources

    https://my.absa.org
    - APHL Biosafety page has great resources

    https://www.aphl.org/programs/preparedness/Pages/Biosafety-Biosecurity-Resources.aspx
    - EPA Disinfectants

    https://www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants#antimicrobial-prod

Always Keep in Mind the GOAL!

- No matter what the pathogen, protecting our most valuable asset:
  - Our lab professionals
- Preventing laboratory associated infections (LAIs)

Laboratory Superheroes

Thank You!

- ABSA

  Especially

  Karen Byers

- APHL

Additional Resources

- APHL (Association of Public Health Laboratories) Risk Assessment Best Practices and Examples
  - http://www.aphl.org/aphlprograms/preparedness-and-response/Documents/APHL%20Risk%20Assessment%20Best%20Practices%20and%20Examples.pdf
- ABSA (American Biological Safety Association) Risk Group Database
  - https://my.absa.org/tiki-index.php?page=Riskgroups
- CDC (Centers for Disease Control and Prevention) MMWR (Morbidity and Mortality Weekly Report) Guidelines for Safe Work Practices in Human and Animal Medical Diagnostic Laboratories
  - http://www.cdc.gov/mmwr/pdf/other/su6101.pdf
- HHS (U.S. Department of Health and Human Services)/CDC/NIH (National Institutes of Health) BMBL (Biosafety in Microbiological and Biomedical Laboratories) 6th Edition
  - http://www.cdc.gov/biosafety/publications/bmbl5/
- WHO (World Health Organization) Biorisk Management for Disease Specific Recommendations
  - Biorisk management: laboratory biosecurity guidance (who.int)
- WHO Laboratory Biosafety Manual Third Edition and Fourth Edition
  - Laboratory biosafety manual, 4th ed (who.int)

Additional Resources

- Government of Canada Canadian Biosafety Standards and Guidelines
  - https://www.canada.ca/en/public-health/services/canadian-biosafety-standards-guidelines.html
- Public Health Agency of Canada Pathogen Safety Data Sheets and Risk Assessment
  - https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/pathogen-safety-data-sheets-risk-assessment.html

Lessons Learned to Improve Biosafety

https://my.absa.org/LAI