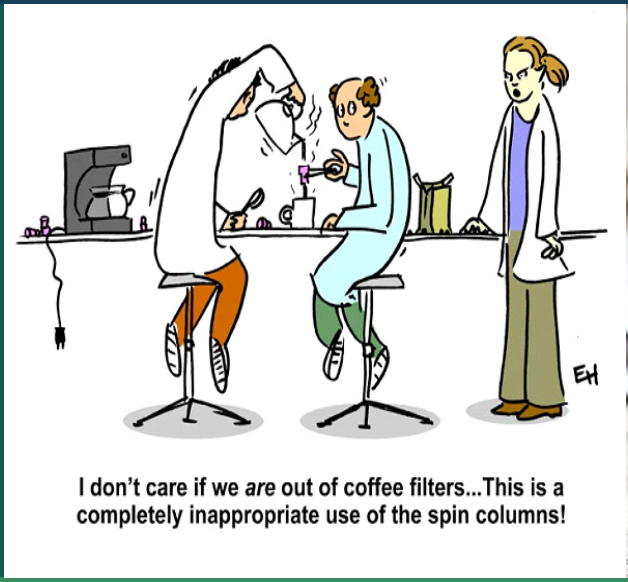
Anatomy of an Exposure

ABSA Conference

Thomas Winters, MD, FACOEM, FACPM
Occupational and Environmental Health Network

Prologue to an Exposure

- Human error
- Underlying medical condition or disease
- Lack of safety training
- Faulty risk evaluation of pathogen
- Improper use of PPE
- Use of unsuitable equipment
- Failure of engineering controls
- Lack of Exposure Response Plans



I don't care if we *are* out of coffee filters...This is a completely inappropriate use of the spin columns!

3 Examples of Exposures

Vaccinia
PUNCTURE

Yersinia
UNKNOWN

Herpes B
SCRATCHED by ANIMAL

Vaccinia Exposure…
Clinical Presentation

Incubation period

7-19 days
Commonly 10-14 days to onset of illness.
2-4 additional days to onset of rash.

Period of Communicability

From earliest sign of lesions to disappearance of all scabs; usually 3 weeks.

Risk of transmission is highest at the appearance of earliest lesions.

Routes of Vaccinia Transmission

- Skin Exposure (Needlestick, bite, or scratch):Direct skin contact with infected animals or vaccinia virus or vector.

- Mucous Membrane Splash to Eye(s), Nose or Mouth:
  Direct contact with vaccinia virus.
- Ingestion: Possible
- Inhalation: Unlikely

Case Presentation - Left thumb needlestick injury

- 24 year-old male immunology researcher was conducting an experiment involving wildtype VACV (non-recombinant Western Reserve) – Animal Biosafety Level 2.
- Administering 10^7 pfu of VACV via scarification with a 25 G needle under a biosafety hood.
- While recapping the needle, he became distracted by a moving mouse in an adjacent cage and punctured the volar surface of his left thumb with the contaminated needle.

PPE worn**:** disposable gown, boots, double gloves, bouffant cap, facemask, goggles.

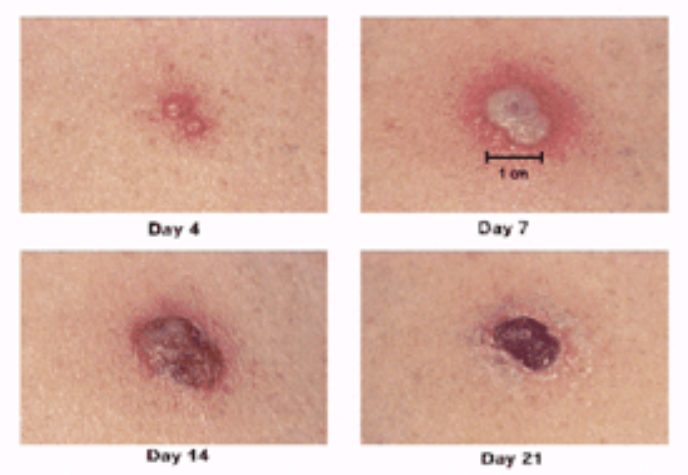
Post Exposure

- Sprayed germicide on gloves, de-gowned and washed hand for 10 minutes.
- PI notified and incident report filed.
- PI contacted Chief of Infectious Disease who advised researcher to go to ER as soon as he displayed any signs of infection.

Immunization History

Vaccinia Vaccine (ACAM 2000)

1/28/13 - 2/4/13, 2/13/13: evaluated for “take” of vaccine



- In the first week, the bump becomes a large blister, fills with pus, and begins to drain.
- During the second week, the blister begins to dry up and scar.
- People who have had the vaccine previously, have a faster progression of scabbing.

Occupational and Safety Training History:

- Hired January 2013, began working with VACV March 2013.
- Training:
  1/18/2013: New Employee Safety Training (includes biosafety)
  3/22/2013: VACV training just prior to working with virus, consisting of:

  Potential Routes of Exposure
  Emergency Procedures
  Incident Reporting
  Standard Work Practices and Procedures
  Meet with Animal Care Tech Supervisor to review established animal procedures.

Day 5

- Puncture wound site was tender and swollen

Day 6

- Non-tender, erythematous rash along Left biceps extending towards antecubital region and volar surface of Left forearm
- Emergency Department visit:

  - Denied fever, chills, systemic, neurological symptoms
  - Left thumb ultrasound: small collection of fluid at puncture site
  - Complete Blood Count: normal
  - Diagnosis: Cellulitis
  - Treatment: Cefazolin IV 1 gm Q6 hours x 3; overnight observation

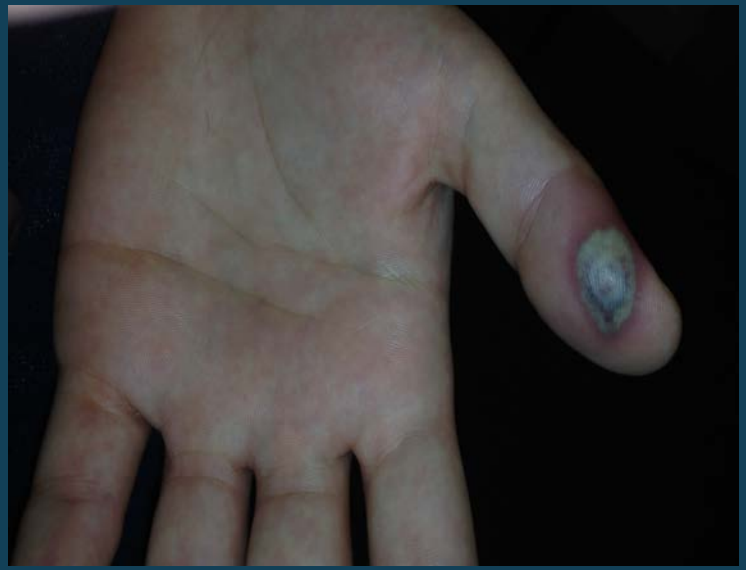
Day 7: Discharged from ED

- Dressing placed over wound
- Dressing change 3x/day (biohazard container provided)
- Keflex 500mg 4 times/day x10 days
- Follow-up with Employee Health

Day 8

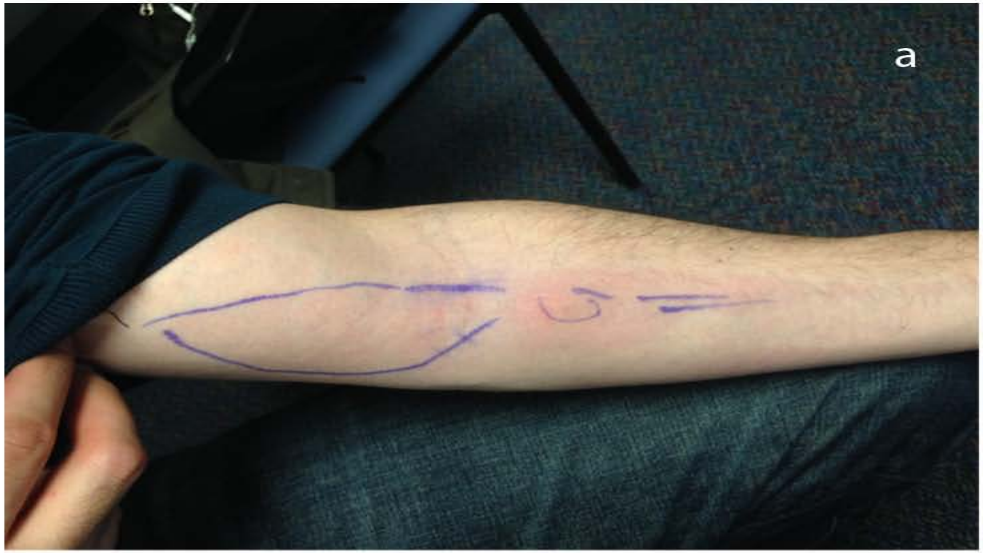
Employee Health Clinic

- Diagnosis**:** Vaccinatum Necrotic Infection
- Treatment**:** Continue Keflex
- Boston Public Health Department (BPHC)
- and CDC notified



Day 9

- BPHC site visit; Blood sent to CDC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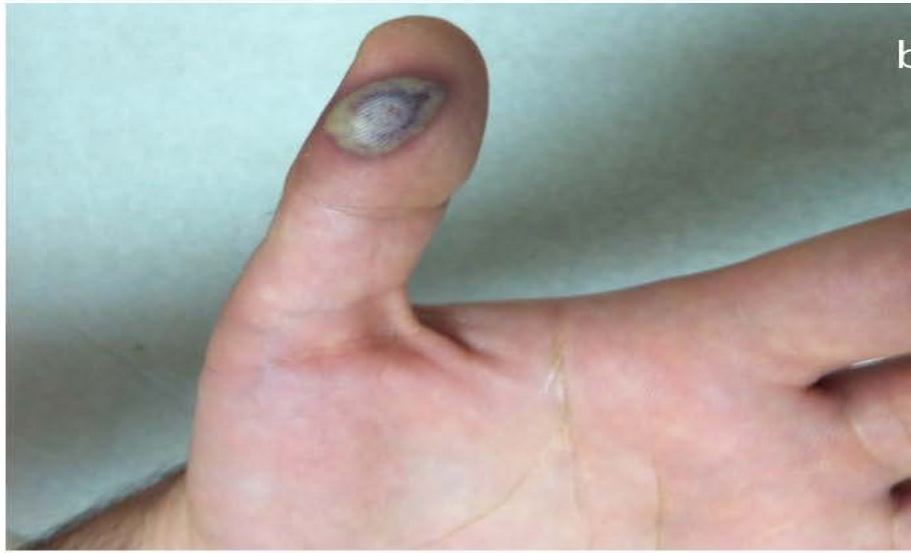
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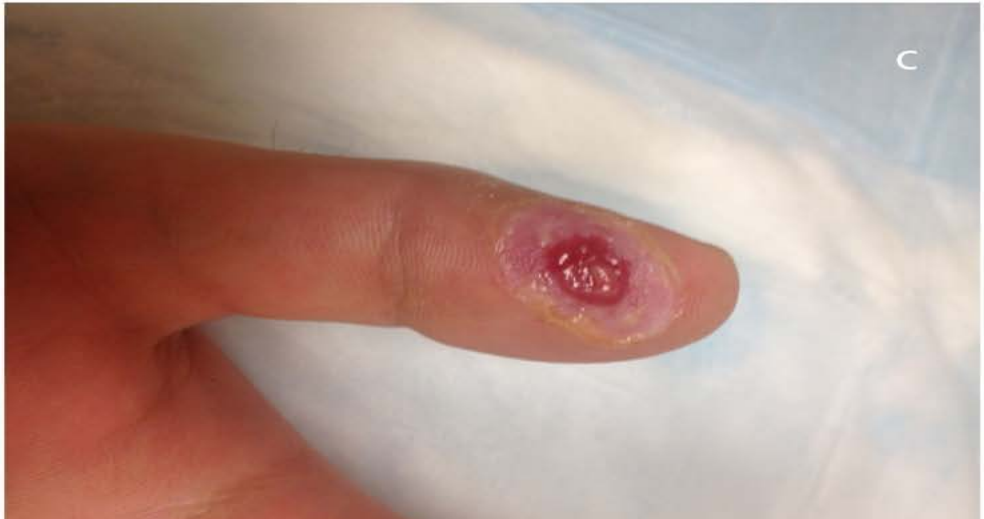
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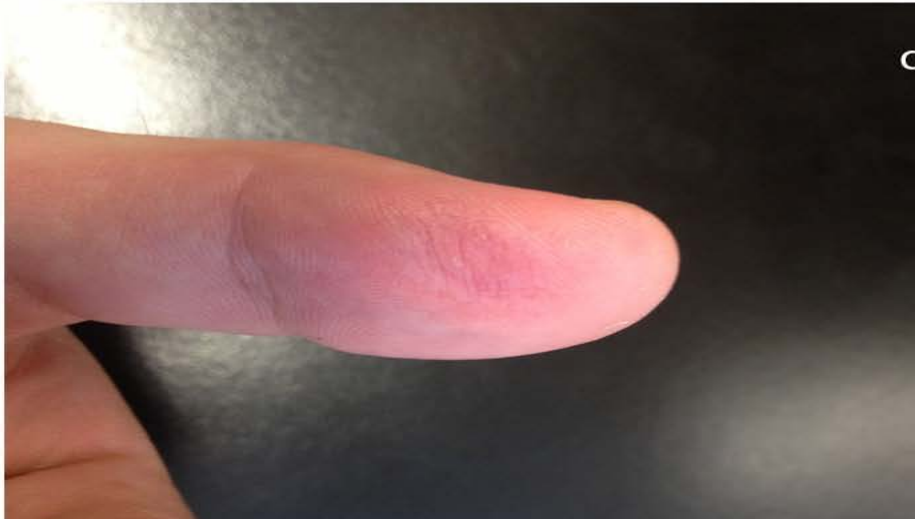
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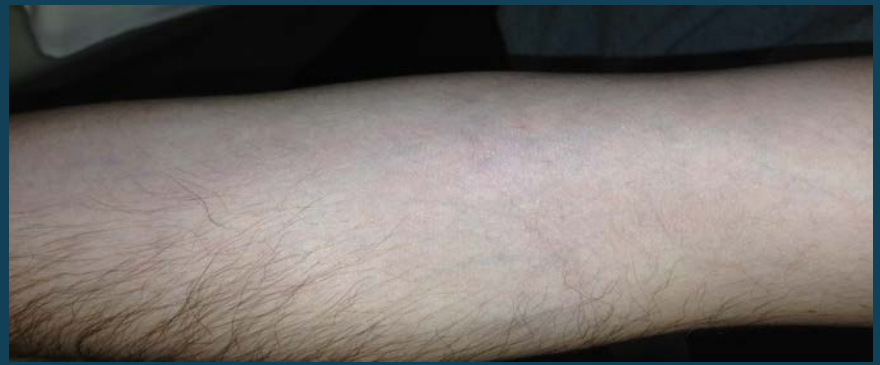
Day 16



Day 23

- Wound debridement (plastic surgery)
- Fluid from lesion sent to CDC
- PCR positive for VACV
- MMWR* article

***Laboratory-Acquired Vaccinia Virus Infection in a Recently Immunized Person — Massachusetts, 2013,** Morbidity and Mortality Weekly Report, Christopher H. Hsu, MD, PhD1,2, Julien Farland, MS3, **Thomas Winters, MD4**, Julia Gunn, MPH3, Donna Caron, MSN3, Jennifer Evans, DVM3, Lynda Osadebe, DVM, PhD1,2, Leon Bethune, MPH3, Andrea M. McCollum, PhD2, Nishi Patel, MS2, Kimberly Wilkins2, Whitni Davidson, MPH2, Brett Petersen, MD2, M. Anita Barry, MD3

Yersinia pestis…

Clinical Presentation

- Plague is an acute, contagious, febrile illness caused by the plague bacillus, a Gram-negative, rod-shaped coccobacillus, a facultative anaerobic bacterium.
- Four types of plague – bubonic, pharyngeal, pneumonic and systematic.
- Septicemic plague is an overwhelming infection.
- Patients with septicemic plague have a toxic appearance and may present with tachycardia, tachypnea, and hypotension. Hypothermia is common.
- Patients may die of a high-grade bacteremia.

Yersinia…

Unknown Route of Exposure

- 60 y/o researcher with insulin dependent diabetes working with attenuated Yersinia pestis KIM D27 (strain not known to cause lab infections).
- KIM D27 is attenuated as a result of defects in its ability to acquire iron.
- With acquisition of sufficient iron to overcome its iron-acquisition defects, the strain becomes virulent.
- Other researchers in lab were working with same organism were asymptomatic.

Case Presentation

- **Day 1** – last day of work.
- **Day 6** - 60 y/o male presented to outpatient clinic with fever, body aches & cough of 3 days duration.

  Physician suspected influenza or other acute respiratory illness, referred to ED for further evaluation but researcher declined.
- **Day 9** - transported to ED by ambulance, labored breathing (oxygen 92%), fever and cough. No lymph nodes, rash or jaundice noted. Chest x-ray – normal lung fields. Initial treatment for congestive heart failure.

Case continued…

- Labs - renal failure, acidosis, ↑ liver function, severe leukocytosis.
- Bacteria noted on blood smear.
- IV vancomycin & piperacillin administered when infection suspected.
- Within 12 hours of admission, respiratory distress, intubation required.
- Death within 1 hour in spite of cardiac resuscitation attempts.
- **Day 13** – Blood cultures yielded gram negative bacilli, gram positive cocci NVS (nutritionally variant streptococci).
- **Day 15** – Hospital lab notified the patient worked in a research facility that conducted research on select agents.
- **Day 17** – DNA sequencing identified either Y.pestis or Y. psuedotuberculosis.

Post Exposure Analysis

- Researcher's occupation never questioned and apparently not offered.
- Autopsy – no sign of pneumonia, endocarditis or bowel perforation.
- Inhalation exposure could not be ruled out.
- All "contacts" offered prophylaxis – 94% compliance.
- Review of training records identified deficiencies.
- Co-workers noted researcher inconsistently complied with policy to wear gloves.
- CDC confirmed the infecting strain was attenuated.

So…What Happened?

- Histopathological exam of lung tissue and blood vessels of multiple organs consistent with systemic plague.
- Abnormal iron deposits found in liver, serum iron significantly elevated.
- Post mortem diagnosis of hereditary hemochromocytosis.
- Serum iron linked with attenuated organism rendering latter as non-attenuated.
- No evidence the researcher was aware of his hereditary hemochromocytosis diagnosis.

Herpes B

Animal Scratch Exposure

- A clinician and researcher at affiliate hospital went to Mass General Hospital ED with complaints of fever, headache and rigors.
- No neck pain, or difficulty with concentration.
- Reported history of scratch on the dorsum of left hand by a Macaque research monkey 9 days prior.
- Washed the wound for few minutes but did not report the injury.
- Exam: 3 cm longitudinal scar dorsum left hand.
- Negative for vesicular lesions, erythema, signs of infection, or rashes.

Herpes B Exposure continued…

- Lumbar puncture performed weekly (x2) CSF negative for Herpes B.
- Elevated white blood cells seen
- 2 MRI's were normal

Treatment:

- Started on IV acyclovir and ganciclovir on presentation to the ED
- Completed a 4 week course of IV antivirals
- Valacyclovir 1 Gram each day for life

Diagnosis:

- On week 3 spinal fluid **Positive for Herpes B and Ab (+)** by PCR.

Post Exposure Analysis

- Did not follow Post exposure guidelines – insufficient washing.
- Delay in reporting the incident led to delay in treatment.
- Luckily the outcome was positive!

Summary

Safety in the workplace is a direct result of:

- **Comprehensive Medical Surveillance** program; including appropriate vaccination and titres.
- Use of **Personal Protective Equipment**
- **Safety Training**
- Adhering to **Protocols and Post Exposure Guides**
- **Reporting injury/illness promptly**
- **Timely & proper post exposure treatment**
- Availability of post exposure information

Agent Information Sheets (AIS)

- Typical Agent Information Sheets provide the following details about an agent:
  - Description
  - Pathogenicity
  - Biosafety Information
  - Information for Lab Workers
  - Information for First Responders/Medical Personnel

- The following pages present a sample Yersinia Pestis Agent Information Sheet.

Research Occupational Health Program

Agent Information Sheet (AIS)

Yersinia pestis

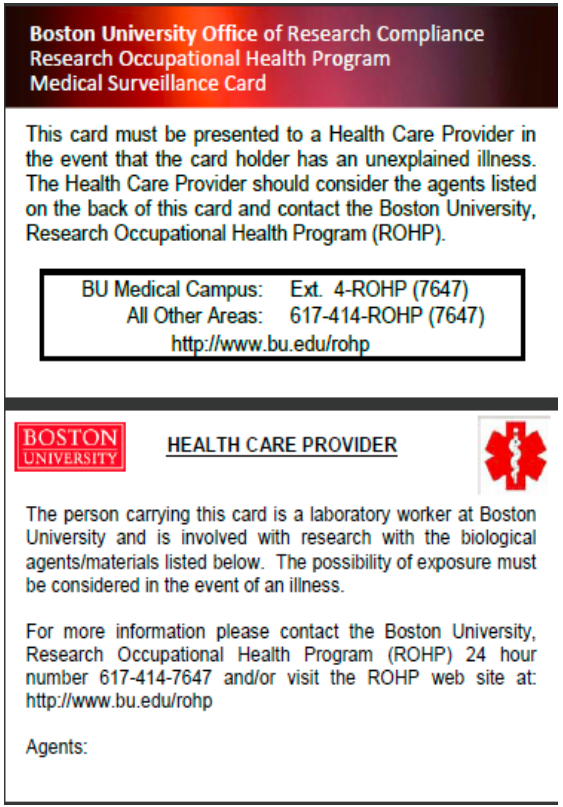
Agent

Gram negative rod-ovoid 0.5-0.8 µm in width and 1-3 µm in length (safety pin appearance), bipolar staining (Giemsa) facultative intracellular, non-motile.

1. **Disease/Infection**
   Y. pestis causes a zoonotic disease of rodents and in humans can take the form of bubonic, septicemic or pneumonic plague.
2. **Pathogenicity**
   Humans generally contract the disease through contact with infected rodents or their fleas.
   Bubonic plague may occur 2-8 days after the bite of an infected flea with rapid onset of symptoms of high fever, severe malaise, headache, myalgias, and sometimes nausea and vomiting. Buboes (swollen and extremely painful infected lymph nodes) usually develop at the same time as symptoms are generally 1-10 cm in diameter. In natural infections these buboes usually develop in the femoral or inguinal lymph nodes because fleas generally bite on the legs, however a laboratory acquired infection might be more likely to develop buboes in the brachial lymph nodes.
   Septicemic plague occurs when the bacteria enters the bloodstream it occurs in 10-20% of plague cases. This can occur with or without the formation of buboes. Without treatment septicemic plague is 100% fatal. With treatment there is a 30 to 50% survival rate.
   Pneumonic plague occurs when the lungs become infected either from the blood stream for from inhaling the bacteria. An infectious dose is < 100 colony forming units. Patients with primary pneumonic plague develop symptoms within 1- 6 days. Without treatment it is 100% fatal. When untreated there is a 60 % mortality rate. Pneumonic plague is the only form of plague which is readily transmissible from person to person. From past plague epidemics the secondary infection rate is estimated to be 1.3 cases per primary case.

Medical Surveillance Card

- A Surveillance Card is provided for all laboratory workers.
- Workers are instructed to present this card to a health care provider in the event of an unexplained illness.
- Card contains medical contact information including the website where the Health Care provider can find information and treatment for biological agents listed on card.



Boston University Office of Research Compliance
Research Occupational Health Program
Medical Surveillance Card

This card must be presented to a Health Care Provider in the event that the card holder has an unexplained illness. The Health Care Provider should consider the agents listed on the back of this card and contact the Boston University, Research Occupational Health Program (ROHP).

BU Medical Campus: Ext. 4-ROHP (7647)
All Other Areas: 617-414-ROHP (7647)
http://www.bu.edu/rohp

BOSTON UNIVERSITY

HEALTH CARE PROVIDER

The person carrying this card is a laboratory worker at Boston University and is involved with research with the biological agents/materials listed below. The possibility of exposure must be considered in the event of an illness.

For more information please contact the Boston University, Research Occupational Health Program (ROHP) 24 hour number 617-414-7647 and/or visit the ROHP web site at: http://www.bu.edu/rohp

Agents:

Thomas Winters, MD, FACOEM, FACPM

- Chief Medical Officer and Principal Partner OEHN
- Board Certified in Occupational Medicine
- Board Eligible in Infectious Diseases
- Board Certified in Internal Medicine
- Certified Medical Review Officer
- Certified Independent Medical Examiner
- 25+ years experience in occupational and environmental medicine.
- Specializing in research laboratory medicine.

THANKS!

Any questions?

Email me at
twinters@bidmc.harvard.edu