Laboratory safety

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Content

- Laboratory safety regulations
- Examples of specific IDs
  - *Brucella*
  - *C. difficile*
  - *HBV / HCV / HIV*
Legislative

- Variety of measures in the field of safety and health at work:
  - EU directives, EU Guidelines, EU Standards, national legislation, OSH strategies
Biological agents (bioAgents)

BioAgents (Directive 2000/54/EC; TRBAs)

- Defined as: “micro-organism which may be able to provoke infection, allergy or toxicity”
  - Viruses
  - Bacteria
  - Fungi
  - Parasites
  - (CJD; infectious proteins)

BioAgents

BioAgents groups (based on ability to cause disease and spread):

• Group 1:
  – **Unlikely** to cause human disease

• Group 2:
  – **Can** cause human disease
  – **May** be an occupational hazard
  – **Unlikely** to spread in the community
  – Effective prophylaxis/treatment exists
BioAgents

• Group 3:
  – Can cause severe disease
  – Serious occupational hazard
  – May spread
  – Effective prophylaxis/treatment exists

• Group 4:
  – Causes severe disease
  – Serious occupational hazard
  – High risk of spreading
  – No effective prophylaxis/treatment exists
BioAgents - Examples

• Group 1:
  • *Bacillus subtilis, Saccharomyces cerevisiae*

• Group 2:
  • *S. aureus, Plasmodium falciparum*

• Group 3:
  • *Mycobacterium tuberculosis; HCV*

• Group 4:
  • *Lassavirus; Ebolavirus; Variola major virus*
Transmission ways

- Ways of transmission in labs
  - inhalation
  - ingestion
  - sharp injuries
  - blood or other body fluids
  - by vectors
Risk assessment

<table>
<thead>
<tr>
<th>Consequence Value (CV)</th>
<th>Impact to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>Personnel Safety</td>
</tr>
<tr>
<td>No Risk</td>
<td>1 No injuries</td>
</tr>
<tr>
<td>Minor</td>
<td>2 Minor injuries</td>
</tr>
<tr>
<td>Moderate</td>
<td>3 Moderate to life impacting injuries</td>
</tr>
<tr>
<td>High</td>
<td>4 Life threatening injuries from single exposure</td>
</tr>
</tbody>
</table>

Risk reduction

“prevention beats infection”

• Establish preventive measures to reduce risk of exposure:
  1. Design work processes
  2. Minimize numbers of workers, minimize hands-on time
  3. Collective protection measures
  4. IPC measures (i.e. PPE)
Risk reduction

- What do you have to do if you lead a lab?
  1. Train all workers (and re-train regularly)
  2. Provide proper safety gear & equipment (e.g. eye showers)
  3. Create an emergency and contingency plan
Risk reduction based on bioAgents

- Roughly, labs handling bioAgents 1-4, need to have a corresponding *Biological Safety Level* (BSL) and are called BSL-1 to BSL-4 labs.
BSL-1 Requirements

- BSL-1 (only limited micro methods)
  - Mechanical pipetting (no mouth pipetting allowed)
  - Safe sharps handling
  - Avoidance of splashes or aerosols
  - Daily decontamination of all work surfaces
  - Hand hygiene
  - Prohibition of food, drink and smoking
  - Personal protective equipment
  - Biohazard signs
Please keep all surfaces clean!
BSL-2

- BSL-2 (a regular micro lab)

All requirements of BSL-1 plus:

- biological safety cabinet (BSC) needs to be in place
- method of decontamination is available for proper disposals
- self-closing, lockable doors
- sink and eyewash stations
BSL-3

• BSL-3 (often a separated part of the micro lab e.g. the TB lab)

All requirements of BSL-2 plus:

• Solid-front wraparound gowns, scrub suits or coveralls
• All work with microbes must be performed in a BSC
• Sustained air circulation system maintaining negative pressure in the lab
• self closing, automatically locking doors with access away from general corridors
• Access is restricted and controlled at all times
BSL-4

- BSL-4 (highly specialized lab, only few around the world)

All requirements of BSL-3 plus:

- Change clothing before entering, shower upon exiting
- Decontamination of all materials before exiting
- Personnel must wear a full body, air-supplied, positive pressure suit
- Class III biological safety cabinet
- Often these labs are in isolated separate buildings

Table 1. European Network of Biosafety-Level-4 Laboratories: Facilities for diagnostics and research operating in the EU.

<table>
<thead>
<tr>
<th>Country</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>Laboratoire P4 Jean Merieux, Inserm, Lyon</td>
</tr>
<tr>
<td>Germany</td>
<td>Bernhard Nocht Institute for Tropical Medicine, Hamburg</td>
</tr>
<tr>
<td>Germany</td>
<td>Philipps Universitat Marburg, Marburg</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Health Protection Agency–Centre for Infections (Cfi), London</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Centre for Emergency Preparedness and Response, Porton Down</td>
</tr>
<tr>
<td>Sweden</td>
<td>Swedish Institute for Communicable Disease Control, Solna, Stockholm</td>
</tr>
<tr>
<td>Italy</td>
<td>National Institute for Infectious Diseases IRCCS “L. Spallanzani,” Rome</td>
</tr>
<tr>
<td>Hungary</td>
<td>National Center for Epidemiology, Budapest</td>
</tr>
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</table>

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BSL-4

https://www.rki.de/EN/Content/infections/Diagnostics/SpecialLab/Bilder_Hochsicherheitslabor_en.html
Specific infectious diseases in a laboratory

*Brucellosis (B. abortus, melitensis, suis...)*

- Worldwide distributed Zoonosis
- Unspecific symptoms: undulant fever, myalgia, arthralgia, night sweats, and malaise
- Can be severe and may become chronic. Particularly can cause spontaneous abortions and intrauterine fetal death
Brucellosis

Most common laboratory-acquired infection! Because....

• Very low infective dose of 10-100 organisms
• Easily aerosolized
• Identification not easy
  • Appear as gram neg coccobacilli on Gram stain
  • However, can occur also Gram pos in staining
  • On solid agar they form small colonies similar to CNS
• Handling only in BSL-3 allowed, however, most infections occur in BSL-1 or 2 labs because they accidently handle Brucella samples from patients (non-specific symptoms)
Most common reasons for exposure:

• Lack of experience (no endemic area, lab workers might be unaware, travellers disease)
• Work on an unsuspected Brucella case on an open bench and not under a BSC
• Lab is not equipped for (e.g. no BSC; MALDI TOF has a database not containing Brucella etc.)
Brucellosis

Most common reasons for exposure:

- Test are performed such as MALDI-TOF MS, API or biochemical test who provoke aerosols
- Within 1.5 metre everyone is exposed if Brucella is aerosolized
- If the dosage of aerosol is high, the whole laboratory can be exposed
Brucellosis

Preventive measures:

• Train the lab workers!!
  • Brucella lecture
  • Lecture on lab conduct e.g. no sniffing on plates, work under a BSC etc.
  • All other things under BSL requirements......
Specific infectious diseases in a laboratory

*Clostridioides difficile*

- Usually known for causing hospital-acquired diarrhoea (CDI)
- Spore-forming bacteria
  - spores can survive in the environment (loss of 10% viability after 1 year)
  - resistant to disinfectants; hand hygiene does not work effectively
- Spore-forming bacteria
Specific infectious diseases in a laboratory

*Clostridioides difficile*

- Laboratory surfaces are contaminated with spores after daily routine cleaning
- Contamination grade is as high as in CDI patient rooms, sometimes even higher
- Toxigenic strains are also found on hands of lab personnel, but no rectal carriage detected (n=25)

→ Risk of acquiring *C. diff* in the lab might be underestimated

E. Reigadas et al. CMI 2019
Specific infectious diseases in a laboratory

HBV / HCV / HIV aka needle stick injury

• Needle stick injuries can occur frequently in the lab

• Preventive measures include:
  • sharps waste management (see talk Gerhard Horinek)
  • training of Lab workers (PPE)
  • Vaccination (HBV)
  • Establishing a notification and first care system

• Post exposure prophylaxis (see talk Armin Rieger)
Specific infectious diseases in a laboratory

HBV / HCV / HIV

- Risk of developing clinical HBV-hepatitis if donor blood was HBsAG and HBeAG positive from a needle is 6-16%.
- HCV ~3%
- HIV ~0.1-0.3%
Specific infectious diseases in a laboratory

Zero blood sample value and follow up are important due to long incubation periods

- Incubation period HBV: 6-25 weeks
- HCV: 2-26 weeks
- HIV: 2-10 weeks
Specific infectious diseases in a laboratory

Overall, risk of acquiring HBV, HCV, or HIV in the lab is low when personnel is trained and correct handling of sharps and waste management are in place.

- When it happens make sure that cases are registered and people speak up. Do not hide it out of shame. Post-exposure prophylaxis and/or early treatment is relevant.