Abstract

This paper aims to explore the changes of school laboratory preparer profession in a context marked by dissatisfaction towards science acquisitions. The meta-analysis of a corpus based on sixteen documents, associated with quantitative data draws up a scientific report to identify development challenges. Three concepts have described preparer history names, assigning them at the beginning missions based on laboratory activities, and spread today to cover all school space. Their distribution over establishments shows disparities delaying acquisitions. The calculated service factors induce a considerable reduction of laboratory activities carried out. In perspective, the articulation between the training and prepare functions constitutes a priority to improve the service qualities and to straighten science teaching and learning.

Keywords: Preparer; laboratory; evolution; function; service factor

1. Introduction

The management of infectious agents in the laboratory where they are being handled or maintained is described by containment levels in medical laboratories as safe practices. The primary containment system is designed to prevent the personnel and the lab environment from coming into contact with infectious agents. It is supplied by using proper safety gear and good microbiological procedure. Vaccinations may offer a higher level of personal protection. The secondary containment is concerned with guarding against exposure to infectious materials in the external laboratory environment. Facilities design and operating procedures work together to
provide it. Strict adherence to the microbiological standard methods and methodologies is the most vital component of containment. People who handle infectious substances or diseased materials need to be trained in the proper procedures. Each laboratory should create a biosafety document that lists potential risks and outlines methods and procedures aimed at reducing or eliminating them. The laboratory staff should study this manual and adhere to its guidelines in order to respect biosafety procedures. The objective of this work is to describe the levels of containment of medical biology laboratories and to assess the situation of the central laboratory of the Mohammed VI University Hospital of Oujda, with regard to the requirements of good biosafety and biosecurity practices. The concept of containment corresponds to all the measures and technical actions that allow an infectious risk agent to be maintained in a determined and limited space.

2. Materials and methods:

Three facility designs are described below, in ascending order by level of containment:

The basic laboratory: This laboratory provides general space in which work is done with viable agents which are not associated with disease in healthy adults.

The containment laboratory: the unique features which distinguish this laboratory from the basic laboratory are the provisions for access control and a specialized ventilation system. The containment laboratory may be an entire building or a single module or complex of modules within a building.

The maximum containment laboratory. This laboratory has special engineering and containment features that allow activities involving infectious agents that may cause serious epidemic disease to be conducted safely.

For the biological risk assessment and for the definition of the containment level of our laboratory:

- We determined the risk group associated with the analyzed organisms.
- We have identified the conditions allowing us to prevent or limit the risk.

There are four different biosafety levels that are detailed, each of which consists of a set of laboratory procedures and methods, safety tools, and facilities that are suitable for the operations carried out, the risk posed by the infectious agents, and the laboratory function or activity. There are four levels of biosafety.

1. Biosafety Level 1: Biosafety level 1 practices, safety equipment, and facilities are appropriate for undergraduate and secondary educational training and teaching laboratories and for other facilities in which work is done with defined and characterized strains of viable microorganisms not known to cause disease in healthy adult humans.

2. Biosafety Level 2: Biosafety Level 2 practices, equipment, and facilities are applicable to clinical, diagnostic, teaching, and other facilities in which work is done with the broad spectrum of indigenous moderate-risk agents present in the community and associated with human disease of varying severity.
3. Biosafety Level 3: Biosafety Level 3 practices, safety equipment, and facilities are applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents where the potential for infection by aerosols is real and the disease may have serious or lethal consequences. Autoinoculation and ingestion also represent primary hazards to personnel working with these agents.

4. Biosafety Level 4: Biosafety Level 4 practices, safety equipment, and facilities are applicable to work with dangerous and exotic agents which pose a high individual risk of transmitting diseases that could be fatal.

**Table 1:** Summary of Recommended Biosafety Levels for Infectious Agents. (Source: https://consteril.com/biosafety-levels-difference/)

<table>
<thead>
<tr>
<th>Biosafety Level</th>
<th>BSL-1</th>
<th>BSL-2</th>
<th>BSL-3</th>
<th>BSL-4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>No Containment</td>
<td>Containment</td>
<td>High Containment</td>
<td>Max Containment</td>
</tr>
<tr>
<td><strong>Sample Organisms</strong></td>
<td>E.Coli</td>
<td>Influenza, HIV, Lyme Disease</td>
<td>Tuberculosis</td>
<td>Ebola Virus</td>
</tr>
<tr>
<td><strong>Pathogen Type</strong></td>
<td>Agents that present minimal potential hazard to personnel &amp; the environment.</td>
<td>Agents associated with human disease &amp; pose moderate hazards to personnel &amp; the environment.</td>
<td>Indigenous or exotic agents, agents that present a potential for aerosol transmission, &amp; agents causing serious or potentially lethal disease.</td>
<td>Dangerous &amp; exotic agents that pose a high risk of aerosol-transmitted laboratory infections &amp; life-threatening disease.</td>
</tr>
<tr>
<td><strong>Autoclave Requirements</strong></td>
<td>None</td>
<td>None</td>
<td>Pass-thru autoclave with Biosafe required in laboratory room.</td>
<td>Pass-thru autoclave with Biosafe required in laboratory room.</td>
</tr>
</tbody>
</table>

### 3. Results

The Central Laboratory of the CHU Mohammed VI of Oujda meets the requirements of the regulations concerning the technical prevention measures to fight against the contamination of the personnel and to avoid pollution of the environment both inside the laboratory and outside. In this laboratory, most of the pathogens handled belong to class 2. This classification is based on the fact that the pathogens treated in our laboratory present a moderate risk for individuals, low for the community. A pathogen capable of causing human or animal disease but rarely poses an a priori serious hazard to laboratory personnel, the community and the environment. Exposure in the laboratory may result in a serious infection, but this can be prevented or treated effectively. Moreover, the risk of spreading the infection is limited.
In addition, level 2 is characterized by:
- Mandatory wearing of gloves (2 pairs).
- Controlled access to authorized persons only.
- Pre-packaged pipettes and waste before leaving the fume hood.
- Centrifugation in closed cups, opening of the cups in the fume hood.

In the microbiology laboratory of the Central Laboratory of the CHU Mohammed VI of Oujda, containment aims to isolate pathogenic organisms in a specific area so that personnel are protected from biological or chemical hazards, including those that are airborne. Depending on the degree of precautionary measures taken in the activity rooms, containment levels can be defined. The Central Laboratory of the CHU Mohammed VI of Oujda requires the rules of good practice:
- adopt good laboratory practices.
- provide disinfection and decontamination procedures.
- provide containers for the transport of pathogens.
- establish a waste management plan.
- have a plan for incidents and accidents.
- inform other team members of pathogens used.

In this laboratory, biosafety and biosecurity are achieved through operational practices and a core subset of physical containment requirements that are commensurate with the risks associated with the pathogens and toxins handled in the facility. Operational practices for Level 2 containment refer to administrative measures as well as procedures such as work practices, use of personal protective equipment, decontamination, that reduce the risks associated with activities conducted in the area. Features related to physical containment include facility design, such as laboratory location, surface coating, access control, and the provision of biosafety equipment, such as primary containment devices, used for certain activities.

4. Discussion

The containment laboratory includes unique engineering features that allow laboratory staff to handle hazardous aerosolized compounds without putting themselves in danger. Primary and secondary barriers are given more importance in order to shield community members and workers in nearby locations from possibly contagious aerosols and to stop environmental contamination. This lab is typically referred to as a level 3 biosafety facility. The access control features and the specific ventilation system are the distinguishing characteristics that set this laboratory apart from the standard laboratory. The containment laboratory could be a complete structure or only one room inside a standard lab. A basic laboratory space or an anteroom with two sets of doors serve as the barrier separating a containment laboratory from other areas of the facility. Air movement entering the laboratory is unidirectional, and all exhaust air is either routed outside the building without any recirculation or it goes through high-efficiency particulate air filtration due to the possibility of aerosol transfer. Biologic safety cabinets or other physical containment devices are used for all procedures involving the handling of infectious materials. These buildings have sealed penetrations, solid floors, and vaulted ceilings. They are constructed and kept in good condition to enable effective decontamination in the case of a sizable leak. Before being disposed of completely, all waste from these laboratories must be rendered non-infectious.

The primary tool used to provide containment of infectious aerosols produced by various microbiological operations is the biological safety cabinet. Personal protective gear such as gloves,
coats, gowns, shoe covers, boots, respirators, face shields, and safety glasses is also included in the definition of safety equipment. In conjunction with biological safety cabinets and other devices that hold the agents, animals, or materials being treated with, this personal protective equipment are frequently employed. In order to safeguard those working in the facility and outside the laboratory from infectious agents that may be mistakenly expelled from the laboratory, facility design (secondary barriers) is crucial. The following descriptions of three facility designs are listed in ascending order by level of containment: The fundamental laboratory, the first design, referred to as the basic laboratory, offers open space where work is done with viable biosafety level 1 agents, such as Bacillus subtilis and Naegleria gruberi, which are not linked to disease in healthy adults, and biosafety level 2 agents, such as hepatitis B and salmonellae, which pose a low potential for aerosol hazard to laboratory staff and the environment. Biosafety ratings 1 and 2 are used in basic laboratories. Although work is frequently done on an open bench, several processes are only allowed in biologic safety cabinets. Spaces that are used primarily to support laboratory tasks should be isolated from common areas and general offices to which nonlaboratory workers must frequently have access. The basic laboratory uses biosafety level 2, which varies from biosafety level 1 in that:

1. Laboratory staff are supervised by qualified scientists and have received special training in managing pathogenic pathogens.
2. When work is being done, access to the lab is restricted.
3. With contaminated sharp objects, strict safety measures are taken.
4. In a biologic safety cabinet or other physical containment equipment, specific processes that could result in the creation of infectious aerosols or splashes are carried out.

There is no standard for single-pass directional inward flow of air from a biosafety level 2 laboratory (a system in which air passes through the laboratory space once before being filtered). However, negative air pressure is typically present as well because the majority of microbiology laboratories also operate with potentially dangerous substances. When recirculation would raise the ambient concentration of hazardous compounds, it is advised to employ chemical fume hoods or single-pass air, according to established guidelines, to prevent the buildup of chemical vapors in laboratories. The provisions for access control and a customized ventilation system are the distinctive aspects that set the containment laboratory apart from the basic laboratory. A single module, a group of modules, or an entire structure may house the containment laboratory. The laboratory with maximal containment contains unique engineering and containment elements that make it possible to undertake infectious agent activities that could potentially lead to serious epidemic disease safely. It can be built as an isolated space within a building, though it is typically housed in a distinct structure.

The Central Laboratory of the Mohammed VI University Hospital of Oujda was designed to meet the needs for level 1 and 2 biological analyzes of the population of eastern Morocco and therefore to implement level 2 of biosafety to reinforce the level protection against infectious agents or toxins that can cause serious infections in and outside the laboratory, and to ensure a safe and secure environment is created.

This laboratory has benefited from the installation of a Covid 19 diagnostic unit by qRt-PCR, after obtaining authorization from the Ministry of Health and the support of the National Institute of Hygiene, and this in the compliance with good biosecurity practices. This unit has appropriate equipment for the diagnosis of Covid 19, with qualified personnel trained in the corresponding
technical procedures and safety practices. National laboratory biosafety guidelines are respected and followed in all circumstances.

The Central Laboratory of the Mohammed VI University Hospital of Oujda is working in this context by setting up a level 3 biosafety level to increase the level of protection against infectious agents or potentially transmissible toxins. Indeed, the central laboratory service has set up a risk management system with a process of continuous and regular evaluation of the risks related to the various physicochemical and biological factors. This system is based on the implementation and monitoring of quality indicators and the calculation of risks including quantifiable parameters defining the degree of seriousness of each identified risk, its frequency and its detectability. In addition, the laboratory has implemented a continuous improvement system with effective corrective and preventive measures. The final objective is therefore to collect all the necessary information and to assess the nature, severity and impact of exposure to one or more occupational hazards present in the workplace or resulting from the spread of these risks, and to identify the appropriate tools and means of control to limit the risks to an acceptable level.

No single biosafety cabinet, facility or method can guarantee safety unless the operator uses safe techniques, which are based on sound information and adherence to the standard operating procedures in place.

Safety training in the laboratory must be repeated regularly and adapted to the evolution of risks. In addition, specific training for certain positions is mandatory, such as autoclave certification. Within the framework of medical prevention, the medical surveillance of the personnel is compulsory according to a rhythm of medical visits at least annual.

Any intervention of external personnel must be carried out outside the periods of activity and after decontamination of the premises. The laboratory manager should draw up a prevention plan with the representative of the external company.

To ensure its alignment with international standards, the central laboratory of the CHU Mohammed VI in Oujda has been designed to meet the various strictest structural and architectural requirements. In addition, he has set up, in collaboration with the hygiene service and the biomedical service of the CHU, an extensive training program including all the necessary practical aspects:

**Laboratory specifications:**

First, Laboratory access doors are lockable if the hallway or area is not restricted. The access doors to the laboratories are equipped with an automatic closing system if they give direct access to a public place. Second, furniture is made to make cleaning and the pest control program easier. Also, having a sink for hand washing and disinfection is a need for laboratories. Besides, the crew has access to coat racks or changing facilities for protective clothing. Street apparel is kept separate from protective clothing. Last, work surfaces are simple to maintain, waterproof, and resistant to organic solvents, disinfectants, and decontamination agents.

**Security equipment:**

The room is located away from doors, windows, air intake and exhaust grilles, and locations of frequent circulation; it has a class I or II microbiological safety enclosure. Its installation avoids
upsetting the equilibrium of air currents in the workspace. Further, if steam sterilization is used to inactivate waste and/or leftover biological components, an autoclave is offered in a room next to the laboratory. Furthermore, the laboratories have access to the centrifuges that are employed. In the absence of this, the tubes or rotors must be sealed.

**Work practices and waste management methods:**

Only those who have been authorized by the manager and are aware of the hazards are permitted access to the laboratories. Moreover, it is necessary to wear protective clothing. Outside of the laboratories, this protective apparel is not allowed to be worn and gloves are available to laboratory personnel. Besides, all windows are closed for the duration of the trial. Viable pathogenic and/or genetically altered (micro-)organisms are physically contained in closed systems other than during handling (tubes, boxes, etc.). In addition, Devices for mechanical pipetting are employed. However, mouth pipeting is not permitted. Also, in laboratories, it is not permitted to consume food or beverages, smoke, handle contact lenses, use cosmetics, or store anything meant for human consumption. Too, it is necessary to maintain a register listing all the pathogenic and/or genetically modified organisms handled and retained and control measures and protective equipment are checked appropriately and regularly. Experimenters wash their hands before leaving the laboratory for another activity and whenever necessary. Additionally, whenever biological material is spilled and when the work is over, work surfaces are decontaminated with an appropriate disinfectant. A notice made available to staff details the directions for using disinfectants and defines the type of disinfectant to be used, its concentration, and the contact time depending on the desired purpose. Also, staff training on biosafety aspects is organized as well as monitoring and regular updating. Besides, a biosafety manual or written instructions are created and adopted. Employees are required to study the instructions on work practices and are notified of the specific hazards to which they are exposed. The appropriate course of action is made abundantly evident in the laboratory in the case of an accident. Finally, incubators, refrigerators, freezers, and liquid nitrogen cryopreservators that house biological material with a risk rating of two or above are marked with the "Biological hazard" pictogram.

The safety equipment (primary barriers) includes biological safety cabinets and a variety of enclosed containers. The biological safety cabinet is the principal device used to provide containment of infectious aerosols generated by many microbiological procedures. Safety equipment also includes items for personal protection such as gloves, coats, gowns, shoe covers, boots, respirators, face shields, and safety glasses. These personal protective devices are often used in combination with biological safety cabinets and other devices which contain the agents, animals, or materials being worked with. Facility design (secondary barriers) is important in providing a barrier to protect persons working in the facility and outside the laboratory from infectious agents which may be accidentally released from the laboratory.

**5. Conclusion**

Medical testing laboratories are distinct and specialized workplaces that can present special infectious disease risks to anyone in or around them. For the wide range of laboratory activities undertaken with a variety of domestic and foreign infectious agents, and to eliminate or decrease
the rate of infections and contaminations, national and international guidelines and standards define four levels of laboratory containment in terms of hygiene and biosafety. In this context, and to create a safe and decontaminated environment, the central laboratory service of the CHU Mohammed VI of Oujda has set up a very efficient system which meets a very strict level of requirement and quality on the structural level and functional. In addition, he is working on a project to develop a biological safety level 3 to be able to accomplish his mission of diagnosis and research on infectious agents or toxins likely to be transmitted by air and to cause potentially fatal infections both inside and outside the laboratory. However, the involvement of staff is fundamental and decisive in overcoming all its constraints and challenges

References

(1) Overview [generalist | immunology | microbiology and virology | management/administration and training] Biosafety Measures in the Clinical Laboratory

https://revues.imist.ma/index.php/NJSV