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PROFESSIONAL RISKS FACED BY MICROBIOLOGICAL LABORATORY WORKERS AND THEIR MITIGATION MEASURES

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Abstract. The publication analyzes possible emergency situations that can occur when working with microorganisms; this confirms the presence of a certain level of risk that can develop in work with pathogenic biological agents of I-II groups. A high level of professional training and knowledge of potential sources and causes of contamination can reduce the level of professional risks faced by laboratory employees when studying properties of microorganisms - infectious agents of bacterial nature.
Key words: biosafety, safe work practices with PBA, accident, bacterial aerosol, hazardous biological facility, training.

Professional risks at hazardous biological facilities can be reduced during the hiring process when selecting staff for microbiological laboratories [11, 12]. Hiring consists of several components including health assessment of the candidates – potential microbiological laboratory employees, assessment of their primary training and specialization as well as further enhancement of their practical skills when working at the laboratory.

As practice shows, hazardous facilities [4] must have a guidance and regulatory package including necessary licenses, instructions, sanitary rules, guidelines and recommendations. The regulatory documents that are currently available call for a specific procedure regarding employee access to works that involve pathogenic biological agents (PBA) [2, 3] at a hazardous facility. The facility must be equipped with effective engineering, technological and biosafety systems, physical protection devices, and a fire alarm system. The laboratory workers at a hazardous biological facility must receive a high level of specialized professional training on biosafety, microbiology of bacterial and virus infections, and epidemiology of infectious Every 5 years, the staff must be certified for their current positions and undergo professional re-training. Access to the works must be authorized by a decree of the facility company director. (S)he must not have any medical contraindications to specific vaccines or medical drugs as well as to

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individual respiratory protection devices. The employees hired for microbiological laboratories are expected to be in a stable psycho-emotional state [11].

Unfortunately, it is sometimes impossible to reveal deviations in the health of a job candidate during the mandatory medical exam conducted when hiring a new employee at a hazardous biological facility; it happens due to a desk-top approach of some healthcare specialists. This may result in malperformance at work. For a more objective assessment of health and professional skills of current or potential employees, it is advisable to carry out primary professional testing directly at a microbiological lab before providing access to work with PBA of I-II groups followed by regular testing in the course of employment.

Long-term observations at the biosafety laboratory of the State Research Center for Applied Microbiology and Biotechnology have shown that in employees working with the microorganisms of I-IV groups, the sense of danger is dulling over years. The employees are starting to disregard simple biosafety requirements, such as daily preparation and control of a working concentration of disinfecting solutions, daily wet cleaning, regular use of bacterial irradiators, etc.

In theory, most employees that work with microorganisms know sanitary rules and requirements which they prove at biosafety trainings when filling out test answers. However when it comes to trainings at damage control laboratories, they often get confused when it comes to emergency procedures and sometimes even forget about some biosafety requirements (e.g.: disinfection of gloves in a disinfecting solution when taking off parts of an antibubonic costume).

Introduction of LAF biosafety boxes at laboratories has somewhat decreased the level of professional risk [6, 8] thus starting a discussion about a high level of employee protection. Nevertheless, a human factor is the key in ensuring safety when working with PBA since a human cannot be excluded from the study of microorganisms [5, 11]. This is proved by the World Health Organization (WHO) which states that "…no biosafety box or other device or method can guarantee safety if a user does not follow the safety procedures based on awareness and understanding…" [8].

In our opinion, the laboratory workers dealing with PBA of I-IV-groups must undergo professional re-training every 5 years. This training should include in-class sessions and practical workshops aimed at giving theoretical and practical knowledge about safety measures when working with PBA, use of new laboratory equipment, emergency damage control and recovery. Emergency management trainings should be carried out on a regular basis in a laboratory setting or a bigger area.

Current working practices used when dealing with infectious agents, engineering and technological systems, and medical activities help to significantly reduce professional risks by preventing potential cases of laboratory contamination. Unfortunately, these measures cannot completely exclude professional risk. Cases of laboratory infection still take place; their analysis is available in professional literature [6, 10, 14-18].

Work with PBA of I-II groups is always connected with the risk of emergencies and, as a result, laboratory acquired infection of the staff and possible environmental contamination [6, 10, 14-18]. At microbiological laboratories, there is a risk of staff infection with microorganisms used in work studies [9]. The necessity for protection to people and the environment when working with the infectious agents has increased with the growth of genetic studies.

There are at least 3 groups of risk mitigation activities aimed at ensuring work safety:

Control and organization;

Medical and biological;

Engineering and technological;

These measures, when properly combined and implemented, ensure relative safety of the staff and the environment [1, 5, 11].

Earlier we have studied several cases of laboratory acquired infections described in professional literature that took place when working with the Siberian plague agent (B. *Anthracis*) [12]. There were several reasons for that.

Firstly, this microorganism in included in the list of biological agents that can be used as biological weapon [7]. Its potential application as bacteriological weapon in local wars, armed conflicts or acts of terror makes it an urgent issue from the point of national biological safety.

Secondly, not only medical workers encounter this microorganism but also veterinaries, farm workers, etc. Consequently, the area of potential infection and biosafety measures implementation is growing.

The fatal Siberian plague infection is mainly introduced through lungs [5, 12, 13]. It is accompanied with skin and less often mucous membrane lesions. Some cases of Siberian plague occur from contact with anchored heating and colored swab of culture B. *Anthracis* [16]. Infection can also result from mishandling syringes when treating the animals infected with Siberian plague cultures [5]. There is a known case of carbuncular fever in a laboratory worker that took place in the USA in March 2002 [15]. The sanitary and epidemiological rules [2, 3] used as the main regulatory document in work with PBA in the Russian Federation describe all possible operations conducted with the microorganisms and infected animals. The document lays out the procedure to control damage from emergencies which may occur when working with

PBA. The accuracy of actions of a microbiological laboratory employee combined with other measures decreases the risk of PBA infection and ensures safety; the level of accuracy often depends on the employee's level of competence, ability to use the equipment, and the knowledge of various potential sources and mechanisms of infection.

The following materials can serve as potential sources of infection in a laboratory setting:

Cultures of infectious agents,

Clinical and microbiological samples,

Contaminated samples of environmental media (soil, water, etc.),

Infected organs and tissues of laboratory animals.

Laboratory acquired infections result from a combination of factors centered around PBA getting outside of a biosafety box as a result of an accident or biosafety rules violation.

Today the possible sources and routes of the microbiological laboratory staff infection are well understood [5, 8, 15]. Infection can transfer during certain operations in a course of laboratory works; some of these works have known quantitative indicators of environmental contamination [16, 17].

In his works, Pike R.M. analyzes the sources and causes of 3921 cases of laboratory-acquired infections [15]. His studies show that infection takes place mostly as a result of s accidents during operations with microorganisms (17.9%) as well as during infecting and dissection of infected laboratory animals (16.9%), formation of bacterial aerosol during centrifugation or destruction of a cell (13.6%) and other unknown reasons (20%). When working with pipettes, the possibility of aerosol formation is rather high. Infection can take place when sucking in or inhaling infected material when using your mouth in the work with a pipette, in violation to the safety rules. Today such violation is almost impossible due to new devices (syringe, automatic device) which exclude contact with mouth.

A drop falling from the tip of a pipette, especially on a smooth solid surface, can also serve as a source of infection. For this reason, the surface of the table when working with PBA must be covered with a tissue placed in a tray and dipped in a disinfecting solution. The last drop in a pipette can also be a source of hazard when it is blown out into a container. Aerosol can also form when infectious materials are prepared with the help of a pipette (a step-by-step transfer from one test tube to another followed by mixing). The risk decreases significantly if no bubbles or foam appear. The tip of the pipette must always be below the level of liquid in a vessel and flow down the inner wall of a vessel.

The risk of bacterial aerosol formation appears when taking out a test tube from a test tube or a bottle. The risk is even higher when taking out a wet cotton-and- gauze plug since it

always results in aerosol formation [5].

Rubber and plastic screw-plugs can also create aerosol during opening especially if they were in contact with an infectious material since the liquid film breaks when removing the plug. Opening of a Petri dish can also lead to the forming of aerosol. If water condensate on the lid touches the edges of the dish, then removal of the lid breaks the liquid film and creates aerosol. Additionally, infection can take place not only as a result of an accident, but also during routine operations with microorganisms. For example, infection can happen as a result of rule violation when preparing a working solution of disinfectants or when using solutions that have lost their activity [10].

The above situations should be regarded as reference material for in-class trainings, workshops and laboratory trainings. Laboratory staff should be trained by the laboratory head to adequately perceive and assess a hazardous situation. This can help the microbiological laboratory staff reduce occupational risks.

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