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Abstract. The right to life and health of employees is a fundamental right, and the employer is obliged to create safe working conditions. Specifically, ensuring the safest and healthiest working environment for employees is crucial for their well-being and safety. The aim of this article is to assess problematic aspects related to the protection and management of occupational health and safety in the sphere of laboratory medicine. It specifically addresses the evaluation of potential biological, chemical, radiological, and physical hazards in the field of laboratory medicine, their management mechanisms, and preventive measures implemented for risk assessment.

Key words: Laboratory Health and Safety, Biological threat, Chemical threat, Physical threat

1. Introduction

During the pandemic period, we have witnessed the vital importance of laboratory diagnostics and its subsequent implementation. Additionally, laboratory health and safety are crucial aspects. To achieve this, the presence of appropriate infrastructure and technologies, as well as competent specialists equipped with the necessary knowledge and skills in these technologies, is essential. Unfortunately, Georgia is facing a shortage of qualified specialists in this field. The knowledge of laboratory health and safety is imperative for those engaged in laboratory work.

The Laboratory Biosafety Manual was first published by the World Health Organization (WHO) in 1983 [1]. The manual provided recommendations and guidelines for countries to establish and implement the main principles of biological safety and work safely with pathogenic microorganisms under geographically specific conditions in laboratories. In 1993, the second edition of the manual was released [2]. The recommendations in this manual were widely adopted and applied in practical work in many countries. The third edition introduced the concept of biological risk management, which includes the containment of genetically modified microorganisms, waste disposal, or diversions, that could lead to incorrect usage of these agents and pose risks to public health. This edition also included information on

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laboratory biosafety based on the experience gained from the Laboratory Biosafety Manual published by WHO in 1997 [3].

The health problems associated with individuals connected to the field of laboratory medicine are primarily related to the types of hazards present in the laboratory. These hazards include physical, chemical, biological, radiological, and psychological risks.

Physical hazards in the context of laboratory medicine can manifest as various types of injuries to the body. A physical factor can refer to the environmental or occupational factors present in the workplace or processes, which can pose physical harm either directly through physical contact or indirectly through the use of physical agents. These physical hazards can lead to accidents, injuries, occupational illnesses, prolonged exposure effects, or changes in health indicators and behaviors.

2. Materials used in laboratories

In a medical laboratory, professional activity is associated with the use of various chemicals. The laboratory personnel's chemical exposure can occur through different routes, which can be quite hazardous, as sometimes the effects are immediate, while in other cases, they may appear later on. The personnel's exposure to chemicals in the laboratory can happen through various means, and it is essential to be cautious, as the effects can be instantaneous in some situations, while in others, they may go unnoticed.

In a chemical laboratory, various chemical substances are used, some of which may pose a risk to human health if not used correctly. Chemical reagents can come in three forms: solid, liquid, and gas. The use of chemical reagents should be done according to the manufacturer's instructions. In every laboratory where chemicals are used, information regarding the hazards of the substances should be stored, including information about the hazards of storage or other types of chemical safety concerns. The manufacturer prepares a technical document called a Material Safety Data Sheet (MSDS) that provides detailed information about the hazards and necessary precautions for handling the substances. It is essential for the personnel to follow these guidelines to ensure their safety.

Chemical factors in a workplace encompass the presence of chemical substances and compounds that may pose a risk to human health and cause occupational hazards or occupational illnesses, whether temporarily or chronically. [8] The assessment of human health and environmental effects has led to the identification of classes of toxicity and hazard levels for different chemical substances. Health care waste can be highly infectious, particularly when contaminated blood or other body fluids result from health care activities. An injury from used sharps (needles, blood collection and infusion sets, and lancets) can transmit serious infectious diseases—hepatitis B, hepatitis C, HIV, and others—to you and other health care support staff—cleaners, waste handlers, laundry workers, and others. If disposed of improperly, scavengers may collect and recycle the used sharps, spreading infectious diseases to patients and the community. Frequently, children are the unfortunate victims of needle-stick injuries from syringes and needles. Another risk is from expired medicines that are often collected and resold if they are not disposed of, creating another public health risk. Finally, unauthorized and improper burning and/or dumping of health care wastes pollutes the air with dangerous gases, contaminating the soil and water with heavy metals and other toxic chemicals, that can enter the food chain, causing respiratory tract diseases and cancer [6] All chemical substances present in a laboratory are considered hazardous. The interaction of chemicals with human health and the environment determines their toxicity classification and hazard levels. Within a laboratory, different body parts such as the eyes, skin, inhalation, and others may be affected. [5].

3. Analysis

The employees of the medical laboratory constantly deal with biological hazards. The risks associated with biological hazards can lead to various health issues, including allergic reactions, infectious diseases, and others. The risks of biological hazards are particularly high during medical procedures. Laboratories that handle numerous samples and perform various procedures are exposed to these risks. During these processes, the risk of infection and contamination is significantly higher for the personnel and individuals working in the laboratory.

All diagnostic and healthcare laboratories should adhere to Biosafety Level 2 or higher. Clinical or healthcare facility laboratories do not have the opportunity for full control over the conditions under which they receive samples, so employees may inadvertently be exposed to a higher-risk group of microorganisms. This possibility should be taken into consideration during the planning and implementation of safety measures or policies. Accreditation is required for clinical laboratories in some countries.

Each laboratory must establish and enforce a biosafety or operational safety program that defines known and potential hazards and specifies specific practices and procedures to minimize these hazards. The laboratory should have as part of its infrastructure a designated space for biosafety, as well as good microbiological techniques.

A biological hazard refers to the presence of pathogenic and non-pathogenic microorganisms in the overall environment that can potentially cause harm to human health and disrupt work activities temporarily or chronically.

The use of laboratory safety protocols helps mitigate the risk when working with biological hazards. Laboratory management should prioritize the well-being of the personnel by focusing on occupational health monitoring, especially in relation to professional exposures and health surveillance for potential adverse effects.

Exposure to radiation at various doses can have different effects on human health. Individuals are already exposed to a certain level of background radiation. While radiation is omnipresent, an increase in radiation dose has the potential to create health problems for individuals. Therefore, continuous radiation monitoring is necessary to ensure safety and minimize potential risks.

One crucial factor to consider for ensuring the safety of laboratory personnel is human errors. Therefore, it is necessary for laboratory employees to undergo training and receive guidance on safety issues before starting their work in the laboratory. Personnel training should always include information about proper handling of hazardous procedures and the use of protective methods to minimize the risks associated with them.

It is of utmost importance that laboratory personnel are confident in their safety and have a thorough understanding of the existing hazards and control measures in the well-equipped laboratory to prevent infections, incidents, and unforeseen events.

Proper management of resources is crucial to delivering patient-centered high-quality medical services and ensuring the safety and protection of patients, personnel, and the general public. Inadequate adherence to guidelines poses a risk to the health of both patients and personnel, compromising infection control, toxic exposure, radiation, and other biological hazards. Additionally, the presence of multidrug-resistant microorganisms in healthcare settings further amplifies the risk of spreading infectious diseases [7].

The management of patients in the „Medical center CITO" is carried out in accordance with the Code of Patient Management of the legislation of Georgia. The medical center has a Standard Operating Procedure (SOP) for the management of patients.

The results of exposure to chemical agents and pathogenic agents can include:

- Radioactive contamination
- Burns

- Poisoning with the use of a gas mask
- Prevention of infectious diseases
- Administration of pharmaceutical products (antibiotics, cytostatics)
- Collection of samples with closed liquids
- Collection of samples with chemical and heavy metals [10].

Decommissioning and disposal are often closely related in laboratories. Excess noise, instruments, or their proper handling can be a recurring issue in the laboratory. The majority principle should be that all infectious material is properly decontaminated, undergoes autoclaving, or is disposed of through incineration or laboratory-specific protocols [4].

Accidents in chemistry and biochemistry laboratories are a regular occurrence and have been associated with injuries, property damage, and deaths. However, despite a high prevalence rate of accident involvement reported in previous investigations of academic lab personnel (approximately 30%), little is known about the context in which academic lab accidents occur. Previous findings also suggest a high degree of accident underreporting (25–40%), but again, little is known about this phenomenon. Pilot data was gathered from a convenience sample of 104 students and postdoctoral fellows in chemistry-related fields through an online survey. Results showed a high level of accident involvement (56.7%); of that number, most of those (65.9%) had been involved in multiple accidents. Most accidents involved only personal injuries and happened on a weekday afternoon with other lab members present. The majority of participants reported wearing multiple types of PPE at the time; however, adherence rates for any one type of equipment (e.g., goggles, gloves, coat) was less than 50%. Most (69.6%) reported their accidents to multiple individuals and were at least somewhat or very satisfied (81.2%) with their decision to report. Participants who chose not to report their accidents reported barriers such as beliefs that the accident was not severe, concerns about judgment, self-blame, and not knowing they had to report the accident or how. Implications for safety training and reporting practices are considered [9].

Certification plays a crucial role in high-level laboratories. Laboratory certification involves the systematic examination of all processes and aspects related to ongoing activities and safety (engineering controls, personal protective measures, and administrative controls). The „Medical Center CITO” verifies the functionality and procedures of biosafety measures. The employees of the laboratory and administration have successfully completed training on biosafety issues. The laboratory certification is a guarantee of the quality and safety of operations, which must be regularly conducted by professionals in the respective field. The „Medical Center CITO” has successfully completed the process of accreditation by the "ANAB" for international accreditation. „CITO” has received the national accreditation certificate ISO 15189, issued by the accreditation center, GAC Georgia, which is the only national body for accreditation in Georgia. It has also obtained the international certificate ISO 9001 for quality management and, in 2015, the ISO 15189 certification for medical laboratory quality. „CITO” has been undergoing successful audits since 2005, with recertification taking place every two years.

The analysis database provided in the previous context belongs to the "Medical Center CITO." It is a prominent laboratory in Georgia that continuously assesses risks and safety measures. The „Medical Center CITO” is a leading laboratory in the country, encompassing clinical chemistry and immunology, clinical diagnostics, clinical microbiology, and PCR laboratories. During the Covid-19 pandemic, the „Medical Center CITO” carried out daily disinfection procedures, used disinfection barriers, and implemented additional biosafety measures. decontamination procedures were also performed when it was necessary.

During the pandemic period, additional ID opportunity for individual protection was purchased for the purpose of contact tracing in case of exposure. Employees were provided with free PCR testing once a week. The staff was divided into shifts to avoid contact with

each other, ensuring the uninterrupted operation of the medical laboratory and preventing the spread of the virus.

In the medical center PCR laboratory was already operational and all the necessary standard operational procedure (SOP) existed. With the increase in laboratory capacity, SOP were reviewed, and additional measures were implemented to prevent the risks of biosafety. In laboratories, there should be regular assessment and evaluation of risks, safety protocols, procedures, and employee performance. The laboratory's occupational safety heavily relies on well-trained personnel, and it is crucial for this personnel to undergo comprehensive training in safety. Each laboratory should have written protocols for responding to emergency situations. All employees should know how to behave during a fire and where to find this information.

Employees shall be provided with instructions on occupational safety and methods of self-protection against hazards prior to the execution of hazardous work activities.

All personnel should be informed about any incidents and should be promptly notified of the incident without delay. Information obtained as a result of incident investigation should be utilized in laboratory procedures and response planning for emergency situations.

Medical laboratories should pay increased attention to occupational safety, risk management, and precautions. The laboratory encompasses significant risks, and prevention of laboratory accidents requires high levels of caution and constant vigilance. In certain situations, improper laboratory practices may pose a serious threat to both health and the environment.

4. Conclusion

- Based on inspections and analyses conducted, the laboratory was compliant with occupational safety standards. The personnel working in the laboratory have the capability to provide initial medical assistance, which is essential for the safety of the employed personnel. The laboratory is equipped with a First Aid kit, a first aid room, and necessary supplies for initial medical assistance. Protective clothing and supplies are regularly maintained and inspected.
- The laboratory of "Medical Center CITO" has the potential to effectively adapt to both general and specific medical requirements, in accordance with the high demands of medical investigations and assessments.
- During 2022-2023, the effectiveness of biosafety and operational management methods and mechanisms has been confirmed through both national and local audits and accreditations.

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