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Original Article

Laboratory risk analysis in branch hospital: The L-type matrix

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ABSTRACT

Introduction: Laboratory workers are often exposed to various risk factors, which can be classified as biological, physical, chemical, psychosocial, and ergonomic. This study aims to conduct a risk analysis in the workers of microbiology and biochemistry laboratories of a branch hospital in Istanbul, Türkiye to identify occupational health and safety risks and provide recommendations for measures to be taken.

Methods: The investigators conducted the risk analysis with a five-person team including occupational health and safety experts, a laboratory manager, and technicians. Risk assessments were performed using the L-type matrix 5x5 diagram. The level of risk was determined with the product of probability and severity.

Results: Risk analysis in the microbiology laboratory showed ten risk factors. Three of them had moderate level scores as following "working with xylene", "continuous standing work" and "insufficient free space". The remaining risks have low-risk scores, including "working in a noisy environment, "microscope light and ambient light", "working with blood", "working with feces", "non-ergonomic chairs", "insufficient airflow in the environment" and "continuous presence in a closed space". In the biochemistry laboratory, four were classified as moderate risk, including working in constant standing, exposure to bodily fluids, blood tests for bacteria and viruses and non-ergonomic furniture.

Conclusion: The priority should be to minimize the risks associated with contact with blood and body fluids. This could involve the implementation of strict safety measures and protocols, as well as providing appropriate personal protective equipment to all personnel who may encounter these fluids.

Keywords: Hospital, Laboratory, Occupational Health and Safety, Risk Analyses.

Introduction

Hospital laboratories are essential to treat patients because they deliver precise and quick findings from laboratory tests that aid medical personnel in making diagnoses. The results of laboratory tests constitute the basis for around two-thirds of significant medical decisions, including the admission and discharge of patients from hospitals and the prescription of medications.[1] Laboratory professionals' excellent work influences most medical decision-making by continuously enhancing the quality, scope, and speed of laboratory tests used for medical diagnostics.[2]

Risk analysis is crucial for hospital laboratories to identify potential hazards and implement appropriate risk mitigation strategies to minimize or eliminate risks that could threaten patient safety and laboratory operations. Risk analysis is a systematic process that involves identifying hazards, assessing the likelihood of their occurrence, and determining the potential consequences of such occurrences.[3] Hospital laboratories face various hazards, including exposure to biohazards, chemicals, radiation, and ergonomic hazards.[4]

Effective risk analysis and management in hospital laboratories require the involvement of all stakeholders, including laboratory managers, laboratory personnel, and hospital management. A study by von Kries, et al., highlighted the importance of involving laboratory personnel in risk analysis, as they possess extensive knowledge and experience in laboratory operations.[5] The involvement of hospital management is also necessary, as they provide the necessary resources and support to implement the identified risk management measures.

Risk analysis also plays a crucial role in ensuring regulatory requirements and standards compliance. Hospitals and laboratories are required to comply with various regulations and standards, such as the Occupational Safety and Health Administration (OSHA) standards, the Clinical Laboratory Improvement Amendments (CLIA) regulations, and the International Organization for Standardization (ISO) standards. Compliance with these regulations and standards requires a thorough understanding of the risks associated with laboratory operations and the implementation of appropriate risk management measures.[6]

Laboratory workers are often exposed to various risk factors, which can be classified as biological, physical, chemical, psychosocial, and ergonomic. In order to eliminate or minimize these risks, a series of measures should be taken, starting with the design and construction stages of laboratories, establishing a safety infrastructure, informing employees about potential hazards, and providing laboratory safety training. Therefore, it is mandatory to conduct risk assessment studies in laboratories.[7]

This risk analysis study by Karahan and Aydoğmuş (2023) included identifying and categorizing 50 risks. The risks were assessed and rated and classified into high, medium, and low categories. Specifically, it was found that 30 risks (60%) were classified as high risk, 18 risks (18%) were categorized as medium risk, and 2 risks (4%) were deemed to be low risk.[8]

This study aims to conduct a risk analysis in the microbiology and biochemistry laboratories of a branch hospital in Istanbul to identify occupational health and safety risks and provide recommendations for measures to be taken. The originality of this study lies in its focus on a branch hospital that provides services in the field of heart disease. Furthermore, the study will provide laboratory personnel with an understanding of all the occupational risks they are exposed to and serve as a guide for minimizing these risks and planning preventive measures.

Methods

A descriptive research design was conducted in the microbiology and biochemistry laboratories of three branch hospitals in Istanbul Türkiye in January 2023. The hospital was chosen as an easily accessible hospital for researchers as a convenient sample. Risk assessments were performed using the L-type matrix 5x5 diagram, a commonly used method for evaluating cause-and-effect relationships due to its simplicity. This method involves assessing the probability of an event occurring and the severity of its consequences if it does occur. The L-type matrix 5x5 diagram has been used in previous studies to evaluate risks in various settings, including healthcare facilities.[9,10] In this study, the L-type matrix 5x5 diagram was used to identify potential risks in the hospital's microbiology and biochemistry laboratories, which could help guide the development of effective risk management strategies.

The investigators conducted the risk analysis with a five-person team including occupational health and safety experts, a laboratory manager, and technicians. The Laboratory Information Form designed by researchers consisted of 10 questions. This form was filled out with general information about laboratory type, conducted tests, number of equipment and personnel, physical structure, chemical materials, noise, and chemical/ physical/ biological hazards.

Using an L-type (5x5) matrix, occupational health and safety risks were evaluated through the Medical Biochemistry Laboratory Safety Guide to identify potential hazards in or outside the laboratory. Risks were considered under six headings: physical, ergonomic, chemical, biological, psychosocial, and noise. The risks were summarized in a table, including the activities, hazards, affected persons, outcomes, probability value, severity value, score value, and necessary precautionary measures. The L-type (5x5) matrix typically consists of five columns and five rows, with each row representing a different aspect of laboratory risk analysis (table 1). The probability column assessed the probability of the hazard occurring. The severity column assessed the potential impact of the hazard on laboratory personnel and the environment. This can be ranked on a scale from low to high, depending on the possible consequences of the hazard. The risk = probability x severity formula will be used to determine the level of risk.[11]

The risk matrix is divided into three bands. A lower band, which may often be coloured green, represents low risks, which are tolerable; therefore, no risk treatment measures are needed. A middle band, which may be coloured orange, represents moderate risks to be reduced to as low as reasonably practicable (ALARP). An upper band, which may be coloured red, represents high risks, which are typically intolerable and, therefore, risk treatment is essential.[12]

Depending on which coloured band the risk rating is assigned to, the assessor decides whether or not to treat the risk and what actions are needed.[13]

Table 1: 5x5 L-type risk decision matrix

		SEVERITY (IMPACT)				
		VERY LOW 1	**LOW 2**	**MEDIUM 3**	**HIGH 4**	**VERY HIGH 5**
		Minor injuries or discomfort. No medical treatment.	Injuries or illness requiring medical treatment. Temporary impairment.	Injuries or illness requiring hospital admission.	Injuries or illness resulting in impairment	Fatality
PROBABILITY	Expected to occur regularly under normal circumstances **5**	5	10	15	20	25
	Expected to occur at some time **4**	4	8	12	16	20
	May occur at some time **3**	3	6	9	12	15
	Not likely to occur in normal circumstances **2**	2	4	6	8	12
	Could happen, but probably never will **1**	1	2	3	4	5

	Extreme risk	Immediate attention & response needed
	Moderate risk	Requires response development, but not quantification
	Low risk	Requires active or passive acceptance

Results

Risk analysis in the microbiology laboratory showed ten risk factors as follows: 1. risk "working in a noisy environment" (score=2), 2. risk "microscope light and ambient light" (score=2), 3. risk "working with xylene" (score=8), 4. risk "working with blood" (score=4), 5. risk "working with feces" (score=4), 6. risk "non-ergonomic chairs" (score=4), 7. risk “continuous standing work” (score=12), 8. risk "insufficient free space" (score=6), 9. risk "insufficient airflow in the environment" (score=2) and 10. risk "continuous presence in a closed space" (score= 4). While three of the ten items (risks 3, 7, and 8) had higher risks than the others, the remaining seven items (risks 1, 2, 4, 5, 6, 9, and 10) were found to have low-risk levels (Table 1).

Upon consideration of the laboratory examinations and matrix results, biological risks are at the forefront. The severity of risks arising from contact with blood is particularly noticeable in Table 2. In addition to these risks, the ergonomic aspects of the laboratory are also of significant importance.

According to the risk analysis performed in the biochemistry laboratory, ten risk factors were identified, and the likelihood and severity of each risk factor were determined by multiplying their occurrence probability and impact (table 3). The results were presented in a matrix, classifying the risks into high- and low-risk categories. Among the ten factors, four were classified as moderate risk, including working in constant standing (risk score=12), blood tests for bacteria and viruses (risk score=10), working with gaita (risk score=10), and non-ergonomic furniture (risk score=9).

Table 2: The L-type (5x5) matrix of findings of risk analysis in the microbiology laboratory

No	Activity	Danger	Person at risk	Consequences	Probability	Severity	Risk	Measure
1	Working in noisy workplace	Noisy	Relevant workers	Ear difficulties	1	2	2	Maintenance and repair of devices that exceed the threshold limit. Performing audiometric tests on employees
2	Microscope light and ambient light	Light	All workers	Eye disease, headache	1	2	2	Adjusting the ambient light Frequency of breaks
3	Working with xylene	Occupational disease	Relevant workers	Chest pain Pulmonary edema	2	4	8	Employee training Wearing personal protective equipment
4	Working with blood	Exposure to blood	Relevant workers	Transmission of AIDS hepatitis viruses	1	4	4	Employee training Wearing personal protective equipment
5	Working with gaita	Exposure to bodily fluids	Relevant workers	Hepatitis a virus	1	4	4	Employee training Wearing personal protective equipment
6	Non-ergonomic furniture	Occupational disease	Relevant workers	Musculoskeletal problems	2	2	4	Using ergonomic office chairs
7	Continuous standing work	Occupational disease and fatigue	Relevant workers	Varicose Veins, Musculoskeletal problems	4	3	12	Establishing rest hours The use of the shift system
8	Limited free space	Falling and crashing	All workers	Injuries, Musculoskeletal problems	2	3	6	Placing items in an orderly manner Freeing up sufficient free space
9	Low airflow	Stress due to a lack of oxygen	All workers	Headache, stress	2	1	2	Placing items in an orderly manner Frequency of breaks
10	Staying indoors all the time	Concentration problems and accidents	All workers	Job stress, injuries,	2	2	4	Adjusting rest hours making encouraging practices

The remaining six factors were classified as low risk, which included working with chemicals (risk score=4), working in a noisy environment (risk score=2), working in areas with cables on the floor (risk score=1), working in closed spaces (risk score=2), working with lung fluids (risk score=4), and inadequate air circulation in the work environment (risk score=6). The matrix analysis and biochemical laboratory examination findings indicated that biological dangers are paramount. Blood and bodily fluid contact pose severe health concerns, as is evident. Ergonomic risks have a high-risk rating, with non-ergonomic seats and extended standing.

Table 3: The L-type (5x5) matrix of findings of risk analysis in the biochemistry laboratory

No	Activity	Danger	Person at risk	Consequences	Probability	Severity	Risk	Measure
1	Working with chemicals	Contact with harmful chemicals	Lab technicians and specialists	Skin problems	2	2	4	Provide training on wearing appropriate gloves and giving first aid during chemical splashes.
2	Working in a noisy workplace	Noisy	Lab technicians and specialists	Ear difficulties	1	2	2	Maintenance and repair of devices that exceed the threshold limit. Performing audiometric tests on employees
3	Working with cable on the ground	Falling	All workers	Injuries	1	1	1	Cable storage and plate placement
4	Staying indoors all the time	Light deprivation	All workers	Occupational disease and vitamin d deficiency	2	1	2	Ensuring that workers enjoy sunlight during breaks and, if necessary, administering vitamin D supplements
5	Working with lung fluids	Transmission by inhalation	Lab technicians and specialists	Tuberculosis and lung diseases	1	4	4	Using a fume hood and the proper masks
6	Working in constant standing	Occupational disease and fatigue	Lab technicians and specialists	Varicose Veins, Musculoskeletal problems	4	3	12	Establishing rest hours The use of the shift system
7	Bacteria and virus test in blood	Exposure to blood	Lab technicians and specialists	Bacterial and viral disease	2	5	10	Employee training Wearing personal protective equipment
8	Working with gaita	Exposure to bodily fluids	Lab technicians and specialists	Bacterial and viral disease	2	5	10	Employee training Wearing personal protective equipment
9	Low airflow	Stress due to a lack of oxygen	All workers	Injuries	3	2	6	Setting up break times and providing adequate ventilation
10	Non-ergonomic furniture	Occupational disease	Lab technicians and specialists	Musculoskeletal problems	3	3	9	Using ergonomic office chairs

Discussion

Hospital risk assessment is an essential step in occupational health and safety activities. By examining risk assessments, appropriate actions are taken, and workers are trained to prevent these risks. Employees receive help with problems by learning to manage risks and protect against them during this training. The risks in the microbiology and biochemistry lab of a training and research hospital in Istanbul were filled into two x-type matrices for risk assessment. Findings showed that biological risks are the most important. In the microbiology lab, samples from human fluids and tissues are used to perform culture tests, parasite tests, and tests to identify bacteria and viruses. In parallel with our findings, previous studies demonstrated that the routine activity in a microbiology laboratory offers many risks, mostly biological influencing the health of its staff, visitors, and the community.[14,15,16] In contrast, the biochemistry lab uses these samples to test hormones, hemograms, biochemistry, and coagulation. In addition, the hospital for which risk analysis is performed is a branch hospital

providing services in the field of cardiovascular disease, which brings biological risks to the fore due to the risk of contamination with blood and body fluids. While chemical and physical risks rank first in other studies,[17] it is noteworthy that psychosocial risks stand out in addition to biological risks in this study. Previous studies categorized similar risks into diverse risk groups. Demirkan identified biological, physical, psychosocial, chemical, and ergonomic dangers such as infections, stab wounds, hearing loss, violence, stress, chemical exposure, explosion/fire, and musculoskeletal disorders.[18] However, previous research identified biological, psychological, ergonomic, physical, and chemical risk categories. The most stated risks are infection, stress, an airless indoor environment, noise, chemical exposure, and violence.[19]

Conclusions

The current study aimed to conduct a risk analysis in the microbiology and biochemistry laboratories of a branch hospital in Istanbul to identify occupational health and safety risks and provide recommendations for measures to be taken.

Risk analysis in the microbiology laboratory showed ten risk factors. Three of them had moderate level scores as following "working with xylene", “continuous standing work” and "insufficient free space". The remaining risks have low-risk scores, including "working in a noisy environment, "microscope light and ambient light", "working with blood", "working with feces", "non-ergonomic chairs", "insufficient airflow in the environment" and "continuous presence in a closed space". In the biochemistry laboratory, four were classified as moderate risk, including working in constant standing, exposure to bodily fluids, blood tests for bacteria and viruses and non-ergonomic furniture The remaining six factors were classified as low risk, which included working with chemicals, working in a noisy environment and many cables on the floor, low airflow and working with lung fluids and staying all the time indoors.

The priority should be to minimize the risks associated with contact with blood and body fluids. This could involve the implementation of strict safety measures and protocols, as well as providing appropriate personal protective equipment to all personnel who may encounter these fluids. Additionally, efforts should be made to improve ergonomics in laboratory settings, such as by providing ergonomic chairs and regular breaks for personnel who are required to stand for prolonged periods of time. By taking these steps, the overall risk profile of the laboratory can be significantly reduced, ensuring a safer and more efficient working environment for all personnel involved.

Although this study was conducted in a cardiology branch hospital, this situation creates a limitation as all laboratories generally have similar characteristics.

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