ENSURING SAFE AND HEALTHY WORKING CONDITIONS FOR HEALTHCARE WORKERS

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Abstract: *Healthcare industry workers are exposed to numerous risks of injuires, but even more to those of work-related illnesses and diseases. Workers at all levels of healthcare are exposed to biological, chemical and physical hazards, carcinogens and mutagens, psychophysical loads and other harmful factors. In order to be able to take care of their patients' health and the quality of provided services, healthcare workers themselfves need to have a safe and healthy workplace environment. The risk assessment in the workplace and workplace environment represents the basic tool that provides both the employer and the employee with an insight into the overall status of safety and health at work, and helps to create such working conditions that would reduce the number of work-related injuries, illnesses and diseases, thus ensuring physical, psycological and social well-being of workers. By creating a safe workplace environment, and by taking care of workers' health, we contribute to higher quality healthcare services.*

Keywords: *healthcare workers, occupational safety*

1. INTRODUCTION

Due to the nature of their job, the employees in community healthcare centres are exposed to a lower level of hazards and harmful factors than those working in hospitals and clinics. Nevertheless, even such threats and hazards may endanger the employees' health and cause its serious and permanent impairments. Healthcare services provided in community healthcare centres can be divided into: (1) preventive and (2) curative. As the services provided in community healthcare centres include diagnostics and treatment at the primary level of helathcare, the centres are accordingly equipped with all diagnostic systems required for this level of healthcare services. Healthcare community centres also include the diagnostic laboratory service centres, where healthcare laboratory technicians work.
This paper is about the risk assessment in the workplace of healthcare laboratory technicians. The healthcare laboratiory employees are exposed to different types of hazards and harmful effects on a daily basis. Since they use a large number of chemicals of different properties (toxic, corrosive, flammable, etc.), and can even get in touch with potentially harmful biological materials, special attention is paid to dealing with chemical and biological materials [1, 2]. The risk assessment process was based on the continuous and systematic identification and evaluation of all the factors that might occur during the work in this workplace and cause work-related injuries, illnesses and diseases. Two risk assessment methods were used: the 5x5 Risk Matrix (OHSAS) and the Risk Assessment Method developed by the Higher Education Technical School of Professional Studies in Novi Sad [3, 4].
The risk assessment performed using the 5x5 Risk Matrix (OHSAS standard) encompasses the assessment of the likelihood of the occurence of a work-related illness or disease (on a five-point scale) and the assessment of potential consequences of a work-related illness or disease (there are also five levels of the severity of work-related illnesses and diseases), and depending on the likelihood and severity of consequences of a work-related illness or disease, the risk isranked on a five-point scale (insignificant, i.e. very low, low, moderate, high and extremely high). The Risk Assessment Method developed by the Higher Education Technical School of Professional Studies in Novi Sad (HETSPS NS), implies the calculation of risk levels using the equation R = V x F x Š x B, where V represents the likelyhood of the occurrence, F – the frequency of the exposure to a risk/hazard, Š – the level of possible harm, and B is the coefficient representing the number of people exposed to the risk at the same time. This method has introduced eight levels of probability (V), seven levels of the frequency of the exposure to a risk/hazard (F), eight levels of possible harm (Š), and five levels of the influence of the number of people exposed to the same risk at the same time (B), whereas each ranking is assigned a numerical value. The product of harmful factors therefore provides a numerical

value of the risk (R), based on which the risk is ranked on a four-point scale (insignificant, low but significant, high and unacceptable) [3, 4].

2. THE RISK ASSESSMENT IN THE WORKPLACE OF A HEALTHCARE LABORATORY TECHNICIAN

2.1. The description of technological and work processes, instruments, tools, personal protective equipment, materials and raw materials

All the activities in the healthcare laboratory that are performed by healthcare laboratory technicians can be divided into three phases: (1) pre-anlytical phase (the reception or collection of specimens) (2) analytical phase (proper and safe dealing with biological materials and relevant chemicals) (3) post-analytical phase (reporting results).
The workplace environment in which healthcare laboratory technicians do their job consists of a series of separate rooms, where the following take place: (1) the reception of patients and collection of necessary specimens, (2) biochemistry analyses, (3) hematology analyses, (4) urine analyses, (5) cleaning and sterilisation of glassware. The employees have a sitting room at their disposal as well, and their restroom is separate from that of their patients. The rooms where the work is done have a sufficient ceiling height and floor area. The floor coverings are easy to clean and disinfect, and they are less slippery than tiles. The thresholds are marked with red colour. The walls are painted with oil paint, which makes them easy to clean and disinfect. Both working and ancillary premises are air-conditioned.
The equipment used: BT 1000 biochemistry analyser, Cell-Dyn 1700 hematology analyser, Uriscan Pro II urine analyser, Gilford Stasar III spectrophotometre, Microlab 200 photometre, microscope, centrifuge, distillation apparatus, dry heat steriliser, laboratory mixer, digester, hotplate, glassware and utensils (test tubes, pipettes, etc.), vacutainer tubes and needles; different types of desks and chairs; computer and phone.
Healthcare laboratory technicians use the following personal protective equipment: protective clothes (coveralls, men's/women's suits), safety footwear, face masks, protective gloves, protective eyewear and aprons.
The analytical phase of laboratory work implies working with biological materials, using chemicals that can be classified as potentially carcinogenic, toxic, explosive, flammable (in the gaseous and solid state) and corrosive. The biological materials taken from patients for analysis purposes (blood, body fluids, etc.) represent potentially hazardous, i.e. infective materials, which can be classified as the Hazard group 2 pursuant to the Rulebook on preventive measures to be taken in order to ensure safe and healthy work during the exposure to biological hazards [5, 6].

2.1. A snapshot of work organisation

The healthcare laboratory technician job is done by five employees (4 women and a man), none of them being under the age of 18 nor with disabilities. In order to get a job as a healthcare technician, one must have at least a secondary school leaving qualification in the healthcare field (laboratory technician). No work experience is required, nor is the pre-employment physical examination mandatory in order to determine whether the applicant is able to perform the tasks required by the position. All the work is done in one, morning shift, lasting from 6 a.m. to 2 p.m. The employees are entitled to a thirty-minute break. The workweek includes five days (Monday-Friday). The employees also work on-call shifts as scheduled by the head of the laboratory, i.e. they must be available to work in case of urgent laboratory diagnostics.
The healthcare laboratory technicians perform the following tasks and activities:
(1) at the reception desk (taking patients' healthcare ID cards, the triage process and assignment of priority; comparing data in the patient's healthcare ID card and ID card, i.e. the identification of patients; entering patients' data into the register; entering the number of the receipt into the register, entering the patient reference numbers into the work list, as well as the type and number of analyses; preparing specimens delivered by home care service providers and brought from infirmaries; reporting results in compliance with urgency degrees and assigned priority; writing reports about the number and type of services to be included in the daily, monthly, quarterly, semi-annual and annual report; entering information into electronic invoices; sending patients to the room where biological materials are taken),
(2) while receiving biological materials (workplace preparation; establishing a good rapport with patients and/or accompanying persons, identifying the patient; labelling test tubes with patient reference numbers; vein puncture and capillary blood collection; dividing samples into separate tubes depending on the type of the requested analysis; after collecting blood specimens – educating patients how to compress the blood vessel and informing them about the time when they can get the results; preparing the materials for next day's work; cleaning the workspace) [7, 8],
(3) while performing biochemistry analyses (turning the apparatus on and checking the settings following the instructions; preparing and defining control specimens using the BT 1000 apparatus; preparing reagents and placing them into the apparatus; checking waste bins and emptying them if necessary; bringing specimens for biochemistry analyses from the specimen preparation room; performing the centrifugation of coagulated specimens; separating serum and pipetting it into previously labelled screw-cap vials or tubes; operating the analyser; classifying and preparing the materials for the transport to other laboratories for the purpose of additional analyses; technical verification of findings;

printing the results of biochemistry analyses after their validation by a specialist in healthcare biochemistry; thorough cleaning of the apparatus and centrifuge after the completion of the work (every day) [7, 8],
(4) while performing hematology analyses (turning the Cell-Dyn 1700 apparatus on; checking and replacing reagents; checking waste bins and emptying them if necessary; preparing and defining control blood specimens; bringing blood specimens from the specimen preparation room; triage and specimen analyses according to their degree of urgency; operating hematology analyzer; defining the sed rate and entering the values into the sedimentation rate notebook; performing the technical verification of results and informing the specialist in healthcare biochemistry about critical values; cleaning the apparatus thoroughly upon the completion of the work (on a daily basis),
(5) while performing urine analyses (preparing the workspace and materials to be used; bringing vials with urine samples and samples for occult blood test; performing the analysis of chemical components of urine, centrifugation and microscope inspection of the sediment; performing occult blood tests; technical verification of results; starting the Uriscan Pro II device, performing the calibration and sample analyses; cleaning the centrifuge, apparatus and microscope; cleaning the workspace and preparing materials for next day's work.
Pursuant to the Rulebook on the organisation and sistematisation of work positions, the risk assessment in the workplace of a healthcare laboratory technician was performed and it was concluded that the actual state did not deviate from the prescribed, i.e. determined work organisation. Furthermore, the information provided by the employees occupying the position of a healthcare laboratory technician complied with the information stated in the Rulebook.

2.2 The identification and assessment of hazards and harmful factors in the wokplace and workplace environment

At the beginning of the process of collecting information on hazards and harmful factors in the workplace and workplace environment, the existing state of occupational safety and health was analysed (valid expert reports on conducted inspections and equipment tests, as well as on the analysis of the conditions in the workplace environment; pre-employment and periodical physical check-ups of employees; information on work-related injuries, illnesses and diseases; information on personal protective equipment and tools, and analyses of measures taken in order to prevent work-related injuries, illnesses and diseases). The work processes taking place in the analysed workplace were observed, and the necessary information was obtained from the employees. The collected data were classified into different types of potential hazards and harmful factors. The hazards were grouped into:
(1) mechanical hazards: associated with the use of work equipment; usually occur due to improper handling and storage of reagents (easily flammable and explosive chemicals), as well as while using dangerous substances which can cause an explosion or fire,
(2) hazards associated with workplace characteristics: usually posed by accidents, which happen due to the uncontrolled release of chemicals or by infective biological materials, but can also happen due to employees' contact with dangerous surfaces (from different kinds of floors to surfaces with sharp edges, pikes, rough surfaces, protrusions, needles and glassware, which can be broken during the work and therefore cause injuries), as well as due to the possibility of slipping and tripping (on wet or slippery surfaces in front of or inside the rooms where the work is done),
(3) hazards associated with the use of electicity (caused either by the direct contact with elements of electrical installations and electrical appliances, or resulting from thermal effects of electrical installations and appliances) [9, 10],
Harmful factors were grouped into:
(1) harmful factors associated with or occurring during the work processes, such as:
(1.1) chemical factors associated with dealing with potentially carcinogenic, toxic, flammable, corrosive and explosive chemicals (chromosulfuric acid, hydrochloric acid, salicusulfonic acid, acetic acid, hypochlorous acid, sodium hydroxide, Eosin-methylene blue, and May-Grunwald solution), which can cause suffocation, burns, poisoning or may penetrate into the body through the skin,
(1.2) biological factors: (a) causes of bloodborne diseases to which the employees are extremely exposed due to continuous, occassional or accidental contacts with blood, (b) causes of infections present in specimens of body fluids (wound swabs, urine, sputum) with which the employees get in touch and might be infected if they have a skin injury or through cornea, (c) the inhalation of microorganisms which can cause droplet infections due to the contact with patients who may spread infectious diseases,
(1.3) harmful factors associated with microclimatic conditions (inappropriate temperature, humidity and airflow),
(2) harmful factors associated with the psychophysical strain caused by the awkward position during prolonged sitting, responsibility for receiving and conveying information, responsibility for sudden changes of work procedures, work intensity, workplace spatial characteristics, conflict situations, work with patients, and physical efforts, which result in psychological loads (stress),
(3) harmful factors associated with the organisation of work, i.e. on-call work (which implies that the employee need not be present at the healthcare institution, but has to be available in case of an emergency), and work when called upon (the employee need not be present at the healthcare facility, but has to come if called upon).

2.3 The assessment of risk caused by potential hazards and harmful factors using two different methods

Having performed the analysis of the likelihood of the occurence and severity of potential work-related injuries, illnesses and diseases caused by the identified hazards, and the likelihood of the occurence and severity of potential work-related injuries, illnesses and diseases caused by the identified harmful factors in this workplace and workplace environment, the risk assessment for each recognised or identified hazard and harmful factor was performed using two different methods. The list of identified hazards and harmful factors, together with the risk assessment results obtained using the 5x5 Risk Assessment Matrix (OHSAS) and the Risk Assessment Method developed by the Higher Education Technical School of Professional Studies in Novi Sad sa well as measures to eliminate hazards and harmful factors completely or partially [11, 12, 13, 14], is shown in Table 1.

Table 1: Lists of hazards and harmful factors; risk assessment in relation with the hazards and harmful factors; and measures to eliminate hazards and harmful factors completely or partially

Mechanical hazards associated with equipment utilisation	**Risk level according to 5x5 Risk Assessment Matrix**	**Risk level according to the Risk Assessment Method developed by the HETSPS NS**	**Risk elimination, reduction or prevention measures**
Using dangerous instruments that may cause an explosion or fire, i.e. irregular handling and storage of easily flammable chemicals (May-Grunwald solution, Eosin-methylene blue, methanol, acetic acid)	Moderate risk	Insignificant risk	- Smoking inside the laboratory must be strictly forbidden Check if the apparatus and devices are properly assembled and if they have all the necessary elements - Closed containers should not be heated unless specially designed for that purpose - Workplace-specific training is mandatory - The adopted work procedures must be obeyed - Fire-fighting appliances and installations must be checked on a regular basis - Evacuation plans must be posted on visible places - Personal hygiene materials and equipment must be used
Hazards associated with the workplace characteristics	**Risk level according to 5x5 Risk Assessment Matrix**	**Risk level according to the Risk Assessment Method developed by the HETSPS NS**	**Risk elimination, reduction or prevention measures**
Accidents caused by excessive spills of chemicals or infectious biological materials	Moderate risk	Insignificant risk	- Desks must be clean all the time, with no devices out of use on them - Any chemical or biological materials spilled on the desk or floor must be immediately removed (spilled acids or bases should be diluted with huge amounts of water before the removal) - In case a flammable liquid is spilled in the laboratory, all heat sources should be turned off immediately - At the end of the work, the workplace must be thoroughly cleaned - General ventilation system is mandatory as a collective protection measure - Personal protective equipment and tools must be used
Dangerous surfaces (floors and other walking areas, surfaces	Low risk	Insignificant risk	- Glassware must be in good condition, and glass instruments must be carefully checked before use - Special precautions must be taken when

that employees may be in touch with and which have sharp edges – spikes, rough surfaces, protrusions, as well as work with needles and glassware, which can be broken during the work and cause injuries)			working with glassware, and broken glass must be carefully disposed of - Bottles with chemicals must be kept clean (if their contents spills on the outer side, they become very slippery and can easily be dropped) - Stuff should receive training on safe work - The adopted work procedures must be obeyed - Personal protective equipment and tools must be used
Slip and trip hazards (wet and slippery surfaces in front of or inside the rooms where the work is done)	Low risk	Insignificant risk	- Holes, cracks, protrusions and dents must be fixed - The floors and passages must have proper lighting - The equipment should be placed so as to ensure that there are no cables running on the floor or in passages - The floor must be kept clean and dry - Occupational safety and health signs should be posted on visible places - Personal protective equipment and tools must be used (adequate footwear, with rubber soles)
Hazards posed by electricity	**Risk level according to 5x5 Risk Assessment Matrix**	**Risk level according to the Risk Assessment Method developed by the HETSPS NS**	**Risk elimination, reduction or prevention measures**
Hazards posed by the direct contact with elements of electrical installations and equipment powered by electricity (all electrical appliances) Hazards posed by thermal effects of electrical equipment and installations (overheating, fire and explosion, electric arcs and sparks, etc.)	Low risk	Insignificant risk	- The equipment must be maintained in proper condition, and inspected at the intervals prescribed by an authorized organisation - The visual inspection of the equipment should be performed before the work starts - In case of damaged or defective equipment, use the safety switch to switch off the electricity supply, and disconnect the plug - Employees should be provided with training on safe and healthy work - Employees should be provided with training on fire protection - Regular control and testing of electrical installations - Regular control of fire protection equipment and installations
Harmful factors resulting from or occurring during work processes	**Risk level according to 5x5 Risk Assessment Matrix**	**Risk level according to the Risk Assessment Method developed by the HETSPS NS**	**Risk elimination, reduction or prevention measures**

Harmful effects of chemicals (dealing with chemicals which can be carcinogenic, mutagenic, toxic, irritable, corrosive, flammable and therefore can cause cancer, genetic diseases, poisoning if inhaled, severe burns if they get into contact with the skin or if swallowed, severe health impairments due to prolonged exposure, very hard irreversible effects if they get in contact with the skin or if swallowed)	Very high risk	High risk	- All chemicals should be handled with the utmost care - All chemicals must be properly labelled even when they are in upright chemical containers or in glasses - Mouth pipetting should be forbidden, as well as inhaling, tasting and smelling chemicals - Chemicals must not be touched with bare hands, but with special dry spoons (in case of chemical solution spills, contact with the skin must be avoided) - The work which involves the use of flammable or odorous chemicals should be done in the laboratory digester - The work which involves the use of flammable chemicals must not be done near heat sources - Toxic substances should never be poured down the drain (they can evaporate from the pipes and thus pose hazards in other premises) - Acids, bases and oxidizing agents should never be poured into toxic waste containers as they may cause some chemical reactions and emissions of toxic evaporation - The workplace environment should be regularly inspected and checked for the presence of chemical hazards - Continuous education of employees, strict abiding by the code of conduct, and training employees how to handle chemical substances are mandatory - Physical examinations of employees on a regular basis are mandatory - General ventilation system is mandatory as a collective protection measure - Personal protective equipment and tools must be used - Eating and drinking must be prohibited in the laboratory work areas - In order to avoid injuries caused by corrosive chemicals, in addition to the protective coveralls, proper protective glasses, half-face masks with proper filters and gloves must be used - Food and drink must not be brought into the library - Employees must wash their hands before leaving the laboratory

Biological harmful factors (infections caused by infectious agents present in samples of body fluids, exposure to microorganisms which cause blood borne infectious diseases, inhalation of microorganisms which cause droplet infections, contact with allergens)	Very high risk	High risk	- Biological materials must be handled with the utmost care - Biological waste must be disposed of into containers specially designed for that purpose - The workplace environment should be regularly inspected and checked for the presence of biological harmful factors - Continuous education of employees and strict abiding by the code of are mandatory - Employees must be trained how to handle microbiological materials (biological harmful factors) - Physical examinations of employees on a regular basis are mandatory - Vaccination of employees is mandatory - General ventilation system is mandatory as a collective protection means - Personal protective equipment and tools must be used - Food and drink must not be brought into the library - Employees must wash their hands before leaving the laboratory
Harmful effects of microclimate condition	Low risk	Insignificant risk	- Air conditioners are properly maintained and checked by competent organisations on a regular basis - Inspection and examination of working conditions
Harmful effects caused by physical or psycho-physical strains	**Risk level according to 5x5 Risk Assessment Matrix**	**Risk level according to the Risk Assessment Method developed by the HETSPS NS**	**Risk elimination, reduction or prevention measures**
Working in awkward positions (prolonged sitting)	Low risk	Low, but significant risk	- The appropriate ergonomic equipment should be provided (desks, chairs) - Employees should have several short breaks during a shift - Systematic physical assessments of employees - Provide employees with physical therapy and massage
Efforts in carrying out certain tasks that cause a psychological burden (stress)	Low risk	Low, but significant risk	- Introducing several short breaks during a shift - Systematic physical assessments of employees - Division of tasks, teamwork, abiding by the determined work-rest schedules, taking breaks during work, mandatory use of annual leave
Responsibility for receiving and conveying information, responsibility for sudden changes of procedures, spatial characteristics of the workplace, conflicts, dealing	Low risk	Low, but significant risk	- Abiding by the code of conduct and obeying the adopted business ethics policy - Improving interpersonal communication - Introducing more short breaks during a shift - Systematic physical assessments of employees - Division of tasks, teamwork, abiding by the determined work-rest schedules, taking breaks during work, mandatory use of annual leave

with patients, etc.			
Harmful factors associated with work organisation	**Risk level according to 5x5 Risk Assessment Matrix**	**Risk level according to the Risk Assessment Method developed by the HETSPS NS**	**Risk elimination, reduction or prevention measures**
On-call shifts, which does not require employees' presence in a healthcare institution, but they must be available in case of an emergency	Low risk	Insignificant risk	- Abiding by the code of conduct and obeying business ethics policy - Systematic assessment of employees - Division of tasks
Work when called upon (the employee need not be present at the healthcare facility, but has to come if called upon).	Low risk	Insignificant risk	- Abiding by the code of conduct and obeying business ethics policy - Systematic assessment of employees - Division of tasks

Having taken a snapshot of the organisation of work, the identification and evaluation of hazards and harmful factors, as well as the assessment of the risk in compliance with the Regulations on risk assessment means and procedures in the workplace and work environment, a conclusion was made that the workplace of a healthcare laboratory technician is a workplace with an increased risk.
Due to the nature of their job, those who work as healthcare laboratory technicians are exposed to different types of hazards and harmful factors on a daily basis, but the risk in this specific workplace is assessed as high due to very high or high risks of professional diseases, i.e. health impairments caused by chemical and biological harmful factors, which might occur during work processes due to the necessity of dealing with chemical substances and biological materials. The employees are exposed to irritant, corrosive, flammable, toxic, carcinogenic and mutagenic chemical substances, as well as to numerous microorganisms, bloodborne viruses being the most dangerous ones, especially the hepatitis B, hepatitis C and HIV viruses, and therefore the employer is obliged to take the proposed measures in order to ensure safe and healthy workplace conditions for the employees.

3. CONCLUSION

In order to ensure the appropriate safety and health management in a healthcare laboratory, first the identification, and then the efficient control of all hazards and harmful factors that exist or might occur during the work processes must be performed. This paper provides a description of the risk assessment in the workplace of a healthcare laboratory technician. Two risk assessment methods were used - the 5x5 Risk Matrix (OHSAS) and the Risk Assessment Method developed by the Higher Education Technical School of Professional Studies in Novi Sad.
The obtained risk assessment results indicate that this is a workplace with an increased risk and therefore the appropriate measures are proposed to eliminate or reduce the identified risks.
By ensuring safer workplace environment and by taking care of our employees, we improve the quality of work, and increase its efficiency and effectiveness, which ensures the achievement of the set goals. Healthcare institutions, i.e. organisations that provide healthcare services, set clearly defined goals, which imply better, higher quality and safer providing of patients with healthcare services.

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