ЈАВНО ЗДРАВЈЕ

ЛАБОРАТОРИСКИ СТЕКНАТИ ИНФЕКЦИИ КАЈ ВРАБОТЕНИТЕ ВО МИКРОБИОЛОШКИТЕ ЛАБОРАТОРИИ ВО РЕПУБЛИКА МАКЕДОНИЈА

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Извадок

Лабораториски стекнати инфекции (ЛСИ) се сите инфекции добиени за време на лабораториската работа, а според начинот на настанување се делат на повеќе видови. Целта на овој труд беше да се прикажат податоците за присуство на ЛСИ и можните причини ки би довеле до нивна појава, според одговорите на вработените во јавно-здравствените микробиолошки лаборатории во Република Македонија. Податоците се добиени од анкетен прашалник, одговорен од страна на 187 вработени во овие установи, а истражувањето претставуваше студија на пресек, спроведено во период од два месеци (март - април 2014 година). Според одговорите на вработените, институциите не се доволно опремени со системи за известување во случај на повреда на работното место. Од вкупниот број испитаници, 18,7 % дале информација за постоење на болест која ја асоцираат со работното место. ЛСИ најмногу пријавуваат вработените со ССС, како и оние со подолг работен стаж. Непостоењето ефикасен систем за следење на ЛСИ, го прави тешко, некогаш и невозможно следењето на овие инфекции. Потребна е континуирана едукација на персоналот, со што ќе се подигне свеста на вработените за нивната заштита и сигурност на работното место, како и спроведување на задолжителна превентивна заштита.

PUBLIC HEALTH

LABORATORY ACQUIRED INFECTIONS AMONG EMPLOYEES IN THE MICROBIOLOGICAL LABORATORIES IN MACEDONIA

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Abstract

Laboratory acquired infections (LAI) are all infections obtained during laboratory work, divided into several types, according to the manner of occurrence. The aim of this paper was to summarize data of LAI and possible reasons that lead to LAI emergence, according to the answers of the employees in the public health microbiological laboratories in the Republic of Macedonia. A cross-sectional study was conducted in a period of two months (March-April 2014) by distributing a questionnaire to 187 employees in these laboratories. According to the employees' responses, institutions are not sufficiently equipped with alert systems in case of injury in the workplace. Of the total number of examined workers, 18.7 % gave information about a history of occupational disease associated with their workplace. The most frequent reports of LAI are from laboratory technicians and employees with longer working experience. Lack of effective monitoring system makes it difficult, if not impossible, to follow LAI. There is a clear need for continuous education of the personnel, raising awareness for their protection and job security, as well as implementation of mandatory preventive care.

INTRODUCTION

Laboratory workers and co-workers employed in microbiological laboratories are at a occupational risk of everyday exposure to microbial pathogens during daily activities, which can cause various infections - ranging from inapparent to life-threatening infectious diseases[1].

Laboratory acquired infections (LAI) are all infections obtained during laboratory work, regardless of their clinical or subclinical manifestations[2,3]. Since the beginning of the last century, several generations of scientists were aware of the health risk involved with certain microbial agents4. For the first time attention to these infections was mentioned by the two German workers, Paneth and Kisskalt, in 1915 and 19295,6. Until 1978, Pike and Sulkin published four studies describing a total of 4079 cases of LAI between 1930 and 1978, out of which 168 ended with death. These studies concluded that the ten most common causes of LAI among workers in microbiological laboratories were: Brucella spp., Coxiella burnetii, hepatitis B virus (HBV), Salmonella typhi, Francisella tularensis, Mycobacterium tuberculosis, Blastomyces dermatitidis, Venezuelan equine encephalitis virus, Chlamidia psittaci and Coccidioides immitis. The authors emphasize that these cases do not represent all LAI that occurred in that period because many cases were not reported due to asymptomatic or subclinical infections, as well as due to not having always effective monitoring system7-10. After the publication of Sulkin and Pike, a series of studies followed in the next 20 years; in 1995 Harding and Lieberman published the results of 375 infections or seroconversions that had occurred in 23 laboratories11 while Harding and Byers presented 1267 infections with 22 deaths[12]. In that period, often isolated causes of LAI were Mycobacterium tuberculosis, Salmonella spp., Shigella spp., and virus B and C hepatitis13-19. The same agents were also encountered at the beginning of this century: shigellosis, salmonellosis, tuberculosis and hepatitis B and C were the top five most common diseases acquired in the microbiological laboratories[20]. In all these reports, only a small percentage of cases were associated with known specific incident or accident in the workplace. In most cases, known data are only contacts with the microbial agent, presence in or around the lab and presence around infected animals.

Jacobson et al. described an annual incidence of about 3 cases per 1000 employees in hospital laboratories[16]. Comparing the data of the first and second half of the last century, when the laboratories started to apply the principles and guidelines for safe laboratory work, as well as security9, the number of LAI decreased. However, with insufficient information on the actual number of infections and the population at risk, it is difficult to determine the true incidence of LAI with any degree of certainty. LAI reports should serve as a lesson about the importance of establishing and maintaining safe working conditions in microbiological laboratories, as well as adherence to the basic principles of working from biological biosafety manuals[21].

According to some authors, laboratory accidents are on the second place as a source of LAI22, and parenteral inoculation of infectious material as a leading cause. Only needlesticks and cuts represent 25.2 % and 15.9 % of all types of accidents that result in infection, respectively[9, 23, 24]. However, the fact that the largest number of LAI (80 %) are with unknown way of transmission, and due to not provided information about the accident in the workplace, suggest that aerosol particles, invisible to the naked eye, pose the greatest danger[25]. Often, in the laboratory there are possible ways of infection not inherent in the general population[26]. An example of this is brucellosis, which among the general population is commonly obtained by consuming unpasteurized milk and/or cheese from infected animals, while in the laboratory almost always it is acquired through inhalation of aerosols that are released during the manipulation with infectious materials[27]. Also, the eyes are rarely a

front door for entrance of the infection outside the laboratory, but there is an impressive list of infections acquired in this way by laboratory workers[28]. Table 1 shows the routes of exposure that are associated with LAI.

Table 1 Routes of exposure associated with laboratory acquired infections[25, 29]

Route of Exposure	Laboratory procedures and / or accidents
Inhalation	Spinning, pouring, spraying, blending, grinding, cutting, opening of samples
Ingestion	Mouth pipetting, eating, drinking, smoking, putting hands in the mouth (eating the nails) and other items (pens, etc.)
Stinging inoculation	Pin - pricks, cuts from sharp objects, bites from animals or insects, scratches
Percutaneous or mucosal contamination and intake	Spill, contact with contaminated surfaces, transfer from the hands of the person

There is a lack of official data about LAI in the Republic of Macedonia (RM), hence this information will help the authorities to make decisions on the improvement of the established system for biological safety.

The aim of this study was to summarize the data for LAI and possible factors that could be responsible for occurrence of LAI among employees in the public health microbiological laboratories in RM, according to answers obtained from the employees / laboratory workers and in correlation with their foreknowledge about LAI and biological safety.

Material and methods

Data from survey for laboratory safety conducted among employees in public health microbiology laboratories were used as material for this research. The respondents answered a questionnaire where among others, there were 6 questions related to occupational diseases:

(I) "During your years of service, have you got any contagious disease that you would associate with your workplace";

(II) "Have you been out of work for a longer period because of occupational infectious disease";

(III) "Is there an evidence in your laboratory for occupational diseases, work injuries or deaths during work";

(IV) "Is there a reporting system in your laboratory for injuries or accidents during work";

(V) "Are the first aid boxes in your laboratory easily accessible" and

(VI) "Are you vaccinated against hepatitis B"?

Design of the study, population group and research sample

This cross-sectional study approved by the management of microbiology laboratories all around the country, targeted a total of 213 employees. Number of respondents on the questionnaire from the microbiology laboratories were as followed: (i) in the 10 Centres for Public Health in the cities of: Skopje (21 respondent), Bitola (13), Prilep (10), Ohrid (7), Stip (9), Kumanovo (12), Tetovo (12), Kocani (7), Strumica (6) and

Veles (8), as well as their regional offices in Kavadarci (4), Gevgelija (4), Debar (3), Struga (4), Gostivar (10), Kicevo (2) and Berovo (3); (ii) the Institute of Public Health of the Republic of Macedonia - Skopje (26) and (iii) the Institute of Microbiology and Parasitology, Faculty of Medicine, University "Ss Cyril and Methodius", Skopje (26). A total of 173-187 employees out of 213 answered the selected questions (response rate – 81.2 - 87.9 %). The survey was conducted over a period of two months (March-April 2014). Respondents were grouped according to gender, age, education, and work experience.

Statistical analysis

Categorical variables are presented in absolute numbers and frequencies displayed by quantitative descriptive parameters (mean, SD, minimum and maximum). Statistical significance of differences between categorical variables was tested using the Pearson's Chi-square test, and between numeric sets, Student's t-test.

Results

Out of total 187 respondents, according the gender most of them - 156 (83.4 %) were female. According the workplace and work duties, 111 (61.3 %) were laboratory technicians, while 37 (20.4 %) were specialists in microbiology and 33 (18.3 %) laboratory staff with other university diploma.

Only 34 (18.7 %) members of the staff gave information about the history of contagious disease probably associated with workplace (question I) (Table 2). Longer absence from work because of occupational disease (infection) could be one of the parameters for LAI, but in our study (question II) only 5.5 % of the participants gave a positive answer (Table 2).

Table 2 Occupational diseases, organization of the evidence of LAI and working conditions

Question	Total respondents / Groups	Yes N (%)	No N (%)	I don`t know N (%)
"During your years of service, have you got any contagious disease that you would associate with your workplace"	N=182	34 (18.7)	144 (79.1)	4 (2.2)
	Management	0 (0.0)	18 (100.0)	0 (0.0)
	Microbiologists/University diploma (n=44)	6 (13.6)	35 (79.6)	3 (6.8)
	Laboratory technicians (n=120)	28 (23.3)	91 (75.9)	1 (0.8)
	Pearson Chisquare: 12.19 df=4 p=0.016			
	Length of service - mean ± SD (years)	27.25 ± 10.2	19.83 ± 11.59	18 ± 2.83
	Variation analysis (yes/no) t = 3.3 p=0.001			
"Have you been out of work for a longer period because of occupational infectious disease"	N=182	10 (5.5)	170 (93.4)	2 (1.1)
"Is there an evidence in your laboratory for occupational diseases, work injuries or deaths during work"	N=178	53 (29.8)	83 (46.6)	42 (23.6)
"Are the first aid boxes in your laboratory easily accessible"	N=183	36 (19.7)	143 (78.1)	4 (2.2)

Respondents with LAI have an average length of service of 27.25 ± 10.2 years versus 19.83 ± 11.59 years of respondents who deny infection at the workplace. The difference of 7.45 years of experience between participants with and without occupational disease is statistically highly significant (p = 0.001) (Table 2). Staff with LAI has a significantly longer length of service, which is a risk factor by itself for getting LAI because of the longer exposition time and perhaps considerably worse safety working conditions in the past years. Briefly, laboratory technicians and employees with longer service gave more often data for existing contagious disease probably associated with the workplace (Pearson Chi-square: 12.19 df=4 p=0.016).

There were highly significant differences in the level of education of respondents with LAI (laboratory technicians, microbiology specialists and other employees with university degree (25.9 %, 8.1 % and 6.1 % respectively) (Pearson Chi-square: 15.25 df=4 p = 0.004) (Figure 1).

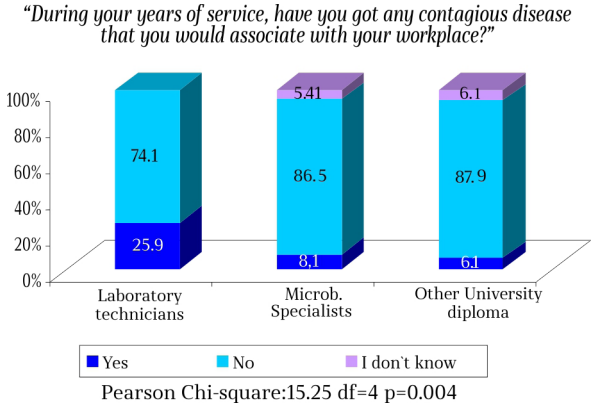
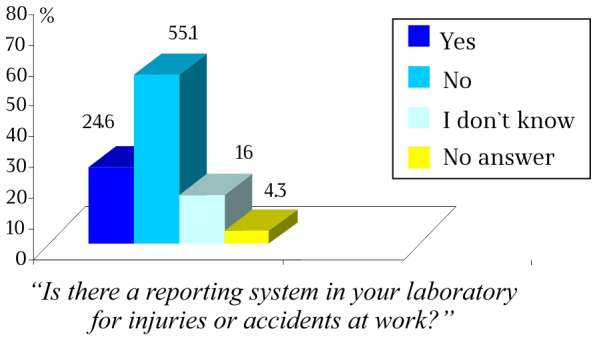


Figure 1 History of contagious disease probably associated with workplace, according to the level of education of participants

Work position of participants such as managers, laboratory staff with university diploma and laboratory technicians significantly affect the incidence of occupational diseases (p = 0.016) (0 %, 13.6 % and 23.3 %, respectively) (Table 2). Workers on the managerial positions are rarely directly involved in the laboratory work. They have more responsibilities for the organization of the work.

Regarding the answers to question (IV) "Is there a reporting system in your laboratory for injuries or accidents during work", institutions are not sufficiently equipped with alert systems in case of injury at the workplace. More than half of the respondents (55.1 %) deny the existence of such system and 16.0 % do not know (Figure 2). These figures suggest that maybe the injures actually are not adequately reported.



"Is there a reporting system in your laboratory for injuries or accidents at work?"

Figure 2 Frequency of participants according to their answers about presence of reporting system in the microbiology laboratories

Positive answers to the question about the first aid boxes existing on the strategic locations in the laboratory (question V), were given by only 36 (19.7 %) of 183 respondents (Table 2).

The results of this survey have shown no statistically significant variability in vaccination status to HBV in different working positions such as managers, microbiologists / university diploma staff and laboratory technicians (55.6 %, 50.0 % and 41.0 %, respectively) (Figure 3).

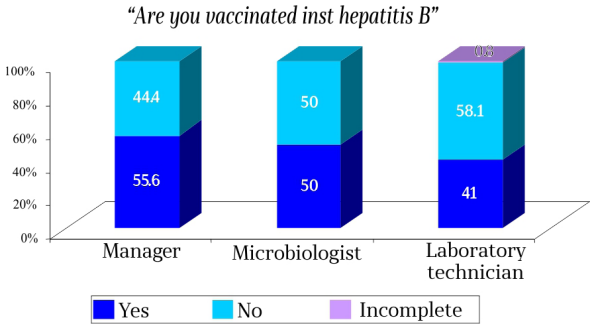


Figure 3 HBV Immunization status of the employees in the microbiological laboratories

Discussion

In our study, which was a part of a larger investigation about risk assessment in the microbiology laboratories in our country30, 85 (69.1 %) of laboratory technicians reported that they were given an explanation for the possible risks associated with the workplace before being assigned to it, while that percentage was higher among respondents with university diplomas and management functions (72.7 % and 88.9 %, respectively).

Our survey shows similar results as the reports of Jacobson et al.16, and Harding and Lieberman11 which means the LAI are underestimated and paid not enough attention. Difficulties in monitoring of occupational diseases arise if the damage is not evidenced or reported immediately. It is often forgotten, because of the long incubation period of some infectious diseases and the emerged symptoms later that cannot be easily linked or associated with the incurred damage2.

The research from Japan31 in 2004 concluded that the most likely reason for the occurrence of infections and diseases related to laboratory work was the lack of biological safety cabinets (BSC). Other risk factors were lack of experience and skills, ignorance or clumsy handling of the equipment. Recently reported case of laboratory-acquired dengue virus in South Korea microbiological laboratory is an example how vector-born disease can easily be transmitted by needle stick injury32. Wearing only gloves is not sufficient for the biosafety of laboratory workers in clinical diagnostic laboratories, concluded Duman at al.33 in their research. Also, a survey conducted in Nigeria34 explained the disregard of the precautionary measures and embarrassment of reporting injuries as a reason for not reporting. According to these data, only 1.5 % of the employees are willing to report accidents at work.

Manuals for working with biological agents21, 35 as well as the Article 16 paragraph 3 of the "Regulation for the rules on minimum requirements for safety and health at work for employees on risks related to exposure to biological agents (pathogens)"36, clearly indicates the need to provide appropriate effective vaccines that are available and can prevent disease in staff working with potentially infectious materials.

Newest achievements in microbiology, such as serotyping and PFGE, can be used as supplement for traditional case investigation techniques whenever a microbiologist is injured to validate or refute suspected transmission scenarios or can expose the source of a laboratory-acquired infection37.

Conclusions

Only 34 (18.7 %) of the employees in the microbiological laboratories in the Republic of Macedonia gave an information about the history of occupational infection during their work experience; most of them were laboratory technicians and staff with longer working service. This fact leads to a conclusion that the lower level of education is often associated with the occurrence of specific diseases. We should not neglect the fact that these workers are much more and directly exposed to samples with potentially infectious material. More attention should be paid to training the staff with secondary school education.

There is neither effective system to monitor workplace incidents nor first aid boxes at strategic locations, quickly and easily accessible in the microbiology laboratories in RM. Establishment of an effective monitoring system will enable simple chronological tracking of possible infections among employees, and overcome the difficulties associated with incubation time of infections and diseases.

Although vaccination against hepatitis B is compulsory for the exposed persons and available at the same time, a very small percentage of respondents were vaccinated. By raising awareness of the staff for their safety and care in the workplace, hopefully the number of immunized will increase.

REFERENCES

1. Sewell DL. Laboratory-associated infections and biosafety. Clin Microbiol Rev 1995;8:389-405.
2. Sulkin SE, Pike RM. Laboratory-acquired infections. JAMA 1951; 147:1740-5.
3. Herman P. Laboratory-acquired Infections: Introduction. Belgian Biosafety Server 2013. Available at http://www.biosafety.be/.
4. Collins CH. Biotechnology and Genetic Engineering Reviews. Safety in Microbiology; 1984.
5. Paneth L. The prevention of laboratory infections. Medizinische Klinik 1915;11:1398-9.
6. Kisskalt K. Laboratoriumsinfectionen mit Typhuzbazillen und anderen Bacterium. Arch fur Hygiene und Bacteriologie 1929;101:137-60.
7. Sulkin SE, Pike RM. Survey of laboratory-acquired infections. Am J Pub Hlth 1951;41:769-81.
8. Pike RM, Sulkin SE, Schulze ML. Continuing importance of laboratory-acquired infections. Am J Pub Hlth 1965;55:190-9.
9. Pike RM. Laboratory-associated infections: summary and analysis of 3921 cases. Health Lab Sci 1976;13:105-14.
10. Pike RM. Past and present hazards of working with infectious agents. Arch Pathol Lab Med 1978;102:333-6.
11. Harding AL, Lieberman DF. Epidemiology of laboratory-associated infections. In: Fleming DO, Richardson JH, Tulis JJ, Vesley D. editors. Laboratory safety: principles and practices. Washington DC: American Society for Microbiology; 1995. p. 7-15.
12. Harding AL, Byers KB. Epidemiology of laboratory-associated infections. In: Fleming DO, Hunt DL editors. Biological safety: principles and practices. 3rded. Washington, DC: ASM Press; 2000. p. 35-54.
13. Grist NR, Emslie. Infections in British clinical laboratories, 1984-85. J Clin Pathol 1987;40:826-9.
14. Grist NR, Emslie. Infections in British clinical laboratories, 1986-87. J Clin Pathol 1989;42:677-81.
15. Grist NR, Emslie in British clinical laboratories, 1988-89. J Clin Pathol 1991;44:667-9.
16. Jacobson JT, Orlob RB, and Clayton JL. Infections acquired in clinical laboratories in Utah. J Cin Microbiol 1985;21:486-9.
17. Pike RM. Laboratory-associated infections: incidence, fatalities, causes and prevention. Annu Rev Microbiol 1979;33:41-66.
18. Vesley D, Hartman HM. Laboratory-acquired infections and injures in clinical laboratories: a 1986 survey. Am J Public Health 1988;78:1213-5.
19. Mackel DC, Forney JE. Overview of the epidemiology of laboratory-acquired infections. In: Miller BM, Groschel JH, Richardson JH, Vesley D, Songer JR, Housewright RD, Barkley WE, editors. Laboratory safety: Principles and practices. Washington, DC: American Society for Microbiology; 1986: 37-42.
20. Forbes BA, Sahm DF, Weissfeld AS. Laboratory safety. Bailey and Scott`s Diagnostic Microbiology, 12th ed. 2007;4:45-60.
21. Centers for Disease Control and Prevention and National Institutes of Health. 5th ed. Biosafety in Microbiological and Biomedical Laboratories. Washington: GPO; 2009.
22. Voss A. Prevention and control of laboratory – acquired infections. In Murray PR. (chief ed.). Manual of Clinical Microbiology. Washington, DC: American Society for Microbiology; 1999. p.165-71.
23. Fleming DO. Laboratory biosafety practices. In: Fleming DO, Richardson JH, Tulis JJ, Vesley D, editors. Laboratory Safety: Principles and Practices. Washington DC: American Society for Microbiology; 1995. p. 203-18.
24. Phillips GB. Control of microbio-

logical hazards in the laboratory. Am Ind Hyg Ass J 1969;30:170-6.

25. Sewell DL. Laboratory-associated infections and biosafety. Clin Microbiol Rev 1995;8:389-405.
26. Lennette EH, Koprowski H. Human infection with Venezuelan equine encephalomyelitis virus. JAMA 1943; 123:1088-95.
27. Collins CH. Laboratory-acquired infections: history, incidence, causes and prevention. London: Butterworth's; 1983.
28. Papp K. The eye as a portal of entry of infections. Medizinische Klinik 1959;11:1398-9.
29. Berrouane Y. Laboratory-acquired infections. In Wenzel RP editor. Prevention and control of nosocomial infections. Baltimore: The Williams and Wilkins Co.; 1997. p. 607-18.
30. Kakaraskoska Boceska B. Јавно здравствени аспекти и проценка на ризик при работа со биолошки агенси [Public health aspects and risk assessment when working with biological agents; in Macedonian].[MSc thesis].Skopje: Medical Faculty, University "Ss Cyril and Methodius" Skopje; 2015.
31. Mieko G, Tomonari Y, Shigeki M, Toshiami K, Katsuka O, Takashi T. Current biosafety in clinical laboratories in Japan: report of questionnaires` data obtained from clinical laboratory personnel in Japan. Kansenshoqanu Zsshi 2007;81(1):39-44.
32. Changhwan L, Eun Jung J, Donghyok K, Heun C, Jung Wan P, Geun-Ryang B. Laboratory- acquired dengue virus infection by needle stick injury: a case report, South Korea, 2014. Ann Occup Environ Med. 2016; 28:16.
33. Duman Y, Yakupogullari Y, Otlu B, Tekerekoglu MS. Laboratory-acquired skin infections in clinical microbiologists: is wearing only gloves really safe? Am J Infect Control 2016; 44(8):935-937.
34. Fadeyi A, Fowotade A, Abiodun MO, Jimoh AK, Nwabuisi C, Desalu OO. Awareness and practice of safety precautions among healthcare workers in the laboratories of two public health facilities in Nigeria. Niger Postgrad Med J 2011; 18(2):141-6.
35. World Health Organization. Laboratory biosafety manual. 3rd ed. Geneva: 2004.
36. Rules on minimum requirements for safety and health at work for employees from risks related to exposure to biological agents (pathogens), Official Gazette of R. Macedonia N˚ 170/2010.
37. Alexander CA, Fitzgerald SF, DePaulo R, Kitzul R, Daku D, Levett PN, Cameron ADS. Laboratory-acquired infection with salmonella enteric serovar typhimurium exposed by whole-genome sequencing. J Clin Microbiol 2016; 54(1):190-193.