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Original Research Article

Evaluation of infectious risk among biomedical agents in Morocco

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ABSTRACT

Background: The Infectious risk among biomedical technicians and engineers is influenced by many variables like the health and immune status of the worker, the education and training they had, the suitability of the establishment for work with highly pathogenic agents, and availability of protective equipment. The objective of the study was the evaluation of the perception of the infectious risk by biomedical agents.
Methods: It is a descriptive study, carried out during May and June 2020 in Morocco and used a questionnaire transmitted to participants by google form.
Results: 84 persons participated in the survey. Biomedical agents report that the risk is either direct because they handle microorganisms (20%; 23/84), but above all indirect, since these are situations where they handle contaminated instruments or waste produced during care activities (41.7%; 48/84). The cutaneous route contamination showed a slight predominance (71.6%; 60/84) because they use sharp tools (64.3%; 54/84). Only half know they have to report this kind of incident (56.8%; 48/84) and less than one in five (17.9%; 15/84) reported these accidents.
Conclusions: Moroccan law has not ignored occupational risk and equipment of protection is available in the workplace. However, most of the participants did not receive specialized training in infection risk management, they do not benefit from medical supervision, and immunization and accidents are underreported.

Keywords: Biomedical engineer, Pathogens, Infectious risk, Reporting incident

INTRODUCTION

Biological safety or biosafety covers working methods associated with the handling of biological materials, in particular infectious agents. It is about principles, containment technologies and practices, which are implemented to prevent unintentional exposure to pathogens and toxins or their accidental release.[1,2]

The risk of infection among biomedical technicians and engineers (BMTE), as well as healthcare personnel, is a major public health problem, particularly in developing countries.[3]

The risk of acquiring an infection is influenced by many variables. Among these factors are the health and immune status of the worker and the education and training they had, the suitability of the establishment for work with highly pathogenic agents, the characteristics and the concentrations of the microbe being handled, and the specific manipulations involved in its handling.[4]

Indeed, technicians and biomedical engineers, as other health workers, are exposed to different reservoirs of infections. One of the main reservoirs of germs may be the patient but other activities can also present a risk of infection like repair and maintenance of contaminated equipment and objects.[5]

The objective of this study is the evaluation of the perception of the infectious risk and the assessment of the biosafety knowledge and behaviors among technicians and biomedical engineers in Morocco.

METHODS

After approval by the institutional ethics committee of the Abulcasis international university of health sciences, Rabat, Morocco, this study was carried out in higher institute of engineering and health technologies of Rabat-Morocco, during May and June 2020. We used technique snow ball and the Google form® developed by Google® (Google LLC, Silicon Valley, California, USA).[6,7]

The sample size formula ($n=Z^2p\ (1-p)/d^2$) for field studies according to Thrusfield was used to obtain the target sample size.[8] This gave a minimum sample size of 72 respondents. For the calculation of frequencies, the data was analyzed on excel® (Microsoft corporation®, Washington, USA).

The questionnaire was sent to engineers and technicians and distributed via the websites or Facebook® pages (Facebook®, Menlo Park, Californie) to national associations (Moroccan Association of Biomedical Engineers (AMIB), Moroccan association of biomedical maintenance (AMMB) etc.)

The study included all engineers and technicians professionally active during the study and excluded those who had an exclusively administrative activity. The questionnaire contained the participant's consent in its first paragraph. It was subdivided into three sections (Table 1): A - socio-demographic, professional, educational and medico-professional characteristics of the studied population, B - dangers encountered, routes of transmission, exposure to risks, training and prevention awareness, C - data concerning accidents and their procedures and treatment.

RESULTS

A total of 84 persons participated to the survey. Approximately 70%, 4/5 persons were male and half of participants have less than 50 years old.

The majority of those studied are engineers and held official positions. Environ 70% of participants work in laboratory of human medical biology or in technical service in a health care establishment.

Less than a third of the participants confirm having benefited from training courses in infection risk, medical surveillance or specific vaccinations.

Biomedical agents report that the risk is either direct because they handle microorganisms, but above all indirect, since these are situations where they handle contaminated instruments or waste produced during care activities. Further information about the socio-demographic, professional, educational and medico-professional characteristics of the studied population are described in Table 2.

In our series, the majority of participants describe indirect exposure to pathogens, most often bacteria and viruses, through the handling of medical instruments, pathological products or potentially infectious waste (41.7%; 48/84). The participants reported all the routes of contamination with a slight predominance for the cutaneous route (71.6%; 60/84). The degree of exposure is rated medium to low by most BMTIs even if the exposure time exceeds one hour a day and even if the participants use sharp and sharp tools (64.3%; 54/84). Table 3 provides a summary of this group of results.

More than half of the participants state that they know the regulatory measures to be taken when they are victims of potentially infectious accidents, but the application of hygiene rules remains the most common procedure (74.5%; 62/84) and only half know they have to report this kind of incident (56.8%; 48/84).

Less than one in five participants (17.9%; 15/84) report accidents with infectious potential but among these individuals, more than half say they have not taken regulatory measures such as notification, medical consultation and application of hygiene rules (57.1%; 48/84). Further results are shown in the Table 4.

Table 1: The questionnaire.

Questions	Eventual answers
What is your sex ?	Man
	Woman
What is your age range? (Year)	Under 25
	25-29
	30-39
	40-49
	50 years old and over

Continued.

Questions	Eventual answers
What are your professional categories?	Engineer
	Technician
What is your status of employment?	Official
	Apprentice
	Intern
	Interim
What is your Sector of activity?	Laboratory of human medical biology
	Laboratory of veterinary biology
	Environmental biology laboratory
	Food biology laboratory
	Technical service in hospital or clinic
	Scientific research laboratory
	Medical engineering laboratory
	Technical service in administration
In the course of your work, have you received training in infectious risk?	No
	Yes
	I don't know
Do you benefit from medical supervision within your work?	No
	Yes
	I don't know
Do you benefit from an immunization program as part of your activity?	No
	Yes
	I don't know
How do you qualify exposure to biological agents in your profession?	Direct (handling of pathogens)
	Indirect (potentially contaminated waste or instruments)
	Human reservoir (risk of exposure to biological agents from other people)
	Animal (risks of exposure to biological agents from animals)
	Other
What are the usual ways of entry in the organism of the microbes encountered in your work?	Skin
	Nose
	Mouth
	Eyes
	Wound/stitch
	I don't know
How long do you estimate the duration of exposure per day to infectious risks in your work? (Hour)	<1
	1 to <2
	2 to <5
	5 to <10
In your opinion, what is your degree of exposure to infections at work?	None
	Low
	Medium
	Important
	Very important
	Maximal
	I don't know
What are the types of microbes you may encounter in your activity? (several answers possible)	Bacteria
	Virus
	Mushrooms
	Associates
	I don't know
Do you use sharp or cutting material in your activity?	No
	Yes
	I don't know
Are the equipment of protection available?	No
	Yes
	I don't know

Continued.

Questions	Eventual answers
Are you aware of any infectious risk prevention measures implemented in your work?	Yes perfectly
	Yes vaguely
	Not at all
	There are not
	I don't know
When you are confronted with an accident involving an infectious risk, what measures would you put in place? (several answers possible)	Application of hygiene rules
	Right of Withdrawal (I withdraw from the site or activity at risk)
	Report
	Consultation with a professional
	No action
	I don't know
Have you been the victim of an accident involving an infectious risk?	No
	Yes
	I don't know
Have you applied the regulatory recommendations concerning the management and reporting of this incident?	No
	Yes
	I don't know

Table 2: Socio-demographic, professional, educational and medico-professional characteristics of the studied population.

Characteristics	Answers	Percent (Numbers/total) (%)
Sex	Man	71.4 (60/84)
	Woman	28.6 (24/84)
Age range (year)	Under 25	20.0 (17/84)
	25-29	27.3 (23/84)
	30-39	20.0 (17/84)
	40-49	24.0 (20/84)
	50 and over	8.3 (7/84)
Professional categories	Engineer	79 (66/84)
	Technician	21 (18/84)
Status of employment	Official	83.8 (70/84)
	Apprentice	4.8 (4/84)
	Intern	9 (8/84)
	Interim	2.4 (2/84)
Sector of activity	Laboratory of human medical biology	63.1 (53/84)
	Laboratory of Veterinary Biology	35.7 (30/84)
	Environmental Biology Laboratory	1.2 (1/84)
	Food Biology Laboratory	22.3 (19/84)
	Technical service in hospital or clinic	7.5 (6/84)
	Scientific research laboratory	6.2 (5/84)
	Medical engineering laboratory	2.2 (2/84)
	Technical service in administration	2.2 (1/84)
Training in infectious risk in the course of the work	No	63.1 (53/84)
	Yes	35.7 (30/84)
	I don't know	1.2 (/84)
Medical supervision within the work	No	66.7 (56/84)
	Yes	29.8 (25/84)
	I don't know	3.6 (3/84)
Immunization program as part of the activity	No	66.7 (56/84)
	Yes	28.6 (24/84)
	I don't know	4.8 (4/84)

Table 3: Dangers encountered, routes of transmission, exposure to risks, training and prevention awareness.

Characteristics	Answers	Percent (Numbers/total) (%)
Types of exposure to biological agents	Direct (handling of pathogens)	20 (23/84)
	Indirect (potentially contaminated waste or instruments)	41.7 (48/84)
	Human reservoir (risk of exposure to biological agents from other people)	19.1 (22/84)
	Animal reservoir (risks of exposure to biological agents from animals)	5.2 (6/84)
	Other	13.9 (16/84)
Ways of entry in the organism of the microbes encountered in work	Skin	71.6 (60/84)
	Nose	64.2 (54/84)
	Mouth	49.4 (42/84)
	Eyes	51.9 (44/84)
	Wound/stitch	55.6 (47/84)
	I don't know	6.2 (5/84)
Duration of exposure per day to infectious risks in work	<1 hour	21.40 (18/84)
	1 to <2 hours	31 (26/84)
	2 to <5 hours	21.40 (18/84)
	5 to <10 hours	26.20 (22/84)
Degree of exposure to infections at work	None	1.2 (1/84)
	Low	28.6 (24/84)
	Medium	31 (26/84)
	Important	21.4 (18/84)
	Very important	7.1 (6/84)
	Maximal	7.1 (6/84)
	I don't know	3.6 (3/84)
Types of microbes encountered in activity	Bacteria	76.5 (65/84)
	Virus	65.4 (57/84)
	Mushrooms	33.3 (29/84)
	Associates	21 (15/84)
	I don't know	9.9 (8/84)
Use of sharp or cutting material in activity	No	33.3 (28/84)
	Yes	64.3 (54/84)
	I don't know	2.4 (2/84)
Availability of protection équipements	No	41.7 (35/84)
	Yes	52.4 (44/84)
	I don't know	6 (5/84)
Awareness of infection risk prevention measures implemented in the workplace	Yes perfectly	31 (26/84)
	Yes vaguely	44 (37/84)
	Not at all	9.5 (8/84)
	There are not	11.9 (10/84)
	I don't know	3.6 (3/84)

Table 4: Data concerning accidents and their procedures and treatment.

Characteristics	Answers	Percent (Number/total) (%)
Measures adopted by BMTE when confronted with an accident involving an infectious risk	Application of hygiene rules	74.5 (62/84)
	Right of Withdrawal (I withdraw from the site or activity at risk)	32.1 (27/84)
	Report	56.8 (48/84)
	Consultation with a professional	66.7 (56/84)
	No action	2.5 (2/84)
	I don’t know	2.5 (2/84)
Antecedent of victim of an accident involving an infectious risk	No	79.8 (67/84)
	Yes	17.9 (15/84)
	I don’t know	2.4 (2/84)

Continued.

Characteristics	Answers	Percent (Number/total) (%)
Application of the regulatory recommendations concerning the management and reporting of incident	No	57.1 (48/84)
	Yes	27.4 (23/84)
	I don't know	15.5 (13/84)

DISCUSSION

Assessing the situation of biomedical engineers and technicians with regard to the infectious risks incurred during their duties and the means placed at their disposal to prevent this type of risk are the objectives of this work.

Our study revealed very interesting results that accurately describe the risks faced by engineers and biomedical technicians in Morocco.

Biomedical engineers and technicians all work in the health sector. Most jobs are located in hospitals or medical biology laboratories. In the literature, they are found to work primarily in the public sector or in public sector partnerships as biomedical or clinical engineers and the objective of their work is to provide a broad-based engineering program that addresses all aspects of medical instrumentation and systems support.[9]

In many publications, WHO recommend to countries to protect the health of their workers by optimizing their working conditions.[10]

Moroccan law has not ignored occupational risk, which defines occupational accidents in article 3 (of the Dahir of June 25, 1927). These accidents are the responsibility of the employer, and this implies that if a technician or engineer is contaminated or infected during his activity, his treatment and medical care are the responsibility of the employer.[11]

The Moroccan guide to the correct performance of medical biology analyzes also emphasizes the need to protect personnel whether they are engineers, technicians, biologists or nurses. They must be informed about the risk and protected against incidents and transmission of microorganisms and in general against all other risks. This is defined in chapter IV of "safety and hygiene" and other similar articles.[12]

The director of the establishment must ensure the protection of the staff, technicians and engineers. For example, the medical laboratory must put in place measures to protect personnel and the environment and ensure that appropriate safety measures are implemented at all levels. To avoid aerosol contamination, all hazardous handling must be carried out under protective enclosures such as laminar flow fume hoods or biological safety cabinets.

Indeed, certain articles of chapter 1 of the general provisions of the health and safety of employees stipulate that the employer must ensure that the packaging of products containing dangerous substances include warnings of the danger on their packaging

The employer is under an obligation to inform employees about the legal provisions in terms of protection from the dangers that machines can generate. He must also post a readable notice on the work premises on the dangers as well as the precautions to be taken. Employees are strictly prohibited from handling a machine without the necessary protective devices in place and must not render the protective devices inoperative.

Most of the participants did not receive specialized education or training in infection risk management. In academic education, during the engineering curriculum, training related to biosafety and risk management is very insufficient or non-existent. Biology teachers include some notions of risk in biology courses and each time they approach a pathogenic microorganism (tuberculosis, hepatitis, salmonellosis) they initiate future engineers to the precepts of protection, clothing, use of particular protective means.[13]

The infections that can be contracted by a technician or engineer, as the other health workers, in the course of their work are many and varied.[14] The most common bacterial infections contracted in the health care setting are tuberculosis and typhoid fevers, and the viral infections most likely to be transmitted through blood and body fluids are hepatitis B, C, and HIV.[15] From this survey, we observe that the types of microbes most familiar to the participants are indeed bacteria and viruses.

Most biomedical technicians or engineers do not benefit from medical supervision. This creates a situation of unprotected status which, combined with the fact that they are not vaccinated, makes the agent very vulnerable.[15]

Technicians or engineers working in the health care facility are most directly exposed to infectious risks due to the nature of their work while those working outside are exposed indirectly. Many factors make biomedical devices vulnerable to infectious risks: duration of exposure to agents, use of sharps, etc.

The availability of equipment of protection in their workplaces and knowledge of the behaviors of prevention are elements in favor of risk reduction.[16] However, it is

legitimate to ask the question about the actual use of this equipment by biomedical technicians and engineers. This risk reduction is moderately felt by technicians and engineers, since few of them consider the risk to be low because they use the means of protection.

In the event of contamination, all the health and administrative provisions are described at different levels of adherence by the participants in this study. Overall, the participants are well aware of the actions to be taken in the event of an incident.

However, only 57% declared the accident of which they had been victims. In Morocco, accidents of exposure to blood are underreported by health workers and the declaration rate does not exceed 26%.[17]

The main reasons given by the authors are the slowness or ignorance of administrative procedures, ignorance or banalization of the risk, negligence by the victims.[18]

Our study shows a few biases that are related to the type of sampling or to the procedure for distributing the questionnaire; for example, the selection of the initial participants to whom the questionnaire was sent, who were all engineers have as consequence that the majority of the population studied is composed of engineers (79%; 66/84). Also, the fact that there are more male participants than female. This fact is explained in a report from the high commission for planning, the feminization rate of engineering schools in Morocco rose from 21.2% in 2000 to 36% in 2012.[19]

CONCLUSION

Infectious risk is related to the presence of pathogens in the workplace. Its evaluation is done by analyzing the protective facilities, knowledge, and behaviors of the exposed agents. Prevention involves measures for work organization, collective and individual protection, as well as staff information and training.

Risk assessment is useless if it is not followed by preventive actions. It is a prerequisite for the definition of preventive actions based on knowledge of the risks to which biomedical engineers and technicians are exposed.

In Morocco, engineers and technicians have tools and equipment of protection, are vaguely familiar with reporting procedures, but they lack training specifically dedicated to their safety. Hence, the need to adopt training courses in biosafety and infectious risk management during the training of engineers and technicians, as well as training and retraining of employees in this field.

This study can be complemented by an analysis of the seroprevalence of the most frequently implicated infectious diseases. This will allow further assess the impact of this risk in the population of biomedical engineers and technicians.

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