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Original Article

Assessment of biosafety measures in clinical laboratories of Al-Madinah city, Saudi Arabia

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Abstract

Introduction: Workers in clinical laboratories are exposed to occupational hazards on a daily basis and their health and safety may be threatened if appropriate protective standards are not implemented. The aim of this study was to assess the knowledge and practices of clinical laboratory workers towards biosafety measures, in Al-Madinah city, Saudi Arabia. Methodology: Clinical laboratory staff was recruited from both the public and private sectors. A structured self-administered questionnaire was used to achieve the aim of the study. Results: A total of 208 workers participated in the study (64% were males, 57% were from the public sector and 71% held a BSc degree). About 68% of the workers were trained in laboratory safety. The majority (> 80%) followed guidelines for disposing medical wastes, decontamination of sample spills, and use of protective lab coats, gloves, etc. However, among participants, 24.2% used to eat, drink or use gum, 18.3% used cosmetics and 24.6% used the mobile phone in the lab. About 18.4% reported that they continued working with a finger cut, whereas 67% reported that they used to recap needles after blood withdrawal. These unacceptable behaviors were associated with lack of lab safety training ($P < 0.05$), biology degree holders ($P < 0.05$), and low experience (3 years and less, $P < 0.01$). With respect to facilities, most of the laboratories complied with standard safety measures. Conclusion: The majority of the sample showed good laboratory practices with respect to safety measures. However, some behaviors are not accepted and need interventions

Key words: Biosafety; clinical laboratory; Al-Madinah.

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Introduction

Workers usually are faced with numerous occupational hazards and their health and safety may be severely jeopardized if appropriate protective practices are not possessed [1-3]. Among such workers are the clinical laboratory staff, who is exposed on a daily basis to various hazards and risks from human samples, infectious aerosols, spills, broken glass, cuts from sharp objects, needle stick injuries, chemical agents, centrifuge accidents and others [4,5]. For example, clinical laboratory staff is at increased risk of acquisition of viral (e.g. hepatitis B and C, corona, and human immunodeficiency viruses) and bacterial pathogens (e.g. *Mycobacterium tuberculosis*), which can all be transmitted through percutaneous damage [6,7]. In review studies, laboratory acquired tuberculosis infection was considered high among health care providers, including medical laboratory staff [8,9]. Similarly, data from England and Wales showed that laboratory technical staff is at a 7.5 times increased risk of acquiring tuberculosis compared to the general population [10]. Therefore, biosafety conception in laboratory practice is of ultimate importance for managing hazardous agents in the laboratory environment; and as such it must be given high priority at all times [11,12]. In addition, compliance with biosafety standards is essential for the accreditation and certification of medical laboratories [13].

In view of this, the present study of knowledge, attitude and practice of laboratory safety measures was carried out among medical laboratory workers in Al-Madinah city, Saudi Arabia. Al-Madinah city is the second holiest city after Mecca for Muslims, receiving more than 10 million pilgrims each year, coming from all over the world [14-16]. The city provides the essential social and health care services to thousands of pilgrims on a daily basis, through ten hospitals and eight primary health care centers. This heavy duty and the diversity of patients adds more parameters to the medical laboratory safety measures to prevent the spread of diseases to the native population and among

visitors [17]. Actually, in Al-Madinah Al-Munawarah there is a lack of data on the level of knowledge and awareness of biosafety practices among clinical laboratory staff. While laboratory practice is not a novel emerging field in Al-Madinah Al-Munawarah, because of the lack of this information, it is essential that biosafety measures, which are a key element of good laboratory practice, be illustrated.

The aim of the present investigation was to assess the knowledge and practices of laboratory workers towards biosafety measures in their respective laboratories in Al-Madinah city. In addition, compliance of medical laboratories with safety standards was also examined. The expected results would serve as a baseline for the level of compliance with standard safety practices and aid to design efficient biosafety training programs for laboratory staff members.

Methodology

Participants and study design

A cross-sectional study of medical laboratory staff was conducted at various private and public hospitals and clinics of Al-Madinah city, Saudi Arabia. The city center has the vast Al-Masjid AL-Nabawi (Prophet's Mosque), which is a major Islamic pilgrimage site. As of 2010, the city of Al-Madinah has a population of 1,183,205, according to the Department of Statistics and Information of the kingdom of Saudi Arabia. In addition, the city welcomes more than 10 million visitors each year, who come from all over the world. Workers from medical laboratories were invited to participate in the study until the target number (> 200 participants) was reached. The response rate was approximately 60%. Participants were presented a description of the purposes of the study, the eventual benefits, and the approximate time (8-10 minutes) needed to fill the anonymous, self-administered questionnaire. Anonymity was a requirement that ensured no possible risks for the participants. Participants were approached during their break time. The study was conducted after ethical approval was obtained from the Ethical Research Committee of Applied Medical Sciences at Taibah University, according to the Helsinki declaration (approval ID: MLT 2016-23).

Study instrument

The survey was standardized and self-administered to scan for attitude, knowledge, and practices of medical laboratory staff. The questionnaire was developed from existing literature and similar studies that were conducted elsewhere [18-22]. The questionnaire consisted of about 40 questions with a choice of answers. The questionnaire was peer reviewed by colleagues from the Department of Clinical Laboratory Sciences and then it was validated by administering the questionnaire to twenty lab workers. The questionnaire was then modified according to the feedback obtained from the analyses of the answers and the comments received from the subjects who participated in the validity study. The questionnaire included four parts. The first part was about demographic parameters such as age, gender, type of work, academic qualifications, specialty, field of work, years of experience and position. The second part asked general questions about laboratory safety training and safety measures related to laboratory place. The third part was about the behaviors of participants in the lab that were related to laboratory safety. The last part was about skills of participants related to dealing with accidents, knowledge of the procedure when an accident takes place and reporting of such incidents. The questionnaire was filled in electronically, either personally using a tablet device or by sending the link using social media or e-mails.

Statistical analysis

Demographic and categorical variables were presented in frequency tables using the SPSS software (version 17, USA). Crosstab and Chi square analysis were used to measure association or correlation between demographic variables and practices/awareness of laboratory staff with respect to safety measures. P value of < 0.05 was considered significant.

Results

The study examined the awareness of medical laboratory workers in Al-Madinah city about laboratory safety procedures. In addition, it assessed compliance of the laboratory facilities with international safety guidelines. To achieve this goal, we recruited 208 participants from medical laboratories from both the private and public sectors. Table 1 shows the demographics of the participants. More than half (56.0%) of the participants were between 18-30 years old and 64.3% were males. The majority of the sample (57%) was from the Ministry of Health hospitals and local health centers. About 71.0% were bachelor degree holders and 17.4% had higher degrees. Finally, about 32% of the sample had not received any training. The rest (68%) was trained in laboratory safety and this included attending a training course/workshop during

their academic education or in their workplaces. Table 1 also shows knowledge of participants about infection. About 89% of the sample had very good to excellent awareness about infection routes. In addition, 84% were knowledgeable in disinfection procedures.

Table 2 shows safety related to laboratory building. Most of the laboratories fitted safety parameters related to buildings and safety equipment. For example, 92.3% had a functional safety cabinet, 85.0% had an eye wash station, 97.1% had sharp boxes, 97.1% had biohazard disposal containers, 79.2% had emergency exists in the building and 84% had a lab safety booklet. However, self-closing doors were present only in about 49% and about 60% had accident and safety violation filing books.

Table 3 shows practices of laboratory workers in medical laboratories. Most of the workers followed good lab practices in handling and processing of specimens in a safe way. In addition, the majority knew how to decontaminate the lab areas. However, 24.2% used to eat, drink or use gum, 18.3% used cosmetics and 24.6% used mobile phones in the lab. About 18.4% reported to continue working with a finger cut, while 67% reported recapping used needles after use. Eating/drinking was associated with lack of lab safety training ($P < 0.05$), biology degree holders ($P < 0.05$), and low experience (3 years or less, $P < 0.01$). The use of cosmetics in the lab was associated with female gender ($P < 0.001$) and low experience (3 years or less, $P < 0.01$). Recapping of needles was associated with

Table1. Demographics of participants.

Variable	Category	Number of subjects (percentage)
Age	18-30	116 (56.0)
	31-40	65 (31.4)
	41-50	24 (11.6)
	> 50	2 (1.0)
Gender	Male	133 (64.3)
	Female	74 (35.7)
Place of work	Public sector	118 (57.0)
	Private sector	89 (43.0)
Academic degree	College	24 (11.6)
	BSc	147 (71.0)
	Master+	36 (17.4)
Academic Field	Medical Laboratory	153 (73.9)
	Applied Biology	23 (11.1)
	Health Sciences	18 (8.7)
	Others	13 (3.6)
Assigned work	Clinical chemistry	60 (29.0)
	Hematology/blood bank	90 (43.5)
	Histology	25 (12.1)
	Microbiology/immunology	32 (15.5)
Years of experience	≤ 3	82 (39.6)
	4-6	56 (27.1)
	7-10	43 (20.8)
	> 10	26 (12.6)
Position	Residency	42 (20.3)
	Technician	134 (64.7)
	Lab director	17 (8.2)
	Consultant	14 (6.8)
Training on Biosafety (course/training workshop)	Yes	140 (68)
	No	67 (32)
Awareness of disinfection procedures	Excellent	120 (58)
	Very good	54 (26)
	Good	25 (12)
	Poor	8 (4)
Awareness of infection routes	Excellent	132 (64)
	Very good	52 (25)
	Good	17 (8)
	Poor	6 (3)

Table 2. Safety related to building in Al-Madinah laboratories.

Item	Yes Number (%)	No Number (%)
Functional Biosafety Cabinet	191 (92.3)	16 (7.7)
Eye wash station	176 (85.0)	31 (15.0)
Sharp boxes	201 (97.1)	6 (2.9)
Biohazards disposal containers	201 (97.1)	6 (2.9)
Emergency exists	164 (79.2)	43 (20.8)
Lab safety booklet	173 (83.6)	34 (16.4)
Hand sanitizer dispensers	201 (97.1)	6 (2.9)
Fire Distinguisher	199 (96.1)	8 (3.9)
Bio-hazard warning sign	178 (86.0)	29 (14.0)
Self-closing doors	101 (48.8)	106 (51.2)
Accident filing book	124 (59.9)	83 (40.1)
Violation filing book	126 (60.9)	81 (39.1)
First aid cabinet	187 (90.3)	20 (9.7)
Fire blankets	141 (68.1)	66 (31.9)

lack of training ($P < 0.01$) and holders of college degrees ($P < 0.05$).

Discussion

In this study, knowledge and awareness of medical laboratory staff about safety measures were investigated in Al-Madinah, Saudi Arabia. The majority of the medical laboratory staff had good knowledge on biosafety procedures and followed good lab practices in terms of safety measures. In addition, most of the laboratory workplaces complied with international laboratory safety standards. However, a fraction of medical laboratory staff had no previous training on lab safety and this was associated with inappropriate behaviors such as eating/drinking in the labs, use of cosmetics and continue working with torn gloves and injured fingers.

A total of 208 participants who worked in Al-Madinah medical laboratories were included in the study. The sample was representative of the study population as it included participants of both genders, different academic degrees, different age groups, and from all areas of medical laboratory sciences. The sample also comprised staff from both the public and

Table 3. Practices of laboratory technicians in Al-Madinah medical laboratories.

Item	Always	Often	Sometimes	Rarely	Never
Following guidelines in disposing medical wastes	165 (79.7)	38 (18.4)	3 (1.4)	1 (0.5)	0 (0)
Inform the lab director about samples and blood spill	130 (62.8)	46 (22.2)	22 (10.6)	6 (2.9)	3 (1.4)
Wear lab coat	149 (72.0)	45 (21.7)	10 (4.8)	1 (0.5)	2 (1.0)
Take off lab coat during resting time outside the lab	111 (53.6)	53 (25.6)	26 (12.6)	10 (4.8)	7 (3.4)
Use of mobile phone in the lab	51 (24.6)	50 (24.2)	67 (32.4)	25 (12.1)	14 (6.8)
Use of head cover during work	75 (36.2)	45 (21.7)	52 (25.1)	14 (6.8)	21 (10.1)
Use of gloves for all purposes	134 (64.7)	50 (24.2)	19 (9.2)	2 (1.0)	2 (1.0)
Changing torn (damaged) gloves immediately	135 (65.2)	51 (24.6)	17 (8.2)	3 (1.4)	1 (0.5)
Use of medical mask	65 (31.4)	47 (22.7)	63 (30.4)	13 (6.3)	19 (9.2)
Put on eye goggles	53 (25.6)	51 (24.6)	57 (27.5)	20 (9.7)	26 (12.6)
Disinfection of Benches	97 (49.9)	63 (30.4)	40 (19.3)	7 (3.4)	0 (0.0)
Recapping needle after blood withdraw	108 (52.2)	31 (15.0)	50 (24.2)	9 (4.3)	9 (4.3)
Putting on warning signs when spills or contamination occur	136 (65.7)	42 (20.3)	21 (10.1)	3 (1.4)	5 (2.4)
Eating or drinking or using of gum in the lab	24 (11.6)	26 (12.6)	18 (8.7)	6 (2.9)	133 (64.3)
Use of cosmetics in the lab	23 (11.1)	15 (7.2)	33 (15.9)	3 (1.4)	133 (64.3)
Reporting of injury and spills accidents	93 (44.9)	82 (39.6)	24 (11.6)	3 (1.4)	5 (2.4)
Touching face/nose/ear during work	40 (19.3)	54 (16.1)	59 (28.5)	19 (9.2)	35 (16.9)
Continue working with finger cut	38 (18.4)	49 (23.7)	60 (29.0)	20 (9.7)	40 (19.3

private sectors including hospitals and small clinics. With respect to demographics, similar distribution was reported in previous studies, regarding age groups, gender and inclusion of private and public sectors [22-24].

Concerning safety related to the laboratory building, most of the laboratories fitted the safety parameters. Most laboratories had functional safety cabinets, eye wash stations, sharps disposal containers, biohazard disposal containers, emergency exists, lab safety booklets, fire distinguishers, fire blankets and so on. This evaluation was based on respondent answers and not on physical evaluation of the places. In comparison with similar studies, a relatively lower compliance with standard biosafety measures with respect to buildings was reported in some other countries [22,23,25,26].

According to the sample, 68% of participants reported receiving training in laboratory safety that included attending a course during college education or through training workshops in their workplace. This percentage is considered high when compared to equivalent studies that were conducted in the region. For example, previous studies from Sudan reported that about 60-84.2% of the respondents did not have any training in biosafety [23]. Similar numbers to that of Sudan were reported in a study from Pakistan [22]. In a recent study from Yemen, of the private and public laboratory staff, 67% and 32% had training in biosafety [27]. In this study, training in biosafety among participants was similar in both private and public sectors.

With respect to behavior of workers related to safety measures, results showed that the majority of the workers followed safety guidelines with respect to disposing medical wastes, using sharp containers, dealing with sample spills, wearing a lab coat, changing torn gloves and disinfection of lab benches. Moderate to low adherence to safety measures was found with aspects such as continue working with a finger cut, eating/drinking in the lab and using eye goggles, head covers and mobile phones in the lab. Similar compliance with these behaviors was reported in studies from Lebanon and India [19,25], whereas lower rates of compliance were reported in some other countries such as Croatia, Nigeria, Indonesia and Sudan [18,20,22,24]. This could be due to the belief of medical laboratory staff that such acts might be associated with low risk of disease transmission. More studies are required to investigate the reasons behind low-moderate compliance with safety measures.

The results showed that about 67% of the participants used to recap needles after blood withdrawal or injections. In a study from Poland, 64% of the respondents occasionally recapped needles after injections [28]. In a review study [7], needle recapping, and the transfer of withdrawn blood from syringes into tubes accounted for the majority of needle-stick injuries. This means that the behavior of medical staff plays an important role in sharp injuries [29]. This behavior can be corrected by applying educational and biosafety training programs and the use of needle protective devices [30,31].

Most of the participants (> 85%) reported excellent to very good knowledge with respect to infection routes and disinfection procedures. In addition, the results showed that a fraction of the participants did not follow good lab practices in terms of safety measures. This includes eating/drinking in the lab, not using eye goggles and continue working with finger cuts and torn gloves. While the majority claimed receiving training in laboratory safety, there is a need for continuous education about the risk of contagious infections and about the most important and innovative ways to maintain a safety environment in medical laboratories. It has been shown that adherence to standard infection control procedures and training programs play a central role in the prevention of occupational infection [32,33].

The results showed that some of the unacceptable behaviors (e.g. eating/drinking in the labs) were associated with lack of training in lab safety, biology degree holders, and low experience. The importance of biosafety training in reducing risk in diagnostic laboratories is well documented [32,33]. With respect to biology and health science degree holders, they are usually assigned similar tasks to that of diagnostic medical laboratory technicians and thus are at the same risk level. Therefore, it is recommended that they receive enough training and examination before obtaining the license to practice a diagnostic laboratory profession.

Finally, it is worth to mention that the current study was a modest scale investigation that provided baseline data related to safety measures of medical laboratories in Al-Madinah city. Thus, large scale studies are needed at a National scale to define compliance rates and identify probable wide spread health hazards to laboratory workers.

Conclusion

Most laboratories in Al-Madinah city fit safety measures with respect to equipment and buildings. With respect to personnel, the majority was compliant with

safety guidelines related to disposing medical wastes, using sharp containers, dealing with sample spills, wearing a lab coat etc. However, some behaviors such as eating/drinking and using mobile phones in the labs, continue working with finger cuts and ruptured gloves and not using eye goggles and masks, are not accepted and need interventions.

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Authors' contributions

All authors have contributed to the study design, writing the grant proposal for funding, study questionnaire development, data collection and reading the final draft. Prof. K. Al Ali has initiated the first draft and Prof. O. Khabour has performed the statistical analysis.

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