International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Biosafety Knowledge and Perceptions of Clinical Laboratory Science Educators in A Saudi University

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Received: 21/04/2015 *Revised: 14/05/2015* *Accepted: 27/05/2015*

ABSTRACT

Educators recognize the importance of biosafety in handling pathogenic microorganisms in teaching laboratories as well as minimizing the risk to students and the community. As facilitators of learning, they play a key role in influencing their students to strictly comply with existing institutional and national biosafety regulations and improving their related policies and practices. Good knowledge of the educators on standard biosafety practices contributes to ensuring safer teaching laboratories. The goal of this cross-sectional study was to determine the knowledge on biosafety regulations and perceptions about occupational risk and biosafety training among the thirty-one Clinical Laboratory Science (CLS) educators in Shaqra University (SU). Biosafety-specific knowledge was also measured among the respondents. A pre-designed questionnaire was administered among the 5 Professors, 10 Assistant Professors and 16 Lecturers of the Departments of Clinical Laboratory Sciences at the campuses of Dawadmi, Quwayiyah and Shaqra. Results revealed that the respondents indicated moderate knowledge on biosafety regulations but they identified gaps such as lack of biosafety trainings and seminars, existence of laboratory-acquired infection, and poor dissemination of national and institutional safety regulations. In terms of biosafety-specific knowledge, the respondents needed to improve their knowledge on several aspects like the use of a biosafety manual, responsibility for the adherence to biosafety regulations, personal protective equipment, biosafety containment level, and protection in the daily laboratory work. Recommended measures were suggested to address the identified gaps, which include behavioral-based biosafety training, one or two short talks or seminars, and revision of institutional safety guidelines.

Keywords: Biosafety, Clinical Laboratory Science, Shaqra University, Laboratory Safety

INTRODUCTION

Biosafety is not only comprised of the protective practices in response to the contamination risks associated with pathogenic microorganisms in the laboratories, manipulation of potentially contaminated stock or products, performance of microbiological tests for medical or scientific purposes, but also the measures observed in protecting the environment and the human population against potential contamination. [1] It is based on the combined impact of good microbiological techniques, facility design of the laboratory and safety equipment. [2]

The prominence of biosafety was fueled by the occurrence of laboratory-associated infections (LAIs), which first appeared approximately at the start of the twentieth century based on published

reports. By 1978, four studies documented 4,079 LAIs that resulted to 168 deaths occurring between 1930 and 1978. [3-6] In 2009, the U.S. Department of Health and Human Service identified the ten most common causative agents of overt infections among laboratory workers in reference to the studies conducted by Pike and Sulkin, which include *Brucella* spp., *Coxiella burnetii*, hepatitis B virus (HBV), *Salmonella typhi*, *Francisella tularensis*, *Mycobacterium tuberculosis*, *Blastomyces dermatitidis*, Venezuelan equine encephalitis virus, *Chlamydia psittaci*, and *Coccidioides immitis*. Recently, the CDC reported human *Salmonella typhimurium* infections associated with exposure to clinical and teaching Microbiology laboratories. The report covered between August 20, 2010 and June 29, 2011 with a total of 109 individuals infected, age range from less than 1 year to 90 years old. Twelve percent of patients were hospitalized, with one death. [7]

Similarly, biosafety concerns have been raised by universities offering biological sciences like Medical Microbiology, which is an integral course in the Clinical Laboratory Science program. One of the pressing concerns in a laboratory used for teaching is the safe handling of microorganisms. Educators acknowledge the important role of biosafety in handling microorganisms as well as adopting measures to minimize risk to students and the community. However, teaching laboratories face difficulties in implementing biosafety practices due to lack of uniform, easy-to-follow set of guidelines for educators. This resulted to failure to establish best practices for achieving biosafety among the different institutions. Lecturers and professors simply rely on their own previous biosafety training, techniques shared from former teachers at their institution, or safety presentations at conferences to enhance their biosafety practices. [8] A study underscored the role of educational institutions, academic laboratories for teaching, research or both as partners in promoting a biosafety culture. These academic institutions prepare the professionals that become regulators, leaders or policymakers. Universities and colleges share a basic role in education and training. [9]

The goal of this current study was to determine the knowledge on biosafety regulations and perceptions about occupational risk and biosafety training among the Clinical Laboratory Science (CLS) teaching staff in Shaqra University (SU). Biosafety-specific knowledge was also measured among the respondents. SU is one of the higher education institutions in the Kingdom of Saudi Arabia offering Applied Medical Science courses such as Clinical Laboratory Science. The university is furnished with three laboratories for Medical Microbiology, Clinical Biochemistry and Pathology. Equipped with the proper knowledge, university educators can play a vital role in influencing their students to strictly comply with existing institutional and national biosafety regulations and improving their related policies and practices. Thus, results of this research would be utilized as bases for recommendations and future action plans to enhance the biosafety culture in Shaqra University.

MATERIALS AND METHODS

Study design: Cross-sectional study

Study setting: The study was conducted in the Clinical Laboratory Science Departments of the three (3) Colleges of Applied Medical Sciences of Shaqra University. The three (3) Colleges are situated at Dawadmi, Quwayiyah and Shaqra.

Study period: August 2014 – January 2015

Study subjects: The Professors, Assistant Professors, and Lecturers of the Clinical Laboratory Science Department were

involved in the study. Part-time teaching staff was also included.

Sample size: A total of thirty-one (31) CLS educators were included in the survey, with 5 Professors, 10 Assistant Professors, and 16 Lecturers.

Sampling: Purposive non-probability sampling technique was employed for the sample size of the study subjects.

Data Collection

Survey

The Knowledge and Perception (K&P) survey was done among the study subjects, using a pre-designed questionnaire as the data gathering tool. Adopted from a study, the questionnaire has two (2) main parts consisting of 10 multiple choice questions each. [10] The first part elicited answers to the questions pertaining to the knowledge on regulations and perceptions about occupational risk and biosafety training. Biosafety-specific knowledge was the theme of the second set of questions. Interpretation of results in terms of the knowledge of the respondents was based on Shinde et al., [11] where a score of more than 75% was considered good, 50-74% moderate, and less than 50% was taken as poor.

Statistical Analysis

Descriptive statistics was employed to calculate frequency and percentage of the responses of the subjects.

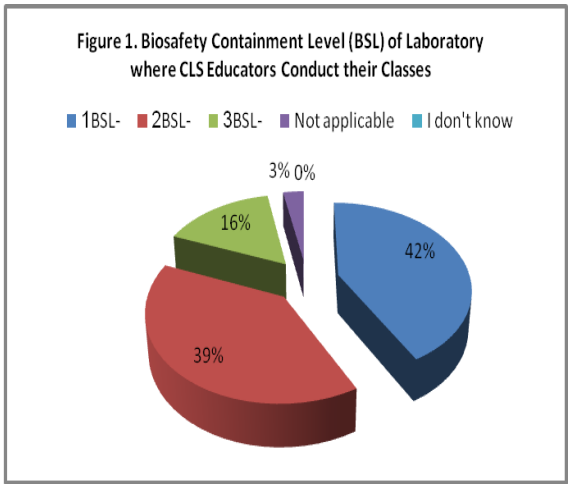
RESULTS AND DISCUSSION

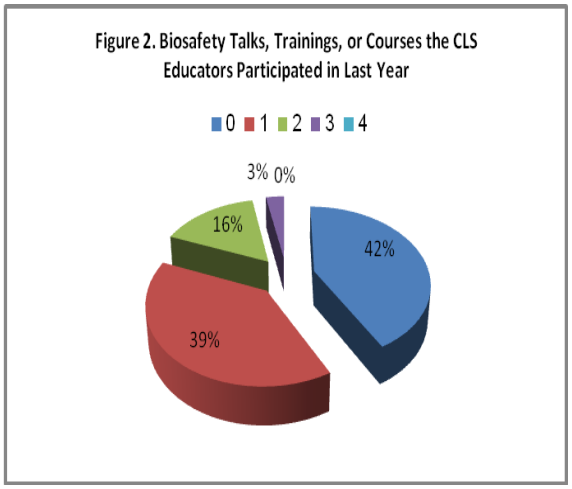
A total number of thirty-one (31) Clinical Laboratory Science (CLS) educators of Shaqra University participated in the study, with 12 subjects from Dawadmi, 9 from Quwayiyah and 10 from Shaqra. Sixteen percent of the CLS educators were Professors, 32% were Assistant Professors, and 52% were Lecturers, specializing in Medical Microbiology, Clinical Laboratory Science/Medical Laboratory Technology, Clinical Biochemistry, Hematology and Immunohematology, Pathology, Biotechnology, Medical Science, Pharmacology, Anatomy and Physiology, Nursing, Organic Chemistry and Computer Applications.

Knowledge on regulations and perceptions about occupational risk and biosafety training among the CLS educators in Shaqra University

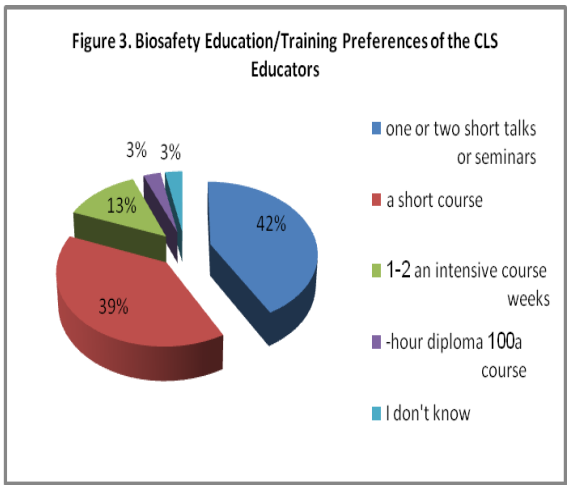
Figures 1-3 depict a self-description of the subjects; their familiarity with workplace or national regulations as it pertains to workplace biosafety or hazardous waste management (Figures 4-6); their perception of occupational risk (Figures 7-8); and their opinion on the importance of biosafety training (Figures 9-10) Interestingly, only less than 50% of the CLS educators responded correctly in identifying the biosafety containment level of the teaching laboratory where they conduct their laboratory activities (Figure 1). Since basic microbiological procedures are commonly performed in a teaching laboratory for Medical Microbiology, BSL-1 is acceptable. [12] In the event that biological specimens and bacterial cultures are also handled in the Microbiology laboratory then the containment level is raised to BSL-2. [10,13]

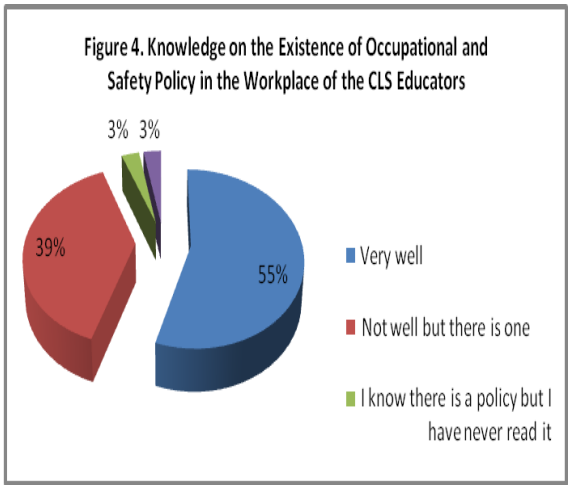
In terms of biosafety training, 42% of the respondents did not attend any biosafety talks, trainings, or courses in the previous year (Figure 2) but all of them were interested to participate in one or two short talks or seminars and avail of a short course (Figure 3). The interest of the CLS educators in attending biosafety trainings is encouraging. Based on a study, a collective responsibility towards the promotion of safety in the laboratory is achieved through the engagement of laboratory leadership in biosafety training activities and provision of job-specific training to all people using biocontainment laboratories. [14]



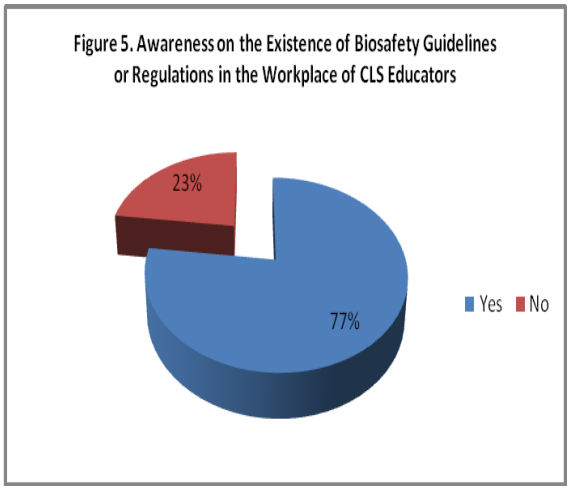


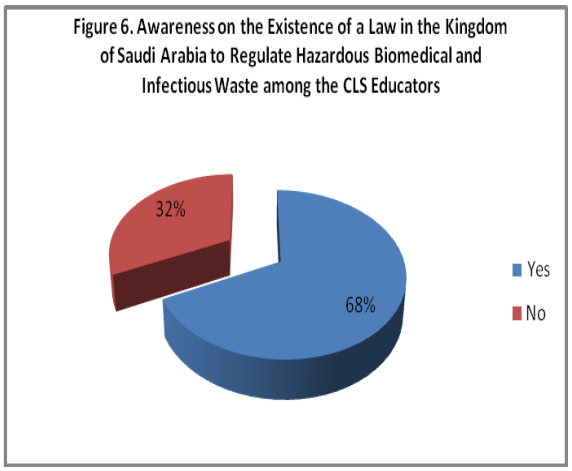
For questions 4-6, the respondents exhibited good knowledge on the occupational health and safety policies of their College as well as the existence of biosafety guidelines or regulations (Figures 4, 5). Of the 31 subjects, 68% were aware of the existence of a law in the Kingdom of Saudi Arabia to regulate hazardous biomedical and infectious waste (Figure 6). In a research conducted, the author reiterated the seriousness of the Saudi Arabia government in promoting a safe and healthy environment, being a moral and religious obligation to safeguard the general welfare of the workers and other stakeholders. [15] In 1969, the Royal Decree No. M/21 dated Ramadan 1389 compels the Ministry of Labor and Ministry of Commerce and Industry to develop a program intended to attain a healthy work environment, reducing cases of workplace injuries. [16]

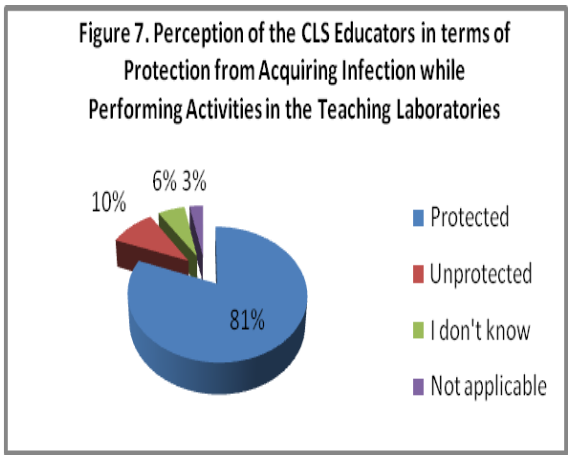




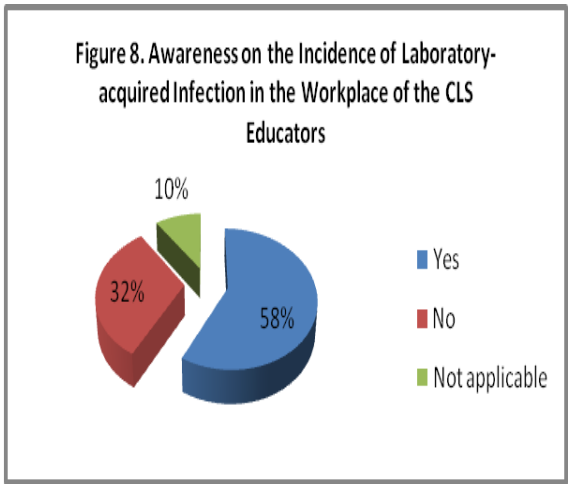
As to the perception of occupational risk, 81% felt they were protected from acquiring an infection while performing their activities in the teaching laboratories (Figure 7) but more than half of the respondents (58%) were aware of laboratory-acquired infection (LAI) in their workplace (Figure 8). With 58% of the CLS educators aware of the incidence of LAI, it is regarded as a special concern and an in-depth investigation must be undertaken prior to urging the employers and laboratory managers to develop a program that will reduce or minimize the occurrence of LAI. [10]

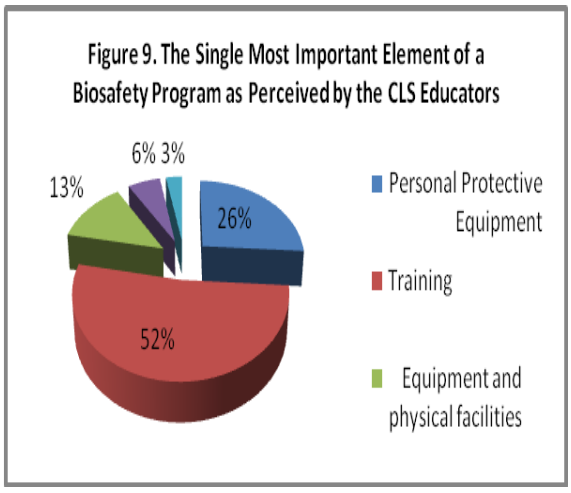


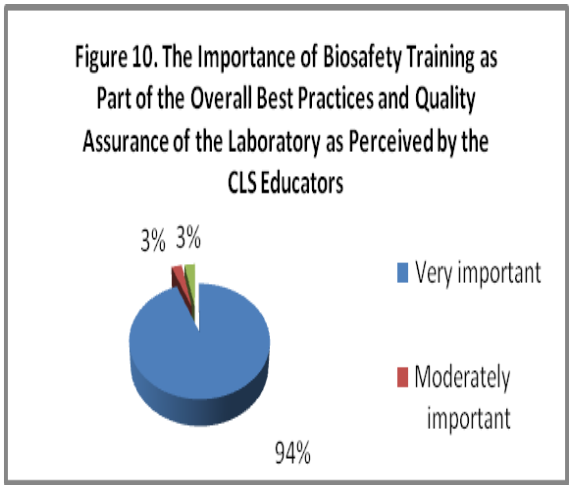




Along their opinions on the significance of training, 52% of the respondents agreed that training is the single most important element of a biosafety program (Figure 9). A remarkable 94% recognize that biosafety training is very important as part of the overall best practices and quality assurance of their workplace (College) (Figure 10). These figures validate the need for a training program on biosafety as reflected also on their responses to questions 2-3.







Biosafety-specific knowledge of the CLS educators in Shaqra University

As presented in Table 1, the respondents have good knowledge in terms of the relationship between science and safety (81%) and importance of having a medical surveillance program for minimizing risks (77%). They were moderate along factor necessary to ensure sustainable behavior (61%); weight of human behavior bear on expected results (64%); and biosafety administrative control (61%). Strikingly, the CLS educators displayed a poor knowledge on the guarantee that having a biosafety manual results to good practices (13%); responsible people for the adherence to biosafety regulations in the teaching laboratory (48%); personal protective equipment (42%); concept that all work in a BSL-2 laboratory must be done inside a biosafety cabinet (19%); and ensuring protection in the daily laboratory work with a sophisticated facility with strong engineering controls (6%). Correct responses were provided. [10]

Table 1 Biosafety-specific knowledge of the CLS educators in Shaqra University (n = 31)

Question	Answer Options and % of Responses (Correct response underlined)
1. How strong do you believe is the relationship between science and safety?	Very strong: 81% Moderate: 19% Not much: 0% No relation: 0% I don't know: 0%
2. Having a biosafety manual guarantees good laboratory practices.	Yes: 87% No: 13%
3. How important is having a medical surveillance program for minimizing risks?	Very important: 77% Moderately important: 16% Not too important: 7% It doesn't make any difference: 0% I don't know: 0%
4. Who is responsible for the adherence to biosafety regulations in the laboratory?	Administrators: 7% Biosafety officer: 23% Lab Director: 19% Lab Technicians: 3% Everybody: 48%
5. Besides knowledge and resources, what is another factor necessary to ensure sustainable behavior?	Understanding risks and benefits of change: 61% Regulations and laws: 39% I don't know: 0%
6. How much weight does human behavior bear on expected results?	Considerable weight: 64% Moderate: 26% Not much: 0% None: 0% I don't know: 10%
7. The following is an example of personal protective equipment:	Biosafety cabinet: 45% Gloves: 42% Decontamination procedures: 3% Standard operating procedures validation: 10%
8. The following is an example biosafety administrative control:	Biosafety cabinet: 13% Gloves: 10% Decontamination procedures: 16% Standard operating procedures validation: 61%
9. True or False: All work in a BSL-2 laboratory must be done inside a biosafety cabinet.	True: 81% False: 19%
10. A sophisticated facility with strong engineering controls ensures protection in the daily laboratory work.	Yes: 94% No: 6%

Very importantly, the CLS educators felt the very strong connection between science and safety as well as the belief that human behavior plays a vital role in handling biological hazards. However, there is an urgency to enhance the knowledge of the respondents in several aspects that they rated poor. One research affirms the link of human factors to laboratory safety. They explained that many human factors affect an

individual's risk to injury. Knowledge or lack of knowledge of safe laboratory practices, awareness or ignorance of hazards, and physiological and behavioral factors must be regarded in incident assessment or prevention. Likewise, they reiterated that specific knowledge is essential in preventing injuries and damaging incidents. Frequently, employees need to refresh the theories and application of laboratory safety that they were taught in their formal education in response to the rapid advancement of technology and research procedures. [17] Consequently, the respondents themselves manifested their enthusiasm and underscored the necessity for training activities, seminars, short courses and other forms of educational strategies to reconcile the gaps in biosafety.

promotion in Shaqra University. Another study refutes that having a biosafety manual is a guarantee to good laboratory practices. Human behavior, knowledge, resources, understanding risks and benefits of change, and presence of a medical surveillance program for minimizing risks constitute a reliable biosafety culture. [10]

Recommended Measures

Based on the results of the survey among the CLS educators of Shaqra University, the researchers urge consideration of the following suggestions geared towards improving the knowledge and perceptions of the respondents as well as to enhance the biosafety culture in the teaching laboratories.

Behavioral-based biosafety training. Worthy of emulation, the proposition of a study for a behavioral-based biosafety training curriculum has been effective for participants from a variety of educational backgrounds. Regarded as behaviors, good laboratory practices must be sustainable over time. In order to sustain these behaviors, individuals must have sufficient comprehension of the risk of poor laboratory practices, the advantages of good laboratory practices, have access to resources intended for good laboratory practice, perform the necessary skills to be successful, and believe in their abilities to discharge good laboratory practices. Through this training scheme, the participants become aware of these concepts and integrate them into their respective institutions to promote a safer laboratory practices. [18]

One or two short talks or seminars. Of the 31 CLS educators, 42% suggested this mode of conducting biosafety education. The researchers suggest quarterly seminars within the university and the topics include biosafety laws and guidelines of Saudi Arabia and Shaqra University; personal protective equipment; and basic concepts of biosafety (biosafety manual, biosafety containment level, standard operating procedures, etc.). Resource speakers must be expert in the field of laboratory medicine, particularly laboratory safety.

Revision of institutional safety guidelines. A recent study underscores the need and opportunity to review and revise safety guidelines. Their study revealed that there has been somewhat of an overemphasis on physical containment guidelines and perhaps too little on laboratory competence in working with infectious agents. They also advocate for guidelines for specific training, anchored on the premise of training people to work professionally and competently. [19]

CONCLUSION

The knowledge on regulations of the Clinical Laboratory Science educators of Shaqra University is moderate but they enumerate gaps that need to be addressed such as lack of biosafety trainings and seminars, existence of laboratory-acquired infection, and poor dissemination of national and institutional safety regulations. In terms of biosafety-specific knowledge, the

respondents need to improve their knowledge on several aspects like the use of a biosafety manual, responsibility for the adherence to biosafety regulations, personal protective equipment, biosafety containment level, and protection in the daily laboratory work. Recommended measures are suggested to address the identified gaps, which include behavioral-based biosafety training, one or two short talks or seminars, and revision of institutional safety guidelines.

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How to cite this article: Cruz CP, Abu Bakr ESA, Thazha SK et. al. Biosafety knowledge and perceptions of clinical laboratory science educators in a Saudi university. Int J Health Sci Res. 2015; 5(6):196-204.

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