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Gaps in knowledge, attitudes and practices on medical laboratory safety among technical officers in Faculty of Medicine, University of Ruhuna

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Abstract:

Background and objectives: With improving quality and standards, assuring safety of employees, users (patients or students) and environment is integral in medical laboratories. The practices and attitudes on safety are built mainly on the knowledge of the technical personnel. This study was carried out in Faculty of Medicine, University of Ruhuna to determine gaps in knowledge, practices and attitudes on laboratory safety as per the International and National safety standards among technical personnel.

Materials and methods: Data were collected with an investigator administered questionnaire containing open and close ended questions. Data were analyzed qualitatively.

Results: Of the 40 technical officers, 32 consented and participated in the study. Majority (27) were Advanced Level qualified. Seventeen (53%) had training on laboratory safety. Their knowledge on door signage and practices in general laboratory safety were satisfactory while knowledge on principles of laboratory safety, waste disposal, universal precautions, first aid, management of blood spills, materials safety data sheet and use of fire extinguishers were suboptimal. Surprisingly, two of them mentioned the use of mouth pipetting which is obsolete. Adherence to safety practices showed lapses. Majority accepted training on laboratory safety as a requirement. They showed a positive attitude towards improvements and safety implementations in the laboratory they are working.

Conclusion: Knowledge and adherence to safety practices of technical officers is suboptimal thus establishing a training program on laboratory safety for technical staff is an urgent need.

Key words: Knowledge, Laboratory safety

Introduction:

It is the twenty first century, we move to total automation in diagnostics. With ever increasing test menu, the quality and standard of practice of laboratory medicine has improved dramatically with minimal errors and accidents. Even though the safety concerns are minimized by automation and recent laboratory innovations, it is mandatory and of paramount importance to ensure safety of employees, patients and the environment in medical laboratories. The potential hazards in clinical laboratories can vary. Safety issues related to handling, analysis and evaluation of clinical samples for diagnostic purposes are well documented (1-5). With the recent Covid 19 outbreak, attention on laboratory safety is stressed and much discussed globally.

Laboratories are indispensable in patient care, teaching and research. Processes in laboratories are designed to fulfill various roles as diagnostic evaluation, research education, analytical testing, quality controlling etc. All laboratories share common characteristics regardless of their purpose or setting. Those include, development and validation of testing protocols and sampling strategies; instrument calibration and internal quality assurance; product sampling and collection; transport and delivery of samples to the laboratory; receipt, acceptance (or rejection) and record keeping; sample preparation; sample analysis; calculation and reporting of results;

information was gathered by an investigator administered, pre-tested questionnaire. The questionnaire was in four parts. Part I inquired about basic demographic data. Part II included twenty semi-structured open ended questions on medical laboratory safety. The participants were expected to provide brief answers. Part III was a checklist to assess knowledge on usage of fire extinguishers. Here, the different fire extinguishers were included with the colour code and they were asked to indicate the type of fire which can be controlled by each. Part IV consisted of twenty items to assess attitudes and practices of the participants on laboratory safety and it included closed ended questions to answer with responses in a scale ranging from never to always. The answers given in Part II and III were categorized in to two groups, either acceptable or unacceptable depending on the accuracy of the answers as per the standard safety requirements. The answers to Part IV were analyzed quantitatively.

Results

Of the 40 permanent technical officers attached to the institution, 32 consented and participated in the study. Only 17 technical officers (53%) had some training on laboratory safety during their period of employment. The educational background of study subjects ranged from advanced level to a diploma or a degree in science. A majority (n=23, 71.88%) were advanced level recruits.

All the participants (100%) were able to describe at least two good laboratory practices which can prevent accidental chemical ingestion. A majority of participants could recognize door signage correctly (Table 1). Twenty two (68.8%) participants appropriately described the need of eye wash stations as a safety measure. Majority (n=22, 68.8%) were aware of potential carcinogens in use in laboratories. The knowledge on infection transmission was satisfactory and 25 (78.1%) officers correctly listed infections which can be transmitted through blood. Twenty three (71.9%) described good laboratory practices which can prevent fire in a laboratory while 22 (68.8%) were able to describe electric hazard preventive measures.

Inadequate knowledge on basic principles of laboratory safety was reflected by the failure to give acceptable answers to many questions including, universal precaution (0%), waste disposal methods (n=8, 25%), first aid measures following needle stick injury (n=10, 31.3%), blood spills management (n=5, 15.6%) and method of carrying and storing corrosives (0%). Surprisingly, in spite of knowing blood borne infection risk, all failed to describe the universal precautions correctly. Only 25% of participants correctly described waste classification and proper disposal while 15.6% were aware of adherence for the central environment authority regulations as a requirement in waste disposal.

The procedure to follow when presented with a needle stick injury was correctly described by only 10 (31.3%) technical personnel. Only 5 (15.6%) were able to describe the proper management of blood spills. Only 11 (34.4%) participants mentioned use of hypochlorite always when blood spills are managed. This indicates non adherence to standard safety practices of other technical personnel.

Eventhough, none could describe the technique of storing corrosives correctly and how to carry corrosives when volume is over 500ml, a majority (n=29, 90.6%) knew it should never be stored in top shelves of the laboratory.

Six (18.8%) participants described the materials safety data sheet correctly and its contents were described correctly by ten (31.3%).

Surprisingly, eventhough obsolete, a few (n=5, 15.7%) stated mouth pipetting as a procedure that is used when performing manual blood cell counts.

The knowledge of technical officers on different types of fire extinguishers and their appropriate use was also sub optimal. A majority (n=27, 84.4 %) was aware on use of water as an extinguisher on fires of

and waste disposal. Out of these, the greatest concern for potentially hazardous exposures involve sample collection, preparation and analysis (1). Despite using automated equipment and techniques, still aerosol formation, sample spillage and surface contamination can occur with an assessable risk of infection transmission. Lack of knowledge on hazards, absence of awareness training and sub optimal safety performance make the laboratory personnel more vulnerable to these hazards (1, 3).

The potential hazards in a laboratory are classifiable into four main categories: chemical, physical, radiological, and biological (1). All these risk categories are prevalent in University laboratory settings as well. Laboratories in Medical Faculties are used to provide direct diagnostic services, teaching and research. Each laboratory exhibits a unique set of concerns depending on the risks which require specialized attention based on their service. Provision of safety training is very important in any health care institution or in any laboratory setting nowadays to promote the standard of care and services offered.

Laboratory safety management includes identification of all the potential hazards of the laboratory and classification of them. Preparation of safety manual, routine safety check, reporting and implementing suitable remedy to contain accidents or emergencies, and prevention of breach in safety in all its operations is the final goal of such a program (1, 6-9).

A study carried out among undergraduates in an allied health sciences faculty in Sri Lanka revealed a significant difference of knowledge on safety between BSc medical laboratory science students and the other students of different allied health disciplines. However, the same study showed adherence to poor safety precautions by all the allied health science students (10). To understand training requirements, it is important to define lapses in the safety system in any institution. It is of paramount importance to research in to the available knowledge level, practices and provisions of laboratory workers with regard to safety. This study was carried out in the Faculty of Medicine, University of Ruhuna in which, many different laboratories are in operation in different Departments and Units. Diagnostic laboratories handle clinical samples collected from patients in teaching hospital and private hospitals. Laboratories involved in medical research handle clinical samples of patients and of healthy volunteers. In addition, student laboratories meant for teaching medical undergraduates handle patient samples as and when required. Some laboratories use strong chemicals such as formaldehyde, absolute alcohol, acids and xylene etc while a few use radioactive agents to carry out immunological and radioimmunoassays. Therefore, biohazards, chemical hazards and general safety hazards are equally, potentially prevail in all these laboratories. Thus, evaluation and assessment of gaps in knowledge, attitudes and practices in relation to laboratory safety among technical officers attached to these laboratories is the foundation stone for the establishment of proper safety training and safety management program. As there is no properly implemented safety training program within the Faculty of Medicine focusing technical personnel, this study can provide a good insight on needs and key areas to address in such a program. Therefore, this study was carried out to determine the gaps in technical officers' knowledge, failures on adherence to general laboratory safety recommendations and their attitudes on laboratory safety as per expectations and recommendations in the national & international safety standards.

Materials and methods

A descriptive cross-sectional study was carried out among all the technical officers working in Faculty of Medicine, University of Ruhuna, after obtaining informed-written consent. Ethical approval was obtained from the Ethics Review Committee of Faculty of Medicine, University of Ruhuna. Objectives of the study were to assess the knowledge, attitudes and practices on medical laboratory safety among technical officers and to determine their adherence to laboratory safety recommendations. The

solids. The knowledge on other types of fires and appropriate extinguishers was inadequate (Figure 01).

Data on attitudes and practices of technical officers on medical laboratory safety is shown in Table 02. Almost all (96.9%) the technical officers correctly mentioned avoidance of use and storage of food inside laboratories. A majority (n=22, 68.8%) was not wearing laboratory overcoats when working in the laboratory but 71.9% (n= 23) used disposable gloves as a practice. Most were aware on prevention of splashes by the use of goggles. Majority (n=26, 81.3%) agreed that left over samples should never be emptied to wash basins. Twenty eight (87.5%) participants understood the safety training as a need and 80% endorsed regular safety check as a requirement. The good practices of not serving and storing food (96.9%,), water (96.9%,), and personal belongings (71.9%,) show their good attitudes towards safety. The collection of needles together with other clinical waste into polythene bags show a mixed response. While 40.6% never practiced such, 43.8% practiced it always which reflected their attitudes.

Discussion

Quality standards and accreditation of medical and clinical laboratories demand assurance of safety of employees, environment and patients (users) as mandatory requirements. Therefore, it is a necessity to have safety measures, safety education, safety training and safety practices in medical clinical laboratories and the laboratory employees should have the necessary knowledge and information on laboratory safety. Technical officers are key players in laboratories whether these are for patient sample testing, research or student teaching. As a medical faculty, we expect appropriate knowledge and practices inculcated among technical personnel to assure safety. The findings of this study highlights the inadequacy of knowledge and gaps in practices on laboratory safety by the technical personnel attached to Faculty of Medicine, University of Ruhuna. Regular training in specific spheres of practice is

Table 1: Technical officers' knowledge on medical laboratory safety (n=32) (Open ended questions)

	Questions on Knowledge on laboratory safety	Acceptable Answer n (%)
1	State the two types of illumination needed in the laboratory.	04 (12.5)
2	What is meant by room temperature?	03 (09.4)
3	What do you understand by the term - universal precautions?	00 (00)
4	Do you know the regulations of Central Environmental Authority of Sri Lanka with regard to medical laboratory waste?	05 (15.6)
5	What is the standard method of disposal of different types of waste in your laboratory?	08 (25.0)
6	When do we need eye wash stations?	22 (68.8)
7	What first aid measures should be taken when there is a needle stick injury?	10 (31.3)
8	State the method for management of a blood spill on a table top	05 (15.6)
9	What do you understand by door signage?	20 (62.5)
10	Link the standard door signage a. Bio hazard b. Laser hazard c. Radiation hazard	 21 (65.6) 24 (75.0) 20 (62.5)
11	State the recommended method to carry corrosives if the volume is more than 500ml	00 (00)
12	State the method of storage of corrosives	00 (00)
13	What do you understand by "MSD or material safety data sheet"?	06 (18.8)
14	Indicate four basic contents of a MSD	10 (31.3)
15	What is a carcinogen?	22 (68.8)
16	State few carcinogenic chemicals used in medical laboratories	13 (40.6)
17	State three measures to be taken to prevent electric current related laboratory accidents	22 (68.8)
18	State two good laboratory practices which can prevent accidental ingestion of chemicals	32 (100)
19	State two good laboratory practices which can prevent accidental fire in laboratories	23 (71.9)
20	State main diseases which can be transmitted by handling clinical samples	25 (78.1)

Fire Extinguisher Chart

Extinguisher		Type of Fire				
Colour	Type	Solids (wood, paper, cloth, etc)	Flammable Liquids	Flammable Gasses	Electrical Equipment	Cooking Oils & Fats
	Water	A. 27 B. 01 C. 04	A. 02 B. 14 C. 16	A. 01 B. 15 C. 16	A. 01 B. 14 C. 17	A. 01 B. 15 C. 16
	Foam	A. 10 B. 02 C. 20	A. 13 B. 0 C. 19	A. 05 B. 04 C. 23	A. 0 B. 09 C. 23	A. 11 B. 02 C. 19
	Dry Powder	A. 12 B. 03 C. 17	A. 16 B. 03 C. 13	A. 13 B. 06 C. 13	A. 16 B. 07 C. 09	A. 14 B. 04 C. 14
	Carbon Dioxide (CO_2)	A. 12 B. 03 C. 17	A. 17 B. 02 C. 13	A. 18 B. 02 C. 12	A. 20 B. 01 C. 11	A. 17 B. 04 C. 11

Figure 1: Fire extinguisher chart with the results of technical officers' knowledge on the type of extinguishers that can be used on different type of fires(n=32)

A – number correctly answered. B - number incorrectly answered, C - number who do not know the answer

described as a mandatory requirement. Development of highly reliable teams through training has been described as the key of success in organizational development (7). Being a medical faculty with resources, absence of an established training program on safety for technical officers is a vaccum in the system.

According to literature, most of the laboratory related infections and accidents are due to inadequate proactive measures due to poor knowledge or negligence (1,3,8). Most of the participants in this study had the concern on safety check as a regular requirement. Their knowledge on measures that can be adopted to prevent chemical ingestion, occurrence of fire and electric hazards endorses their potential to implement good safety practices (9). Surprisingly none of the technical personnel knew accurate handling of corrosive volumes exceeding 500ml. Inconsistent use of laboratory overcoats stresses the need of implementation and regularization of general safety requirements, establishment of safety protocols and standard operative procedures within departments. A clear relationship between absence of accidents and compliance with safety practices has been described (9). Whether accident occurrence and incidence reporting is timely and appropriately reported in our setup is doubtful and in this study we could not assess it. However, the responses of the participants raise a potential higher risk of laboratory related adverse events. It will be interesting to assess the accidents and events related to laboratory practices and the steps taken at individual Departmental level in the University. High overall incidence of laboratory related occupational illnesses over a period of four years (1998 -2001) in medical and dental laboratories compared to private industry and testing laboratories in USA have been documented (1). This shows the overall high risk in medical laboratories even with highest facilities. Although the initial education and training of people

Table 2: Technical officers' attitudes and practices on medical laboratory safety (n=32) (closed questions)

	Assessment of attitudes and practices on laboratory safety	Never n (%)	Occasionally n (%)	Frequently n (%)	Most of the time n (%)	Always n (%)
1	Drinking water is stored in laboratory refrigerator.	31(96.9)	1(3.1)	0	0	0
2	Food is served and stored inside the laboratory.	31(96.9)	0	0	0	1(3.1)
3	Personnel belongings are kept in the laboratory.	23(71.9)	6(18.8)	1(3.1)	2(6.3)	0
4	Wear laboratory over coat when work in the laboratory.	22(68.8)	6(18.8)	2(6.3)	2(6.3)	0
5	Wear disposable gloves when handle all the clinical samples.	0	1(3.1)	5(15.6)	3(9.4)	23(71.9)
6	Broken pieces of sample tubes are removed from a centrifuge by bare hand.	27(84.3)	1(3.1)	2(6.3)	0	2(6.3)
7	Blood spill is cleaned with hypochlorite solution.	6(18.8)	8(25)	3(9.4)	4(12.5)	11(34.4)
8	Blood soaked cotton, syringes and needles are collected in to polythene bags in a bucket.	13(40.6)	3(9.4)	0	2(6.3)	14(43.8)
9	Left over blood samples from patients are directly emptied in to laboratory sink.	26(81.3)	2(6.3)	2(6.3)	0	2(6.3)
10	Universal precautions are applied to all the clinical samples	4(12.5)	5(15.6)	0	7(21.9)	16(50)
11	Fume hood is needed when volatile toxic substances are handled.	2(6.3)	0	3(9.4)	21(65.6)	6(18.8)
12	Corrosive chemicals are stored in top shelf of the laboratory rack.	29(90.6)	1(3.1)	0	0	2(6.3)
13	Mouth pipetting is practiced when perform manual blood cell counting.	24(75.0)	3(9.4)	2(6.3)	0	3(9.4)
14	Goggles are needed to prevent harmful flashes.	3(9.4)	3(9.4)	0	3(9.4)	23(71.9)
15	Electrical safety is a requirement in medical laboratories.	0	2(6.3)	2(6.3)	2(6.3)	26(81.3)
16	Emergency exit is a requirement in laboratories.	2(6.3)	2(6.3)	0	2(6.3)	26(81.3)
17	Entry to a laboratory must be restricted.	2(6.3)	3(9.4)	1(3.1)	11(34.4)	15(46.9)
18	Routine safety check is a requirement in your laboratory.	0	3(9.4)	3(9.4)	6(18.8)	20(62.5)
19	Safety practices in other countries can be directly applied and practiced in our laboratories.	2(6.3)	10(31.3)	3(9.4)	10(31.3)	7(21.9)
20	Safety training is a requirement for technical officers.	0	0	2(6.3)	2(6.3)	28(87.5)

cause an impact on their knowledge and practices on safety, whether what was learnt is applied when they are employed is questionable. The results of a study carried out among allied health science students at University of Sri Jayewardenepura, Sri Lanka shows inadequacy of their safety practices although they were taught and trained on those as undergraduates (10). This highlights the need of continuous training when they are employed since, what was learnt are inculcated when they are practiced and applied. Other than that, the working environment too should encourage the technical personnel to adhere to proper practices and proactive safety measures (10).

Training is very important in spite of the advent of latest error detection methods and safety engineering which cannot prevent man related failures in safety practices or man related errors in safety (1, 8, 9). Safety always needs proactive measures before its occurrence (1,2,7,8). Therefore, it is an urgent need to establish a reliable human force to carry out safety assurance program in any institution. The role of reliability of human factor in safety management is based on the knowledge and attitudes of laboratory employees (7).

The reason for these observations can be attributed to the fact that most of them are advanced level qualified while only 17 (53%) had training on laboratory safety during their carrier. Mentioning of obsolete practices such as mouth pipetting, absence of knowledge on handling of corrosives, not knowing information on material safety data sheet, inability to describe procedures to follow in a needle stick injury and failure to describe universal precautions urge imperative remedy. This highlights potential high risk of infection transmission to the technical staff due to the absence of updated knowledge. Issues related to laboratory safety in the recent past in UK related to brucellosis cases

detected among laboratory workers show breach in safety practices, absence of high degree of suspicion and stress the need of adherence to safety guidelines always (2). A study conducted in Costa Rica showed an increasing proportion of work-injury absence in general services (27.5%) compared to professionals (7.3%) (8).

The findings of this study points towards unseen and un-estimated occupational health risks of employees in Universities and shows the iceberg of the hidden problem of laboratory safety in Sri Lanka. This endorses the importance of implementation of proper training programs and regular audits in relation to safety in all the health care and educational institutions in Sri Lanka. This study is an eye opener to plan and implement regular safety training programs to improve knowledge, attitudes and practices of the technical staff on laboratory safety to prevent occurrence of laboratory related occupational hazards and accidents and to prepare them for twenty first century practices.

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Conflicts of interest

Authors declare no conflicts of interest.

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