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Improved Safety Practices in Teaching Laboratories of Health Institute

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Abstract: Background: Laboratory practices offer students the opportunity to develop manipulative skills, experimental experience and the capability to plan trials and interpret experimental data. Instead of conventional teaching methods, laboratory experience better for the development of conceptual understanding of sciences. Thus, the absence of safety in the laboratory room can affect the health of students, staff and the environment. Objectives: The aim of this study is to improve safety practices in teaching laboratory rooms of Bule Hora University, Institute of Health, 2021. Methodology: A descriptive survey study was used from November 15 to 20, 2020, among staff at the Bule Hora University Health Institute. From two purposively selected departments, 17 academic staff and lab assistants were enrolled in the study. Data were collected through a self-administered questionnaire and observations. Finally, the data were coded and entered into SPSS version 20 for analysis. Based on the findings of the assessment, action was planned and implemented, and then the improvement was evaluated at the end. Results: Of the respondents, 58.8% did not regularly inspect the safety of laboratory rooms, while 77% did not ever receive training on laboratory safety. The observation revealed that lack of labeling and proper storage of regents, lack cleanliness of work, absence of covering laboratory equipment and lack of waste drainage, good ventilation and water flow were major factors affecting laboratory safety. Conclusion: Implementation during applied research improved laboratory safety, but we conclude that continuous safety management from everyone is needed.

Keywords: Safety Practice, Laboratory Room, Institute, Health

1. Introduction

The laboratory is a central and distinctive role in active learning, and educators have suggested that rich benefits in education accrue from using laboratory activities [1]. Laboratories are described as secure environments with adequate experimental material where open-ended activities can be carried out; the rules to be followed are clearly defined and designed properly for both individual and cooperative studies of students [2]. Laboratories are described as secure surroundings with acceptable experimental material where open-concluded conditioning can be carried out; the rules to be followed are easily defined and designed for both individual and collaborative studies of students [2].

Laboratory settings give students the chance to observe scientific events, promote theoretical understanding and abstract change, develop scientific exploration skills, promote a perception of wisdom and induce colorful literacy terrain. The culture of laboratory safety eventually depends on the working habits of individualities and their sense of cooperation for the protection of themselves, their neighbors, and the wider community and terrain [3, 4]. Laboratory safety is a set of approved procedures and methods to ensure the protection of life and property before the incident. It also means “avoiding damage and losses that may occur as a result of not taking care much in a work”. Safety in school laboratories is a set of procedures and rules aimed at keeping laboratory staff from injuries, preserving the property from damage and loss, and providing safe work environments [5, 6].

All age groups of students (secondary academy, high academy, undergraduate or graduate degree positions) might be exposed to several hazards unless they follow certain preventives while working at laboratories [7]. Moreover, these hazardous properties (information) of chemicals, broken glasses and clinical specimen accidents in science laboratories occur due to mishandling or misusing of those materials [8, 9]. Chemical, equipment and clinical specimen accidents mostly occur due to the neglect of safety precautions or the absence of related precautionary symbols on the chemicals or materials [10].

There has been veritably little academic exploration into the prevalence and incidence of laboratory accidents. In the only study that could find using a proper multi-institutional epidemiological approach, by examining 574 accidents at 13 Colorado institutions between 1966 and 1984, 81 of the accidents passed in tutoring labs, 13 in exploration labs and 2 in fabrication apartments. Most accidents passed in entry-position chemistry lab courses or organic lab courses and are generally passed among youngish individuals [11].

Ethiopia is one of those developing countries aggressively working on the expansion of advanced institutes to increase yearly registration of students in different fields, including health sciences, to meet the demand of professed, well-skilled, scientifically knowledgeable and competent educated human power [12, 13]. More emphasis has been given to field science, and students are expected to gain adequate practical knowledge parallel to the theoretical knowledge of science disciplines. Researchers in the field of science widely use a variety of samples, chemicals and equipment. This is a worry that students, workers and researchers could face health risks due to mishandling or misuse of human specimens, equipment, and chemicals or failures to understand hazard sign labels and to comply with safety measures [14].

In the histories of laboratories of higher institutes of the country, there are no reports on clinical specimens, equipment damage, chemical accidents and environmental pollution except minor incidents that are easily controlled, similar to the Bule Hora University in which the present study was carried out. Therefore, it is a sensible idea to conduct applied research in the area of laboratory safety to identify safety problems and to create a good learning environment for both staff and students who engage in it and to enhance the outcomes of the practices.

2. Methods

2.1. Study Area and Period

The study was conducted from November 15 to 20, 2020, at the Bule Hora University Health Institute, which is located in the Bule Hora town in the West Guji zone of Oromia regional state. The town was located 464 km south of Addis Ababa, the capital of Ethiopia. The health institute is one of five colleges and two institutes under Bule Hora University.

2.2. Study Design and Population

The descriptive study research design used both qualitative and quantitative research methods. A quantitative approach addresses describing data using percentiles and frequency tables to increase the neutrality and delicacy of the study. However, qualitative studies rely on the skill and capacities of the researcher to describe commodities about the content to increase the validity of the study. The study populations were all lab assistants, instructors and department heads of environmental and medical laboratory science of Bule Hora University Institute of Health.

2.3. Inclusion and Exclusion Criteria

All lab assistants, instructors and department heads that practiced students at laboratory rooms were included in the study, while new staff and guests were excluded from the study.

2.4. Samples Size of the Study

In total, 17 medical laboratory and environmental health department academic staff and laboratory technical assistants who used laboratory rooms participated in the study.

2.5. Sampling Techniques

From five laboratories in the Bule Hora University Health Institute, two laboratories were selected by purposive sampling methods. Out of 17 staff members, 10 (8 instructors and 2 lab assistants) were from the medical laboratory department, while 7 (6 instructors and 1 lab assistant) were from the department of environmental health. To gather the information of the existing situation of laboratories safety; constraints that affect the laboratory safety practice in science; the roles and readiness of instructors, department heads and laboratory technical assistance toward establishing functional and safe laboratories; and the improvement strategies of functional and safe laboratories (Figure 1).

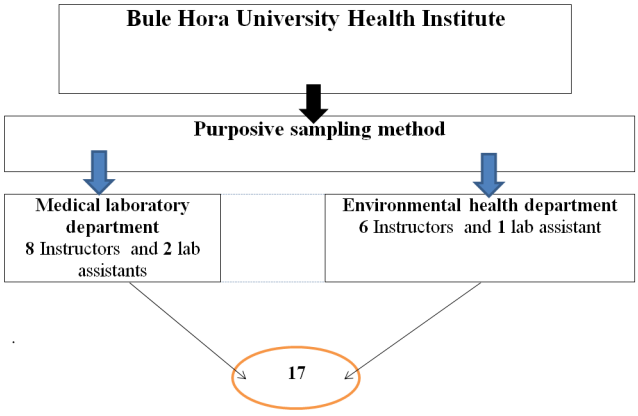

Figure 1. *Schematic of sampling procedure of improving safety practices in laboratory rooms of Bule Hora University health institute.*

2.6. Data Collection Tools and Procedure

The researchers collected sufficient primary data through self-administered questionnaires and observation checklists (S files). The questionnaires and checklists were adopted from revised and analyzed related literature [14]. Then, the developed questionnaires were distributed to the instructors, department heads and technical assistants to collect quantitative data. The observations checklist was used to gather qualitative information and finally integrated and triangulated to enrich and elaborate the quantitative data gathered although the questionnaire.

2.7. Data Quality Assurance

The questionnaires and checklists were prepared through deeply revised, identified and critically examined literatures review. Then, chemistry department Instructors and head evaluated whether questionnaire and observation checklists were appropriate and consistency for data collection.

2.8. Data Analysis

The data collected were organized and enciphered. Data were entered into the Statistical Package for Social Sciences (SPSS) version 20.0 for analysis. Then, the data were analyzed using simple quantitative descriptions, such as frequency counts and percentages. Percentage and frequency are important data analysis techniques to show the constraints that inhibit laboratory safety and to explore the responsibility and accountability of department heads, instructors and laboratory technical assistants to establish safe and functional laboratories in the institution. In addition, the data obtained through observation were analyzed using narrative description (qualitative methods of analysis).

3. Results

A total of 17 questionnaires were distributed to instructors, department heads and laboratory assistants, and all of them were returned. Additionally, all questionnaires were properly completed. Out of 17 participants, 10 (58.8%) were from the department of the medical laboratory, and 7 (41.2%) were from the environmental health department. Regarding the sex of respondents, 14 (82.4%) were females, while 3 (17.6%) were males.

3.1. Safety Practices in Laboratory Room

The majority of respondents (94.2%) shared their knowledge of safety in the laboratory room for the students or colleagues, while all respondents used personal protective equipment while practicing/teaching students, and 58.8% did not regularly inspect the safety of the laboratory rooms. Regarding the safety of the laboratory room for student practice or teaching, 53% agreed that the room was safe for student practices. On the other hand, 77% of respondents did not ever take training on laboratory safety (Table 1).

Table 1. *Safety practices related self-administered questionnaire results.*

Variables	1. Yes always		2. Yes sometimes		3. Never	
	N	%	n	%	N	%
Share safety knowledge to the students or colleagues	8	47.1	8	47.1	1	5.9
Practice labeling of reagents, equipment and samples in laboratory room	3	17.6	13	76.5	1	5.9
Using personal protective equipment during practicing/teaching student in laboratory room	14	82.4	3	17.6	0	0
Store or handle reagents, materials and samples properly in laboratory room	5	29.4	10	58.8	2	11.8
Decontaminate working place or sterilize materials after each activities	11	64.7	6	35.3	0	0
Dispose solid and liquid waste into appropriate containers	2	11.8	15	88.2	0	0
Regular inspect safety of laboratory room	1	5.9	6	35.3	10	58.8
Hand wash with proper detergent at the end of occupation	15	88.2	2	11.8	0	0
Practices record keeping in laboratory room	1	5.9	15	88.2	1	5.9
Follow all of the safety protocols to protect himself, students and environment of laboratory room	4	23.5	13	76.5	0	0
Think the laboratory environment safe for student practice	9	53	-	-	8	47
Ever train on laboratory safety	4	23	-	-	13	77

n= number of respondents

3.2. Factors Affecting Safety in Laboratory Room Obtained Through Observations

Factors that obstacle safety practice in laboratory rooms were:

Laboratory manual, first aid logbook or guidelines are not available in laboratory rooms; Absence of properly storing laboratory reagents/chemical, materials and samples. Also there are many expired laboratory reagents in laboratory rooms.

Poor cleanliness of work place in laboratory rooms and properly labeling chemical/ reagents, equipment and samples in laboratory rooms; Lack of record sheets of inspection and quality control available around equipment.

Absence of covering all laboratory equipment and personal protective equipment cannot easily accessible in laboratory rooms;

Limitation of drainage system in laboratory buildings and good ventilation, water flow (Table 2).

Table 2. *Observation checklist for Medical laboratory and environmental health laboratory rooms [Available (√), Not available (x)].*

No.	Items	Med. L. room	E. H. L. room
1.	Personal protective equipment	X	X
2.	Drainage system	X	X
3.	Spill kit	√	√
4.	Labeling chemical/ reagents, equipment and samples	X	X
5.	Waste containers	√	√
6.	Record sheets around equipment	X	X
7.	Well ventilation	X	X
8.	Cleanliness of work place	X	X
9.	Disinfectants and sterilizer materials	√	√
10.	Expired laboratory reagents	√	X
11.	Laboratory manual, first aid logbook or guideline	X	X
12.	Power supply	√	√
13.	Storing laboratory reagents/chemical, materials and samples	X	X
14.	Covering all laboratory equipment	X	X
15.	Well protected security	√	√
16.	Continuous water flow	X	X
17.	Eyewash, emergency shower, fire blanket and fire extinguisher	√	X
18.	Adequate laboratory size and properly separated	X	X

MesL. L. room=Medical laboratory department laboratory room, E. H. L. room=Environmental health laboratory room

4. Discussions

Laboratory safety and operations can improves through creating a safety management and prevent before it causes injury, illness, or adverse environmental impact [15]. In present study, majority of respondents (94.2%) share their knowledge of safety in laboratory room for the students or colleagues, while all respondents use personal protective equipment during practicing/teaching student and 58.8% do not regularly inspect safety of laboratory rooms this finding lower than study conducted in wolaita sodo, Ethiopia [14]. Regarding laboratory room safety for student practice, 53% agree that the room safe for student practices. On another hand, 77% respondents do not ever took training on laboratory safety, this finding lower than reported from the study conducted in Wolaita Sodo, Ethiopia (89.8%) personnel trained [14].

In observation of laboratory rooms using checklists, the following major challenges that hinder successful implementation of laboratory safety were identified: Laboratory manual, first aid logbook or guidelines are not available in laboratory rooms; Absence of properly storing laboratory reagents/chemical, materials and samples. Also there are many expired laboratory reagents in laboratory rooms. These practices may lead to difficulty in managing accidents, accumulation of waste chemicals in the room causes room overcrowded and cross-reaction between chemicals reagents.

Poor cleanliness of work place in laboratory rooms and properly labeling chemical/ reagents, equipment and samples in laboratory rooms; Lack of record sheets of inspection and quality control available around equipment. The absence of covering all laboratory equipment and personal protective equipment cannot easily accessible in laboratory rooms. This activity may result in cross contaminations of chemical agents, surrounding environment, students and workers lead to affecting health of individual and fire. There were absence of drainage system, good ventilation, water flow in the laboratory rooms and no enough space. This limitation may create bad odor of room, air pollute, floor and benches contaminations.

Based on these findings the research team proposed different actions to be taken in order to improve the laboratory safety in general and safety practices in laboratory rooms. The possible solution identified from the practical experience of Instructors, departments head and lab assistants were the following to improve the effectiveness of safety in teaching laboratory rooms that promote safe equipment, reagents, personal health and surrounding environments.

5. Action Plan, Implementation and Evaluation

5.1. Action Plan

In this applied research, the researchers developed strategies that clearly identified the role of department heads and instructors and the role of lab assistants. The role department heads in improving laboratory safety is fundamentally different from that in a more traditional model. It is vital that department heads first provide support and encourage safety practices and opportunities for team building. Alongside this is the necessity for developing interpersonal skills as part of a planned program. Additionally, instructors and lab assistants play indispensable roles in the success of the plan among the fundamental roles undertaken by the department heads seen the following action plan (Table 3).

Table 3. *Action plan.*

No.	Activities	Responsible body	Period	Expected outcome
1.	Prepare personal protective equipment (PPE) and easily accessible	Department heads	3 weeks	Available & easily accessible PPE
2.	Implementing drainage system in laboratory rooms	Department heads with concern body	2 weeks	Provide the drainage
3.	Label chemical reagents, equipment and samples	Lab assistants	1 week	Create labeled reagents and easily identify
4.	Keep record sheets around equipment	Lab assistants	1 week	Keep information
5.	Prepare laboratory manual, first aid logbook or guideline	Instructors	1 month	Follow safety logbook or manual
6.	Removal of expired laboratory reagents	Lab assistants	3 Days	Free from expired things
7.	Cleaning work place	Lab assistants and sweepers	1 day	Clean rooms
8.	Cover all laboratory equipment	Lab assistants	1 day	Protect equipment
9.	Store laboratory reagents, materials and samples properly	Lab assistants	1 day	Prevent deterioration of reagents
10.	Avail continuous water flow	Department heads with concern body	3 weeks	Easily to use at the needed time
11.	Training for laboratory personnel and cleaners	Instructors & Department heads	1 day	Create awareness

5.2. Implementation of the Action Plan

Activity-1. Creating a drainage system, preparing personnel protective equipment and availing continuous water flow some of the initial action takens since their absence are the major factors affecting safety; hence, it has been one of the causes for the low achievement of safety practices in teaching laboratory rooms. As a result, implementation of those facilities was held with concerns body for a month from Monday 5/10/2020 and Wednesday 4/11/2020.

Activity-2. Preparing safety manuals, logbooks, guidelines and training, since their absence, was found to be one of the factors affecting laboratory safety. The instructors assigned to perform those activities from 11/10/2020 to 30/10/2020.

Activity-3. The lab assistants also provided label chemical reagents, equipment and samples, prepared record sheets around equipment, removed expired laboratory reagents, cleaned the work place, covered all laboratory equipment and stored laboratory reagents, materials and samples properly as well as all necessary support for laboratory safety. The lab assistants and sweepers conducted this activity for almost one week starting from 01-08 November 2020.

To evaluate the performance, the researchers observed whether the laboratory rooms changed between the preimplementation and postimplementation laboratory safety improvement actions taken.

5.3. Action Evaluation

After the intervention had taken place, the research team evaluated what change occurred. The drainage system, personnel protective equipment and continuous water flow are not available in laboratories before and are now easily accessible. All laboratory reagents, equipment and samples were properly labeled as well stored/covered while the laboratory work place was cleaned. Additionally, lab assistants took training on laboratory safety practices, and laboratory manuals, logbooks, guidelines and record sheets were prepared and are now ready to use.

6. Conclusion

The present study revealed that poor safety practices in teaching laboratories of Bule Hora University health institute medical laboratory and environmental health. This is due to poor practice of staff working in laboratory, lack of training, resource limitations in terms of laboratory setup and materials necessary for safety. These limitations can cause environmental contaminations, chemical accidents and affect human health. However, most of those limitations were minimized during this action research. Moreover, laboratory safety program requires a daily commitment from everyone in the institution. A strong culture of safety within an organization creates a solid foundation upon which a functional laboratory and chemical safety program can be built in the institutions. As part of that culture, all levels of the organization (i.e., administrative personnel, scientists, laboratory technicians) should understand the importance of minimizing the risk of exposure to hazardous materials in the laboratory and should work together toward this end.

Authors' Contributions

AA: Conceptualization, developed proposal, investigation, and supervision, did data analysis and interpretation, wrote and review the manuscript.

AE: data analysis and interpretation, and review the manuscript.

All author reviewed and approved manuscript.

Ethics Approval and Consent to Participate

Ethical approval for the study was received from Bule Hora University review board. The letter of endorsement was also obtained from Bule Hora University which was taken to departments' head. The informed consent administration clear descriptions of the study including

purpose, procedures, durations, possible risks and benefits were explained to the respondents and head of departments. They were also informed that the participation is fully voluntarily; confidentiality of collected data and their right to refuse the participation fully or partially. A written informed consent was signed by respondents. The questionnaire that was used to collect data does not have personal identifiers like name. Confidentiality of collected data was kept by research's team.

Consent for Publication

"Not applicable".

Availability of Data and Materials

Data essential for the conclusion are included in this manuscript. Additional data can be obtained from the corresponding author on a reasonable request.

Conflict of Interests

All authors do not have any possible conflicts of interest.

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