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Assessment of Biosafety Practices in Clinical Laboratories in Khartoum State, Sudan

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Abstract

Background: Several related accidents occur in the laboratories due to insufficient regulation, inappropriate implementation of safety measures or unawareness attitude and practice toward safety precaution. Biosafety is a tool through which we are managing safety and security related to any kinds of hazards that may be either to the human, animals, plants and environment as well. We can implement good laboratory practice to minimize the risk while performing any kind of test procedures, either handling to the samples like blood and other body fluids which is playing important role for infections and transmissible diseases. If we will provide facilities and training to the lab personnel, then we can protect public, agriculture, and the environment from which is leading cause of infections as well as hazards such as biological, chemical, electrical and glassware. For achieving effective and necessary biosafety and security, it should make sure that any unauthorized person is not able to handle, process, transport to minimize loss and misuse of the any kind of hazards especially biohazards. Therefore, it's highly recommended to make an international system to avoid any kind of biosafety related issues. **Objective:** Because biosafety is an important element in quality management system (QMS) and it is a fundamental tool for compliance with accreditation and certification standards, the aim of this study was to assess the practices of lab personnel towards biosafety measures in their laboratories. **Method:** The study was cross-sectional study that conducted among 70 laboratories by use of structured questionnaire. Data analysis was done by using statistical package for social science (SPSS). **Result:** Among 70 laboratories, 2 (3%) were appointing a biosafety officer, 16 (23%) have fire detection system and fire alarm system, and 20 (29%) of all laboratories were provided by fire extinguisher. Among provision of personnel protection, 56 (80%) always wearied lab coat and gloves, 35 (79%) wearied masks (surgical mask) with low availability of safety

goggles and eye shield. Vaccination for hepatitis B virus identified in 40 (57%) of the laboratories. In 41 (59%) of laboratories, the cleaning personnel were not aware about optimal handlers of biohazard in the laboratory. 20 (29%) of all laboratories have exit door and 43 (61%) were used biological safety cabinet. Availability of sharp container and color-coded biohazard bags were found in about 60% (86%), 55 (79%); safe disposal policies were found in 49 (70%) of laboratories. **Discussion:** Biosafety measures and practices in Sudan need to be restructured if we target to achieve good laboratory practices as well as safe environmental testing for clinical human samples. **Recommendation:** There are a great need to establish and implement biosafety precaution program included in government and private clinical laboratory in Sudan.

Keywords

Biosafety, Quality Management System, Data Analysis, Biohazard

1. Introduction

The issue of safety has always been the strongest and apparent human requirement, and feeling safe is second in the hierarchy of human requirements just after physiological needs [1]. Therefore, the biosafety is always a challenging job for the staff working in the labs. It is a very important task for them to follow the basic lab safety procedures which include hand washing before and after handling biological and potentially hazardous materials, and after taking off gloves and before leaving the lab, and avoiding hand-to-face or mouth contact, and totally prohibiting the practices if eating, drinking, smoking, or applying cosmetics.

Laboratory biosafety is described as a safe method for managing the infectious/hazardous agents in laboratory environment. The concept of biosafety is the one that is of utmost important and must be given top priority at all time. There must be a continuous effort on the part of laboratories to ensure that their testing procedures are safe and in line with international best practices for safety of staffs, patients and safeguard to the environment from potentially hazardous pathogens [2]. To avoid any kind of acquired laboratory infection as well as spreading of these kinds of infection which are not only hazardous agent but also have potential to infect the personnel from the recent viruses such as SARS-CoV-2 as well Ebola virus, the diagnostic labs and research centers must uphold a safe and healthy environment [3].

Biosafety is a tool that deals with quality management systems in good laboratory practice this is a tool for the measurement and submission of accreditation followed by certification standards. The application of biosafety principles is to make sure the justification of risk with respect to process as it pertains to laboratory acquired infections. The knowledge as well as application of biosafety principles makes sure that test methods are safe in the laboratory and that potentially

infectious pathogens are handled with minimum risk to laboratory staff. The field of biosafety covers risk assessment, management of such risks, the regulation, communication and mitigation of adverse events with the aim of promoting a safe environment for Clinical Laboratory testing [4].

There is application of biosafety principles in the clinical laboratories to make sure the justification of risk with acquired infections and ensure that test methods are safe in the laboratory and the infectious pathogens are handled with proper care to assure the minimum risk of laboratory staff [5].

The clinical laboratory considered as a potentially hazardous place to work so that a distinct policies and procedures must put in place to detect and eliminate risk and prevent the infections and occupational infections [6]. Some studies have revealed that clinical laboratory personnel are more likely than general population to become infected with pathogens like mycobacterium tuberculosis [7].

Biosafety in our day to day life is playing important role in labs to control and manage any kind of agents which are causing infection in laboratory as well as to the environment as we are disposing the infectious material should be thrown in the directed beans to reduce the exposure to the risk factors inside the laboratory. Biosafety has been designed into four different levels such as level-1 basic comes under basic norms of lab safety, level-2 considered in containment, level-3 as moderate contaminant and maximum level of containment is level-4 [8]. Generally diagnostic laboratories are situated in Public health centers, in the hospitals and different types of research centers these are dealing with many infectious materials which are considered as a high risk for staffs and workers which are working in that organization [9]. If precaution is not taken by the staff members there are chances the infection will take place in the laboratories there are many types of hazards such as blood spills, body fluids, broken glassware, radioactive materials if these kind of hazards will be exposed to the staff members those who are working in that laboratories will suffer from injury, accident and infection [10]. Apart from that, if the staff members will be exposed with burning chemicals such as strong acid and strong bases , or exposed to flammable solid and gases, electrical accidents and fire hazards [11]. Laboratory infections are a big and common issue to increase the rate of acquired infection throughout the world causing many challenges, as many cases of infections have been reported [12]. In year 1949, two scientists named Sulk in and Pike published survey and point out the seriousness of laboratory associated infections. Since 1980s, there are guideline to the laboratories that has been implemented to prevent the activities which is associated with blood borne pathogens [13]. According to Harding and Byers whose hard work shows that around 45% to 51% infection of laboratories associated infections took place in clinical, diagnostics and research laboratories [14]. So it has been highly recommended to follow the guideline of biosafety like the staff members should wear the gloves, hand should be washed at regular interval apart from that safety glasses and face shield is

highly recommend in diagnostic laboratories. In Maryland State, United States of America, there was one study conducted in connection with the biosafety it has been highly appreciated that if the staff members are following the instruction of biosafety like uses of personal protective equipment like eye glasses, face mask and protective clothing [15]. So it is highly recommended to follow the biosafety instruction as well as disposal of different types of hazards accordingly.

2. Materials and Methods

2.1. Study Design

This cross-sectional study is conducted in Khartoum state laboratories in Sudan the study period was during June-2021 to July 2021.We have included the study subjects for both categories of the laboratories government as well as private selected 70 different laboratories in Khartoum 41 government labs and 29 private labs. The reason to select Khartoum city was crucial as the city is capital of the country as well as number of both government and private labs are more as compared to the other cities of Sudan. Another reason for the selection of Khartoum was many of our friends are from that region it's easier to get information and access in the laboratories was much more convenient to our team. The most important part to select 70 laboratories is that we have covered almost 78% of the laboratories based on Khartoum region. Four members team selected for the data collection so during the study period we coordinate each other to get more and more information in least possible time. So during our study we had included structured questionnaire for data collection from the laboratories which was involved in six different variables or domains like in domain one demographic data, domain two personnel availability, domain three health and safety of staffs, in domain four Domain four: biosafety signs in laboratory, material safety data sheet (MSDS) and biological safety cabinet (BSC), domain five fire safety and alarm in the six and last domain included staffs training as well awareness of good laboratory practices.

2.2. Data Analysis

Data entered and analyzed by statistical package for social science (SPSS).

3. Results

3.1. Demographic Information

Total number of laboratories included in this study were 70 in which around 41 were government sector that is about 59% and private 29 that is about 41% clinical laboratories in Khartoum state have been investigated about their compliance with standard biosafety precautions during study period using questionnaire (**Table 1**/**Figure 1** and **Figure 2**). The majority of respondents (64%) were less than 10 years in the field of laboratories (**Table 2**/**Figure 3** and **Figure 4**).

Table 1. Types of clinical laboratories in Sudan.

	Frequency	Percent
Government	41	59%
Private	29	41%
Total	70	100%

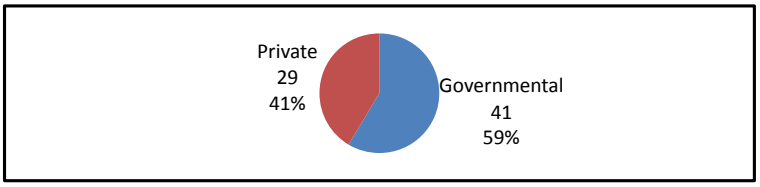

Figure 1. Types laboratories.

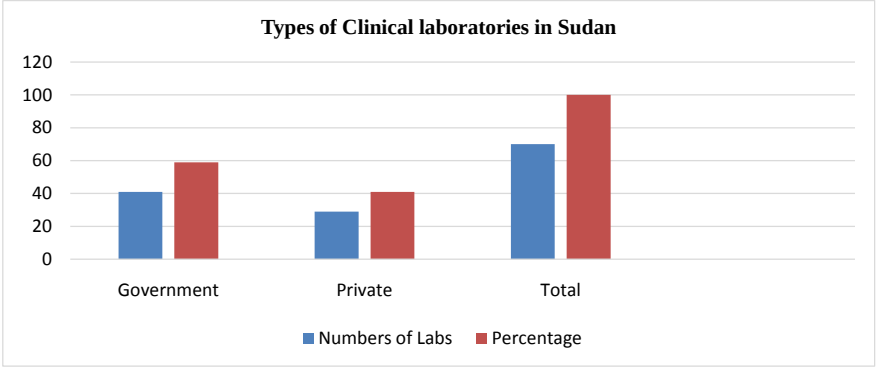

Figure 2. Types laboratories.

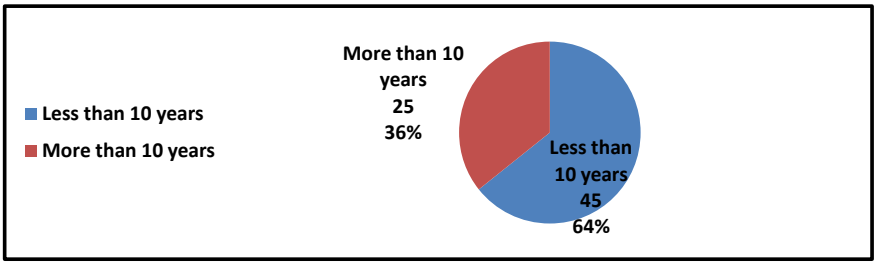

Figure 3. Duration of labs.

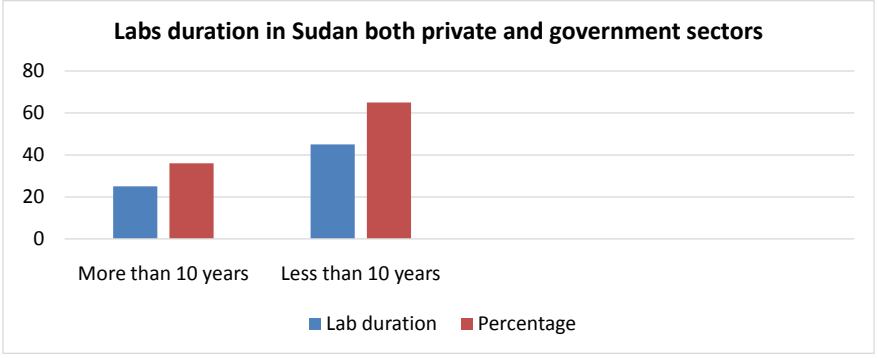

Figure 4. Duration of labs.

Table 2. Duration.

Duration	Frequency	Percent
Less than 10 years	45	64%
More than 10 years	25	36%
Total	70	100%

3.2. Personal Protective Equipment and Immunization

The gloves and lab coat were available in about 80% of laboratories (Table 3, Figure 5) meanwhile 17.15% of the gloves and lab coat were not available and about 2.85% were not have idea about gloves and lab coat. The safety goggles were available only 7.15% in the labs while 85.71% labs were lack of safety goggles about eye shield were available to only 3% of laboratory (Table 3, Figure 5), also cryogenic gloves and rubber lab coat were made available in only 6% of laboratory (Table 3, Figure 5).

As per our survey Only 6% of participant had been administered post exposure prophylaxis (Table 4, Figure 6) and it was observed 57% of respondents had been administered the HBV vaccine, while 31% of the participants were not taken the HBV vaccine and about 11% they do not say anything regarding HBV vaccine (Table 5). In our study we find that Biological safety cabinet (BSCs) available in 43 labs that is around (61%) only in 33% of the labs Biological safety cabinet (BSCs) not available (Table 6). In our study, we also found that majority of Biological safety cabinets were tested regularly 40 out of 70 labs which has around 57% of the labs (see Table 7).

In the above (Table 8, Figure 7) there are many policies among them biosafety policies, SOP, personnel biosafety, safety officers and OSHA awareness these are some very important factors in our study we found that about only 54% of the laboratories following the biosafety policies, 64% laboratories have available SOP, personnel biosafety policies are achieved by only 43% of the laboratories its big issue that around 93% of the labs have no safety officers and 50% of the staff members are not aware about OSHA.

4. Discussion

Clinical laboratory scientists the most vulnerable to health care associated infections among hospital staff. Several types of hazardous events occur in the laboratories therefore it is essential to assess the biosafety practices of staff to current biosafety practices in the laboratory.

This study was aimed to evaluate the current situation of biosafety performance among 70 different clinical laboratories in Khartoum state through a questionnaire.

The role of laboratory biosafety officers is very important to supervise and train the staff in this area, from our study we found that there are lack of biosafety officers (only 3%) that may reflect in low number of laboratory reporting accidents that increase the infection and injury among staff.

Table 3. Different types of safety items available in the labs.

	Gloves and lab coat	Safety goggles	Eye shield	Cryogenic Gloves & Rubber lab coat
Yes	56 (80%)	5	2	4
No	12 (17.85)	60	60	60
ID	2 (2.85%)	5	8	6
Total	70	70	70	70

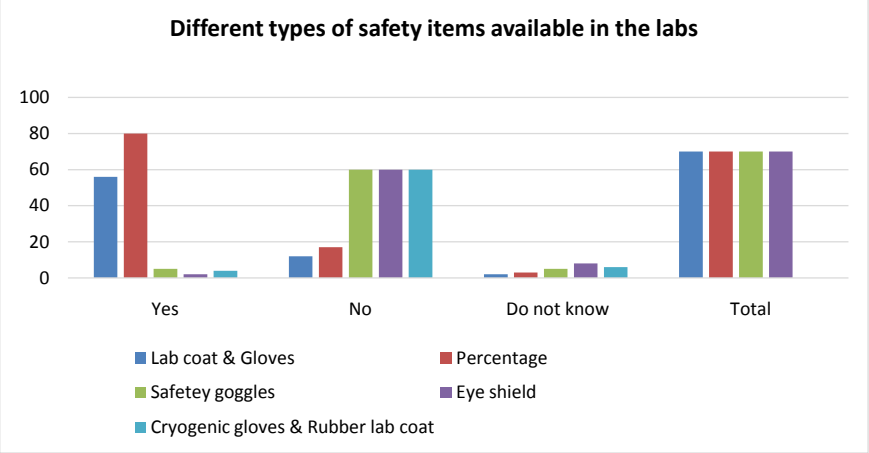

Figure 5. Different type of safety items in the labs.

Table 4. Exposure prophylaxis program.

	Frequency	Percent
Yes	4	6%
No	60	86%
ID	6	9%
Total	70	100%

Table 5. HBV vaccination.

	Frequency	Percent
Yes	40	57%
No	22	31%
ID	8	11%
Total	70	100%

Table 6. Biological safety cabinet (BSCs) available.

	Frequency	Percent
Yes	43	61%
No	23	33%
ID	4	6%
Total	70	100%

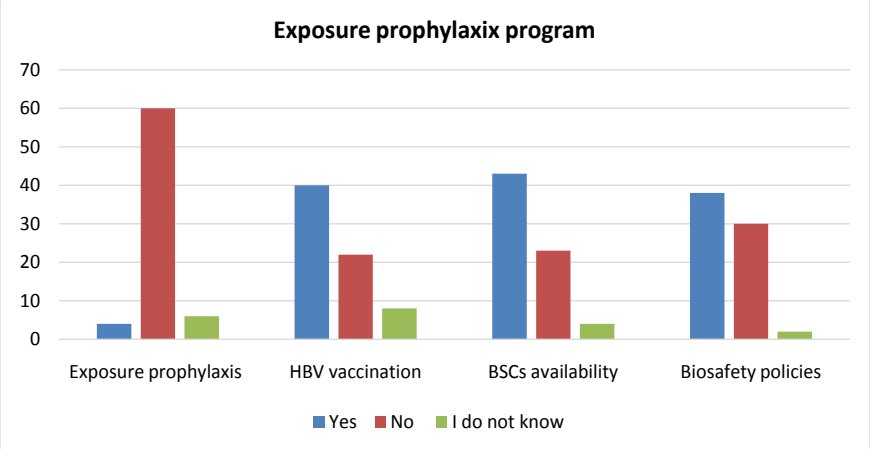

Figure 6. Exposure prophylaxis program.

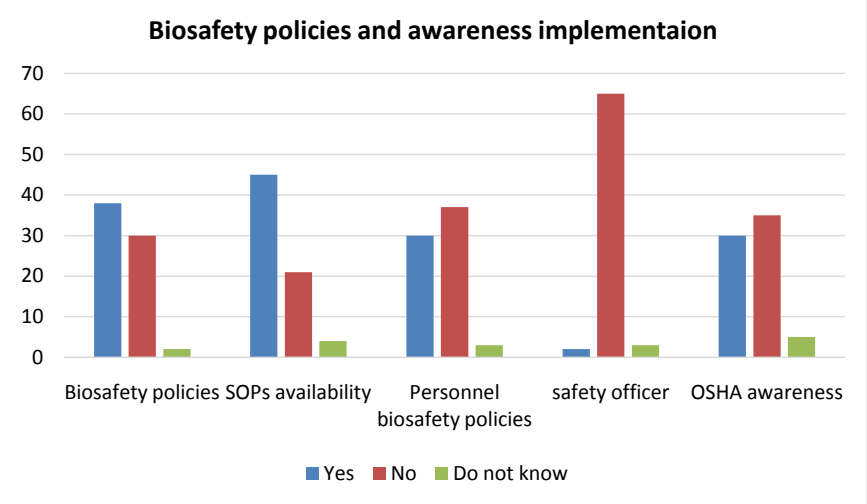

Figure 7. Biosafety policies and awareness implementation.

Table 7. BSCs serviced and regularly tested.

	Frequency	Percent
Yes	40	57%
No	25	36%
ID	5	7%
Total	70	100%

Table 8. Biosafety and other policies followed by the labs.

	Biosafety policies	SOPs available	Personnel follow biosafety policies	Availability of safety officer	Aware of OSHA
Yes	38 (54%)	45 (64%)	30 (43%)	2 (3%)	30 (43%)
No	30 (43%)	21 (30%)	37 (53%)	65 (93%)	35 (50%)
ID	2 (3%)	4 (6%)	3 (4%)	3 (4%)	5 (7%)
Total	70	70	70	70	

Provision of personal protective equipment (PPE) is very important in the laboratory. Attitude like wearing lab coats, gloves, safety goggles and eye shield will protect workers and decrease injuries and infection among staff in laboratory. Our study tells that the wearing of lab coat and gloves is high among respondents (80%) but due to refusal in wearing of safety goggles and eye shield attitude (only 7% and 3% respectively). The mask use will help to prevent respiratory infection in laboratory so it should be mandatory especially N95 mask, our study showed there is increase in use of surgical mask (84%) as compared with N95 mask (14%).

It is evident from our study that several respondents (53%) did not follow biosafety policies and majority of them (50%) said they are not aware of OSHA standards. We found also that safety manual is available only in 29% of all laboratories.

From our study, we found that that several respondents know well how to dispose laboratory waste and availability of sharp containers and color-coded biohazard bags is high in laboratory (86% and 79%).

The study identified that the laboratories are still lacking separate room for eating and drinking and in 20 laboratory (29%) laboratory staff eats and drinks inside laboratory.

There was absent of fire alarm system, fire detection system and fire extinguisher were be found available in 20 laboratory (29%); also our study revealed that there was lacking in fire extinguisher maintenance and training of staff on using of fire extinguisher.

5. Conclusion

From the above discussion, lack of safety officer as well as ignorance of the staff's work in the laboratory is the biggest challenge in most of the clinical laboratories for Khartoum state in Sudan. Apart from that, there are some other draw backs like the suppliers' failure to provide the safety tools on the prescribed schedule. Hence, we can conclude that the ignorance by staffs as well as supplier is the biggest challenge and this challenge will be overcome by the collective effort to provide proper training to the staffs and awareness program in the society. Therefore, this calls for governments, society, and academic and medical research institutions to build the laboratories' capacity through training personnel in biosafety management (BSM) practices to curb emergent public health events [16] [17]. The Global Health Security Agenda (GHSA) aims to mitigate risks from emerging and re-emerging infection causing agents, which can be achieved through training to the personnel, including medical laboratory students, in biosafety and biorisk management before they are rolled out as professionals [18].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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