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A Survey of Biosafety Practices of Clinical Laboratory Personnel in Four Selected Clinical Laboratories

Shobowale E[1]*, **Elikwu CJ**[1], **Coker AO**[2], **Mutiu PB**[3], **Nwadike V**[4], **Olusanya**[5] and **Osinupebi A**[6]

[1]*Department of Medical Microbiology and Parasitology, Babcock University, Ilishan, Remo Ogun State, Nigeria*

[2]*Department of Medical Microbiology and Parasitology College of Medicine University of Lagos, Nigeria*

[3]*Department of Medical Microbiology and Parasitology, Lagos State University College of Medicine, Nigeria*

[4]*Department of Medical Microbiology and Parasitology, Federal Medical Centre Abeokuta, Nigeria*

[5]*Pathcare Laboratories Lagos, Nigeria*

[6]*Department of Medical Microbiology and Parasitology, Olabisi Onabanjo University, Nigeria*

*__Corresponding author:__ Shobowale Emmanuel Olushola, [1]Department of Medical Microbiology and Parasitology, Babcock University, Ilishan, Remo Ogun State, Nigeria, Tel: +234 802 381 8205; E-mail: shoekineh@gmail.com

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Abstract

Objective: Biosafety is an important element of quality management systems in laboratory practice as it is a measuring tool for compliance with accreditation and certification standards. Our aim was to assess the practices of laboratory personnel towards biosafety measures in their respective laboratories.

Methods: The study design was a quantitative and qualitative cross sectional prospective one obtained with the use of a structured questionnaire. Data analysis was done with Epi Info version 3.4.1 and was presented using frequency tables with chi square calculated for different variables with the significant p value set at ≤ 0.05.

Results: There were 63 respondents in the study. Private laboratories fared better in an assessment of their biosafety practices. Comparative variables identified as unsafe biosafety practices between public and private laboratories were non availability of Hepatitis B virus antibody testing, p value 0.01, odds ratio 5.4, consuming food in the laboratory, p value 0.00, odds ratio 0.2., non-use of N95 masks p value 0.04, O.R 3.9 and biosafety cabinet use p value 0.05, O.R 2.8.

Discussion: Biosafety practices in Nigeria need to be streamlined in accordance with good laboratory practices in order to forestall workplace accidents and promote a safe environment for testing of clinical human samples.

Conclusion: The absence of appropriate biosafety policies and practices is one of the challenges facing health care workers in sub Saharan Africa. There is the need for biosafety to be placed in the front burner of issues in laboratory practice in our respective facilities.

Keywords: Biosafety; Laboratory technicians; Biohazards; Biosafety cabinet; Laboratory acquired infection

Introduction

The concept of biosafety in laboratory practice is one that is of utmost important; and as such it must be given top priority at all times. There must be a continuous concerted effort on the part of laboratories to ensure that their testing procedures are safe and in line with international best practices both for the safety of staff and patients and also to safeguard the immediate environment from potentially hazardous pathogens [1].Biosafety is also an important element of quality management systems in laboratory practice as it is a measuring tool for compliance with accreditation and certification standards. The application of biosafety principles also ensures the mitigation of risk with respect to litigation as it pertains to laboratory acquired infections. The knowledge and application of biosafety principles also ensure that test methods are safe in the laboratory and that potentially infectious pathogens are handled with minimum risk to laboratory staff [2].

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 [3].

The Clinical Laboratory is a potentially hazardous place to work and as a result it is essential that policies and procedures are put in place to detect and eliminate risk and errors to the barest minimum. The prevention of infections and occupational infections is therefore of prime importance in regulatory agency agendas [4].

Some studies have revealed that clinical laboratory personnel are 3 to 9 times more likely than general population to become infected with pathogens such as Mycobacterium tuberculosis and this reveals the extent of hazards such population group are exposed to [5].

Indeed on a daily basis laboratory workers are exposed to sundry risk and hazards from human samples, tissues animate and inanimate

objects which they encounter in the course of their routine activities and this may have lifelong consequences for such individuals [6].

In order for a laboratory biosafety program to be successful it must be able to recognize and promptly assess risk accurately and mitigate possible hazards [7]. It is therefore essential that biosafety measures be implemented at all times in order to reduce the risk of exposure to hazard on pathogens and possibility of laboratory acquired infections on the part of workers in the laboratory. Biosafety will also help to reduce accidental discharge(s) of such pathogens into the immediate environment [3].

Over a twenty five year period from 1979-2004, a total of 1,141 laboratory acquired infectious were studied in the US and Mycobacterium tuberculosis was responsible for 199 cases with *Rickettsia spp* and *Coxiella burnetti* accounting for 192 and 177 respectively [8].

In another survey of eighty eight Laboratories spanning two years in fifty three labs, *Shigella spp*, *Brucella spp* and *Salmonella spp* accounted for the prevalent pathogens responsible for Laboratory acquired infection, while *Staphylococcus aureus* (MRSA). *Neisseria meningitis*, *Coccidioides imitis* and *Clostridium difficile* accounted for the remainder [9].

The impact of biosafety was made evident in an outbreak of Brucellosis in 1991 at a Laboratory where eight out of twenty six microbiologists were infected with *Brucella melitensis* despite the fact that there had been no laboratory isolation of the pathogens in the preceding three years [10].

In yet another example, a six year old child visiting a laboratory touched an open plate and three days later developed Colitis and Hemolytic Uraemic Syndrome despite his hands having been washed. The implicated Escherichia coli strain was 0157:H7 positive and these cases involved laboratory technicians in clinical laboratories [11].

Rationale for the study

At present in Nigeria there is paucity of data on the level of knowledge and awareness of biosafety practices amongst clinical laboratories in Nigeria. Laboratory practice is a novel emerging field in Nigeria and it is essential that biosafety practices which are a key element of good laboratory practice be elucidated.

Our aim was to assess the prevalent practices of laboratory scientists towards biosafety measures in their daily practices in their respective laboratories. This study on their practices regarding biosafety measures among laboratory scientists would serve as a baseline for their level of compliance with standard safety practices and help to design programs for training on biosafety for laboratory technicians working in clinical laboratories in Nigeria.

Methods

This survey was conducted in laboratories in two states in South western Nigeria: Babcock University Teaching Hospital (BUTH), Path care Laboratories Lagos, Ogun State University Teaching Hospital (OSUTH), Lagos University Teaching Hospital (LUTH) and Federal Medical Centre Abeokuta (FMC).

These teaching hospitals are located in urban and semi-urban locations respectively. BUTH is a 141 bed hospital, LUTH 744, OSUTH 180 and FMC Abeokuta, 150. PathCare laboratories is an ISO 15189 laboratory that performs over 20000 tests per annum across all the branches of laboratory medicine. The combined laboratory staff strength of all the centers involved in the study is one hundred and eighty.

After obtaining consent from the heads of the various laboratories the questionnaires were given to laboratory personnel to fill. The questionnaire was developed from existing literature; and composed of basic questions pertaining to safe work practice, the use of personal protective equipment (PPE), disinfection methods, hand hygiene, handling of specimen, availability of alternative exits in the laboratory and waste disposal.

Other aspects the study sought to assess included vaccination protocols with respect to Hepatitis B vaccination, biosafety cabinet use, fire safety protocols and awareness of Occupational Safety Health Administration (OSHA) guidelines as well as Material safety data sheet use (MSDS).

The study design was quantitative and qualitative cross sectional prospective one intended at gathering data on prevalent biosafety practices in our local hospitals and clinical laboratories at the moment.

The sample size for the study was 70 participants calculating from the formula [12].

$N=Z2Pq/d2$

Where $Z=1.95$, $p=0.06$, $q=1-0.06$, $d=0.05$

Data analysis: This was done with Epi Info version 3.4.1. Data was presented using frequency tables with chi square calculated for variables. The p value was set at ≤ 0.05 and the confidence interval used was set at 95% with the odds ratio calculated from the statistical software.

Results

Summary statistics: There were 63 respondents in the study. Majority (61.9%) 0f respondents work in public laboratories as against (30.8%) in private laboratories. Medical Microbiology accounted for 44.4% of laboratory staff samples; with the remainder (55.0%) belonging to other fields. The majority of respondents (69.8%) were <10 years in the field of laboratory practice. In all it was only; 42.9% of all laboratories that had biosafety cabinets. Most laboratories (79.4%) routinely disinfected their work benches and New staff receive training on biosafety issues in 47.6% of cases (Table 1).

Variable		Number (N)	Frequency
Specialty	Chemical Pathology	16	25.4
	Hematology	12	19.0

	Histopathology	7	11.1
	Microbiology	28	44.4
Type of laboratory	Government	39	61.9
	Private	27	38.1
Duration of practice	< 10 years	44	69.8
	> 10years	19	30.2
Training for new staff on biosafety	No	30	47.6
	Yes	33	52.4
Functional biosafety cabinet	No	43	68.3
	Yes	20	31.7
Total		63	100

Table 1: Summary Statistics of Respondents.

Personal protective equipment and immunization: The N95 mask was made available to 31.7% of laboratory staff; while elbow length gloves are available for 15.9%. In the course of routine work eye splashes occurred to only 12.7%; while eye goggles were provided for 61.7% of staff. 23.8% have sustained a needle prick accident while working on patient samples. 73% of participants had been administered post exposure prophylaxis in the past and it was observed that 44.4% respondents had been administered the HBV vaccine with antibody testing done on 68.3% of them (Table 2).

Variable		Number (N)	Frequency
Elbow length gloves available	No	53	84.1
N95 masks	Yes No Yes	10 43 20	15.9 68.3 31.7
Needle prick injury	No	48	76.2
	Yes	15	23.8
Post exposure prophylaxis	No	17	27
	Yes	46	73
Sharp box available	No	6	9.5
	Yes	57	90.5
Eye splashes	No	55	87.3
	Yes	8	12.7
Eye goggles available	No	43	68.3
	Yes	20	31.7
Eye wash station provided	No	35	55.6
	Yes	28	44.4
Hepatitis B antibody testing	No	20	31.7
	Yes	43	68.3
Hepatitis B Vaccine	No	35	55.6

	Yes	28	44.4
Total		63	100

Table 2: Use of Personal Protective Equipment and Immunization.

Biosafety and fire safety: Up to 47.6% read MSDS materials before using kits or operating machinery. 45.1% of respondents said they were abreast of OSHA guidelines Few laboratories (9.5%) did not have fire extinguishers, however only 30.2% had regular fire drills; 39.7% with training their staff on the use of extinguishers. 50.8% of laboratory workers responded that their laboratories had an alternative exit, with only 42.9% having a first aid kit for emergencies. Alarmingly 31.7% of participants said they always use gloves in handling specimens on the bench; with up to 52.4% responding that they consume food in the laboratory. 44.4% have an eye wash station in their Laboratory; 31.7% have a bio hazard warning sign on their lab entrance door. 15.9% reported that they have recorded results on blood stained form; only 9.5% of labs did not have a sharps box; 58.7% of labs disinfected their waste prior to disposal (Table 3).

Variable		Number (N)	Frequency
MSDS read	No	33	52.4
	Yes	30	47.6
Aware of OSHA	No	22	34.9
	Yes	41	65.1
Consume food in the laboratory	No	33	52.4
	Yes	30	47.6
Disinfect waste routinely	No	26	41.3
	Yes	37	58.7
Biohazard warning sign	No	43	68.3
	Yes	20	31.7
Use of blood stained forms	No	53	84.1
	Yes	10	15.9
Fire extinguisher available	No	6	9.5
	Yes	57	90.5
Periodic fire drills	No	44	69.8
	Yes	19	30.2
Training on extinguisher use	No	38	60.3
	Yes	25	39.7
First aid kit	No	36	57.1
	Yes	27	42.8
Alternative exit	No	31	49.2
	Yes	32	50.8
Hand glove use	No	43	68.3
	Yes	20	31.7
Total		63	100

Table 3: Biosafety practices and fire safety. MSDS-Material safety and data sheet. OSHA-Occupational safety and health administration/agency.

Inter laboratory comparisons: ten variables were identified as unsafe biosafety practices. Private laboratories were 5.4 times more likely to offer antibody testing to their staff and 0.2 times to give HBV. In the same vein eye goggles were 7.7 times more likely to be found in private laboratories, with eye wash station 3.3 times more frequent in them.

The private labs were 6.5 times more likely to have fire drills and 3.8 times more likely to have a first aid hit in the lab. Biosafety cabinets were 2.8 times less likely to be found in public laboratories. The N95 mask was 3.9 times less likely to be used in public Laboratories. Finally private laboratories were 9.4 times more likely to have training on fire extinguisher use. (Table 4).

Variable	Category	No	Yes	p value	O.R	(χ)	CI
HBV Ab Testing	Public	17 (43.6)	22 (56.4)	0.01	5.4	5.3	1.4 – 21.2
	Private	3 (12.5)	21 (87.5)				
Consume food in the laboratory	Public	13 (33.3)	26 (66.7)	0.00	0.2	8.4	0.01 – 0.6
	Private	17 (79.2)	7 (20.8)				
Elbow length gloves available	Public	30 (76.9)	9 (23.1)	0.04	0.15	3.9	0.2 – 1.2
	Private	23 (95.8)	1 (4.2)				
Eye goggles provided	Public	33 (84.6)	6 (15.4)	0.00	7.7	12.0	2.3 – 25.0
	Private	10 (41.7)	14 (58.3)				
Eye wash station available	Public	26 (66.7)	13 (33.3)	0.02	3.3	5.1	1.2 – 9.6
	Private	9 (37.5)	15 (62.5)				
Periodic fire drills	Public	33 (84.6)	6 (15.4)	0.00	6.5	6.5	2.0 – 21.2
	Private	11 (45.8)	13 (54.2)				
First aid kit available	Public	27 (69.2)	12 (30.8)	0.01	3.8	6.1	1.3 – 11.0
	Private	9 (37.5)	15 (62.5)				
BSC available	Public	26 (66.7)	13 (33.3)	0.05	2.8	6.1	1.0 – 8.0
	Private	10 (41.7)	14 (58.3)				
HBV vaccine	Public	28 (71.8)	11 (28.2)	0.00	6.2	10.9	2.0 – 19.0
	Private	7 (29.2)	17 (70.8)				
N95 mask available	Public	23 (59)	16 (41)	0.04	3.9	4.1	1.0 – 15.0
	Private	20 (83.3)	4 (16.7)				
Training on extinguishers	Public	31 (79.5)	8 (20.5)	0.00	9.4	15.7	2.9 – 30.5
	Private	7 (29.8)	17 (70.8)				

Table 4: Inter laboratory comparison of biosafety practices of private and public laboratories. HBV - Hepatitis B Virus, Ab-Antibody, BSC-Biosafety cabinet, OR-Odds Ratio, CI-Confidence Interval (95%), χ – Chi Square.

Discussion

Clinical laboratory scientists are among the most vulnerable to health care associated infections among hospital staff. Several types of hazardous events occur in the laboratories on a regular basis and it is therefore essential that we assess the biosafety practices of these staff with respect to current biosafety practices in the laboratory.

The concept of biosafety is an important one particularly in developing countries such as ours where safety checks are not always in place or implemented. Important variables that may hinder safety in the laboratory include: lack of training for laboratory personnel on biosafety, an excessive workload, excessive demands for a rapid turn-around time, and overconfidence [6].

From our findings we discovered that on the average private laboratories complied with good laboratory practices as opposed to public laboratories that failed to do so. This might be connected to the fact that such private laboratories need to be abreast of current biosafety practices in order to retain certification and accreditation for commercial purposes.

It is evident from our study that relevant personal protective equipment are lacking in government hospitals and as a result of this

standard operating procedures need to be put in place to address this. The initial phase in establishing a biosafety program in any laboratory is the development of standard operating procedures (SOPs) that will act as a guide. Such SOP's will dictate practices pertaining to the handling of human samples, disposal of wastes generated in the laboratory and also the use of personal protective equipment [13].

Majority of public laboratories sampled in our study also lack dedicated biosafety officers. As a result of this observation there is the urgent need to appoint biosafety officers who will document untoward events and near misses, ensure vaccine are taken appropriately and report back to the laboratory directors on safe practice amongst personnel. Such biosafety officers need regular training in order for them to function optimally [13].

In our study Hepatitis B vaccination rates were 44.4% which appears to be higher than that of other studies previously conducted. In the cross sectional study conducted by Elduma and his colleagues on biosafety practices in teaching hospitals, they discovered that these was a low rate of reporting laboratory accidents(14.7%), which was a disturbing find. In addition in their study they observed that only 7.35% of laboratories involved in the study used syringes and needles that had safety lock devices. Furthermore it was discovered in that study that a paltry 10% of laboratories had Hepatitis B Virus vaccination program for its staff [2].

The N95 mask use will undoubtedly help to prevent respiratory infections in laboratory personnel and its use needs to be made mandatory in procedures that generate aerosols in our public laboratories. In a survey conducted by Sejvar and his colleagues in 2001, they discovered that there were 10 cases of probable Laboratory acquired infections due to Neisseria meningitides from 1985 to 2001. Of these 8(50%) were fatal cases and occurred only in Clinical Microbiology. In their study 94.4% of the cases involved manipulation of isolates without respiratory protection [14].

Hand hygiene protocols are poorly enforced in our public laboratories and it is pertinent that these be improved upon. In an investigation on laboratory infections due to *Escherichia coli* 0157:H7, Spina and her co-workers discovered that 4 cases which occurred in a Laboratory were due to a clonal source that was processed in the Laboratory. Typing was done with Pulsed Field Gel electrophoresis which was used to determine that all strains were from the same source. In all four cases hand hygiene was not followed strictly in the Laboratory [15].

According to Ozsakin and his colleagues who conducted a study on safety awareness among laboratory workers in Turkey, several respondents still did not know to correctly dispose laboratory waste. The result from their study revealed that laboratory workers would benefit greatly from educational initiatives that are targeted towards promoting Laboratory safety [15].

All Laboratory personnel who handle blood, sputum, urine or any other human tissue or sample fluids are at risk of exposure to accidental injuries. The lack of awareness regarding safe biosafety practices makes them vulnerable to laboratory acquired infections [15].

Appropriate waste disposal is still a problem in Nigeria and training on these needs to be instituted. A similar study from Pakistan showed that up to 30.7% of laboratory technicians discard used syringes into municipal dustbins due to the non-availability of sharps disposal boxes. It was also observed in the same study that standard operating procedures were not available in up to 67.3% of laboratories sampled; and there was no record keeping with respect to accidents in 83.4%. The summary of their findings is that no formal biosafety training had been provided in 82.4% of the respondent's practice [16].

Conclusion

The absence of appropriate biosafety policies and practices is one of the challenges facing health care workers in sub Saharan Africa. There is the need for biosafety to be placed in the front burner of issues in laboratory practice in over respective facilities [16].

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Conflict of Interest

The study was funded by personal contributions from the authors. There were no external financial interests.

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