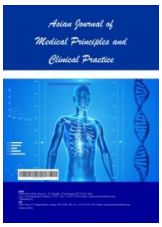

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Knowledge and Practices on Biosafety in Clinical Laboratories of Kinshasa in the Democratic Republic of the Congo

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Authors' contributions

This work was carried out in collaboration among all authors. Authors CAM, PTL and KNN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors VM, HMM, AM, SL and RM managed the analyses of the study. Authors CAM and GNB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Biosafety, as a set of measures to prevent laboratory acquired infections, has been recommended for more than fifty years. Indeed, since that time, evidence of contamination of laboratory workers has been provided in several articles. Are these measures known and applied in laboratories in Kinshasa, this was the question to what this study tried to answer. A cross-sectional study was carried out in Kinshasa city laboratories having both qualitative and quantitative components. A visit

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and observation of the application of these measures was also conducted. The World Health Organization (WHO) standard form was used for this survey with some modifications. An interview was performed on Data were processed using Atlas Ti and Epi Info 2000 software.
A total of 24 laboratories were surveyed and 55 interviews were conducted. The knowledge on biosafety is good, especially among young people coming from school. The majority of the laboratories surveyed apply the measurement of appropriate clothing. On the other hand, simple measures are not applied at all, such as oral pipetting (91% of the laboratories do not prohibit it) or eating or drinking in the laboratory (more than 58%) or food in refrigerators (45% of the laboratories).
Only five safety measures are applied in all of the laboratories surveyed. Simple measures such as pipetting are still not applied. This was also found elsewhere in developing countries. Measures to raise awareness among both laboratory workers and their managers are necessary for better biosafety.

Keywords: Biosafety; laboratory, prevention; contamination; Kinshasa.

1. INTRODUCTION

Biomedical analysis laboratories are an indispensable tool for better patient care. Through direct or indirect observations using sophisticated equipment, they help diagnose disturbances observed in patients. To do so, the laboratories use manipulations of patients' different moods, i.e. blood, urine, stools, cerebrospinal fluid, saliva, etc. [1]. These humours can reveal abnormal values for disease-indicating substances but also allow the identification of pathogens responsible for communicable diseases. The manipulation of these humours has been mentioned for more than 50 years by Sulkin and Pike as a probable source of viral contamination of laboratory workers [1]. It was in 1976 that a more detailed study by Pike highlighted the risks of infection in laboratories. A total of 3921 laboratory-acquired infections (LIAs) have been reported and described since 1949. Of these, approximately 59% were from research laboratories and 17% from clinical diagnostic laboratories [2].

In 1985, Jacobson et al. [3] reported an annual incidence of three LAIs per 1000 workers in a survey of 1191 laboratories in Utah, USA, conducted between 1978 and 1982. They found that the proportion of clinical cases of hepatitis B was 10 times higher than in the general US population. Smaller laboratories reported three times as many LAIs as larger laboratories, and microbiologists were at greater risk than other laboratory workers [4].

In view of the evidence of contamination in laboratories, several authors have proposed measures to be taken, which are represented by the terminology "biosafety". The first measures come from Pike's 1976 analysis [2]. He proposed in particular that the use of laminar flow fume hoods since most of the LAIs had aerosols as a route of contamination. According to Sewell, the application of this measure would explain why the distribution of LAIs by frequency has changed [5]. Several organizations as Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have included different measures in guidelines [6]. Since then, several biosafety manuals have been developed, including the January 2012 Guidelines for Safe Work Practices in Human and Animal Medical Diagnostic Laboratories Recommendations of a CDC-convened, Biosafety Blue Ribbon Panel and the 2009 Microbiological and Biomedical Laboratories 5th Edition U.S. Department of Health and Human [7]. As far as the WHO is concerned, a manual entitled "Biorisk management Laboratory biosecurity guidance" was developed in September 2006, as well as the Laboratory biosafety manual [8]. Recently, the WHO has recently included biosafety as a priority in its document entitled "Laboratory Biorisk Management Strategic Framework for Action 2012-2016" Applicable as of January 2012 [9].

All these documents have stratified the risk into four levels according to the contagiousness and the existence of treatment for the concerned pathogens. All biosafety documents emphasize the responsibility of the employer to provide the necessary biosafety conditions, but also the responsibility of laboratory workers to respect and maintain the biosafety concept [6-9]. Despite all these efforts, a recent study in Pakistan reported an alarming situation regarding biosafety in clinical laboratories. Out of a sample of laboratory staff from 1782 with more than 5 years experience from the majority of cities, more than 28% did not use any protective

equipment, while 25.2% reused syringes either routinely or occasionally. On the other, 28.3% used mouth-to-mouth pipetting, standard operating procedures were missing in 67.2% and accident reporting was not maintained in 83.4% of the laboratories. A total of 84.2% of respondents had no formal biosafety training. These authors concluded that there was a lack of awareness of good laboratory practice and biosafety but also a lack of resources [10]. Mulumba conducted a pilot study on biosafety in reference hospitals in Kinshasa. Based on the results of this study, it was necessary to further investigate the aspects of the LAIs [11].

All these findings call on researchers and laboratory managers to document the problems of biosafety in both research and clinical laboratories in developing countries such as the Democratic Republic of the Congo (DRC) with regard to the perception and practice of biosafety. The findings of the current study will allow the development of strategies and policies adapted to the local context in order to better protect laboratory workers. Henceforth, a study on the perception and practices in clinical laboratories in the city of Kinshasa in DRC was conducted. The main objective was to document the compliance of clinical laboratories in the city of Kinshasa with biosafety standards for better protection of laboratory workers. Specific objectives were to: (i) describe the level of knowledge, attitudes and practices regarding biosafety, (ii) identify gaps between standards and current practices, and (iii) suggest areas for improvement.

2. MATERIALS AND METHODS

2.1 Study Design, Study Area and Surveyed Laboratories

This is a descriptive cross-sectional study combining two approaches, qualitative and quantitative.

The following laboratories were selected based on their importance in terms of attendance and their geographical location in Kinshasa (Fig. 1) based on a list of laboratory infrastructures from the laboratory directorate of the Ministry of Health. The clinical laboratories of the following hospitals and centers were selected:

1. Hospital Centre of Roi Baudouin,
2. Mother and Child Center of Ngaba,
3. Bondeko Clinics
4. Ngaliema Clinics
5. Sino-Congolese Hospital of Ndjili
6. Referral General Hospital of N'djili
7. Referral Provincial General Hôpital
8. Referral General Hospital of Kintambo
9. Hopital Kimbanguiste of Kinshasa
10. Pediatric Hospital of Kalembe-lembe
11. Referral National Laboratory for HIV
12. LOMO-Laboratory

2.2 Methods

For the qualitative approach, semi-structured interviews were conducted with laboratory managers, senior lab technicians and new lab technicians who shared each other's experiences. For the quantitative part, the adapted WHO form was used to assess and inspect the laboratories for the biosafety aspects [12]. The interviewers were trained and pre-tested the questionnaires to standardize the interviews and the completion of the survey forms.

Following a specific schedule, the interviewers visited clinical laboratories and conducted the interviews based on a WHO standardized interview guide and questionnaire, as well as by inspecting the personnel present in the laboratories and the way in which they managed the waste produced by their clinical laboratories. Three people were interviewed, including the laboratory manager, the oldest and the youngest (by considering their experiences in the field).

The laboratory manager answered the questionnaire related to laboratory design, human resources in the laboratory, the concept of biosafety, good laboratory practice, the results of certain tests carried out in his clinical laboratory and the traceability of biomedical wastes. Another member of the research team was recording data using GPS for mapping the clinical laboratories surveyed and another member was taking pictures with the LUMINA using a digital camera of the facilities.

2.2.1 Qualitative part

To understand the perceptions and practices of laboratory technicians, we combined two methods used in social science for qualitative data collection: observation and individual interviews.

We visited a total of 12 institutions, notably: Kinshasa Provincial General Reference Hospital, Lomo Médicale, Kalembelembe Hospital, Ngaliema Hospital, Ngaba Mother and Child

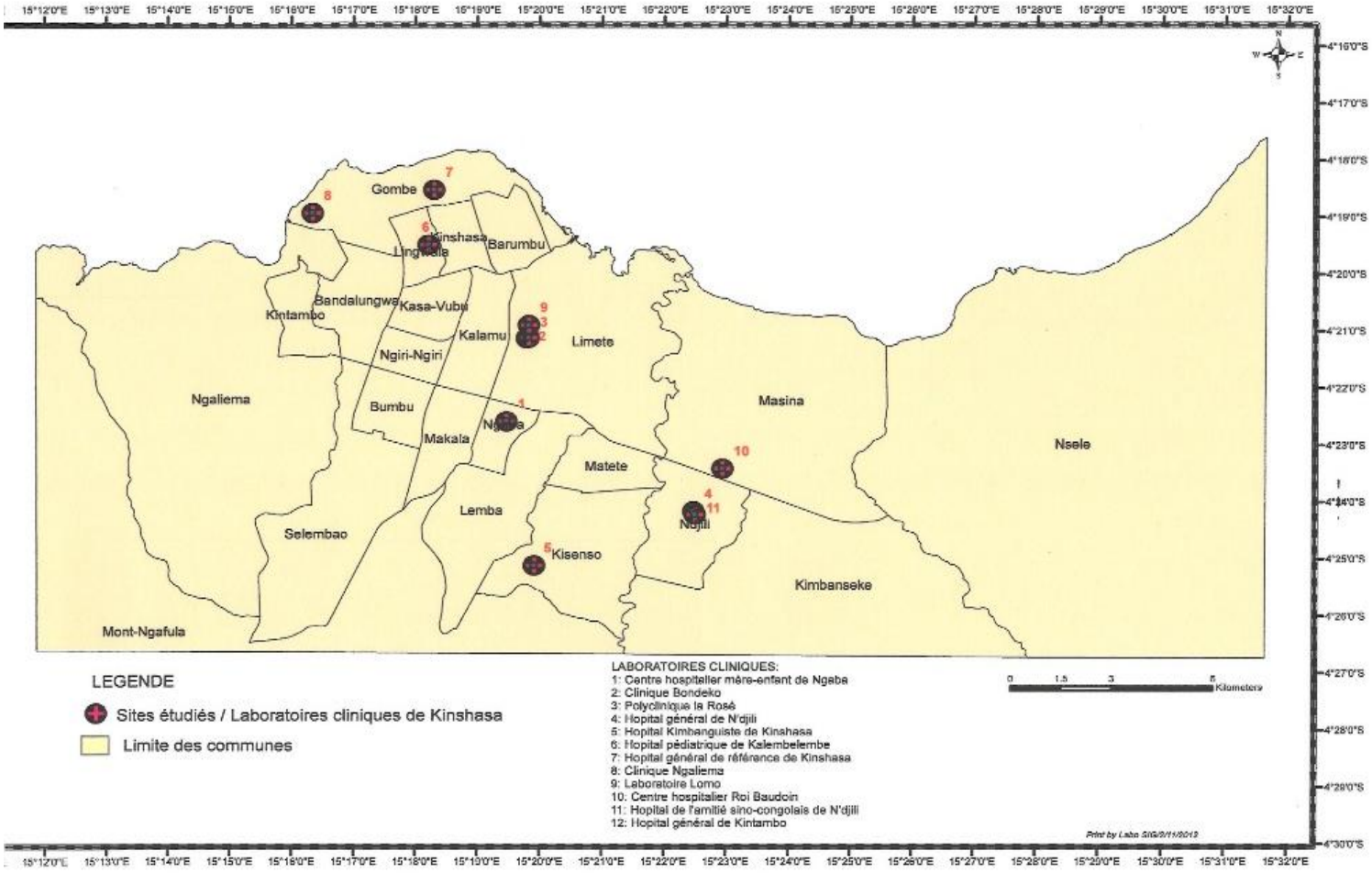

Fig. 1. Administrative map of different hospital facilities selected for this study

Table 1. Category of interviewed persons according to the type of laboratories

N°	Types of laboratories	Responsible of the lab	The oldest lab technician	New lab technician	Total
1	Anatomo-pathology	1	1	0	2
2	HIV	1	1	0	2
3	Biochemistry	1	1	1	3
4	Hematology	2	2	2	6
5	Parasitology	2	1	1	4
6	Microbiology	1	0	1	2
7	Bacteriology	1	1	1	3
8	General lab	11	9	10	30
9	Pbletomy	1	1	1	3
	Total	**21**	**17**	**17**	**55**

Center, Roi Baudouin Hospital, Kitambo Hospital, Larose Polyclinic, Ndjili General Hospital, Kimbanseke General Hospital, Bondeko Hospital, Sino-Congolese Friendship Hospital. We visited 9 types of laboratories: Anatomo-pathology, Biochemistry, Bacteriology, Microbiology, Haematology, Parasitology, AIDS Lab, Sampling and General Laboratory.

(a) Semi-structured interviews: We recruited a socio-anthropologist to conduct the semi-structured interviews based on a pre-tested interview guide and he was trained on the study protocol. All interviews were conducted in French under the direct supervision of the principal investigator. A total of 55 interviews were conducted, which were digitally recorded. In each laboratory visited, we interviewed the head of the laboratory, the oldest technician (more than three years of experience) and the newest (less than three years of experience) as described in Table 1. This number of interviews allowed to reach saturation. The interview guide had covered the following topics: knowledge of biosafety, level of safety in the laboratory, biosafety measures, biosafety training, type of laboratory accident, vaccination and medical control of laboratory technicians.

(b) Observation: We observed the practices of technicians in their laboratories during different visits performed. We opened the refrigerators and some cabinets to observe how things are kept in routine and also the way wastes are managed.

(c) Analysis of qualitative data: The interviews were literally transcribed into French and entered into MS-Word before being imported into the Atlas ti software that was used for analysis. The codes were developed on the basis of the themes of the guide and were imported into software for coding. Additional codes were added during coding as needed. Meaningful quotations were selected to support our results.

2.2.2 Quantitative part

Using the adapted WHO questionnaire, the targeted laboratories were visited. Data were entered into Epi Info 2000 and were verified by double entry as well as the use of comparative data. Different parameters were summarized by proportions.

3. RESULTS

A total of 24 laboratories from 12 institutions were surveyed and 55 interviews were conducted. Of these 24 laboratories, 20 (83.3%) were in the public sector, 3 (12.5%) in the private sector and 1 (4.2%) in the denominational sector. The heads of these laboratories were 66.7% male. Their level of education was represented by the laboratory technicians for 13 managers (54.2%), 9 medical biologists (37.5%), 1 doctor (4.2%) and 1 nurse (4.2%). The average number of years of experience was 16 years with an interquartile range of 20.5 years. The minimum was 3 years and the maximum 51 years. The median of the total number of staff in these laboratories was 7.5, a minimum of 2 and a maximum of 28. Fig. 2 shows the profile of staff in the laboratories.

A total of 24 laboratories (100%) reported testing with pathogens that are at least level 2 biosafety.

3.1 Qualitative Part

We interviewed a total of 55 laboratory technicians, 24 of whom were female and 31 male in 9 types of laboratories (Anatomo-pathology, biochemistry, hematology, bacteriology, parasitology, microbiology, AIDS

Fig. 2. A fridge with soft drinks and storage on a shelf blending any image observed in one of the laboratories visited in Kinshasa during the survey

lab, sampling lab and general laboratory). Three categories of individuals were interviewed: 21 laboratory managers, 17 former and 17 new laboratory technicians.

a. Perceived knowledge of biosafety standards: In general, laboratory technicians believe that they have a good knowledge of biosafety standards. These standards are defined by laboratory technicians as a set of protective and hygienic measures or methods to avoid any kind of contamination while working in the laboratory. *Laboratory materials should be isolated and placed in a less or low-traffic area to avoid inappropriate contact. "... it is a measure to prevent the agents working in the laboratory from becoming infected, it is a protective and hygienic measure or method to avoid any kind of contamination.... "(INT_22).*

The most frequently cited biosafety measures are: wearing gowns, wearing gloves, room disinfection, use of disinfectants and hand washing. Laboratory technicians recognize that in addition to these measures, there are also rules to be observed in the laboratory to avoid contamination, such as the rule of asepsis. "... biosafety is any rule in the laboratory that can be done to avoid contamination, therefore asepsis...". (INT_11).

Other laboratory technicians believe that biosafety standards are a way of behaving to avoid contamination at the laboratory level. "However, some laboratory technicians say they do not know the term biosafety. This is the very first time they have heard this term as this quote shows. "...I don't know, it's my very first time to hear that word if you can explain it to me... " (INT_20).

b. Biosafety training: The majority of laboratory technicians report that they have never had biosafety training. A few lab technicians in the manager category still acknowledge having had biosafety training. In the majority of cases they refer to their academic training. *"...Yes, at school, at the Institut Supérieur desTechniques Médicales" (INT_5). Still others have had on-the-job training such as "...* at the Institute of Tropical Medicine in Antwerp in 1992 and 2002" (INT_2). Other laboratory managers have simply read these notions of biosafety *" ... no, I only read ... "(INT_1).*

c. Perceived level of safety: The majority of laboratory technicians report that they are not aware of the different levels of biosafety in the laboratory; they do not know how to recognize the level of safety in their laboratory and even identify the different levels of safety that may exist. *"I don't have a clue... " (INT_16)*. These levels of biosafety are seen as safeguards that must be respected in the laboratory to avoid contamination during different handling procedures. They refer to the lack of certain

protective materials such as gloves, "*many times we lack gloves, sometimes we lack gloves, sometimes we lack materials, sometimes we work with bare hands"* (INT_18). Others think that the level of safety is good because they wear long sleeves and gloves *"...in my opinion, the safety here is good, we are well secured, we work well because I wear a long sleeves blouse, I wear the gloves.... "* (INT_19). Some technicians say that their laboratory is at a minimum level and that there are other levels such as level two and level three. They acknowledge that there is no level three laboratory in DRC. " .*But in our country, there is only level P2, P3 does not exist in the Democratic Republic of Congo...* » (INT_2). Others think that level three is for the nuclear laboratory *"...We don't have the level..., there is P3 at the nuclear laboratory level...* "(INT_3). For example, other technicians say that their security level is such that a foreign person cannot access the laboratory. *"... no, a foreign body cannot enter the laboratory...*" (INT_8).

d. Observed laboratory practices: Several practices related to biosafety standards were observed in the laboratories visited during the survey. In general, all laboratory technicians were in white coats, although a few worked without coats. The majority of technicians wore gloves. Some technicians had gloves on one hand only. Other lab technicians were also observed to handle the microscopes with gloves. *"... it's protection, like us here in the lab, it's occupational safety, we work with biosafety: the gown, the gloves like I wear here. (INT_19).*

In several refrigerators in the laboratory, bottles of water, bottles of sweets and other consumer foods such as deli meats were found together with other laboratory reagents (Fig. 2). Some laboratory technicians were also observed eating breakfast (bread, sweets, avocado, etc.) in the laboratory.

e. Waste Management: Concerning waste management at the laboratory level, in general, waste are mixed (needles, syringes, gloves, empty vials of reagents and samples, tubes, cans, etc.). In the majority of cases, there are non-functional incinerators (Fig. 3). For example, overfilled incinerators have been observed which have even overflowed, leaving waste all around. Holes have even been dug next to the incinerators to bury the waste. We even observed a working incinerator between the pavilions.

f. Vaccination and medical control of technicians: Lab technicians say they are not vaccinated and never do regular medical check-ups. They say that in Africa it is not usual to have a routine medical check-up. Doing a medical check-up depends on one's willingness to do it, and usually you only do it when you are sick. *"...it depends, but generally we don't do it, only when we don't feel well, we can do some tests" (INT_10).*

g. Perceived type of laboratory accident: In general, laboratory technicians report that they have not experienced any laboratory accidents. However, some accidents have been reported, for example cases of a laboratory provider who ingested acid during oral pipetting that resulted in breathing difficulties leading to hospitalization. Incidents of accidental needle sticks and ingestion of blood during oral pipetting have been reported. Technicians recognize that all these incidents often occur discreetly and remain hidden. *"... but when you contaminate yourself like this it is done discreetly" (INT_24)*. Some illnesses are perceived as contamination in the laboratory. For example, a laboratory technician who had been infected with tuberculosis may have been infected in the laboratory. *"...there was a friend who had tuberculosis, we don't know if it was here or at home, maybe in the cab bus"(INT_5).*

h. Accessible Biosafety Manual: Laboratory technicians report that they do not have an accessible biosafety manual when needed. Some laboratory technicians consult the Internet when needed. Others say they are not even aware of the existence of such a manual. *"... for me, I've never seen that" (INT_14).*

3.2 Quantitative Part

The results are subdivided according to the recommendations for Level 1 and then Level 2 (see Tables 2 and 3).

However, some limitations can be noted in this study. In particular, the selection of laboratories was not based on chance but on pre-determined criteria. This may make it difficult to extrapolate results to other laboratories in Kinshasa.

Fig. 3. Incinerator observed in a Kinshasa hospital during the survey

Table 2. Status of compliance with some standards for level 1 safety in the surveyed laboratories

Standards	N	Yes		No	
		Frequency	%	Frequency	%
Absence of portable radiators	23	23	100.0	0	0.0
Personnel wearing appropriate clothing	24	24	100.0	0	0.0
Grounded sockets with the appropriate polarity	24	23	95.8	1	4.2
No passage of wires and hoses in the door opening	24	23	95.8	1	4.2
Traffic lane at least 1 m wide	24	23	95.8	1	4.2
Good labelling of all solutions	24	22	91.7	2	8.3
Mouth pipetting not prohibited	24	21	87.5	3	12.5
No objects stored on pipes or electrical appliances	24	21	87.5	3	12.5
No devices with frayed or damaged wires	24	19	79.2	5	20.8
Products not stored on the ground	23	17	73.9	6	26.1
Hazardous products not stored above eye level	24	17	70.8	7	29.2
Unopened chemical containers	24	17	70.8	7	29.2
Eye rinse in the laboratory	24	17	70.8	7	29.2
Flammable products stored in the appropriate cabinet	24	14	58.3	10	41.7
No connection near shower sinks	24	14	58.3	10	41.7
Containers for sharps properly used and disposed of	24	14	58.3	10	41.7
Absence of litter on the ground	24	14	58.3	10	41.7
No food in freezers or refrigerators for human consumption	24	13	54.2	11	45.8
Acid-proof and acid-proof coating of benches	24	12	50.0	12	50.0
Presence of carcinogenic, radioactive or biohazardous substances indicated by an external mark	24	12	50.0	12	50.0
Absence of signs of faulty waste disposal	24	12	50.0	12	50.0
Correctly labelled laboratory equipment: biohazard, radioactivity, etc.	24	10	41.7	14	58.3

Standards	N	Yes		No	
		Frequency	%	Frequency	%
Flammable products not stored in secure units	24	10	41.7	14	58.3
Personal protective equipment (gowns, gloves, safety glasses, goggles, etc.) …	24	10	41.7	14	58.3
Staff do not eat, drink, smoke or wear makeup in the laboratory.	24	10	41.7	14	58.3
Mechanical pipetting devices, pro pipettes etc. supplied and used	24	9	37.5	15	62.5
Separate storage for streetwear and laboratory clothing	24	9	37.5	15	62.5
Food for human consumption preserved outside the laboratory	23	8	34.8	15	65.2
Asphyxiating or toxic gases present only in ventilated rooms	24	8	33.3	16	66.7
Absence of extension cords	24	8	33.3	16	66.7
Existence of biosafety guidelines and their follow-up	24	7	29.2	17	70.8
Grounded electrical cables	24	6	25.0	18	75.0
Gowns, coveralls, gloves and other protective clothing or accessories not worn outside the laboratory	24	6	25.0	18	75.0
Effective and active arthropod and rodent control program	24	6	25.0	18	75.0
Disposal procedure display	24	5	20.8	19	79.2
Safety shower	24	4	16.7	20	83.3
Appropriate signage for the hazard	24	3	12.5	21	87.5
Double dating of products	24	2	8.3	22	91.7
Laboratory risk communication	24	2	8.3	22	91.7
A warning of the kind (no food allowed - for laboratory work only) clearly marked on microwave ovens or other household appliances.	24	2	8.3	22	91.7

Table 3. Status of compliance with selected Level 2 safety standards in surveyed laboratories

Standards	N	Yes		No	
		Frequency	%	Frequency	%
No presence of open flames in ESB	23	23	100.0	0	0.0
Panel legible and in good condition	3	3	100.0	0	0.0
Hand washing after removing gloves and before leaving the laboratory when working with infectious agents.....	24	24	100.0	0	0.0
Presence of the Biological Safety Cabinet (BSE)	24	23	95.8	1	4.2
Self-locking or disposable syringes are used for work with infectious agents	24	23	95.8	1	4.2
Le chef de labo est prévenu si du matériel infectieux est répandu ou impliqué dans un accident	24	19	79.2	5	20.8
Transport of the decontaminated material out of the laboratory in closed, sturdy and leak-proof containers in accordance with regulations	24	19	79.2	5	20.8

Standards	N	Yes		No	
		Frequency	%	Frequency	%
Specific decontamination of the microorganism(s) in question	24	17	70.8	7	29.2
An appropriate decontaminant is used to clean before and after each handling, daily or if a product has been spilled.	24	17	70.8	7	29.2
Wearing gloves when handling infectious biological materials or contaminated equipment	24	17	70.8	7	29.2
Cleaning of the BSE surface with disinfectant	23	16	69.6	7	30.4
All doors are closed	24	16	66.7	8	33.3
Possibility of administering an anti-infective agent as first aid..……	24	16	66.7	8	33.3
Work surfaces are cleaned before and after each handling, daily or if a product has been spilled.	24	15	62.5	9	37.5
Access limited to authorized personnel	24	12	50.0	12	50.0
Limited access to staff with full knowledge of all risks	24	12	50.0	12	50.0
Proper use of contaminated waste containers	24	12	50.0	12	50.0
Handling is carried out in such a way as to produce as little aerosols or splashes as possible	24	9	37.5	15	62.5
Crops and other waste subject to regulations duly decontaminated before disposal	24	8	33.3	16	66.7
Wash basins installed near the exit of the laboratory	24	8	33.3	16	66.7
Biological decontamination of mixed waste prior to disposal as chemical or radiological waste	24	7	29.2	17	70.8
Buckets and centrifuge rotors are only opened inside a BSE	24	6	25.0	18	75.0
Use of BSE in the presence of a risk of aerosol formation	23	5	21.7	18	78.3
Use of BSE if there is a possibility of splashes or aerosol formation of infectious material …	23	5	21.7	18	78.3
A biosafety manual has been prepared and adopted. ……	24	5	20.8	19	79.2
Front grille and unobstructed BSE filter	23	4	17.4	19	82.6
Infectious specimens are transported out of BSE in containers approved in accordance with the regulations for the transport of this type of products.	24	4	16.7	20	83.3
Biohazard sign on the laboratory door	24	3	12.5	21	87.5
Control carried out	23	2	8.7	21	91.3
Properly labeled and closed containers	24	2	8.3	22	91.7
Facial protection when working with infectious material outside of BSE	24	1	4.2	23	95.8
Staff reads, studies and follows instructions on practices and techniques and in particular those in the laboratory manual (mandatory once a year for all staff).	24	1	4.2	23	95.8
Necessary vaccinations or tests reminded to staff depending on the infectious agents handled	24	0	0.0	24	100.0
Competent medical services contacted for medical check-up, professional medical supervision	24	0	0.0	24	100.0

4. DISCUSSION

The biosafety issue is something to consider while we talk about laboratory quality in a health facility. The studied laboratories are among the largest in terms of attendance and quality of staff (2 doctors, 41 medical biologists and 113 technicians with a higher A1 level), it can be thought that other laboratories would have the same or worse biosafety profile as observed in this study. The number of laboratories surveyed is also not high and may be confusing. This would have little influence on our study because inqualitative studies, there is no need of determine the sample size. The interview would continue until saturation is reached. In addition, this survey was not for analytical purposes. These findings are consistent to those reported by Nasim et al. in Pakistan, particularly with regard to the wearing of clothing in a high proportion of laboratories and the absence of a biosafety manual or biosafety training [10]. Aksoy et al. in Turkey found the same, as did Elduma in Sudan where only 40 staff had received biosafety training [13-14]. Wearing of clothing is often respected but not other measures, and knowledge, attitudes and practices are quite low with regard to biosafety standards.

It was observed that the technicians drink and eat in the laboratory, this constitute a common habit among this personnel. The due observation is similar with Nasim et al. who reported that 70% of laboratory workers eat and drink in the laboratory due to lack of space for catering [10], while Aksoy et al. observed the same situation in Turkey where 38% of laboratory staff do not respect the basic principles of biosafety (38%) [13]. In this study, it was found that in 41% of the laboratories, laboratory staff eat in the laboratory without any fear of respecting the rules of a laboratory. This was confirmed by the observation done in the qualitative part.

Regarding oral pipetting, the findings are consistent with Nasim et al. who reported a proportion of oral pipetting in 28% of cases although in India the proportion was 1.6% [15]. In our study, oral pipetting was not prohibited in 91% of the laboratories surveyed knowing this practice is strictly forbidden. The CDC (2009) document on biosafety states: "Mouth pipetting is prohibited; mechanical pipetting devices must be used" [16].

In contrast, the number of BSEs was higher in our study than that of Nasim et al. and Aksoy et al. [10,14]. The difference may be related to the fact that in our study, we selected the laboratories on the basis of attendance and geographical orientation. Most of the laboratories with high attendance would be the most successful and would have BSE. Also, this study is conducted in the capital city of DRC where the acquisition of such equipment would be facilitated.

5. CONCLUSION

Biosafety measures are not optimally applied in the surveyed laboratories in Kinshasa. Several reasons were given such as lack of training, lack of manuals etc. The total lack of reporting of IALs does not make technicians and other laboratory workers, despite their high qualification, aware of the danger of contracting IALs. This study did not attempt to formally identify the reasons for non-compliance with biosafety measures.

In view of these findings, it is clear as reported by laboratory technicians that IALs do indeed exist in these laboratories but as those in charge do not report them and as no medical control system has been put in place, it is almost impossible to determine the extent of these diseases.

The more experienced technicians would be less concerned about the fact that over time they think that IALs do not exist, especially since they are diseases they can contract themselves in their natural environment. A comprehensive awareness program on IALs is necessary in this context.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).It is a study that does not involve human experimentation but consists of interviews and surveys of clinical laboratory personnel during their work. Investigators wore laboratory-compliant attire (long-sleeved cotton jacket, closed shoes). Participation in the study was voluntary and unpaid. Personal data were not published. Confidentiality was ensured by limited access to both study and personal data.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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