

Research Article

Evaluation of the Application of Biosecurity Among Healthcare Workers in Kinshasa, with a View to Preventing Infectious Risks: A Cross-Sectional and Analytical Study

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Abstract

Context: The application of biosafety is not effective in the world, the rare case that exists, is almost undocumented. Biological risks are not limited only to laboratories, it is also great in the daily practice of the health care profession, doctor or nurse; but it is largely ignored by practitioners due to their attitude, reason for nosocomial diseases. The health sector in the DRC (Democratic Republic of Congo) suffers from several ills, not allowing the implementation of biosafety actions. Evaluated the extent of the application of biosafety among health care professionals in order to prevent infectious risks. **Methods:** The study took place in medical institutions in the health zones of the City of Kinshasa, during the period from 10/06/2023 to 10/06/2024. It was a multicenter, cross-sectional and analytical study carried out among healthcare professionals (doctors and nurses) in the city of Kinshasa, with a convenience sample, exhaustive of the number of doctors and nurses present at the time of our survey, thus giving a sample size of 305 respondents. Being a doctor or nurse and giving consent were the selection criteria. The data were collected electronically with the KoboToolbox application, and analyzed by the SPP (Statistical Package for the Social Sciences) software version 24. **Results:** The Congolese healthcare workers (Doctors and Nurses) were born outside Kinshasa (57.4%), and were in the age group of 36 to 41 years (34.1%) with an average age of 37.6 $\pm$ 9.05 years. They were married (53.8%) and worked in the City's Hospitals and Reference Centers (28.5%). They were aware of biosecurity (53.1%) and its importance (67.9%) among the staff of medical institutions, while ignoring its importance among the healthcare workers (50.5%). They were not aware of the concepts of biosecurity (58.7%), but were still aware of its primary purpose, which is health risk management (76.1%). The application of biosafety is not effective among medical staff in the country's medical institutions (78.4%), and emergency procedures in different exposures are not known at all (3.3%). **Conclusion:** Biosafety is not effectively implemented among healthcare workers in the country's medical institutions, and emergency procedures in various exposures are not well known. Biosafety remains a serious problem for doctors and nurses in terms of knowledge and applicability.

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Keywords

Biosecurity, Biosafety, Doctor, Nurse, Kinshasa

1. Introduction

The first safety measures in laboratories handling pathogenic microorganisms, such as the laboratory of the "Institut Pasteur" in Paris, were put in place around 1889, and in North America and the United Kingdom around the 1970s [1, 2].

Biosafety refers to all preventive and regulatory measures aimed at reducing the risks of spreading microbes; that is, measures encompassing work practices, protective measures for personnel and physical containment measures aimed at limiting the spread and progression of biological pathogens in medical institutions (laboratories and hospitals) [3-5].

Safety measures applied to medical institutions handling organisms and microorganisms have been largely inspired by the guidelines established in microbiology. But this has not prevented the emergence of the first infectious diseases acquired due to the lack of biosecurity [6].

The application of biosafety is not effective in the world, the rare case that exists, is almost undocumented. In a study carried out by Silvia Bellini on "the application of biosafety in different production systems at individual, national and regional levels", the author confirmed that "half of the respondents (53.85%) specified that their country had national funds to support the implementation of biosafety, and 89.74% of the respondents had procedures in place to evaluate the implementation of biosafety", without ever discussing the application of this biosafety [7].

In our era, the deadly spread of epidemics such as Ebola hemorrhagic fever (mortality rate of 88% in DR Congo) [8] and Covid 19 (crude mortality rate of 69.1/100,000 inhabitants in Tunisia) [9], sufficiently prove how the failure of biosecurity can set a given region or the entire world ablaze.

In the management of epidemics in Africa, taking into account only Ebola and COVID-19, despite the biosecurity measures developed by the World Health Organization to avoid contact with the virus strain (corpse), African and professional cultures and habits had been erected as a barrier to stopping the spread of these diseases. In addition, the behavior and negligent attitude of medical staff in hospitals towards biosecurity measures also promote the health risk [10].

The health sector in the DRC suffers from several problems, including a low budget allocation which does not allow the implementation of biosecurity actions in order to encourage the transmission of diseases in hospitals as much as possible.

Biological risks are not limited only to laboratories, it is also great in the daily practice of the healthcare profession, doctors or nurses; but it is largely ignored by practitioners due

to their attitude, which is the reason for nosocomial diseases. In the world, in the Asian continent, an error was made in China by laboratory personnel or by a lack of biosafety in this laboratory. This had endangered the lives of the Chinese population in particular, and the whole world in general, by contamination with SARS-COV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) (COVID-19: Coronavirus Disease 2019) [11-13].

The COVID-19 pandemic has reached the number of 6,955,141 deaths worldwide. In Africa, although the disease has not really raged due to the prevalence of deaths, but has inevitably affected the economy and the social [11].

In Africa, in 2015, 815 healthcare workers were infected with the Ebola virus and, in 2020, the first death recorded in the Democratic Republic of Congo for COVID-19 was a doctor. In the context of the failure of biosecurity, healthcare workers are the first to pay a heavy price [11, 12].

The objective of this study was to assess the extent of the application of biosecurity among healthcare workers in medical institutions in Kinshasa, with a view to preventing infectious risks.

2. Methods

2.1. Framework, Period and Type of Study

This study is cross-sectional, analytical, and multicenter. It was conducted in the health zones of the city-province of Kinshasa, in the Democratic Republic of Congo, specifically in hospitals and reference medical centers. The study was conducted during the period from 06/10/2023 to 06/10/2024.

2.2. Target Population

The target population of the present study was only the healthcare staff (doctors and nurses) in the reference medical institutions and modern clinics of the city-province of Kinshasa.

2.3. Sampling and Sample Size

Our sample was selected from reference medical institutions and modern clinics in the city-province of Kinshasa. We used non-probability sampling to constitute our sample.

The sample was convenience, exhaustive of the total

number of medical staff (doctors and nurses) found in the research institutions during the period of our research. Giving a sample of 305 respondents.

2.4. Inclusion and Non-Inclusion Criteria

All healthcare providers (doctors and nurses) who gave their informed consent were included in this study. Those who did not answer the questionnaires correctly were excluded from the study.

2.5. Data Collection

We obtained permission from the John Wesley Methodist University Ethics Commission to conduct this research. Data were collected using a software called KoboToolbox. The questionnaires were developed electronically and contained four (4) sections with a total of 24 questions designed according to our objectives.

2.6. Variable of Interest

The variables of interest concerned socio-professional data, the respondents' knowledge of biosecurity, the application of biosecurity among healthcare workers and the exposure of healthcare workers to the risk of infection following the non-application of biosecurity.

2.7. Statistical Analysis

The data, collected and automatically entered into the KoboToolbox application, were exported into SPSS version 24 statistical software to perform the analyses. These data will

be presented in the form of figures and tables. We will use the mean, standard deviation, and extremes to describe the variables. Concerning qualitative variables, they will be described in the form of relative (%) and/or absolute (n) frequency.

We also used the Chi-square test to compare the propositions (comparing the application of biosafety among doctors versus nurses). The determinants of infectious risks due to the non-application of biosafety will be sought using the logistic regression test. The OR (Odds Ratio) and 95% CI (Confidence interval) were calculated to measure the strength of association between the non-application of biosafety among doctors and nurses.

2.8. Ethical Consideration

The study was conducted under the authorization and approval of the Ethics and Research Committee of John Wesley Methodist University under number 0004/UMJW/SGAC/FEV/2024. The respondents will sign an informed consent after having had an explanation on the objectives of the study. They will be free to leave the study without inconvenience or request for explanation. We are required to maintain the confidentiality of the data obtained.

3. Results

3.1. Sociodemographic Profile of the Respondents

The socio-professional profile of the respondents is shown in Table 1.

Table 1. Sociodemographic characteristics.

Variables	Professional category		Total	p
	Doctor n (%)	Nurse n (%)		
Place of birth				0.741
In Kinshasa	32 (10.5)	98 (32.1)	130 (42.6)	
Outside Kinshasa	46 (15.1)	129 (42.3)	175 (57.4)	
Age gone by				0.015
18 – 23 years old	0 (0.0)	2 (0.7)	2 (0.7)	
24 – 29 years old	3 (1.0)	49 (16.1)	52 (17.0)	
30 – 35 years old	14 (4.6)	35 (11.5)	49 (16.1)	
36 – 41 years old	32 (10.5)	72 (23.6)	104 (34.1)	
42 – 47 years old	20 (6.6)	45 (14.8)	65 (21.3)	
≥ 48 years old	9 (3.0)	24 (7.9)	33 (10.8)	
Mean + Standard Deviation	37.6 ± 9.05 years			

Variables	Professional category		Total	p
	Doctor n (%)	Nurse n (%)		
Minimum & Maximum	18.6 to 66.7 years			
Marital status				0.000
Married	63 (20.7)	101 (33.1)	164 (53.8)	
Bachelor	15 (4.9)	126 (41.3)	141 (46.2)	
Level of study				0.557
Secondary	0 (0.0)	1 (0.3)	1 (0.3)	
University	78 (25.6)	226 (74.1)	304 (99.7)	
Cultural area				0.001
Kongo	3 (1.0)	28 (9.2)	31 (10.2)	
Luba	36 (11.8)	54 (17.7)	90 (29.5)	
Ngala	30 (9.8)	103 (33.8)	133 (43.6)	
Swahili	9 (3.0)	42 (13.8)	51 (16.7)	
Medical institution				0.004
Clinical	12 (3.9)	79 (25.9)	91 (29.8)	
Reference hospital	17 (5.6)	58 (19.0)	75 (24.6)	
Hospital center	30 (9.8)	49 (16.1)	79 (25.9)	
Medical Center	15 (4.9)	33 (10.8)	48 (15.7)	
Reference medical center	4 (1.3)	8 (2.6)	12 (3.9)	
Religion				0.058
Catholic Christian	15 (4.9)	63 (20.7)	78 (25.6)	
Protestant Christian	31 (10.2)	74 (24.3)	105 (34.4)	
Christian Revival Church	26 (8.5)	49 (16.1)	75 (24.6)	
Kimbanguist Christian	3 (1.0)	15 (4.9)	18 (5.9)	
Muslim	3 (1.0)	18 (5.9)	21 (6.9)	
Non-believer	0 (0.0)	8 (2.6)	8 (2.6)	

The majority of respondents were born outside Kinshasa (57.4%), they were in the age group of 36 to 41 years (34.1%) with an average age of 37.6 ± 9.05 years.

The majority were married (53.8%), had a university education (99.7%), belonged to the Ngala cultural area (43.6%) and were of the Protestant Christian religion (34.4%). Hospitals and Reference Centers represented only 28.5% of the surveys.

Comparing doctors with nurses, there is a significant difference in terms of age ($p = 0.015$), civil status ($p = 0.000$), cultural area ($p = 0.001$) and medical institution ($p = 0.004$).

3.2. Knowledge of Biosecurity

The respondents' knowledge of biosecurity is recorded in [Table 2](#).

Table 2. Knowledge of respondents on biosecurity.

Variable	Professional category		Total	P
	Doctor n (%)	Nurse n (%)		
What is biosecurity?				0.084
Know	48 (15.7)	114 (37.4)	162 (53.1)	
Don't know	30 (9.8)	113 (37.0)	143 (46.9)	
Is biosecurity important for staff in medical institutions?				0.000
Yes	72 (23.6)	135 (44.3)	207 (67.9)	
No	6 (2.0)	92 (30.2)	98 (32.1)	
Who is concerned by biosecurity?				0.001
Lab staff	0 (0.0)	19 (6.2)	19 (6.2)	
Healthcare staff	78 (25.6)	193 (63.3)	271 (88.9)	
Prosant és	0 (0.0)	15 (4.9)	15 (4.9)	
Importance of biosecurity for the medical profession?				0.000
Know	54 (17.7)	97 (31.8)	151 (49.5)	
Don't know	24 (7.9)	130 (42.6)	154 (50.5)	

The majority of the surveys were aware of biosecurity in 53.1%, they also knew the importance of biosecurity (67.9%) among the staff of medical institutions, both knowing that it is more the healthcare staff (88.9%) who are concerned by biosecurity. In evolving the importance of biosecurity among the healthcare staff, the majority, i.e. 50.5%, were unaware of it.

Comparing Doctors to Nurses in terms of knowledge about biosafety, it is noted that this knowledge was very significant

with regard to the importance of biosafety among staff in medical institutions ($p = 0.000$), the professional category concerned by biosafety (0.001), and the importance of biosafety for the medical profession (healthcare staff) (0.000).

3.3. Knowledge of How Biosecurity Is Applied

The respondents' knowledge of the mode biosecurity application is described in Table 3.

Table 3. Knowledge of respondents on the method of applying biosecurity.

Variable	Professional category		Total	P
	Doctor n (%)	Nurse n (%)		
What biosecurity concepts are you familiar with?				0.038
Know	40 (13.1)	86 (28.2)	126 (41.3)	
Don't know	38 (12.5)	141 (46.2)	179 (58.7)	
What is the primary purpose of biosecurity?				0.023
Popularize biosecurity	5 (1.6)	23 (7.5)	28 (9.2)	
Health risk management	68 (22.3)	164 (53.8)	232 (76.1)	
Fight against epidemics	5 (1.6)	40 (13.1)	45 (14.8)	
What are the principles of biosecurity?				0.037
Must be applied by lab staff	2 (0.7)	1 (0.3)	3 (1.0)	

Variable	Professional category		Total	P
	Doctor n (%)	Nurse n (%)		
Must be applied by nurse	0 (0.0)	13 (4.3)	13 (4.3)	0.029
Must be applied by Doctor	9 (3.0)	37 (12.1)	46 (15.1)	
Exposure study based on voice, duration, dose, etc.	67 (22.0)	176 (57.7)	243 (79.7)	
What are the biosecurity control tools?				
I know	52 (17.0)	119 (39.0)	171 (56.1)	
I don't know	26 (8.5)	108 (35.4)	134 (43.9)	

The majority of the surveys were not familiar with the concepts of biosecurity (58.7%), but they were still familiar with the primary purpose of biosecurity, which is the management of health risks (76.1%), just as they were familiar with the principles of biosecurity (exposure study based on voice, duration, dose, etc.) in 79.7% and the tools for combating biosecurity (56.1%).

Comparing Doctors to Nurses, all variables were significant.

3.4. Knowledge of Emergency Management if Biosecurity Is Compromised

The respondents' knowledge of emergency care if biosecurity is compromised is described in Table 4.

Table 4. Knowledge of respondents on emergency management if biosecurity is compromised.

Variable	Professional category		Total	P
	Doctor n (%)	Nurse n (%)		
Emergency procedure in case of exposure with contact with mucous membranes (eyes, nose and mouth)				0.004
The exposed area should be disinfected with disinfectant	14 (4.6)	81 (26.6)	95 (31.1)	0.000
The infected area should be first washed with water	64 (21.0)	146 (47.9)	210 (68.9)	
Emergency Procedure for Exposure to Cuts, Pricks, and Scrapes				
The exposed area should be disinfected with disinfectant	69 (22.6)	165 (54.1)	234 (76.7)	
The infected area should first be washed with water	3 (1.0)	58 (19.0)	61 (20.0)	
Washed with water + post-exposure prophylaxis	6 (2.0)	4 (1.3)	10 (3.3)	

In case of exposure with contact with mucous membranes such as eyes, nose and mouth, the emergency procedure is known in 68.9% of cases and in case of exposure with cuts, stings and scratches, the emergency procedure is not known, only 3.3% of the surveys know this procedure.

Comparing the knowledge of Doctors and Nurses regarding the emergency procedure in case of exposure, the knowledge of the emergency procedure in case of exposure with contact with mucous membranes and the lack of knowledge of the

emergency procedure in case of exposure with cuts, stings and scratches were significant, with a "p" value of 0.004 and 0.000 respectively.

3.5. Application of Biosecurity

The application of biosecurity by the respondents is presented in Table 5.

Table 5. Application of biosafety in medical institutions.

Variable	Place of birth		Total	p
	In Kinshasa n (%)	In Kinshasa n (%)		
Do you wear scrubs every time you are at the hospital?				0.168
Yes	66 (21.6)	205 (67.2)	271 (88.9)	
No	12 (3.9)	22 (7.2)	34 (11.1)	
If so, how do you wear it?				0.659
I know	18 (5.9)	47 (15.4)	65 (21.3)	
Don't know	60 (19.7)	180 (59.0)	240 (78.7)	
Do you wash or disinfect your hands every time you touch patients or work materials?				0.115
Yes	9 (3.0)	44 (14.4)	53 (17.4)	
No	69 (22.6)	183 (60.0)	252 (82.6)	
Do you wear gloves every time you touch patients or work equipment?				0.335
Yes	9 (3.0)	41 (13.4)	50 (16.4)	
No	69 (22.6)	186 (61.0)	255 (83.6)	
Is biosecurity enforcement effective in your institution?				0.012
Yes	9 (3.0)	57 (18.7)	66 (21.6)	
No	69 (22.6)	170 (55.7)	239 (78.4)	
Presence of biosecurity logos to manage the movement of staff, patients and visitors				0.757
Yes	6 (2.0)	14 (4.6)	20 (6.6)	
No	72 (23.6)	213 (69.8)	285 (93.4)	
Regular cleaning of the floor, surface and work equipment				0.800
Yes	3 (1.0)	7 (2.3)	10 (3.3)	
No	75 (24.6)	220 (72.1)	295 (96.7)	
Proper waste management: separation between liquids and solids and rapid disposal				0.001
Yes	9 (3.0)	4 (1.3)	13 (4.3)	
No	69 (22.6)	223 (73.2)	292 (95.8)	
Availability and use (wearing) of protective equipment (gloves, goggles, clogs, coats, etc.)				0.910
Yes	15 (4.9)	45 (14.8)	60 (19.7)	
No	63 (20.7)	182 (59.7)	245 (80.3)	

The majority of respondents wear work clothes (white coat, surgical uniform) in 88.9% of cases, but wear them badly in 78.7% of cases.

The majority of healthcare workers do not wash or disinfect their hands every time they touch patients or work equipment

(82.6%). Similarly, they do not wear gloves every time they touch patients or work equipment (83.6%).

They acknowledge that the application of biosafety is not effective in their institutions in 78.4% of cases. This is justified by the absence of a logo indicating biosafety in medical

institutions, in 93.4% of cases, the absence of proper waste management with separation between liquids and solids as well as rapid evacuation (95.8%), and the absence of protective equipment (gloves, goggles, clogs, gowns, etc.) in medical institutions in 80.3% of cases.

4. Discussion

This multicenter, cross-sectional and analytical study on the evaluation of the application of biosecurity among healthcare professionals in order to prevent infectious risks showed the following:

4.1. Knowledge of Biosecurity

In this study:

The majority of the surveys were aware of biosecurity in 53.1%, they also knew the importance of biosecurity (67.9%) among the staff of medical institutions, both knowing that it is more the healthcare staff (88.9%) who are concerned by biosecurity. In evolving the importance of biosecurity among the healthcare staff, the majority, i.e. 50.5%, were unaware of it.

Compared to the study of Mutata Amisi and Koto-te-Nyiwa, on the knowledge and practice of biosafety in clinical laboratories in the City of Kinshasa in the DRC, reported a good knowledge of biosafety in laboratories in the city of Kinshasa, especially among young technicians recently coming from universities [14].

4.2. Application of Biosafety in Medical Institutions

In this study:

The majority of respondents wear work clothes (white coat, surgical uniform) in 88.9% of cases, but wear them badly in 78.7% of cases.

The majority of healthcare workers do not wash or disinfect their hands every time they touch patients or work materials (82.6%). Similarly, they do not wear gloves every time they touch patients or work materials (83.6%).

The respondents acknowledged that the application of biosafety is not effective in their institutions in 78.4% of cases. This is justified by the absence of a logo indicating biosafety in medical institutions, in 93.4% of cases, the absence of proper waste management with separation between liquids and solids as well as rapid evacuation (95.8%), and the absence of protective equipment (gloves, goggles, clogs, gowns, etc.) in medical institutions in 80.3% of cases.

The study by Mutata Amisi and Koto-te-Nyiwa shows that laboratories in Kinshasa apply biosafety measures such as appropriate clothing. On the other hand, simple measures are not applied at all, such as oral pipetting in 91% of cases; or eating or drinking in laboratories in 58% or putting food in laboratory refrigerators in 45%. In conclusion, biosafety is not

applicable in laboratories [14].

Strength of the Study

The strength of this study stems from the fact that it is one of the rare studies carried out on biosecurity among healthcare professionals such as doctors and nurses.

Low of the Study

The weakness of the study is due to the lack of studies carried out on biosafety among healthcare professionals, which could be used for discussion.

5. Conclusion

The Congolese healthcare workers (doctors and nurses) were born outside Kinshasa and were in the 36-41 age group, with an average age of 37.6 ± 9.05 . They were married and worked in the city's hospitals and referral centers. They were aware of biosafety and its importance among the staff of medical institutions, while ignoring this importance among healthcare workers. They were unaware of the concepts of biosafety, but were still aware of its primary purpose, which is health risk management. The application of biosafety is not effective among healthcare workers in the country's medical institutions, and emergency procedures in different exposures are not known at all. Biosafety remains a serious problem among doctors and nurses in terms of knowledge and applicability.

6. Suggestion

We suggest that biosafety and even biosecurity be taught to doctors as well as nurses, and that its application be rigorous in all medical institutions and among all healthcare professionals.

Abbreviations

DRC	Democratic Republic of Congo
COE/CBRN	Center of Excellence for Chemical, Biological, Radiological and Nuclear Risk Reduction
MD	Doctor of Medicine
DIU	Interuniversity Diploma
M.Med	Master of Medicine
SPSS	Statistical Package for the Social Sciences
SARS-COV-2	Severe Acute Respiratory Syndrome Coronavirus
COVID-19	Coronavirus Disease 2019
OR	Odds Ratio
CI	Confidence interval
UMJW	John Wesley Methodist University
SGAC	Academic General Secretariat
FEV	February

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Conflicts of Interest

The authors declare no conflicts of interest.

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