Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Assessing the Biosafety Precaution Measures and Their Application in Veterinary Research Laboratories and Clinics Across Three Egyptian Governorates

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Abstract

BIOSAFETY precaution measures and their application among veterinary laboratories and clinics are crucial in order to safeguard researchers, veterinarians, and technicians from laboratory-acquired infections. This work was designated to assess the status of veterinary labs, clinics, and research institutes' biosafety and biosecurity protocols. Besides the level of awareness and use of biosafety practices among researchers, veterinarians, and technicians in the three regions under investigation. In addition, staff should be aware of waste management practices. A structural questionnaire (n = 84) was administered to respondents to obtain all data from respondents across targeted research labs belonging to universities, colleges, research institutes, and veterinary clinics about routine laboratory work and practices such as sampling collection and processing, knowledge of laboratory biosafety, availability and proper use of personal protective equipment (PPE), attitude towards and use of standard laboratory practices, as well as disposal of biological waste. Results evaluating biosafety precautionary measures in the three occupational categories clarified that 28 out of 41 labs of universities were uncategorized (68.2%), besides research institute labs (57.1%) and veterinary clinics (52.7%). The majority of waste disposal types in veterinary laboratories were biological waste (54.2%). Meanwhile, the highest percentage of waste disposal types in veterinary clinics was pathological waste (58.3%). In laboratories, 62.5% of the respondents had moderate knowledge about biosafety measures, and 50.0% in veterinary laboratories. In conclusion, improvement of biosafety and biosecurity protocols is needed to guarantee the health and safety of researchers, veterinarians, workers, their environment, and efficient responses to proper management of hazardous wastes.

Keywords: Veterinary laboratory, Biosafety levels, Biosecurity measures, Veterinary clinics, Bio-hazardous wastes.

Introduction

Biosafety focuses on the careful management and control of hazardous biological substances and infectious microorganisms to ensure safety. The emergence of previously undiscovered infectious agents and diseases, some of these items carry the potential for use as bioterrorism weapons, has led to a surge in research on infectious pathogens in recent years [1]. Biosafety in labs is crucial in order to safeguard researchers from laboratory-acquired infections (LAIs) and to shield the general public from unintentional or deliberate exposure to infectious microbes. Biosafety is of the utmost importance when it comes to infections and diseases that spread. Infections and risks, including biological, chemical, electrical, and glassware, will damage agriculture, the environment, and the general population if proper biosafety procedures are not implemented in veterinary clinics and laboratories [2]. Systems for biosafety in labs are employed worldwide to lessen the threats that harmful

pathogens pose in the lab. To be able to manage disease-causing germs safely and securely, veterinary laboratories have specific obligations to their employees and the surrounding community [3]. Technician in laboratories face several potential risks, including biological, physical, chemical, and radioactive ones. Many employees are more susceptible to harm due to their ignorance of the possible risks present in their workplace [2]. Establishing the biosafety level is crucial for staff members operating in environments where microbiological organisms, including bacteria, viruses, fungi, and related agents, as well as other microbiological products, are present. This is because the fact that establishing the biosafety level serves the dual purpose of shielding the surrounding environment and laboratory staff from biological threats [4]. The four biosafety levels for laboratories are BSL-1, 2, 3, and 4. The protective procedures for each level rise. BSL-1 laboratories handle the least hazardous materials and need the fewest safety measures, while BSL-4 laboratories handle the most hazardous materials and need the most stringent procedures [5]. The ecology is now seriously threatened by the huge amounts of waste that have accumulated there. It pollutes our soil, water, and air. It poses a threat to both humanity and the environment because of its harmful impacts [6]. Furthermore, inadequate waste disposal and improper handling not only put workers at risk of contracting diseases and getting injured, but they also increase the likelihood of germs entering the environment, thereby endangering public health [7]. Clinical laboratories generate three main categories of waste: pathological (large tissue), infectious (biohazardous), and chemical waste. Any substance—solid, liquid, or gaseous—that exhibits one of two conditions: it is either explicitly "listed" as a hazardous waste or exhibits a "hazardous characteristic" [8]. Waste management's primary goals are to prevent pollution, save the environment from negative consequences, and safeguard public health from dangerous effects. The processes of properly gathering and characterizing wastes to ascertain their hazards, separating hazardous wastes from non-hazardous wastes, storing waste that contains one or more hazardous components, treating and disposing of hazardous wastes, and meeting record-keeping and reporting obligations are all considered waste management practices [6] .Therefore, the purpose of this work is to assess the existing state of veterinary labs, clinics, and research institutes' biosafety and biosecurity protocols in the three regions under investigation (Cairo, Beni-Suef, and El-Fayoum). Determine the degree of biosafety knowledge and application among academics, researchers, veterinarians, and technicians in the different domains under investigation by creating a structured questionnaire to gather all the information related to the research points.

Material and Methods

Study location and period

A cross-sectional biosafety and biosecurity survey was conducted in three occupational categories (labs of universities (n=29), research institutes (n=7), and private veterinary clinics (n=48) during the period from February 2022 to June 2022. The target populations include academics, researchers, laboratory technicians, attendants, and veterinary clinicians working in veterinary research facilities across the three investigated zones (Cairo, Beni-Suef, and El-Fayoum).

Ethical statement

There are no experimental studies on either animals or human data in the manuscript. All methods used in this context were carried out in compliance with the rules and regulations that applied. All participants and the relevant administrative staff at each facility where the questionnaire was distributed gave their consent.

Study setting and design

This study was designed to determine the current level of biosafety and security protocols in veterinary labs, research institutes, and clinics in the three regions under investigation. Find out how much academics, researchers, veterinarians, and technicians know about and use biosafety in the various domains under investigation. For this study, as we had no prior data regarding the proportion of researchers in veterinary facilities having good laboratory knowledge and to increase precision, a structural questionnaire (n = 84) was administered to respondents throughout the study period. It was developed to obtain all data from respondents across targeted research labs belonging to universities, colleges, research institutes, and veterinary clinics. Information regarding the demographic characteristics of the three occupational categories under investigation and the classification of veterinary research laboratories and clinics based on the basic biosafety levels (BSL) was obtained. In addition, knowledge of laboratory biosafety measures, availability and proper use of personal protective equipment (PPE), attitude towards and use of standard laboratory practices, biosafety awareness, and biological waste management.

Questionnaire structure and application

The questionnaire was divided into four sections: demographic characteristics, biosafety levels, generally applicable biosafety and biosecurity issues, and waste management practices in veterinary research laboratories and clinics. The questionnaire's questions drew on worldwide laboratory biosafety guidelines [9]. In the current text, questions illuminating respondents' general precautionary biosafety measures, including issues such as

biosecurity measures, disinfection protocols, biosafety levels (BSL) and cabinets, availability of personal protective equipment (PPE), frequent training for researchers and attendants, biohazard collection, separation, storage, transport, and hygienic methods of disposal, were questioned of the respondents. Regarding PPE, the responders were asked to enumerate as many as five essential pieces of PPE (such as a face mask, hand gloves, hand wash, protective clothing, and disinfection before and after admittance) that they employ when working with pathogens. Ten veterinary laboratory researchers from four veterinary universities and research institute labs in the governorate of Beni-Suef, Egypt, participated in a pretest of the questionnaire. A deliberate sampling strategy was used to select contributing laboratories and respondents according to their accessibility and the existence of a veterinary research institution or laboratory. When it came to evaluating the current state of biosafety and biosecurity precaution measures at all three occupational facilities, staff awareness, waste management procedures, and biosafety levels, all provided information was kept confidential by the staff members who administered the questionnaire and tabulated the results. Additionally, all data was used to evaluate the facilities' strengths and weaknesses.

Data analysis

All data was assembled in a Microsoft Excel spreadsheet for statistical analysis using SPSS version 22.0 (the Statistical Package for the Social Sciences software). The obtained data from the structural questionnaire related to demographic characteristics, biosafety level, staff awareness, and waste management practices in veterinary research laboratories and clinics were analyzed by the chi-square test as a non-parametric test. The *P*-value of $\leq$ 0.05 was regarded as statistically significant.

Results

The obtained data from the structured questionnaire during the survey (Table 1) clarified that the veterinary laboratories are widely distributed in the investigated districts (Cairo and Beni-Suef) when compared to veterinary clinics. The number of veterinary laboratories examined in those districts didn't exceed 48, while there were 36 private veterinary clinics. Respondents' occupations include all three occupational categories (labs of universities, research institutes, and veterinary clinics) across the investigated areas, although academic researchers (labs of universities or colleges) composed the greatest proportion (29.9%), followed by veterinarians (26.2%). In addition, the lab design and availability of equipment were satisfactory in only ten laboratories (20.8%). Meanwhile, the majority of investigated veterinary clinics were located in Cairo district (58, 3%), and all of them were private clinics

(100%). As well, the design of clinics and availability of equipment were satisfactory in only seven veterinary clinics (19.4%).

The classification of veterinary research laboratories and clinics depended on the basic biosafety measures of each sector or level, as displayed in Table 2. The majority of respondents to university laboratories, research institute laboratories, and veterinary clinics reported that 3 out of 7 (42.8%) research institute labs used biosafety cabinets (as BSL 2) compared to veterinary clinics (5/36; 13.8%) and university labs (8/41; 19.5%). Oppositely, in the three occupational categories, 28 out of 41 labs of universities were uncategorized (28/41; 68.2%), besides research institute labs (4/7; 57.1%) and veterinary clinics (19/36; 52.7%) related to biosafety precautionary measures.

The current situation of biosafety and biosecurity measures in both veterinary laboratories and clinics is shown in Table 3. It has been found that the measures in both were applied in a satisfactory state (68.8% and 55.5%, respectively). As well, the availability and appropriate usage of personal protective equipment (PPE) were acceptable but did not exceed 58.3% in both research laboratories and veterinary clinics. The disinfection protocol was applied and exceeded 72.9% in both veterinary laboratories and clinics. On the other hand, wearing special clothes and gloves at work was better in research laboratories than in veterinary clinics (75% and 69.4%, respectively).

The waste management practices in veterinary research laboratories and clinics, as designated in Table 4, clarified that the majority of waste disposal types in veterinary laboratories were biological waste (26/48; 54.2%). On the other hand, pathological wastes represented the highest percentage of waste disposal types in veterinary clinics (21/36; 58.3%). The colored bags are used to dispose of waste in only 22.9% (11/48) of veterinary labs and sometimes in 56.3% (27/48) of investigated labs. On the contrary, 72.7% of veterinary clinics did not use colored bags for waste disposal. The most practical hygienic method of waste disposal in research labs was incineration (28/48; 58.3%), followed by using chemical disinfectants (17/48; 35.4%), while in veterinary clinics, 66.6% (24/36) used chemical disinfectants, followed by incineration (16.6%; 6/36). The majority of respondents were from veterinary laboratories and clinics (60.4% and 58.3%, respectively). As well, the percentage of attendee's workshops on waste management was very low in both veterinary laboratories and clinics, not exceeding 41.6%.

The general knowledge of staff members about biosafety measures and waste management in veterinary research laboratories and clinics is displayed in Table 5. In laboratories, most of the

respondents (30/48; 62.5%) had moderate knowledge about biosafety measures, and 4.2% (2/48) were not aware of biosafety measures. 31 out of 48 veterinary laboratory providers (64.6%) were not aware of the color-coding system, and only 35.4% were aware of medical waste management. In contrast, 50% (18/36) of the respondents had moderate knowledge of biosafety measures in veterinary clinics. Moreover, 80.5% (29/36) were not aware of the color-coding system, and only 33.3% (12/36) were aware of medical waste management.

Discussion

In light of the one health concept, training on biosafety and biosecurity should be expanded across disciplines working about veterinary and other health professions that may expose people to harmful pathogens [10]. Since every facility has different circumstances and limitations, achieving sustainable biosafety and biosecurity capabilities and applications of biosafety and biosecurity requires flexibility [11]. Understanding the concepts of decontamination, cleaning, sterilization, and disinfection is essential to the implementation of a laboratory biosafety and biosecurity program [12]. The geographic distribution of respondents was expected and is reflective of the distribution of researchers in the few available veterinary research facilities (laboratories and clinics) across the investigated areas in this study. Furthermore, the data supplied by the participants lacks confirmation, which could have an impact on our outcome variables and introduce bias. This risk was mitigated by asking certain questions in different ways to confirm earlier answers and eliminate inconsistencies. Respondents' occupations include all three occupational facilities (labs of universities, research institutes, and veterinary clinics) from different investigated zones.

In addition, the lab design and availability of equipment were satisfactory in only ten laboratories and seven veterinary clinics. The majority of respondents to university laboratories, research institute laboratories, and veterinary clinics reported that 3 out of 7 research institute labs used biosafety cabinets (as BSL 2). Oppositely, 28 out of 41 labs of universities were uncategorized (68.2%), besides research institute labs (57.1%) and veterinary clinics (52.7%) related to biosafety precautionary measures. According to [13], the majority of researchers lack access to BSL (1-4) in the facilities. Few report using biosafety measures and personal protective equipment (PPE) appropriately, and most have inadequate general understanding and proficiency in laboratory biosafety. Furthermore, 79.7% of respondents said they used personal protective equipment (PPE), yet many (63.5%) did not have access to any biosafety-level facilities; only 2.7% of respondents used BSL-3 facilities, compared to 13.5% who used BSL-1 and 20.3% who used BSL-2.

There was no response about the existence of a BSL-4 facility. Whereas about 40% of researchers are generally not very aware of the national and international regulations and organizations that deal with laboratory biosafety.

Bajjou et al. [14] revealed that the majority of laboratories do not employ sufficient biosafety procedures while containing BSL-2. Lack of instruction on biosafety concepts, containment structures and their goals leads to both a lack of understanding of these concepts and inadequate laboratory facilities. Preventing occupational infections requires the appropriate use of containment devices, biosafety level facilities, and personal protective equipment [15]. The availability and appropriate use of biosafety devices and PPE (such as a face mask, hand gloves, hand wash, protective clothing, and disinfection before and after admittance) are examples of biosafety preventive measures in veterinary laboratories and clinics. Moreover, the biosafety measures in both veterinary laboratories and clinics were applied in a satisfactory state in these study areas. As well, the availability and appropriate usage of PPE were acceptable in both research laboratories and veterinary clinics. According to [16], just 35.4% of respondents used the proper PPE. This figure is in contrast to the World Health Organizations recommended standard, which calls for the use of heavy-duty gloves, boots, and an apron. Heckert et al. [17] found that 69% of the participants had an intermediate level of knowledge regarding biosafety based on their accurate answers to the questions. This suggests that the definite level of understanding among all the laboratory employees who answered the questionnaire was fairly satisfactory. According to [13], 47.3% of the applicants had an acceptable degree of awareness regarding laboratory biosafety precautions. Al-Abhar et al. [18] found that 87% of participants knew the laboratory precaution measures at a high level. Thus, efforts must be made to raise one's level of knowledge to one that is more acceptable. According to a survey conducted in research facilities across the globe, the most commonly utilized biosafety measure is wearing PPE [19]. Additionally, [20] discovered that only 35.4% of people were utilizing the proper PPE, with 32.3% failing to comply and 32.3% not applying. Concerning the disinfection protocol in the investigated facilities, according to [13], it was made obvious that 16.2% of the research workers had records of their medical histories, and 44.6% had laboratory decontamination processes in place. Letho et al. [20] found that 90.0% believe that using bleaching for the disinfection of medical waste is necessary, and 72.9% are aware that a 0.5% bleaching solution is used for the disinfection of infectious medical waste. In underdeveloped countries, waste management poses a significant public health risk since, in contrast to industrialized

countries; infectious waste management has not gotten enough attention [21]. The majority of waste disposal types in veterinary laboratories were biological waste (Table 4). In addition, the period of waste storage was not exceeded by 24 hours in 68.8% of veterinary laboratories. The colored bags are used to dispose of waste in only 22.9% of veterinary labs and sometimes in 56.3% of investigated labs. The most practical hygienic method of waste disposal in research labs was incineration, followed by chemical disinfectants, while in veterinary clinics, 66.6% used chemical disinfectants, followed by incineration. Letho et al. [20] registered that just 48% of the waste produced is carried out in compliance with the guidelines, and the waste is not separated into general and infectious wastes (58.0%). The percentage of wastebaskets that were correctly available in the requisite color-coded bins was 83.85% on average, with the lowest percentage of waste bins being blue (45.2%). Of the waste containers, only 58.1% were covered, and 74.2% were operated by foot. In contrast, the separated trash is kept for a maximum of 24–48 hours during the summer and a maximum of 24–72 hours during the winter in specially designated storage areas within the units, wards, and departments. Every morning, the waste is gathered from each ward, unit, and department and delivered to the waste treatment facility. After being autoclaved, the infected material is disposed of with regular waste [20]. The study done in Nigeria found that 81.9% of respondents had a good understanding of the cooler-coding of trash, a critical criterion for appropriate waste segregation (80%) [16]. On the other hand, Odetokun et al. [13] clarified that 51.0% of respondents said they had burned biohazardous waste, while 31.1% said they had disposed of it in regular waste disposal. The staff member's awareness about biosafety measures and waste management in veterinary research laboratories and clinics in Table 5 clarified that in laboratories, most of the respondents (62.5%) had moderate knowledge about biosafety measures, and 4.2% were not aware of biosafety measures. The staff's awareness about medical waste management didn't exceed 35.4% in

veterinary laboratories and 33.3% in veterinary clinics in all occupational facilities. According to [22], retraining and ongoing education are essential for promoting behavioural modifications, increasing awareness, and creating a new standard for appropriate laboratory techniques. Additionally, Odetokun et al. [13] found that there is a poor level of biosafety awareness. 74.3% of the respondents reported having low awareness. The majority of respondents (71.6%) were not aware that Nigeria has national legislation governing biosafety and biosecurity. JDWNRH (Jigme Dorji Wangchuck National Referral Hospital) healthcare professionals are aware of biomedical waste management. Letho et al. [20] found that nearly all (98.5%) have heard of medical waste, and 69.7% are aware of medical waste management regulations.

Conclusions

The biosafety measures in both veterinary laboratories and clinics were applied in a satisfactory state but did not exceed 68.8%. The most practical hygienic method of waste disposal in research labs was incineration, while in veterinary clinics, 66.6% used chemical disinfectants. The staff's awareness of medical waste management didn't exceed 35.4% in veterinary laboratories and 33.3% in veterinary clinics in all occupational facilities.

Consent to Publish

All the authors have given their consent for publish this manuscript.

TABLE 1. Demographic characteristics of Veterinary research laboratories and clinics during the survey.

Items of characteristic	Veterinary Laboratories (*n* = 48)		Veterinary clinics (*n* = 36)		P value
	NO.	%	NO.	%	
Study region (Governorates)					
Cairo	20	41.6%	21	58.3%	
Beni-Suef	20	41.6%	9	25%	0.05
El-Fayoum	8	16.6%	6	16.6%	
Facility type					
Department Labs of University/College	29	60.4%	0	0%	
Animal Research Institute					0.001
Private vet. labs/clinics	7	14.5%	0	0%	
	12	25%	36	100%	
Occupation					
Academic staff	164	29.9%	0	0%	
Technician	48	8.7%	72	28.5%	
Researchers	96	17.5%	0	0%	0.02
Veterinarians	144	26.2%	108	42.8%	
Attendants	96	17.5%	72	28.5%	
Total	548	100%	252	100%	
Design and available equipment					
Low	6	12.5%	5	13.8%	
Moderate	32	66.6%	24	66.6%	0.07
High	10	20.8%	7	19.4%	

TABLE 2. Basic Biosafety levels of Veterinary research laboratories and clinics during the survey.

Biosafety level (BSL)	Labs of Universities/colleges (*n* = 41)	Labs of Animal Research Institutes (*n* = 7)	Veterinary clinics (*n* = 36)	P value
BSL 1 - Using hand wash - Wearing gloves - Wearing mask -Limited access - No eating and/or drinking	5 (12.1%)	0(0%)	12(33.3%)	0.05
BSL 2 - Using biosafety cabinet - Regular training of researchers and attendants -Regular vaccination of workers against LAIS	8 (19.5%)	3 (42.8%)	5 (13.8%)	0.03
BSL 3 - Periodical inspection of workers -Full body garment with respiratory restriction - Restricted access at all times	0.0 (0%)	0.0 (0%)	0.0 (0%)	
Un categorized	28 (68.2%)	4 (57.1%)	19 (52.7%)	0.05

TABLE 3. Current status of biosafety and biosecurity measures in Veterinary laboratories and clinics during the study period.

Items	Veterinary Laboratories (*n* = 48)		Veterinary clinics (*n* = 36)		P value
	NO.	%	NO.	%	
Biosafety precautionary measures					
Poor	6	12.5%	10	27.7%	0.03
Satisfactory	33	68.8%	20	55.5%	
Good	9	18.8%	6	16.6%	
Availability and proper use of biosafety devices and PPE					
Poor	6	12.5%	10	27.7%	

Items	Veterinary Laboratories (n = 48)		Veterinary clinics (n = 36)		P value
	NO.	%	NO.	%	
Fair	28	58.3%	16	44.4%	0.05
Good	14	29.1%	10	27.7%	
Workers wear special clothes and gloves at work					
Yes	21	43.8%	15	41.6%	0.07
Sometimes	25	52.1%	16	44.4%	
Rarely	2	4.2%	5	13.8%	
Labs disinfection protocol					
Yes	35	72.9%	23	63.8%	0.3
No	13	27.1%	13	36.1%	
Hands Washing and disinfection pre- & post admission					
Yes, always	36	75%	25	69.4%	
Sometimes	12	25%	11	30.5%	0.5
Rarely No	0	0%	0	0%	

TABLE 4. Waste management practices in Veterinary laboratories and clinics during study period:

Items	Veterinary Laboratories (n = 48)		Veterinary clinics (n = 36)		P value
	NO.	%	NO.	%	
Type of waste dispose					
Biological	26	54.2%	9	25%	0.01
Chemical	9	18.8%	0	0%	
Pathological	7	14.6%	21	58.3%	
Others	6	12.5%	6	16.6%	
Colored bags used to waste dispose					
Yes	11	22.9%	7	19.4%	
Sometimes	27	56.3%	3	8.3%	0.003
No	10	20.8%	26	72.7%	
Do you have bins for disposing off non-infectious waste?					
Yes	26	54.2%	18	50%	
No	22	45.8%	18	50%	
					0.6
Is there any mean for transferring medical waste?					
Yes	26	54.2%	9	25%	0.001
No	22	45.8%	27	75%	
Method of waste treatment					
Autoclaving	5	10.4%	6	16.6%	
Incineration	28	58.3%	6	16.6%	0.05
Burial	0	0%	0	0%	
Others(chemicals)	17	35.4%	24	66.6%	
Is there a secured waste storage area on site?					
Yes	10	20,8%	12	33.3%	0.04
Sometimes	9	18.8%	3	8.3%	
No	29	60.4%	21	58.3%	
How long, the waste be storage?					
12 h	33	68.8%	24	66.6%	
24 h	2	4.2%	0	0%	
48h	5	10.4%	6	16.6%	0.7
72 h	0	0%	0	0%	
More	6	12.5%	6	16.6%	
Not stored	2	4.2%	0	0%	
attending workshops on waste management					
Yes	20	41.6%	6	16.6%	0.003
No	28	58.3%	30	83.3%	

TABLE 5. Staff awareness associated with biosafety measures, waste separation, and disposal in Veterinary laboratories and clinics:

Items	Veterinary laboratories (*n* = 48)		Veterinary clinics (*n* = 36)		*P value*
	NO.	%	NO.	%	
General knowledge of laboratory biosafety					
High	16	33.3%	10	27.7%	
Moderate	30	62.5%	18	50%	0.05
Low	2	4.2%	8	22.2%	
Waste separation and color-coding system					
Yes	17	35.4%	7	19.4%	0.03
No	31	64.6%	29	80.5%	
Waste storage and collection scheme					
Yes	23	47.9%	9	25%	0.01
No	25	52.1%	27	75%	
Waste disposal management					
Yes	34	70.8%	20	55.5%	0.01
No	14	29.2%	16	44.4%	
Awareness about medical waste management					
Aware	17	35.4%	12	33.3%	0.7
Not aware	31	64.6%	24	66.6%	

References

1. Coelho, A.C. and García Díez, J. Biological risks and laboratory-acquired infections: a reality that cannot be ignored in health biotechnology. *Front. Bioeng. Biotechnol.*, **3**,1-10 (2015).

2. Alam, M.S., Abdalla, S.B. and Jabeen, F. Assessment of Biosafety Practices in Clinical Laboratories in Khartoum State, Sudan. *JBM.*, **10**, 93-103 (2022). https://doi.org/10.4236/jbm.2022.1011008

3. Brass, V. H., Astuto-Gribble,l. and Finley, M .Biosafety and biosecurity in veterinary laboratories. *Rev. Sci. Tech.*, **36**(2), 701-709 (2017). doi: 10.20506/rst.36.2.2687

4. Rakhman, A.J. and Nasri, S.M. Biosafety Level Di Laboratorium Mikrobiologi Pt Sci. *PREPOTIF: Jurnal Kesehatan Masyarakat*, **5**, 522-535(2021).

5. Trapotsis, A. Biosafety Levels 1, 2, 3 & 4: What's the Difference? (2022). Available at: https://consteril.com/biosafety-levels-difference/

6. Murugesan, V. Modern Waste Management Techniques - A Critical Review. *IOC.*, 64-72 (2020). IOC-2020 Innovation and sustainability through E-STEM - 14th & 15th October, 2020.

7. Sharma, S. K. and Gupta, S. Healthcare waste management scenario: A case of Himachal Pradesh (India). *Clin. Epidemiol. Glob. Health*, **5**(4), 169-172 (2017). https://doi.org/10.1016/j. cegh.2017.07.002

8. Cavallini, S., Cerutti, F., Costanzo, P., Fotia, G., Gismondo, M. R., Mastroianni, M., Mugavero, R., Sabato, V.,Vitale, R. and Vitali, L. Handbook on chemical and biological waste management. *UNICRI.*,(2014).https://www.researchgate.net/publication/281106561

9. CDC (Centers for Disease Control and Prevention) Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th ed, CDC Laboratory Portal CDC, (2020)

10. Emery, R.J., Rios, J. and Patlovich, S.J. Thinking outside the box: biosafety's role in protecting non-laboratory workers from exposure to infectious disease. *Appl. Biosaf.*, **20**(3), 128-129 (2015). doi: 10.1177/153567601502000301

11. Fair, J.M. Biological engagement programs: reducing threats and strengthening global health security through scientific collaboration. *Front Public Health*, **5**,148 (2017). https://doi.org/10.3389/fpubh.2017.00148

12. Gaudioso, J., Rivera, S.B., Caskey, S. and Salerno, R.M. Laboratory biosecurity: a survey of the U.S. bioscience community. *Appl. Biosaf.,* **11**,138-43 (2006). doi:10.1177/153567600601100305

13. Odetokun, I.A., Jagun-Jubril, A.T., Onoja, B.A., Wungak, Y.S., Ibrahim Adisa Raufu,I.A. and Chen,J.C. Status of Laboratory Biosafety and Biosecurity in Veterinary Research Facilities in Nigeria. *Saf. Health Work*, **8**, 49-58 (2017). doi: 10.1016/j.shaw.2016.08.002

14. Bajjou, T., Sekhsokh ,Y., Amine, I. L. and Gentry-Weeks, C. Knowledge of Biosafety Among Workers in

Private and Public Clinical and Research Laboratories in Morocco. *J. ABSA Int*, **24**(1) 46-54 (2019). https://doi.org/10.1177/1535676018797140

15. Adogu, P.O.U., Ubajaka, C. F. and Nebuwa, j.E. Knowledge and practice of medical waste management among health workers in a Nigerian general hospital. *AJST.*, **5**(12), 833–838 (2014).

16. Windfeld, E. S. and Brooks, M. S.-L. Medical waste management–A review. *J. Environ. Manage*, **163**, 98-108(2015). https://doi.org/10.1016/j.jenvman.2015.08.013   PMID: 26301686

17. Heckert, R.A., Reed, J.C. and Gmuender, F.K. International biosafety and biosecurity challenges: suggestions for developing sustainable capacity in low-resource countries. *Appl Biosaf.*, **4**, 223-240 (2011). http://dx.doi.org/10.1177/153567601101600404

18. Al-Abhar, N., Al-Gunaid, E. and Moghram, G. Knowledge and practice of biosafety among laboratory staff working in clinical laboratories in Yemen. *Appl Biosaf.*, **22**,168-171 (2017). doi: 10.1177/1535676017733451

19. Althaus, C.L., Low, N., Musa, E.O., Shuaib, F. and Gsteiger, S. Ebola virus disease outbreak in Nigeria: transmission dynamics and rapid control. *Epidemics,* **11**, 80-4 (2015). doi: 10.1016/j.epidem.2015.03.001

20. Letho, Z., Yangdon, T., Lhamo, C., Limbu, C.B., Yoezer, S., Jamtsho,T., Chhetri,P. and Tshering,D. Awareness and practice of medical waste management among healthcare providers in National Referral Hospital. *PLoS ONE.*, **16**(1), (2021). doi: 10.1371/journal.pone. 0243817

21. Moazzam, A. and Chushi, K. Status and challenges of hospital solid waste management: case studies from Thailand, Pakistan, and Mongolia. *J. Mater. Cycles Waste Manag.,* **11** (3), 251-7 (2009). http://dx.doi.org/10.1007/s10163-009-0238-4

22. Delany, J.R., Pentella, M.A. and Rodriguez, J.A. CDC and the Association of Public Health Laboratories guidelines for biosafety laboratory competency. *Morb. Moral Wkly Rep.*, **60**, 1-6 (2011).

تقييم تدابير السلامة الحيوية الإحترازية وتطبيقاتها في المختبرات البحثية والعيادات البيطرية في ثلاث محافظات مصرية

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الملخص

تُعد تدابير السلامة الحيوية الإحترازية وتطبيقها في المختبرات والعيادات البيطرية أمراً بالغ الأهمية من أجل حماية الباحثين والأطباء البيطريين والفنيين من العدوى المكتسبة في المختبرات. خُصص هذا العمل لتقييم الوضع الحالي لبروتوكولات السلامة البيولوجية والأمن في المختبرات والعيادات البيطرية والمعاهد البحثية ومستوى الوعي بممارسات السلامة الحيوية واستخدامها بين الباحثين والأطباء البيطريين والفنيين في المناطق الثلاث قيد الدراسة. بالإضافة إلى ذلك، يجب أن يكون العاملون على دراية بممارسات إدارة المخلفات. لذا تم إجراء استبيان هيكلي (العدد = 84) على المستجيبين للحصول على جميع البيانات من المستجيبين في مختبرات البحوث المستهدفة التابعة للجامعات والكليات ومعاهد البحوث والعيادات البيطرية حول العمل والممارسات الروتينية في المختبرات مثل جمع العينات ومعالجتها، والمعرفة بالسلامة البيولوجية في المختبرات، وتوافر معدات الحماية الشخصية واستخدامها بشكل صحيح، والموقف من الممارسات المختبرية القياسية واستخدامها، وكذلك التخلص من النفايات البيولوجية. أوضحت نتائج تقييم التدابير الاحترازية للسلامة البيولوجية في الفئات المهنية الثلاث أن 28 مختبراً من أصل 41 مختبراً في الجامعات لم يتم تصنيفها (68.2%)، إلى جانب مختبرات معاهد البحوث (57.1%) والعيادات البيطرية (52.7%). كانت غالبية أنواع المخلفات التي تم التخلص منها في المختبرات البيطرية هي المخلفات البيولوجية (54.2%). وفي الوقت نفسه، كانت أعلى نسبة من أنواع التخلص من المخلفات في العيادات البيطرية هي المخلفات الباثولوجية (المرضية) (58.3%). أما في المختبرات، كان لدى 62.5% من المستجيبين معرفة متوسطة بتدابير السلامة البيولوجية، و50.0% في المختبرات البيطرية. في الختام، هناك حاجة إلى تحسين بروتوكولات السلامة البيولوجية والأمن الحيوي لضمان صحة وسلامة الباحثين والأطباء البيطريين والعاملين والبيئة المحيطة بهم، والاستجابات الفعالة للإدارة السليمة للمخلفات الخطرة.

الكلمات الدالة: المختبرات البيطرية، مستويات السلامة الحيوية، تدابير الأمن الحيوي، العيادات البيطرية، المخلفات البيولوجية الخطرة.