Review

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Posted Date: 22 April 2024

doi: 10.20944/preprints202404.1414.v1

Keywords: Veterinarian; Biocontainment research animal facility; Epicentre; Pathogens; Contamination

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Review

The Veterinarian's Role in Biocontainment Research Animal Facilities and Prevention of Spread Of Pathogens in Africa

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Abstract: COVID-19, caused by SARS-CoV-2, was first identified in China in 2019. The exact origin of the disease remains uncertain, with theories suggesting it may have emerged from animals or accidentally leaked from a research laboratory. If the hypothesis that COVID-19 originated from a research laboratory is accurate, it is crucial to investigate potential pathways for pathogens to escape from biocontainment research animal facilities (BRAFs). We examine key biosafety issues associated with BRAFs, including inadequate decontamination procedures for water and experimental samples, handling high biosafety level pathogens in lower level laboratories, risks of animal bites and sharps injuries, contamination of bedding and enrichment materials, and improper management and transportation of biohazard samples. Additionally, we discuss the role of veterinarians in African research animal facilities and the challenges they encounter in maintaining biocontainment standards. We emphasise the importance of routine monitoring of effluent water to detect possible disease outbreaks. We recommend a thorough investigation of the COVID-19 pandemic to identify potential sources of pathogen release from BRAFs, which could serve as hotspots for future disease outbreaks. Findings from such investigations will inform the development of policies aimed at safeguarding human populations from future pandemics and preventing BRAFs from becoming sources of infectious disease outbreaks.

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Introduction

Since the beginning of the 21st century, there has been a rise in new risks in the form of disease outbreaks, including SARS, Ebola, AIDS, and most recently, COVID-19. COVID-19, caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), is a respiratory illness that was first identified in Wuhan, Hubei province, China in 2019. The exact origin and source of the COVID-19 disease remain uncertain, leading to various theories. Some suggest that the disease may have originated from animals, while others propose the possibility of it being engineered in experimental laboratories[6,13]. When considering the suggestion put forth by Law and Segreto et al., it is important to thoroughly investigate the COVID-19 pandemic to explore potential sources of pathogen escape from biocontainment research animal facilities (BRAFs). These facilities could serve as epicentres for future disease outbreaks if pathogens were to escape. Therefore, it is crucial to gather data from such events to inform the development of policies and guidelines for the operation of BRAFs. This will

 doi:10.20944/preprints202404.1414.v1

help safeguard human populations from the devastating consequences of pathogen escape from these facilities.

BRAF facilities house animals of various species utilised in biomedical research to explore solutions for preventing, diagnosing, and treating diseases that impact the health of both humans and animals [1]. Despite being equipped with specific engineering controls to contain experimental pathogens and infected animals [1], these facilities pose a significant risk to the environment in the event of pathogen release or escape of infected animals. Therefore, there is an urgent need to enhance preparedness to ensure resilience and reliability in biocontainment research animal facilities. However, existing disaster risk management strategies primarily target families and households, with limited focus on organisations such as laboratories, particularly BRAF [16].

Nevertheless, these establishments, regardless of their size, are increasingly susceptible to potential disruptions caused by various events such as earthquakes, fires, floods, human error, infrastructure failure or deliberate release of animals, which could result in the release of pathogens and infected animals into the surrounding environment. Several instances of such occurrences have been documented. For example, in 2007, an outbreak of foot-and-mouth disease in the United Kingdom was traced back to a private research laboratory that handled live virus samples for vaccine development [14]. Similarly, in 2003, Taiwan faced a SARS outbreak that originated from a research facility at the National Taiwan University, where the virus was accidentally released, leading to infections and deaths in the community [9]. Furthermore, in 2015, a number of rhesus macaques escaped from the Tulane National Primate Research Centre in Louisiana, raising concerns about public safety due to the potential transmission of diseases by the monkeys [15].

This article delves into the topic of preparedness in BRAFs and the measures that should be implemented to prevent these facilities from becoming epicentres of infectious disease outbreaks, similar to the COVID-19 pandemic. It emphasizes the importance of utilising a risk assessment and management framework to identify and evaluate potential hazards and risks within these facilities. By doing so, recommendations can be made for risk management strategies, including prevention, mitigation, preparedness, response, and recovery measures, in order to minimise the impact of disasters and enhance facility safety. One of the key factors contributing to the high risk of pathogen transmission and infection in BRAFs is the close proximity of animals used in experiments and personnel. Therefore, it is crucial to address this issue and implement appropriate measures to ensure the safety of both humans and animals within these facilities. Furthermore, we highlight the significant role of veterinarians in BRAFs in Africa. These professionals play a vital role in maintaining biocontainment within the facilities. However, they face various challenges in fulfilling this responsibility effectively.

In light of the COVID-19 pandemic, it is essential for the BRAF community to view this crisis as a valuable learning experience. By closely analysing the pandemic from all angles, including identifying potential sources of pathogens responsible for disease outbreaks, policies can be formulated to protect humans, animals, and the environment from future catastrophic pandemics. It is imperative for BRAFs to prioritize preparedness and implement effective measures to prevent infectious disease outbreaks. By utilising risk assessment and management frameworks, addressing the challenges faced by veterinarians, and learning from the COVID-19 pandemic, these facilities can enhance their safety protocols and minimize the risk of future outbreaks.

The COVID-19 pandemic has highlighted the importance of integrating disaster management into the strategy for managing BRAFs, as emergency preparedness can help mitigate the impact of disasters and ensure business continuity. Historically, research animal professionals have not given sufficient attention to disaster preparedness and the potential effects of natural and manmade disasters on BRAFs. While the South African Disaster Management Act No. 57 of 2002 defines disaster management as focusing on planning, risk reduction, disaster preparedness, recovery, and business continuity, this aspect is not adequately addressed in the undergraduate veterinary curriculum to equip veterinarians for decision-making in disaster situations. By developing disaster management plans in advance, BRAFs can better respond to emergencies such as floods, which may lead to the collapse of facilities and the release of pathogens and infected animals into the environment. This

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proactive approach can help minimise risks to personnel and the environment, as well as ensure the continuity of operations.

Although this article does not present ground-breaking findings, we believe it can be valuable to colleagues in the research animal and disaster management fields, highlighting the importance of robust disaster planning in BRAFs and in veterinary education.

The Veterinarian in the Care and Use Of Animals for Scientific Purposes in Africa

In Europe and other countries in the global north, a laboratory animal veterinarian (LAV) specialising in laboratory animal science (LAS) or laboratory animal medicine (LAM) is tasked with providing veterinary services to animals utilized for scientific purposes [11]. The field of LAS/LAM is a specialized area of veterinary science that emphasizes the ethical care and appropriate utilization of animals for scientific research and educational purposes [11]. The LAV's responsibilities commence early in the research process, during the stage of study design and protocol development, where they offer guidance on suitable veterinary procedures (e.g., surgery), methods for compound/drug administration, sample collection, housing conditions, and enrichment for animals involved in experiments. Involving the LAV in the study design phase is essential to ensure that the appropriate animals are selected for studies and that refined, less invasive procedures are employed, leading to favourable research outcomes. Apart from providing veterinary services and aiding researchers in study design, the LAV is actively engaged in training researchers and other technical personnel in the proper care and management of animals. The LAV educates researchers on veterinary procedures such as humane euthanasia methods, surgery, restraint, injection techniques, and the correct use of anaesthetic and analgesic drugs. Additionally, they instruct on the diverse housing requirements and physiological needs of various animal species used for scientific purposes, enabling researchers to minimize deviations from the animals' typical experiences under normal circumstances.

The LAV plays a crucial role in breeding facilities, overseeing health monitoring and identifying factors that may impact colony productivity, such as nutritional requirements, environmental needs, and disease risks. Additionally, the LAV is responsible for managing and designing animal research facilities. Some LAV professionals also engage in independent research, focusing on medical procedures, drug therapies, surgical techniques, or nutrition. Furthermore, they provide guidance to other researchers on the most suitable animal models and bio-methodology for their studies.

Several articles have been published on the various responsibilities of the LAV in different contexts, as evidenced by the works of Brian et al., (2004), and Poirier et al. (2015). However, there is a lack of published literature on the specific roles and challenges faced by veterinarians working in breeding and research animal facilities (BRAFs) in Africa. This manuscript aims to address this gap by describing the roles of the LAV in Africa, with examples from South Africa and Nigeria, and highlighting the major challenges encountered by veterinarians who have chosen this career pathway.

The earliest documented use of animals for scientific purposes can be traced back to Aristotle's description of animal dissections in the fourth century BC. It was in the period of 150-200 AD that Galen established the significance of animal experimentation as a means to acquire scientific knowledge [4]. In Europe, the utilization of animals for scientific purposes was not widespread until the 1500s, when Andreas Vesalius conducted dissections on dogs, pigs, and humans4. Although these early animal experiments lacked refinement and biocontainment measures, they laid the foundation for our current understanding of anatomy and physiology. Notably, in 1628, William Harvey became the first scientist to describe the circulatory system of a dog, and in 1740, Stephen Hales successfully measured blood pressure in a horse [4].

Becoming a Laboratory Animal Veterinarian in Africa

In the majority of African countries, individuals aspiring to work as a LAV should be registered with the veterinary regulatory council of that country to practice as a veterinarian. To the best of our knowledge, there is no country in Africa requiring that an individual attain a post graduate qualification in LAS/LAM before employment as LAV. The LAV trained on the job is a general practitioner that has developed interest in laboratory animal medicine by regularly attending to caseloads from animal facilities in academic and research institutions.

In most countries, it takes between five and six years to complete a Bachelor of Veterinary Science degree. Subjects studied in the veterinary science undergraduate degree include anatomy, physiology, biochemistry, nutrition, animal husbandry, ethology, microbiology pathology, toxicology, pharmacology, jurisprudence, and clinical skills (surgery and medicine) and to our knowledge, no veterinary faculty currently teaches disaster management modules at undergraduate level. During the final years of study, students do clinical rotations where they gain clinical experience for treating different animal species.

In South Africa veterinarians who wish to formally specialize in laboratory animal medicine complete a three to four-year experiential training residency program offered by the University of Pretoria. Currently this residency program is not being offered by any other veterinary faculty in Africa. The program covers laboratory animal husbandry, biocontainment, bioexclusion, medicine and surgery, research guidelines, animal models, formulating health monitoring programs and animal welfare assessments.

In Nigeria, there are eleven first degree awarding veterinary schools and none of these currently offer postgraduate training in LAS/LAM. Therefore, obtaining an academic postgraduate qualification in LAS/LAM is not a possible route to becoming a LAV except if the degree is obtained outside the country. This implies that one is left with either of two options, which is to train/learn on the job or get admitted into the fellowship programme of the College of Veterinary Surgeons of Nigeria (CVSN). Laboratory animal medicine is listed in the CVSN brochure as part of the complex nomenclature designated as "wildlife, aquatic and laboratory animal medicine".

The South African route to become a specialist LAV is similar to the European and American system where one must undergo a formal training after graduating with the bachelor's degree to become a specialist veterinarian for a particular field. Since there is no formal training in other African countries, the only available route to become a LAV is to self-train on the job. The challenge with self-training is that the training is not structured and only demand based.

Biocontainment Research Animal Facility Risk

This section provides an overview of the various types of infectious material hazards that can potentially lead to human and environmental contamination in biocontainment research animal facilities. These hazards can manifest in the form of any material that is suspected to be contaminated with pathogens, including bacteria, viruses, parasites, or fungi, in concentrations or quantities sufficient to cause disease in susceptible individuals. The potential sources of infectious materials encompass laboratory waste that is contaminated with blood or other bodily fluids, as well as cultures and stocks of infectious agents. Additionally, pathological waste derived from experimental animals, such as tissues, organs, and body parts, can also serve as a source of infectious materials.

While personnel and researchers working with infected experimental animals face the highest risk within these facilities, it is important to recognize that improper disposal of waste can also pose a risk to the general public. It is crucial to approach infectious waste with the assumption that it may contain a range of pathogenic microorganisms, as the presence or absence of pathogens cannot be determined at the time of waste collection. Pathogens present in infectious waste can potentially infect individuals through various routes, including puncture or cut wounds on the skin, mucous membranes, inhalation, or ingestion. For disease transmission to occur, several factors must align, including the presence of pathogens with sufficient virulence and dose, a mode of transmission (such as spills or container breakage leading to skin contact or airborne transmission), a portal of entry

 doi:10.20944/preprints202404.1414.v1

(such as an open wound, inhalation, or exposure through mucous membranes), and a susceptible host (such as a cleaner, waste worker, or scavenger at an open dump site).

Possible Sources of Risk

Accidental Release

BRAF facilities are specifically designed to handle infectious pathogens and should have strict protocols in place to prevent the release of these pathogens into the environment, although such protocols are not consistently available in most African facilities. However, despite these measures being available in some facilities, there is still a concern regarding the risk of accidental release, which can have devastating consequences. Accidental releases can occur due to equipment failure, human error, or inadequate decontamination of equipment and water used for cleaning the laboratory.

One of the main causes of accidental release is the failure of laboratory equipment such as biosafety cabinets, laminar flow systems, and HVAC systems. For example, a leak in a biological safety cabinet can result in the release of pathogens into the laboratory environment, posing a risk to both laboratory personnel and the surrounding community. Similarly, if the HVAC system fails to maintain the required pressure differentials, pathogens can be released into the surrounding air. To minimize the risk of accidental releases, it is crucial to regularly service and monitor laboratory equipment to ensure optimal functionality. Any suspicion of equipment malfunction should be immediately reported to the facility management and maintenance officer. Additionally, proper decontamination of laboratory equipment is essential when moving equipment between rooms or facilities. Furthermore, it is important to decontaminate the water used for cleaning BRAF before it is flushed into the sewer system. If the water is not adequately decontaminated, experimental pathogens can find their way into the environment. Inadequate decontamination can occur due to failure to observe the recommended contact time for the disinfectant or the use of diluted disinfectants. It is worth noting that inadequate decontamination can also contribute to pathogen resistance and mutation. Research has shown that plasmids from laboratory strains, present in health-care waste, can be transferred to indigenous bacteria through the waste disposal system [3]. This highlights the importance of proper decontamination practices to prevent the spread of pathogens. Antibiotic-resistant Escherichia coli has been found to persist in an activated sludge plant, despite the absence of significant transfer of this organism under typical conditions of wastewater disposal and treatment [5]. Pathogen resistance and mutations may also arise from experimental animals that have been infected with pathogens and treated with suboptimal doses of experimental drugs. When inadequately disinfected water (from facilities holding animals infected with pathogens) is discharged into the sewer system, wild animals and birds scavenging for food and water in the sewage can transport the pathogen from the sewage system to the environment and other animals. These birds or animals that have acquired the pathogen may be preyed upon by other animals, facilitating further transmission of the pathogen. As the pathogen is passed from one animal to another, there is a potential for the pathogen to evolve into a more virulent strain. Humans can become infected through contact with or consumption of the infected animal.

At present, there is a lack of evidence regarding the transmission of pathogens like the COVID-19 virus through sewer systems, with or without wastewater treatment, underscoring the importance of routine monitoring of effluent water to detect potential disease outbreaks. This is especially critical for regions with limited resources, where adherence to waste treatment protocols may be compromised due to financial constraints.

Natural Disasters

Natural calamities like floods, fires, and earthquakes can result in significant damage to BRAF, leading to the potential escape of pathogens into the environment. Floods, for instance, can harm building structures, creating openings through which pathogens can spread and contaminate the surrounding areas. Moreover, floodwaters have the ability to transport pathogens to various locations such as wastewater treatment plants, rivers, and dams, thereby heightening the risk of

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contamination. The heat from fire has the capacity to harm buildings, electrical systems, and equipment essential for containing pathogens. Similarly, ground movements caused by earthquakes can result in damage to buildings and equipment, ultimately causing the release of pathogens into the environment, thereby posing a severe health hazard to individuals and animals in the vicinity.

In order to mitigate the risk of pathogen release during a natural disaster, it is imperative for BRAF to have emergency response strategies in place to effectively and promptly address such situations. Additionally, facilities should implement contingency measures to reduce the likelihood of pathogen escape during disasters, such as utilizing backup power systems and installing automatic shut-off valves for water and other critical services.

Security Breaches

Most BRAFs are equipped with various layers of access control, yet they are still susceptible to security breaches that could lead to the release of harmful pathogens into the surroundings. Unauthorized individuals gaining entry to the laboratory with the intent of stealing pathogens or damaging the laboratory's infrastructure can cause security breaches. For instance, the theft of a virus or bacterial culture for personal gain or to harm a specific population could result in widespread illness and fatalities. Moreover, power outages that are becoming common in most African countries could compromise the laboratory's access control system, allowing unauthorized individuals to enter. Intentional release of animals is also a possibility, such as in facilities situated in universities during student demonstrations and strikes, or by antivivisection activists advocating against animal experimentation. To mitigate the risks associated with security breaches, laboratory administrators must adhere to stringent safety protocols, regularly assess their emergency contingency plans, and remain vigilant against potential threats like theft and sabotage.

Conducting Experiments with Higher Biosafety Level Pathogens in Lower Biosafety Level Laboratories

Experiments involving a higher biosafety level pathogen being conducted in a lower biosafety level laboratory, such as a BSL3 pathogen in a BSL1 setting, pose a significant risk due to inadequate biocontainment measures in the lower level facility. The classification of pathogens into different biosafety levels may not be sufficient, as it is now understood that all pathogens should be handled at the highest biosafety level possible. This is because pathogens have the ability to mutate into more virulent and easily transmissible forms. For instance, the coronavirus, initially considered to have low transmissibility, has shown the potential to mutate and change its mode of transmission, such as transitioning from oral to airborne transmission.

Human Error

An additional hazard linked to BRAF involves the susceptibility to human error. Even with thorough training and safety measures in place, individuals working in laboratories are prone to errors due to their human nature. Mishandling of pathogens, inadequate training of personnel, and failure to comply with biosafety protocols may lead to the accidental release of pathogens into the surroundings.

Animal Bites

Personnel involved in handling infected animals may encounter situations where they get bitten or scratched by animals but fail to report the incident to the occupational health and safety officer. There are several reasons why they choose not to report or act upon such incidents. One of the main reasons is lack of knowledge about the project they are working on and the specific pathogen they are dealing with. This lack of understanding may lead to a sense of uncertainty and hesitation in reporting the incident. Additionally, some staff members may avoid completing the necessary occupational health and safety documents due to the perception that the process is time-consuming and tedious. This reluctance to engage in the documentation process further contributes to the

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underreporting of animal bite incidents. Another significant reason for not reporting or acting upon animal bites is the fear of appearing incompetent to line managers and the potential risk of losing employment. Personnel may worry that reporting such incidents could reflect negatively on their abilities and job performance. However, the failure to report animal bite cases can have serious implications. Without proper reporting, prophylactic treatment may not be administered in a timely manner. This delay in treatment can allow the pathogen, which may be present in the animal's bite, to multiply within the individual who has been bitten. Consequently, the individual bitten or scratched by an animal becomes a potential source of pathogen transmission to the surrounding environment and poses a risk of infecting other individuals.

The lack of adequate training in Africa [7], maybe the reason why personnel may choose not to report or take action after being bitten by infected animals. However, if such training is provided, it is crucial to emphasize the importance of reporting such incidents to ensure timely treatment and prevent the spread of pathogens to both the environment and other individuals.

Sharps

Sharps pose a dual threat of physical harm and infection when contaminated with pathogens. According to Prüss-Ustun et al., injuries caused by sharps have resulted in infections among healthcare workers, including hepatitis B (66,000 workers), hepatitis C (16,000 workers), and HIV (200-5,000 workers). It is estimated that over two million healthcare workers are exposed to percutaneous injuries from contaminated sharps annually[12]. Proper disposal of all sharps is crucial, requiring them to be placed in a designated sharps bin, sealed when full, autoclaved outside the laboratory, and then incinerated.

Contaminated Animal Bedding and Enrichment Devices

The bedding and enrichment items have the potential to come into contact with animal waste, urine, fur, and sweat. These bodily fluids can harbour pathogens that may have been expelled by infected laboratory animals. Improper disinfection of the bedding and enrichment items could lead to the transmission of infections to unsuspecting individuals who come into contact with them.

Transportation of Biohazard Samples

During experimental termination, samples such as blood or organs are collected for further processing at analytical laboratories. These particular samples are known as biohazard samples because they originate from infected animals. It is crucial to transport these samples from the research animal facility in a manner that prevents any environmental contamination or the transmission of experimental pathogens to individuals. The handling and transportation of biohazard samples are subject to specific laws and regulations. If these samples are mistakenly delivered to an incorrect address and subsequently opened and handled by uninformed individuals, it can pose a significant risk. Furthermore, if sample containers are improperly labelled or inadequately marked, there is a possibility that individuals may handle the samples without appropriate protective clothing, potentially leading to spread of infection. Depending on the nature and method of pathogen transmission, uninformed individuals can become infected through inhalation or direct contact with the samples. In situations where an uninformed individual mistakenly opens a sample but then realizes the error, and proceeds to reseal the package and send it to the correct address without implementing necessary preventive measures, they unintentionally contribute to environmental contamination and the potential transmission of pathogens.

The Role of Veterinarians in Biocontainment Facilities

The LAV provides a service in academia (private and state universities), biotechnology/pharmaceutical companies, government/military agencies, and commercial vendors, e.g., purpose-bred animals, laboratory animal product suppliers [2]. The OIE recognises the role of LAV in biomedical research and that LAV have unique skills, that make them important members

 doi:10.20944/preprints202404.1414.v1

for research teams that includes scientists and animal care staff [10]. Being team members to this scientific community, LAV should ensure that animal use leads to high quality scientific outcomes with adequate welfare for the animals as well as ensure that measures are put in place to prevent the escape of pathogens and animals into the environment.

Performing Veterinary Clinical Procedures

Veterinary clinical procedures and responsibilities are conducted in compliance with necessary professional standards and national regulations. The OIE emphasizes that proper veterinary care should encompass the duty to safeguard the health and well-being of research animals prior to, during, and after research procedures; as well as offering advice and guidance to researchers based on veterinary best practices. Veterinary care involves monitoring the physical and behavioural condition of the animal, with the veterinarian having the authority and obligation to make decisions regarding the overall welfare of the animal. The OIE further suggests that veterinary care should always be accessible. In South Africa, individuals performing veterinary procedures are governed by the Veterinary and Para-veterinary Professions Act No. 19 of 1982 and are required to be registered with the SAVC. Veterinary clinical procedures refer to those actions carried out on animals for the purpose of diagnosis, treatment (including prescribing and administering scheduled drugs), or prevention of any pathological conditions in animals, as well as any surgical operations. Professional standards and national regulations assign all veterinary clinical procedures responsibilities to the LAV. The LAV is tasked with ensuring the continuous health of research animals by diagnosing illnesses, prescribing medications, and administering treatments. Additionally, the LAV must oversee surgical procedures to ensure they are completed successfully with minimal complications. It is the responsibility of the LAV to prioritize the welfare of the animals undergoing procedures, rather than solely focusing on the procedures themselves. The LAV is also accountable for fostering a culture of care and respect for animal life within the facility where they work, by raising awareness that procedures on animals require skill and training.

Researchers should be encouraged to seek veterinary assistance for animal procedures they are not competent or comfortable to perform. The LAV is responsible for disease surveillance and health monitoring programs within the facility. Disease surveillance should involve routine monitoring of colony animals for parasitic, bacterial, and viral agents that may cause clinical or subclinical diseases. The LAV should have the authority to implement appropriate treatment or control measures, including euthanasia if necessary, and access to necessary resources following the diagnosis of an animal disease or injury [10].

Oversight of Animal Health and Welfare

In organizations that are well-funded, the LAV collaborates closely with the Animal Welfare Manager. However, in most institutions, the LAV also assumes the role of the Animal Welfare Manager. The primary responsibility of the LAV is to promote a comprehensive understanding of animal care, health, and welfare among both veterinary and non-veterinary staff. This includes a particular focus on minimizing animal suffering and distress. Additionally, the LAV is tasked with ensuring that the health and welfare of animals involved in research adhere to national and international standards of excellence.

To achieve this, the LAV, in consultation with the researcher, must establish humane endpoints before the commencement of any study. Humane endpoints serve as predetermined criteria to terminate a study if it is likely to cause pain and/or distress to the animals involved. Throughout the course of the study, the LAV is responsible for ensuring that these approved humane endpoints are followed. Furthermore, the LAV possesses the authority to euthanize animals in order to alleviate pain and distress, unless the project proposal explicitly prohibits such intervention based on scientific justifications and ethical evaluations.

Management of Research Facilities and Leadership

The LAV plays a vital role in facility management, as the decisions made regarding the facility directly impact animal welfare. According to the authors, a poorly managed facility often results in inadequate housing for research animals, which ultimately affects the quality of scientific research. Inadequate housing facilities fail to provide the necessary environmental enrichment for animals to engage in species-specific behaviours. This lack of enrichment can lead to stress and the development of stereotypic behaviours such as circling. Facility management encompasses various aspects, including staff management, occupational health and safety, quality assurance, staff recruitment, and procurement of equipment, books, instruments, and consumables. Quality assurance within the LAV may involve the development of clinical standard operating procedures, information and procedure documents, as well as their regular review. Additionally, the LAV may need to charge researchers for the services provided, including procedures performed and training. Effective communication and active participation in meetings, such as those related to planning, management, operations, and budgeting, are also essential for the LAV.

Training of Personnel

The OIE emphasizes the importance of ensuring that personnel involved in animal care and use programs are adequately trained and competent to work with the species used, as well as familiar with the procedures to be carried out, including ethical considerations. It is recommended by the OIE that a system for ensuring competency, whether institutional, regional, or national, should be established, with supervision provided during the training period until competence is demonstrated. The LAV plays a crucial role in training staff, researchers, and Animal Ethics Committee (AEC) members. For instance, in South Africa, individuals who are not registered with the South African Veterinary Council (SAVC) as veterinary or para-veterinary professionals must undergo training and prove their competence before being authorized by the SAVC to perform specific procedures (e.g. oral gavage, intraperitoneal injections) on laboratory animals [8]. In these situations, a veterinarian must provide training and verify the competence of these individuals, who are then required to work under the direct or indirect supervision of a veterinarian. The allowance for non-veterinary professionals to conduct veterinary procedures is primarily due to the current shortage of veterinarians in Africa. In addition to procedural training, the LAV also provides training on best housing practices, welfare monitoring, the use of animals in research, and the principles of the 3Rs to personnel, animal caretakers, researchers, and AEC members. This training aims to instil a culture of care and foster an understanding of the intrinsic value of animal life.

Service on Animal Ethics and Biosafety Committees

The OIE mandates the establishment of a comprehensive animal use oversight system that encompasses both ethical review of animal use and considerations related to animal care and welfare. The oversight body bears the responsibility of evaluating the acceptability of animal research protocols through a risk-based assessment approach, weighing the potential harms to the animals against the benefits of the study outcomes. These benefits include the implications for animal welfare, the advancement of knowledge and scientific merit, as well as the societal advantages. According to the OIE, an institution may utilise a local committee, such as an Animal Care and Use Committee, Animal Ethics Committee, Animal Welfare Body, or Animal Care Committee, to administer some or all aspects of animal use oversight. It is crucial for the institutional oversight committee to report to senior management to ensure that it possesses the necessary authority, resources, and support.

The OIE specifies that the oversight committee must consist of at least one scientist, one veterinarian, and one public member. This veterinarian must possess the requisite expertise to work with research animals and provide guidance on the care, use, and welfare of animals involved in biomedical research. Although recommendations suggest having a veterinarian as a member of the AEC, in Africa, there is lack of training for veterinarians that become members of AEC. This poses a challenge for them in decision making, as this aspect is not typically covered in the veterinary undergraduate curriculum.

Oversight of Legal and Regulatory Compliance

The LAV has the duty of guaranteeing compliance with national laws and regulations pertaining to the utilization of animals in research at the facility where they are employed. In South Africa, the LAV assumes responsibility for all scheduled medications, and it is their obligation to ensure strict adherence to legislative requirements concerning the procurement, storage, utilization, and documentation of scheduled substances. Additionally, the LAV is tasked with ensuring that the facility adheres to established standards and facilitates external inspections and audits.

Challenges Faced by Veterinarians in Preventing and Managing Outbreaks

Like any profession, the LAV has difficulties and challenges they face when they do their job. One of the major challenges of being a LAV is that the society does not really understand how the field works. In most of the time, they think LAV are only there to facilitate unnecessary use of animals in research that does not benefit both animals or humans and that they do not respect animals as most animals used in research end up being killed. In some cases, the staff does not understand why animals used in experiments should be euthanised and incinerated as they perceive this as a waste of food (meat) that they could take to their family for a meal. When a LAV makes recommendations on procedures or housing of animals, some researchers misconstrue this to mean that the veterinarian is trying to stop them from doing an experiment. The other dilemma is that academic institutions are measured on research output and this conflict with decision making in terms of animals used for research. For example, the LAV might end up being compromised because they may be forced to accept substandard conditions succumbing to pressure from researchers wanting to fulfil their research output expectations. The other challenge in Africa is that most facilities housing laboratory animals are very old buildings that have been converted into animal houses. The problem with such old buildings is that they cannot support the HVAC requirements for the modern animal facilities. Governments and academic institutions do not have enough funding for building new infrastructure. There is also not enough funding for buying modern laboratory equipment.

Although international organisations like the OIE and the International Council for Laboratory Animal Science provide advice to African member countries on how to formulate systems of oversight for the use of animals in research [10], the system of oversight remains variable from one country to another due to varying cultural, economic, religious, and social factors. In Africa there is no country with legislation that governs the use of animals in research and LAV are only guided by laws and regulations that govern the veterinary profession. The lack of a specific legislation makes it difficult for the LAV to fully execute their mandate of actively taking part in decision making involved with animal research. Since most decisions being made relate to the use of animals in research, senior researchers and academic professors end up overshadowing the LAV in decision making. In countries that actively regulate the use of animals for scientific purposes, the LAVs do so by amalgamating various laws to guide them. South Africa and Nigeria are some of the countries with a well-regulated system and we have used them as examples, although most African countries use a similar approach.

Strategies for enhancing the Involvement of Veterinarians in BRAFs in Africa

Over the years, the African continent has grappled with significant shortages of veterinarians, primarily due to the economic constraints faced by most African countries. This has led governments to prioritize certain areas of the veterinary profession, such as food production veterinarians, over others like companion animal veterinarians. Consequently, there is a notable skills gap within the veterinary domain, making it challenging to address all tasks effectively. One specific area that is particularly struggling is laboratory animal science, which often lacks adequate funding and support. The main issue faced by laboratory animal science in Africa is the insufficient funding for training programs and the lack of mutual recognition of qualifications among member countries. Additionally, the varying requirements for veterinary curriculum and registration by professional bodies pose another obstacle. To overcome these challenges, it is crucial to establish mutual recognition and harmonization of training programs across African countries, allowing for automatic registration of laboratory animal science professionals in different regions. Countries with well-established training programs can serve as models for others to follow. While long-term solutions involve government funding for training programs, interim measures can include sending aspiring laboratory animal science professionals to study in countries with established programs. For instance, South Africa offers a specialized master's degree in laboratory animal science at the University of Pretoria. Furthermore, we recommend incorporating disaster management modules into the veterinary curriculum to ensure that veterinarians are equipped to handle emergency situations effectively.

Conclusions

In Africa, the absence of specific laws regulating the practice of research animal veterinarian poses challenges for them to effectively engage in decision-making processes related to animal research in order to prevent the release of pathogens and research animals into the environment. Despite the type of risk involved, facility veterinarians are accountable for preventing the escape of pathogens and animals from laboratories. Equipping veterinarians with disaster management training is crucial to empower BRAF in establishing comprehensive disaster management procedures to avert research animal facilities from becoming sources of potential pandemics. We recommend further research on disaster management for BRAFs to provide evidence supporting the need for emergency preparedness in these facilities, which could influence policy decisions related to disaster management and disease prevention. In the meantime, we hope that our manuscript will encourage research animal facility managers and policymakers to review and enhance their disaster management protocols.

Funding: The authors did not receive any funding for writing this manuscript.

Conflicts of Interest: The authors declare no potential conflict of interest associated with this work.

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