

Actions of military veterinarians from other nations in Chemical, Biological, Radiological and Nuclear Defense: a subsidy to modernize the Brazilian Army doctrine

La actuación del médico veterinario militar de otras naciones en la Defensa Química, Biológica, Radiológica y Nuclear: subsidio para modernizar la doctrina del Ejército Brasileño

Abstract: The involvement of military veterinary in responding to bioterrorism is anchored in Chemical, Biological, Radiological and Nuclear Defense (CBRN Defense). This study aimed to analyze the actions of military veterinarians from other nations in CBRN Defense, identifying technical and laboratory skills for these specialists, proposing trainings and courses in Friendly Nations and new doctrinal manuals in this field. This is a bibliographical review, in which manuals of Armed Forces from other countries like United States and Portugal were consulted. Thus the main CBRN attributions developed by veterinarians from Brazilian Army and from other countries were identified. This review concluded that a deeper knowledge in other countries doctrinal, combined with the development of international cooperation activities, would enhance the contribution of military veterinarians in defense against CBRN agents.

Keywords: Military veterinary medicine. CBRN Defense. Biological defense. Doctrine. Brazilian Army.

Resumen: La participación de la veterinaria militar en la respuesta al bioterrorismo está anclada en las competencias de la medicina veterinaria frente a la Defensa Química, Biológica, Radiológica y Nuclear (DQBRN). Así, el presente trabajo tuvo como objetivo estudiar la actuación del veterinario militar de otras naciones en DQBRN, identificando capacidades técnicas, competencias de laboratorio necesarias para este especialista, proponiendo entrenamientos, cursos en Naciones Amigas y nuevos manuales doctrinales en ese campo. Se trata de una revisión bibliográfica, a través del cual se consultó a los manuales de las fuerzas armadas de otros países como los Estados Unidos y Portugal. Así, se identificaron las principales atribuciones en DQBRN desarrolladas por el médico veterinario militar en el Ejército Brasileño y en otros países. Se concluyó que la profundización en el conocimiento doctrinal de otros países, sumado al desarrollo de actividades de cooperación internacional, potenciaría la contribución de la actividad médica veterinaria militar en la defensa contra los agentes QBRN.

Palabras clave: Medicina militar veterinaria. DQBRN. Defensa biológica. Doctrina. Ejército brasileño.

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1 Introduction

In view of the frequent cases of terrorism reported in the international media in recent years and the current globalization, worldwide defense measures have been increasingly important to protect animals and humans against agents that can be used as biological weapons and cause major damage to a country's economy (CARDOSO; CARDOSO, 2011).

Chemical, Biological, Radiological and Nuclear Defense (CBRN Defense) refers to the group of actions for the protection against chemical, biological, radiological and nuclear agents that produce harmful effects on health and material integrity (BRASIL, 2016a). In the context of the Military Doctrine, biological defense, a component of CBRN Defense, handles structured measures to be implemented by the Armed Forces to prevent and respond to attacks caused by biological or toxin agents (BRASIL, 2013a). In the broader context of society protection, biological defense is part of the multisectoral field of health security and CBRN emergency response (BRASIL, 2014b).

The health support from CBRN Defense aims to preserve human life and animal health, assuming a multiprofessional character, as it involves different health actors, such as physicians, nurses, veterinarians, nursing technicians and pharmacists, among others. Planning this support considers the characteristics and effects of chemical, biological, radiological and nuclear (CBRN) hazards. Health support actions are focused on preventive medicine, health surveillance and health programs (BRASIL, 2016a).

According to the doctrine in the Manual of Land Military Logistics Services, veterinary support is among the tasks covered by the Health Logistics Role, including veterinary support to animal health, troop health protection with health security actions (BRASIL, 2018). This activity assumes special importance when there is evidence of biological agents in the area of responsibility of the Operational Force in question.

Learning about and managing the human-animal-environment triad under the Unified Health System is the responsibility of veterinarians, critical for the prevention and control of the main emerging and reemerging infectious diseases involved in the military theater of operations.

In addition to biological defense, veterinarians are qualified to perform several other duties, such as water and food protection, bioprotection and public health, animal health, environmental management, research and innovation, among others. All these activities are somehow related to biological defense and should be included in doctrinal manuals (SOARES, 2014).

Brazil has increasingly participated in the United Nations (UN) Peacekeeping Missions, which draw special attention to the zoonoses that may affect the military in the work sites. Therefore, this subject must be the theme of debates and studies among military veterinarians, focusing on the search for doctrines of countries with advanced activities in this field.

The last manuals of the Brazilian military veterinary services were published in the 1970s. For this reason, the doctrinal procedures to guide veterinarians should be updated

and standardized, taking as reference the vast normative literature of veterinary services of other nations with experience in biological defense (MARQUES; DE ANDRADE LIMA, 2016). The Armed Forces of countries such as Portugal and the United States have been regularly used in NATO and other operations, especially in Asia and Africa. As a result, these nations have advanced doctrine in the field of troop bioprotection and can act as a reference for the development and reformulation of the Brazilian Army manuals, offering more employment opportunities for military veterinarians in Brazil (STEELE; ALVEZ; CHAPMAN, 2007; PENHA-GONÇALVES et al., 2016).

Then this study aimed to analyze the performance of military veterinarians from other nations in CBRN Defense, identifying technical and laboratory skills for this specialist and proposing training and courses in Friendly Nations and updated doctrinal manuals in this field.

This study is a descriptive literature review of applied nature. It used exploratory and selective reading of the research material and an integrative review.

A theoretical review on this subject was conducted using the following keywords: military veterinary, CBRN Defense, biological defense, employment, doctrine, and the corresponding terms in Portuguese (*veterinária militar, DQBRN, defesa biológica, emprego, doutrina*), through a bibliographic search in scientific articles from the databases of Google Scholar, PubMed, LILACS, SCIELO, and ISI, as well as books, academic papers, end-of-course assignments, legislation and doctrinal manuals of the Brazilian Army available at the EBConhecer portal repository, and documents and other national and international scientific studies.

The selection of research sources was based on publications by important authors in the academic environment of articles published in journals indexed by the Coordination for the Improvement of Higher Education Personnel (CAPES – *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*), as well as doctrinal manuals of the Armed Forces from different countries.

The study design comprised the stages of bibliographic survey and selection, data collection, data analysis, analytical reading and file of sources, argumentation and, finally, discussion of results.

Study limitations include the difficult access to manuals of the Armed Forces from other countries and scarce information about the actions of military veterinarians from other countries in CBRN Defense.

2 Literature review

Worldwide armed conflicts that occurred in the 20th century were marked by decisive use of weapons of mass destruction, such as nuclear weapons. The accelerated evolution of science and technology in the last decades and increase in terrorism have enhanced the possibilities and the probability of using biological agents in future conflicts. Also, frequent threats from pandemics and epidemics devastated large continental regions in the early years of the 21st century. These public health emergencies, in many cases,

showed the magnitude of their negative impact on the economy and their ability to induce fear among populations, and above all, they showed important weaknesses in the existing response systems.

In this context, humanity has been affected by a growing wave of outbreaks caused by new and old pathogens, with 65% of all 215 most relevant emerging human infectious diseases corresponding to zoonoses. Examples of these biological threats are Ebola, avian influenza virus (H5N1) and anthrax (DE ANDRADE LIMA, 2016).

Using the military veterinary service in response to biological threats is anchored in the competences of veterinary medicine in the areas of epidemiology, infectious and parasitic diseases, and in the fact that biological agents can be used in bioterrorism through infectious agents that cause zoonoses and diseases in animals (POPPE, 2013).

United Nations Peacekeeping Missions may have different theaters of operations significantly impacted by various health problems, affecting military officers and the local population. Multiple challenges are found in these scenarios, which are difficult to resolve due to aggravating factors, such as poor conditions of food supply chains and local health and sanitation systems. A critical point is the fact that the health service teams are not familiar with the health problems found in foreign countries where the troops are distributed, increasing the risk, for example, of importing pathogens and late diagnoses of tropical diseases (SMITH, 2007).

De Andrade Lima (2016), based on the participation of Brazilian veterinary officers in Haiti, reported in his studies the main biological risks related to the environment in peacekeeping missions and presented the doctrinal basis of actions of these veterinarians, describing their main roles in the protection of troop operations, especially in food security, environmental management, and zoonosis and vector control.

Then in terms of food security, food can be contaminated by the use of CBRN weapons or by a terrorist contamination of food supply facilities and food supplies. CBRN agents can be inserted in ingredients before they reach the production facilities, during production, in the storage area of the supply facility, while the product is in transit, in the military storage facility, or when installing the unit ranch. Regardless of where the agent is used, the effect is the same, that is, one can get sick or die after consuming the contaminated food. To ensure food protection, veterinarians must inspect and monitor foods, from their acquisition to consumption. In the whole area of a military operation, the personnel involved in the service and logistics must take precautions to protect subsistence food against contamination through actions called food defense (BONI; CALVET; BORNERT, 2016).

A CBRN incident is also considered a significant and realistic threat against military working dogs (MWD), also called war dogs, and against government-owned animals (GOA), such as horses. Both chemical warfare agents (CWA), which can be dispersed by aerosol, steam or liquid, and through ammunition or other methods, and toxic industrial materials (TIM) pose a threat to these animals, because these agents can be

used offensively, or be accidentally released or be part of an accidental disaster. In addition, MWDs tend to be contaminated with CWAs and TIMs because they work close to the ground and do not always wear paw protectors or proper protective clothing, and can lick their own hair or paws, or drink water or eat contaminated food. Diseases caused by an offensive use of biological warfare agents (BWA) are lethal or disabling. These agents can infect the animal population in a certain contaminated area; and diseases caused by biological weapons in humans can lead to less severe clinical signs in working dogs, mainly due to the variation in susceptibility between species of most BWAs. MWDs and GOAs can be a source of zoonotic infection and be fomites or vehicles of arthropod vectors (UNITED STATES, 2016).

As several transmissible biological agents can be used in bioterrorism, adopting containment and decontamination measures and individual and collective protective equipment is extremely important to prevent contamination and infection of the professionals involved in this type of situation, which would increase the number of victims (CARDOSO; CARDOSO, 2011).

A veterinary response to CWAs and TIMs will depend on the agent, dispersion method, route of exposure, clinical signs and duration of contact between MWDs/GOAs and the agent. In general, these animals show similar clinical signs to humans for most CWAs. Respiratory absorption may occur after dispersion of agents in aerosol, vapor or liquid forms, and it represents a major concern due to the speed of absorption and toxicity. Agent absorption through the mouth can occur simultaneously with respiratory exposure. However, oral and gastrointestinal absorption is also a major concern when an animal ingests contaminated food or water or licks its own contaminated skin. Absorption through the paws is the biggest concern, since paw pads have sweat glands and no hair, promoting an effective absorption of agents. And due to a combination of hair coverage and a lack of sweat glands, these animals present a lower risk of chemical absorption through the skin than people; however, risks are still significant and surface decontamination procedures must be performed (UNITED STATES, 2019).

2.1 Veterinarians in cbrn defense in the brazilian army

The field of biological defense is among the various areas of action of military veterinarians. The importance of veterinarians in this field goes back to late 19th century and early 20th century, when the health situation of the Brazilian herd did not have quality standards that would allow the agricultural activity to meet the needs of society and the Army. In addition, the high incidence of diseases such as foot-and-mouth disease, malaria and the spread of glanders revealed vulnerabilities in the health control system, which implied serious economic limitations (PIMENTEL, 1942).

In those days, the Brazilian government sought foreign help and sources that would allow the country to adapt technologically to the challenges and inaugurated in 1896 the Laboratory of Clinical Microscopy and Bacteriology of the Army, currently the

Institute of Army Biology (IBEx – *Instituto de Biologia do Exército*), which led to the creation of the Veterinary School of the Brazilian Army (GERMINIANI, 1998).

The Technical Manual T 42-260, Veterinary – Veterinary Hygiene, of 1967, mentions soil and water hygiene, addressing water supply, collection, distribution, potability criteria, wastewater destination, control of pests and vectors, pathogenic microorganisms, and even prevention of snakebites. It indirectly mentions, in general terms, that the factors favoring the disease process in animals are shared by humans, attributing to veterinarians the role of co-participation in the promotion of human health. It is the first Veterinary Service Manual that clearly addresses the integration of animal health and human health aspects, and environmental aspects (BRASIL, 1967).

The most recent land military doctrine recognizes the veterinarian involvement in health promotion. According to the 2018 Military Land Logistics Manual, which provides operating doctrine, veterinary medicine is identified as a strategic field in the health area. This manual mentions health intelligence, zoonosis control, water and food quality management, biological defense and environmental management as areas of veterinary practice (BRASIL, 2018).

In the Brazilian Army doctrine, more detailed information about military veterinarians in a CBRN environment is provided in Chapter IX of the Army CBRN Defense Service Manual, updated in 2016. It shows that veterinarians are trained to work with multifunctional health groups in the areas of health intelligence, health estimates, health surveillance, laboratory analysis, sample collection, screening and decontamination, health treatment, evacuation and support in mortuary issues (BRASIL, 2016a).

Their joint actions in health, which are in expansion in the Brazilian Armed Forces, are addressed in the recent Manual of Health Support in Joint Operations, issued in 2017 by the Ministry of Defense, which describes the actions of veterinarians as critical for support and treatment of animal health, pest control, assessment of threats related to endemic zoonotic diseases, food security, and guarantee of health and quality of foods for consumption that otherwise could be used in bioterrorism, and sanitation of the various operational units implemented on site. The manual considers the presence of veterinarians as soon as possible in the area of operation and planning joint operations (BRASIL, 2017).

In general, veterinarian training comprises fields in common with similar to CBRN Defense. In the undergraduate course, students learn about biochemistry, biophysics, microbiology, infectious diseases, parasitology, food inspection, among other disciplines, favoring their growing participation in this area, both in the Army and civilian environments, especially in situations of health crisis and natural disasters.

A 2014, the first CBRN Defense training for Health Officers (BRASIL, 2013a) was provided at the School of Specialized Instruction (*EsIE – Escola de Instrução Especializada*) to train different health specialists, including veterinarians, to work in that area at the World Cup held in the same year, in the city of Rio de Janeiro.

In the following year, the contribution of veterinary to this field of knowledge consolidated with the creation of the first Specialization Course in CBRN Defense for Health Officers (BRASIL, 2014a), also at EsIE, through which military veterinarians became specialists in this field, acquiring knowledge and practice in health support in a CBRN environment. This course involved the work of a multidisciplinary health team that included physicians, dentists, pharmacists, nurses, and military veterinarians.

Since 2015, one military veterinarian joined the research team of the Institute of Chemical, Biological, Radiological and Nuclear Defense (IDQBRN – *Instituto de Defesa Química, Biológica, Radiológica e Nuclear*) of the Army Technology Center (CTEx – *Centro de Tecnologia do Exército*), developing new knowledge in the field of biological defense.

In 2016, during the Olympic Games in the city of Rio de Janeiro, three veterinarians specialized in CBRN Defense worked in this major event, as the CBRN Defense health team leader and CBRN Defense Health Officer (PEREIRA, 2017).

In 2017, one of the veterinarians trained in the first class of CBRN Defense specialists, was a biological defense instructor in the CBRN Defense Division of EsIE, also participating in other activities and the basic and advanced courses in “Assistance and Protection Against Chemical Weapons” organized by the Organization for the Prohibition of Chemical Weapons and held in Serbia and Pakistan, respectively.

2.2 Veterinarians in cbrn defense in armed forces from other countries

For many decades, veterinarians of the Armed Forces from other nations have participated in military peacekeeping or war operations; for instance, the Armed Forces with significant combat experience, such as the United States Army (USA), have operated in theaters of operations where illnesses, especially tropical ones, have caused more deaths of the military than the combat itself. It is not different in peacekeeping missions. For example, in one of the first Brazilian experiences in UN missions in the 20th century, three soldiers died of malaria in Angola due to several failures in vector control and prevention of this endemic disease (SANCHEZ et al., 2000).

The subsections below will address CBRN Defense activities developed by the Armed Forces from different countries, with an emphasis on biological defense.

2.2.1 *The United States*

The United States Armed Forces developed a joint manual for the Army, Navy, Air Force, and Marine Corps FM 4-02.7 / MCRP 4-11.1F / NTTP 4-02.7 / AFTTP 3-42.3 (UNITED STATES, 2016), updated in 2016, which addresses tactics, techniques, and procedures for supporting health services in a CBRN environment.

According to this manual, after receiving a CBRN warning, veterinary leaders implement contingency plans and guide the veterinary personnel to assume the appropriate

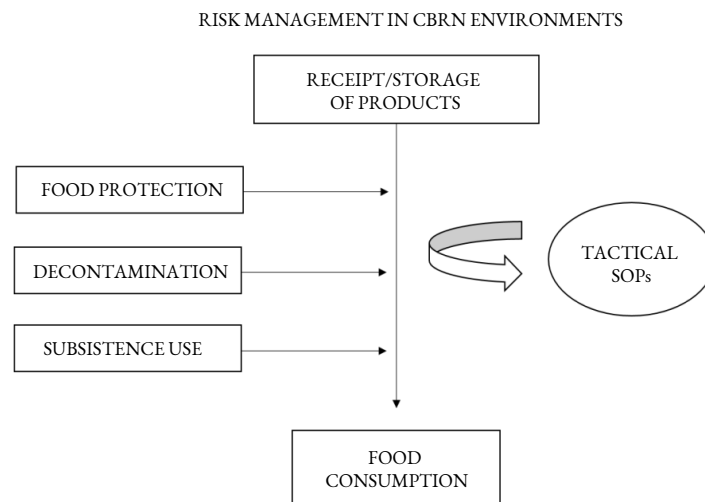
level of Operating Preventive Protection Measures (MOPP – *Medidas Operacionais de Proteção Preventiva*). The definition of MOPP levels, which range from 0 to 4 according to the increase in the level of protection, considers the probability of occurrence of attacks and the types of CBRN hazards. After defining the required level of MOPP, the veterinary personnel, within the limits imposed by the tactical situation, ensures that actions are taken to protect subsistence items, war dogs and other GOAs.

In some cases, the U.S. Army Veterinary Service provides support to partner agencies such as the Departments of State, Agriculture, Commerce, Transport, Security and Justice (Drug Enforcement Administration); the Federal Bureau of Investigation; the Central Intelligence Agency; and Human and Health Services, such as the Food and Drug Administration and the Center for Disease Control and Prevention (CDC).

2.2.1.1 Food defense

The responsibility for the physical structure of food storage, from the place of origin to consumption by the United States Forces, must be assigned through tactical Standard Operating Procedures (SOPs). Veterinary personnel assist commanders in the development of preparedness plans and tactical SOPs for protection, decontamination and use of subsistence items in the CBRN environment. To mitigate the risk of foodborne illnesses, all units must implement the basic risk management principles (Figure 1).

Figure 1 – Flowchart representing the risk management system adopted by the U.S. Armed Forces to ensure food security in a CBRN environment



Source: Developed by the authors (2019).

The availability of uncontaminated Class I subsistence items in the area of operations depends on the amount of planning taken to protect subsistence. Proper defensive behaviors for attacks by chemical agents (CA) will also protect food against contamination by biological agents (BA) and radioactive precipitation.

All planners must incorporate food and water risk management into the planning, preparation and execution of all operations. Medical planners must identify all food protection issues as they develop health attachments to operating orders. The veterinary team officer provides information about all food defense issues to the medical planner for inclusion of these attachments in the Health Service Support Planb.

After receiving the water and food risk assessment with recommendations of risk mitigation, operational commanders are responsible for health risk decisions to allow the purchase of food and water from sources without prior approval.

After a CBRN attack, all subsistence within the boundaries of the affected area is considered contaminated and treated accordingly, until a test determines which foods are safe for consumption. Veterinarians scan subsistence tanks contaminated with CBRN agents to assess the situation and obtain data, using available CBRN detection equipment. The scan is conducted, if possible, in conjunction with CBRN detection teams.

Packaged foods are tested for the presence of CBRN agents. The presence of unusual liquids or stains is usually observed. The degree of biological contamination can only be determined by laboratory analysis. Symptoms and contaminated animals are recorded, and macroscopic pathology tests are performed. This information, combined with histopathology and other laboratory tests, helps identify the nature, level and type of CBRN agent.

In most cases, subsistence decontamination does not start until the surrounding area and the storage facility are decontaminated. The decontamination process can significantly reduce the subsistence storage period, thus requiring a fast action of the supply system.

Decontamination should be performed just enough to support operations, and not to try to control or create a contamination-free environment. Decontamination efforts are usually limited to the scope and nature of packaging. In addition, food decontamination, if necessary, only occurs in critical situations where other food supply options are not available.

Laboratory analysis in veterinary units is focused on confirming the presence of biological agents, particularly foodborne pathogens and some chemical contaminants. In case of a positive result in the initial screening, samples can be sent for further testing to the Area Medical Laboratory in Aberdeen Proving Ground (APG), Edgewood, Maryland; the Department of Defense's Food Analysis and Diagnostic Laboratory (in Fort Sam Houston, San Antonio, Texas); or the European laboratories of the U.S. Army Public Health Center, in Landstuhl, Germany, through the Department of Microbiology Molecular and Biology, and the Division of Veterinary Pathology of Science Laboratories. Food samples suspected of containing BA or CA are transported by a specialized CBRN Defense team.

In the United States, the main foodborne pathogenic bacteria can be identified by many state-owned diagnostic laboratories and the CDC. A chain of custody

documented in a form must be provided with all food or water samples suspected of being intentionally contaminated or containing endemic pathogens of food or water origin. These samples will not be separated before arriving at the first receptor laboratory to prevent accidental sample contamination and ensure valid samples reach the destination laboratory.

2.2.1.2 Medical-veterinary assistance

Animals should be protected from CBRN contamination, when feasible. In addition, if possible, they should be placed into compartments to avoid contamination. Protective equipment is not available for MWDs; however, protection of the animal's paws and body must be considered. When MWDs need to cross a contaminated area, paw protection can be improvised, for instance using rubber items, and dogs can be transferred to vehicles to avoid contamination.

As collective protection systems are not part of the veterinary units, veterinary assistance facilities for animals must be created in areas free from contamination. The veterinary care team must remain at MOPP Level 4 when treating victims of animals contaminated by CBRN agents, until they are decontaminated. Veterinarians must be practical when considering requests for evacuation and handling contaminated animals; the main focus is the safety of the unit and support staff.

Decontamination of MWDs and GOAs and GOA equipment must be performed as soon as possible to avoid or reduce any additional absorption of CWAs or TIMs and prevent cross contamination. During decontamination, special attention should be dedicated to the face, ears, eyes, nostrils, abdomen, tail, paws and the region between the legs.

Veterinary responses to threats or use of biological weapons may vary, depending on whether veterinary measures are employed before or after exposure, and whether symptoms are present. If provided prior to exposure, active immunization or antibiotic prophylaxis can prevent disease in exposed MWDs.

Active immunization can be effective against several potential agents in humans, but there is no canine immunization approved for probable BWAs. The best future protection for MWDs against a wide variety of biological threats is the implementation of vector control measures and proper decontamination procedures; however, these animals are often less susceptible than humans to most BWAs.

If a MWD is contaminated by a biological agent, decontamination must end with soap and water, as previously described. The equipment of these animals must be decontaminated with 5% chlorine solution.

In the case of attacks with nuclear weapons or exposure to radiation from nuclear or radiological accidents, MWDs will present the same types of medical problems observed in humans. These medical problems will include explosion injuries, thermal and radiation injuries, and radiation sicknesses, depending on the amount of radiation received. Veterinary care will be based on the dog's clinical condition and its prognosis for recovery.

2.2.1.3 Veterinary public health

Veterinary public health identifies and controls zoonoses and foodborne and waterborne diseases.

Animals can act as sentinels (markers) for contamination or CBRN exposure. Attention should be paid to reports of unexpected death or disease in wild or indigenous animals, especially if the onset is sudden and affects a large number of animals in a short period. This is especially important for BWAs, as many of them cause similar clinical signs in animals and people.

2.2.2 Portugal

After the terrorist events that occurred in 2001, the threat of bioterrorism and agroterrorism became a priority of studies and investments aiming to build surveillance and prompt response capabilities. Following the new strategic concepts of the North Atlantic Treaty Organization (NATO), the Portuguese Army took the initiative to establish a Biosafety Level-3 (BSL-3) laboratory). The Portuguese Army's Biological Defense Laboratory (LDBE – *Laboratório de Defesa Biológica do Exército*) was inaugurated in 2006, providing the Land Force with additional operational capacity in the area of biological defense, reinforcing the triad of recognizing, identifying and decontaminating. Since then, the LDBE has been part of an international consortium for CBRN Defense research with Germany, Italy, Poland and other countries, with a focus on the design and implementation of projects for the development of new technologies and systems to detect biological agents, and new recognition techniques and development of decontamination methodologies (FREITAS, 2012).

These projects included SNIFFER (2013-2016), which aimed to develop a system or platform for the integration of CBRN agent detection and identification equipment that could be arranged at several more sensitive or vulnerable points in food production or distribution chains. This system provides countermeasures to mitigate a possible incident with CBRN agents in the food production and marketing chains. Another important project for the biological defense area was RACED (2015-2018), which assessed the risk of exposure to persistent biological and chemical agents on surfaces after application of the decontamination procedures defined by the Armed Forces of European member states of NATO. In this consortium, the LDBE sought to optimize procedures for the collection of biological agent samples from the surfaces of different natures and quantify the residual contamination of biological nature that may persist after decontamination of these surfaces, allowing a subsequent exposure assessment (PENHA-GONÇALVES et al., 2016).

2.2.3 Argentina

The Argentine Veterinary Service supports the Argentine Army, and its main responsibility is to maintain the health of animals and their good conditions for

service, food inspection, prevention of zoonoses, and environmental preservation. The *Diretoria Departamental de Veterinária* (Veterinary Department Administration) is the agency that plans the administration and supply of war animals to the country, according to its operational needs. Its main activities include conservation and recovery of physical conditions of animals, prevention of zoonoses, inspection of food products consumed by the troops, coordination of intelligence work about the enemy's veterinary material, collaboration with the troops for the development of passive defense measures against CBRN action, and provision of instructions to service personnel (DÍA..., 2012).

In events with more victims than expected, the affected animals from the combat zone are gathered in veterinary facilities, located along the axes of their units. The veterinary service must coordinate veterinary public health measures with the civil affairs units to reduce health hazards affecting the troops. The only body in Argentina that can provide support to CBRN Defense is a division of the Argentine Army created in 1998 for this purpose *Companhia de Engenheiros QBN e de Apoio à Emergência 601* (DÍA..., 2012).

2.2.4 Finland

The Finnish Armed Forces have a mobile diagnostic CBRN field laboratory approved in 2013 according to NATO standards. Besides CBRN detection units, this laboratory, which has one veterinarian in its staff, has a specific segment of field hygiene that can conduct quality control of food and environmental samples (KINNUNEN et al., 2012).

This field laboratory, designed to meet BSL-3 requirements, has modern and compact functionality and is ready to be used for a variety of defense purposes, including international crisis management. The laboratory has four separate modules, that is, laboratories that analyze chemical (C), biological (B), radiological/nuclear (R/N) samples, as well as hygiene (H) from food and environmental samples. A semi-trailer provides the necessary infrastructure, with C and B laboratories – R/N and H laboratories are located in two tents with air conditioning, adjacent to the semi-trailer. This mobile diagnostic CBRN field laboratory and its highly trained personnel can be transported by land, sea or air, and it is fully operational for 72 hours without external support (KINNUNEN et al., 2012).

2.2.5 Russia

Russia has a huge system of research and production of biological weapons organized by the Ministry of Defense and a civil organization called *Biopreparat*, which has a large number of units spread across the country. Due to a constant concern about agents of medical and medical-veterinary importance, such as the Ebola virus and bacterial toxins, the Ministry of Rural Economy has designated one of the units to support the

Veterinary Service, whose responsibility is to maintain a secret inventory of biological products (MOODIE, 2001).

2.2.6 Spain

Spanish military veterinarians perform their activities in biological defense and other interprofessional fields, such as chemical, nuclear and radiological defense. These specialists perform field work, conduct studies and manage high-tech laboratories. This way, they ensure protection to troops in domestic and international operations (CIQUE, 2003). In addition to CBRN Defense, veterinarians are responsible for campaigns of environmental sanitation, food safety, and pest monitoring and control in fields, ships and airplanes, thus avoiding entry of microorganisms in the national territory. In public health, military veterinarians are present in great number, acting in areas like food security, zoonoses, pest control, entomological surveillance and environmental sanitation. To accomplish their missions, military veterinarians have field laboratories and equipment to be used across the national territory and in international operations, including field modular laboratories; sampling equipment; biological defense equipment; state-of-the-art equipment for cleaning, disinfection, decontamination and deratization for pest control; biological disintegration equipment; entomological diagnostic equipment; equipment for cleaning, decontamination and sanitation for medium and large goods vehicles; radioactive detection equipment; food analysis equipment; veterinary assistance kits for animals; insect control equipment; and equipment for cynological groups (FERNÁNDEZ-CAPARRÓS, 2013).

2.3 technical and laboratory skills, training and updated doctrine in cbrn defense in the context of military veterinary

2.3.1 Technical and laboratory skills

As previously discussed, military veterinarians of the Brazilian Army is technically qualified to perform according to the CBRN Defense doctrine in the areas of health intelligence, health estimates, health surveillance, laboratory analysis, sample collection, screening and decontamination, health treatment, evacuation and support in mortuary issues (BRASIL, 2016a).

They can also work, according to the Brazilian Army doctrine, in control of zoonoses, management of food and water quality, and environmental management, which are fields of knowledge intrinsically linked with CBRN Defense (BRASIL, 2018).

At a U.S. Veterinary Corps, veterinarians are trained to act in CBRN environments, in protection and decontamination of personnel, subsistence, equipment, and military working dogs. The commanders of these units develop contingency plans and

tactical SOPs so that veterinary teams can operate in the contaminated area (UNITED STATES, 2016).

In Argentina, its Veterinary Service supports the Argentine Army, collaborating with the troops in the development of preventive measures against the CBRN action (DÍAZ..., 2012).

Spanish military veterinarians, in order to accomplish their missions, have CBRN Defense laboratories with high-tech regulatory field equipment to be used across the national territory and in international operations (FERNÁNDEZ-CAPARRÓS, 2013).

In the CBRN Defense doctrine of the Portuguese Army, a biological defense system was developed by teams of specialists with advanced technologies for recognition, detection and decontamination, equipped with laboratory capacity and supported by a laboratory of high biological security, with access to ultra-resolution methodologies. This modern equipment is continuously used in the development of master's and doctoral research, integrating graduate studies and ongoing investigation projects. Scientific publications and communications are the hallmark of scientific quality of the results obtained, and the maintenance of this dynamics depends on the renewal of the Veterinary Service's staff (PENHA-GONÇALVES et al., 2016).

The Portuguese Ministry of Defense concentrated its efforts on establishing capacities of support to operations, creating specialized Biological Defense Teams equipped with advanced technology and high levels of protection for biological assessment and recognition in crisis situations caused by deliberate (bioterrorism and/or biocrime) or not deliberate releases (epizootics, epidemics, accidents with agent release). Using the BSL-3 laboratory structure as a back-up support for the identification and quantification of biological agents, the Biological Defense Teams work in conjunction with other capabilities in CBRN Defense of the Army (FREITAS, 2012).

In a vision of the future, LDBE seeks to perform activities to reach a new level of operational support in biological defense, such as nanomorphology in the identification of biological agents; development of robotics in actions of CBRN recognition, detection and decontamination; increasing the degree of laboratory biological safety to allow the manipulation of synthetic or modified biological agents with unknown pathogenic potential (BSL-4); and participation in joint international cooperation actions (PENHA-GONÇALVES et al., 2016).

2.3.2 Training

The search for new knowledge and the exchange of experiences between national and international civil and military institutions that actively operate in the field of CBRN Defense are critical for the improvement and update of the Brazilian Army professionals, and for the constant preparation for a CBRN incident.

Among the Brazilian institutes dedicated to CBRN Defense that are open to improvements, and actions and collaboration of military veterinarians, IDQBRN is comprised of a group of researchers, military and civilians. It has contributed to the

growth of this area in the Brazilian Army, especially due to international cooperation in expansion (BRASIL, 2012). This institute has a CBRN Defense BSL-3 mobile laboratory. Currently, one veterinary is among its group of researchers, linked with the Laboratory of Biological Defense (LDB) of this Institute that operates the mobile laboratory and conducts doctoral research about the presence of *Bacillus anthracis* in the environment.

Another Brazilian Army institute with intense activity in CBRN Defense is IBEx, which recently created its own graduate program, offering a master's degree in biodefense. This institute has a BSL-3 laboratory for the identification of biological agents, which conducts research in the area of biosafety with the collaboration of other research centers, such as the Oswaldo Cruz Foundation, and other national and foreign forces. However, this biodefense center has never had a veterinarian in its staff.

Despite more restricted areas for veterinary practice, the Military Engineering Institute (IME – *Instituto Militar de Engenharia*) is responsible for providing technical and scientific support about CBRN Defense to the Brazilian Army and has training and graduate programs in the fields of chemical and radiological defense; also, it conducts research with the cooperation of foreign institutions and develops, in Nuclear Engineering, the basic and advanced levels of radiological protection for multiprofessional health teams, including military veterinarians (BRASIL, 2013b, 2013c).

At an international level, the Portuguese LDBE aims to build a network of partners and collaborators to promote direct interventions in its areas of interest and a good position in the context of national and European actors in the area of CBRN Defense, ensuring proper and balanced visibility as its sensitive mission requires. Its current network of partners includes national and foreign military and civilian entities from the academic or business universe, as well as recognized institutions and authorities (PENHA-GONÇALVES et al., 2016).

Training programs between the Brazilian Army and civilian and military institutions from other countries for the field of military veterinary could cover the following units, with their respective specialties:

- a. Portuguese Army's Biological Defense Laboratory (LDBE – *Laboratório de Defesa Biológica do Exército*) of BSL-3. This laboratory recently received, for the first time, the visit of an Army veterinarian, a member of the Ministry of Defense, to learn about its physical structures and establish contact for future activities;
- b. Mobile diagnostic CBRN field laboratory of the Finnish Army – field hygiene segment, responsible for quality control of food and environmental samples;
- c. *Biopreparat*, linked with the Veterinary Service of the Russian Ministry of Defense, which is a system of research and production of biological weapons;
- d. The U.S. Army Veterinary Service with CBRN Defense operations, including the Fort Hood Sentinel, in Texas, for animal decontamination and treatment in CBRN environment. The veterinarians and animal care specialists of the Fort develop training in partnership with universities to es-

establish care protocols for animals affected by national disasters and CBRN incidents (CONNER, 2018);

- e. CBRN Defense laboratories of the Spanish Army equipped with advanced technology.

2.3.3 Doctrine update

In Brazil, there is still no document addressing the activities of military veterinary in CBRN Defense. However, the Ministry of Defense, together with the Ministries of Science, Technology and Innovation and the Ministry of Health, developed in 2016, prior to the Olympic Games in Rio, a collective technical note, establishing and standardizing procedures to be adopted during the event by the several civil and military bodies, agencies and institutes, including health teams trained in CBRN Defense. This note was developed considering the possibility of occurrences with a CBRN incident, with provisions addressing care, screening and removal of CBRN victims; aeromedical evacuation; handling and transportation of samples; in addition to the definition of responsibilities to the main actors in this environment (BRASIL, 2016b). Despite not being defined in the document, in this context of responsibilities, veterinarians are inserted in handling and transportation of animal samples.

The joint health manual for CBRN Defense of the U.S. Armed Forces, and the other manuals mentioned in it specifically related to the veterinary activity of each U.S. Armed Force have a detailed description of the capabilities of the Veterinary Service in CBRN Defense, acting as reference materials for updating and reformulating, not only the CBRN Defense manuals of the Brazilian Army, but all the manuals addressing the actions of military veterinary, both individually and when inserted in the health service.

The U.S. Army Veterinary Corps, created in a CBRN environment, is focused on the protection and decontamination of personnel, equipment and war dogs, areas that deserve to be highlighted and included in the Brazilian Army doctrine (UNITED STATES, 2016).

The LDBE sought to bring innovative aspects to the CBRN Defense area of the Portuguese Army, either by introducing a technical-scientific component in the design of operating procedures, or by printing a culture of cutting-edge technology in operational support to specialists in the field. This approach has allowed updates, reformulations and innovations in relevant areas of the CBRN Defense doctrine of the Army, leading to the introduction of laboratory support for recognition and decontamination operations, and innovation in research and technological development activities, with an impact on operational capabilities (FREITAS, 2012).

3 Discussion

Despite being defined by the General Administration of the Army that military veterinary is today a strategic specialty in the field of health, as it is dedicated to the actions of biological defense, public health/sanitary surveillance and environmental management (BRASIL, 2010), it is a military health field that performs activities in military operations that are not yet well defined in the Brazilian Army manuals.

Biological threats represented by intentional actions or natural events are a concern of States and international institutions. The current global context contains determinants that help increase biological threats, such as conflicts throughout the planet, flows of refugees, easy access to biotechnologies that support genetic manipulation and synthetic biology, climate change and massive deforestation, favoring the destruction of ecological niches and reduction of natural epidemiological barriers (JANSEN et al., 2014).

In fact, the influence of thawing at unprecedented speed has been recently reported as leading to reactivation of microorganisms, such as those that cause anthrax, smallpox and pest, which were dormant for long periods (SERRANO, 2019).

The work in CBRN Defense performed by the Armed Forces in Brazil requires a multidisciplinary team, and the technical-professional knowledge of veterinarians has proved to be essential and increasingly important in Brazil and worldwide. The potential use of biological weapons by terrorist groups and even nations has increased quickly, just like the availability of information and the easy access to technical knowledge and equipment for handling CBRN materials (CASTANHEIRA, 2016).

In response to this scenario, which requires strengthening of international biological defense systems as an important tool to discourage and prevent these threats, the Portuguese Army is an example of solid base to develop a projectable biological defense system in a field of limited availability of means with operational specialization, followed by Spain, which has high-tech CBRN Defense laboratories, and Finland, with a mobile CBRN laboratory, both operated by their veterinarians, in addition to Argentina, whose Veterinary Service collaborates with the troops in the development of CBRN preventive measures (FREITAS, 2012; KINNUNEN et al., 2012; FERNÁNDEZ-CAPARRÓS, 2013; DÍA..., 2012).

The Brazilian Army, to acquire more experience and improve, must interact with different partners to increase the laboratory and technical-scientific capabilities of the Military Veterinary Service. Such improvements would strengthen the technical support and trust in the quality of the response, which, in turn, would expand the diversity of operating scenarios and the dimension of operational capacity.

The Brazilian Army has grown more and more in terms of technology and research in the area of CBRN Defense; it has a BSL-3 laboratory and a CBRN Defense Mobile Laboratory in good operating conditions, with IBEx, CTEx and IME as its main development sites. Some partnerships have already been created, with frequent exchange of professionals, but with few opportunities for veterinarians to work in these places. In addition, in general, the military personnel of the Brazilian Army who dedicate mainly to laboratory activities are not usually involved in operational activities, just as operational military personnel are usually far from the laboratories. And the actual number of career military personnel tends to decrease more and more with career plan adjustments, creating obstacles to flexible practice.

Comparatively, in the LBDE, the military directly involved in operational activities also develop and conduct research and technological development projects, just like the Biological Defense Teams, which provide direct support to operations. This

model adapts research activities to operational needs, creates opportunities for immediate migration of laboratory methodologies and technologies developed for operational benefit. A recent example of this LBDE strategy was the investigation into an extensive outbreak of viral gastroenteritis in Portuguese military units, a crisis situation that may be caused by weaknesses in the supply chain or the consequence of bioterrorist actions, requiring fast response (LOPES-JOÃO et al., 2019).

A few years ago, the Brazilian Army regulated its Chemical, Biological, Radiological and Nuclear Defense System (SisDQBRNEx), aiming to ensure, among other aspects, continuous staff training and the performance of interagency operations (BRASIL, 2012).

Regarding the health area, SisDQBRNEx foresees several assignments to the Health Administration and IBEx, such as providing health advice and technical support to the operational tasks of the CBRN Defense Military Organizations, managing health staff and specialized hospital facilities in CBRN Defense, conducting research in the area of biosafety, also with the collaboration of other national or foreign Forces, and, finally, operating a reference BSL-3 laboratory for the identification of biological agents (BRASIL, 2012).

To start the doctrinal reformulation of the CBRN Defense manuals of the Brazilian Army, the collective technical note developed for the 2016 Olympic Games by the Ministry of Defense, the Ministry of Science, Technology and Innovation, and the Ministry of Health, in addition to the collective health manual in CBRN Defense of the U.S. Armed Forces could be adopted to address military veterinary activities in CBRN Defense, such as training of veterinary personnel to work in the CBRN environment; monitoring of responsibility for physical structure and subsistence protection in CBRN environments; maintenance of assigned CBRN equipment; inspection of subsistence in CBRN environments; monitoring of subsistence decontamination that had been contaminated with CBRN agents, military working dogs and other government-owned animals; treatment of working dogs and other GOAs that are CBRN victims; reporting of intelligence data through command channels; vector and pest control and waste and carcass management in CBRN environments; and guarantee of safety of veterinary equipment, supplies and personnel (PENHA-GONÇALVES et al., 2016; UNITED STATES, 2016; BRASIL, 2016b). Such activities, in general, are already performed in the routine of veterinary officers in an environment not contaminated by CBRN agent (BRASIL, 2017).

In view of so many possibilities of action and training of the veterinary corps of the Brazilian Army in CBRN Defense, besides the need to update its doctrine considering the growth of other similar Armed Forces, the military veterinarians at the most distinguished roles of the Brazilian Force should be supported by their superiors so that this Veterinary Service keeps up with modernization of military veterinary in CBRN Defense.

4 Conclusion

Given the above, the authors of this study conclude the following:

1. In the context of biological defense addressed in this study, Veterinary Medicine is inserted as an anchor point of knowledge about biological warfare

agents, many of which cause animal diseases. In addition, this science is certainly an important connection of possible interagency operations, required in crisis scenarios;

2. In addition, the Brazilian Army has in its organization actors in the health field with reasonably well-defined responsibilities for biological defense, which should be explored by professionals and structures related to veterinary medicine;
3. Based on the example the actions of military veterinary corps from other countries in a CBRN environment, the following duties of military veterinarians could be included in the Brazilian Army manuals: training of veterinary personnel to work in CBRN environments; monitoring of responsibilities for physical structure and subsistence protection in CBRN environments; maintenance of CBRN equipment; inspection of subsistence in CBRN environments; monitoring of subsistence decontamination that had been contaminated with CBRN agents, military working dogs and other government-owned animals; treatment of working dogs and other GOAs that are CBRN victims; reporting of intelligence data through command channels; vector and pest control and waste and carcass management in CBRN environments; and guarantee of safety of veterinary equipment, supplies and personnel;
4. In order to detail more specific activities such as decontamination and treatment of victims of CBRN military working dogs, in addition to decontamination of food affected by CBRN agents, future studies could be conducted to analyze other manuals available in this field of knowledge;
5. It is widely recognized that CBRN threats, especially biological ones, are not blocked by borders and the effectiveness of a response will depend on international cooperation. Therefore, among the expected perspectives, exchanges between Armed Forces, international institutions or agencies should be highlighted in order to enhance military veterinary capacity in the Brazilian CBRN Defense.

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