



General biosafety measures for laboratory environments, outpatient clinics, medical centers, and veterinary hospitals during the SARS-CoV-2 pandemic

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Abstract

This study aimed to guide professionals working in veterinary laboratories, outpatient clinics, medical centers, and hospitals regarding the biosafety measures that should be adopted during the novel coronavirus (SARS-CoV-2) pandemic. While the population is not yet fully immunized by vaccines, the adoption of biosafety measures is essential to control the spread of circulating strains of the new coronavirus. Thus, the importance of professionals and collaborators following biosafety guidelines in different veterinary work environments is highlighted. The main protocols on biosafety to be adopted include frequent handwashing with water and soap or using 70% alcohol-based hand sanitizers, using personal protective equipment (PPE) (including gloves, lab coat, face mask), avoiding the contact of the hands with mucous membranes (eyes, nose and mouth), not sharing personal objects, keeping environments clean and well ventilated, social distancing of 1.5 m between individuals, and maintaining objects and surfaces regularly clean throughout the work environment. The transformation of work processes, such as various biosafety practices, is necessary within the context of the COVID-19 pandemic and improves the safety of professionals in their work environment and other people and animals, decreasing contamination risks in order to reduce the spread of this viral agent.

Keywords Novel coronavirus · COVID-19 · Health professionals · Safety at work · Veterinarian

Introduction

On March 11, 2020, the World Health Organization (WHO) declared the new COVID-19 outbreak a pandemic. The disease, severe acute respiratory syndrome coronavirus 2

(SARS-CoV-2), is the causative agent of an acute and severe respiratory syndrome in humans known as the coronavirus disease 2019 (COVID-19). Due to the rapid spread of this infectious agent, COVID-19 transmission between humans typically occurs through direct contact or droplets and particles

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in the air, coughing, sneezing, during speech, contact with objects (fomites), and the movement of people in contaminated areas. When infections occur via mucous membranes (e.g., eyes, mouth, and nose), the virus multiplies and spreads to organs and tissues, causing the disease [1]. In addition, the novel coronavirus can survive for hours and even days on surfaces depending on environmental conditions [2, 3].

The average coronavirus incubation period can last from 5.2 to 12.5 days, and the average transmission period is approximately 7 days. Moreover, an infected person may not present clinical signs of the disease and still transmit the etiological agent. The symptoms of COVID-19 are mainly respiratory and include fever, coughing, sore throat (laryngopharyngitis), runny nose, fatigue, headache, myalgia, and loss of smell and taste [4–6].

Given the COVID-19 pandemic, several factors contribute to transmitting the infectious etiologic agent in workplaces, especially in healthcare settings [5–7]. The behavior and transmission capacity of the virus demand work environment processes of diverse contexts to reorganize and readapt [1, 8]. In late 2020 and early 2021, some countries developed and released protocols for different vaccines as a way to control the spread of the new coronavirus. However, vaccines are under study and are not yet available to the entire population. Therefore, measures to contain the pandemic COVID-19 include biosafety care. Hence, biosafety measures are essential to ensure the health security of individuals and consist of standardized technical procedures in human and animal health organizations, including veterinary laboratories, outpatient clinics, medical centers, and hospitals. Biosafety is pivotal in these sectors due to their physicochemical, biological, and ergonomic risks and accidents, as those are environments in which there is intense manipulation of chemical, physical, and biological agents, including collecting biological samples and performing laboratory exams, consultations, and clinical-surgical procedures.

Therefore, this study aimed to guide professionals working in veterinary laboratories, outpatient clinics, medical centers, and hospitals regarding biosafety measures to provide health security and prevent or minimize the risks of SARS-CoV-2 infection in the individuals in these establishments.

Development

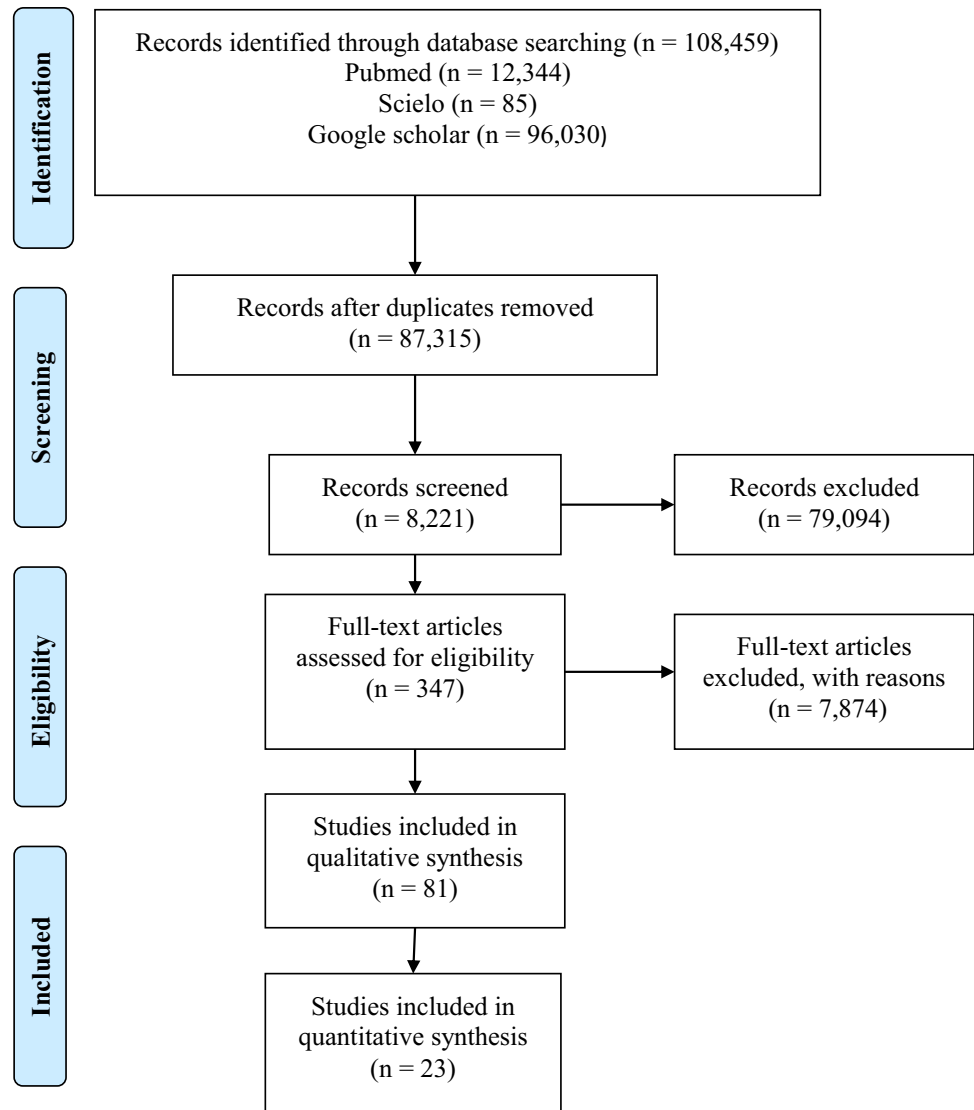
This study was composed of a systematic review that was carried out according to the PRISMA flow chart, as suggested by Moher et al. [9]. A bibliographic search was performed in the following databases, PubMed, SciELO, and Google Scholar, and included websites of international and Brazilian health authorities at the municipal, state, and federal levels. The search included reviews, original articles,

and documents with technical guidance from health authorities published since the WHO declared the COVID-19 pandemic on March 11, 2020 (March 2020 to Jan. 2021). The descriptors “SARS-CoV-2” and “COVID-19” were used with “biosafety,” “health professionals,” and “disinfection.” A total of 108,459 documents were analyzed, and the chosen ones were selected according to the combination of descriptors and publication period. According to the indication of the main items for reporting systematic reviews and meta-analyses, the selection flow of the documents is shown in Fig. 1.

Veterinary laboratories, outpatient clinics, medical centers, and hospitals that provide essential services and handle animals and samples of animal origin must take exceptional care to avoid the infection of professionals, patients, and collaborators, as well as prevent contamination of the work environment and the spread of the virus [10].

Additionally, it is necessary to take all possible precautions to avoid SARS-Cov-2 transmission in humans and animals. Almendros [11], Santos et al. [12], and the World Organization for Animal Health [13] expressed that, to date, there is no consensus in the scientific literature regarding the real role of pets as a source of infection for people or other pets. Nonetheless, the opposite situation has been described concerning pets licking and kissing their owners, which are additional risk factors that facilitate the transmission of the virus between sick people and their pets [14]. Another possible scenario includes pets as carriers of the virus through fur, skin, and secretions/excretions [15].

At this time, extra care is required concerning personal hygiene and work environment measures, respiratory etiquette, and the use of personal (PPE) and collective protective equipment (CPE). Notably, health measures must be in line with the standards described by official bodies and global and Brazilian health authorities (e.g., WHO, Brazilian Ministry of Health, ANVISA, FIOCRUZ, CFMV, Health Surveillance) to face COVID-19. Employees and collaborators in the risk group (people over 60 years of age or with chronic diseases) should strongly consider working remotely, and using information and communication technologies (ICT) for holding meetings and events from a distance is highly recommended [16]. Laboratories are advised to send documents and exams by digital means, via e-mail or website logged in by a password. If face-to-face meetings are necessary, well-ventilated environments must be used while also respecting the minimum social distance and use of face masks, and 70% alcohol-based hand sanitizer must be available for individuals to clean their hands frequently. Moreover, veterinary laboratories, outpatient clinics, medical centers and hospitals must be ready to work in shifts, respecting social distancing. Employees who present symptoms of the disease must make themselves absent from work, immediately inform their supervisor, and seek medical

Fig. 1 Flow diagram of selected articles

advice. If an individual tests positive for COVID-19, they must remain in quarantine in compliance with the health standards recommended by the Brazilian Ministry of Health and WHO [16, 17].

The following chapter will describe the main biosafety protocols to be adopted by veterinary medical professionals in their professional environment and people and animals in order to avoid infection by SARS-CoV-2 in laboratories, outpatient clinics, medical centers, and veterinary hospitals.

Biosafety guidelines for professionals in veterinary laboratories, outpatient clinics, medical centers, and hospitals

All professionals in the technical area of laboratories, outpatient clinics, medical centers, and veterinary clinics must wear PPE. Professionals working at the reception of such establishments must wear a face mask and lab coat to

further decrease the possibility of SARS-CoV-2 infection and transmission [1]. All professionals should wear protective clothing exclusively for their work environment, including face masks, face shields, lab coats, specific footwear or disposable shoe covers, caps, and gloves during activities [2, 3]. Personal hygiene is also highly recommended, the hair should be tied and/or a cap worn, and nails must be trimmed and clean. Furthermore, it is recommended to refrain from touching the hair, mouth, eyes, and nose, in addition to avoiding the use of makeup products, accessories, and adornments (rings, earrings, piercings, watches, bracelets, among others) [17]. Professionals should wear closed work shoes exclusive for their work environments, and this footwear must be low, slip resistant, made of resistant and waterproof material, and easy to clean [2, 3].

When entering their work environments, all individuals must wear a face mask that covers the mouth and nose. Masks made of cotton, silk, and chiffon provide adequate

protection as long as they have a dense weave (e.g., 600 thread count) and are properly adjusted to the face [18, 19]. The masks should be changed every 2 to 3 h or when wet and removed using the side flaps or the elastic while avoiding touching the center of the mask to minimize the risk of contaminating the hands [20]. The proper use of masks is an important protective measure, although it must also be accompanied by other equally relevant biosafety measures, including handwashing with water and liquid soap and, in the absence of this possibility, 70% alcohol-based hand sanitizer. This hand hygiene procedure must occur before and after changing face masks (including disposable and reusable masks made of fabric) [16, 21].

In addition to face masks, professionals working in veterinary laboratories, outpatient clinics, medical centers, and hospitals can use face shields and PPE masks with different specifications for healthcare professionals, surgical masks, and masks that have a minimum efficiency of 95% in filtering particles up to 0.3 μm (N95, N99, N100, PFF2, or PFF3) for exclusive use in certain work activities [22]. Individuals are recommended to practice breathing etiquette by covering their mouth and nose with the inside of their elbow or using a disposable tissue when coughing or sneezing. The tissue must be disposed of in an appropriate container, and the face mask immediately changed and kept in a closed recipient (such as a plastic bag or storage container that is reusable and hermetically sealable with a zipper) until cleaned [16, 23]. Masks should be washed by immersion in boiling water for 5 min and followed by immersion in sodium hypochlorite (0.1–1%) [24] for proper disinfection [25].

Another measure relevant to the health of the professional refers to frequent hand hygiene, which must be done before and after performing various work activities, including consultations and clinical examinations, collecting biological samples, diagnostic imaging and laboratory tests, surgical procedures (specific protocols), and after touching potentially contaminated surfaces and objects. The use of procedure gloves is essential during consultations and exams, and they must be changed after each visit. The gloves must be removed without touching the outside area, turned inside out, and properly disposed of, followed by handwashing with water and liquid soap and dried with paper towels [1–3].

However, the primary collective protective equipment (CPE) for preventing COVID-19 includes 70% alcohol-based hand sanitizer dispensers positioned at the entrances of establishments, elevators, and other places where their use is required. These dispensers can also be placed along corridors that give access to different rooms, such as the waiting room of outpatient clinics, doctor's offices, hospitals, inpatient rooms for animals (kennels, large animal stalls, etc.), and depositories (medicine, feed, materials) and diagnosis (imaging, clinical laboratory, anatomopathological, among others). There should be signs providing information

on practicing breathing etiquette, forms of contamination and spread of the novel coronavirus, social distancing, and the maximum capacity allowed per room (elevator, reception, waiting room, collection room of biological material). Social distancing floor markers should also be placed at the reception, payment locations, waiting rooms, among other places [1].

Health professionals must adopt good practices regarding the correct use and maintenance of PPE and CPE to provide protection and prevent the transmission of the virus in their surroundings, which includes knowing how to use the equipment, being trained to correctly use it, and properly disposing of waste according to safety standards [1, 16, 26].

Biosafety guidelines for individuals who circulate in laboratories, outpatient clinics, medical centers, and veterinary hospitals

In light of the new SARS-CoV-2 pandemic, measures that promote the safety of all individuals must be observed in different environments, including laboratories, outpatient clinics, medical centers, and veterinary hospitals to ensure their health and minimize the risk of transmitting the virus. Social distancing rules are indispensable for professionals, customers, employees, suppliers, and pets. In addition to the professionals, other individuals also circulate in those environments (laboratories, outpatient clinics, veterinary clinics, and hospitals), including clients, animal owners, service providers, equipment maintenance workers, and sales representatives. Given this scenario, it is essential to control people's access to reduce crowds as much as possible. It is recommended that only one representative per family group be present at the reception while always respecting the physical space of the environment and maintaining a social distance of 1.5 to 2.0 m between individuals, with social distancing floor markers to facilitate compliance [17, 27]. In addition, information on the symptoms caused by the novel coronavirus should be provided to help identify people presenting symptoms, the actions to take, and the necessary protective and anti-COVID-19 measures. Access to the premises must be informed via booklets, posters at the entrances to the buildings, and social media to instruct the population [17].

All nonurgent or emergency clinical/surgical cases that require assistance must be scheduled (by phone, communication applications, social media, etc.) in advance. Consultations, therefore, should be spaced, in a timely manner, between patients, to prevent individuals from crowding at the reception or waiting room [25]. The treatment rooms must always receive one patient at a time, who can be accompanied by only one individual. Given that some people are asymptomatic, all individuals should be considered potential carriers of the virus [10]. For this reason, professionals

who are in direct contact with the public can also use face shields. Additional biosafety measures include measuring body temperatures and providing 70% alcohol-based hand sanitizer to anyone who has access to the premises. When disposable masks are available, face masks are advised to be changed by carefully removing them and keeping them in a hermetically sealed container until cleaning [25, 27]. Avoiding greeting others with handshakes, kisses, or hugs is also a critical preventive step that must be followed by those who visit different places. In addition, sharing objects of personal use, such as glasses, cutlery, office supplies, books, magazines, and the like, is not recommended [7].

Attention to the surroundings

Work environments, including laboratories, outpatient clinics, medical centers, and veterinary hospitals, must be well ventilated, with doors and windows open in order for the air to circulate, and the use of air conditioners and fans should be avoided so as not to spread the viral agent [28]. Furthermore, 70% alcohol-based hand sanitizers must be readily available in each work environment. Preferably, there should be a sink and faucet with water and soap or liquid soap available in at least one environment for handwashing [29].

The environment's cleaning routine should be reinforced by decontaminating surfaces and the floor with a mop, and cleaning cloths should be exclusive of each room [30]. Frequent cleaning of equipment, instruments, and furniture should also be performed in different locations. It is advised to clean surfaces in the consulting and waiting rooms in addition to the doorknobs, tables, chairs, stretchers, and medical-hospital equipment used before and after clinical procedures [16, 31].

The waste generated during clinical, surgical, and laboratory procedures (gauze, gloves, surgical drapes, surgical dressings, etc.) [2, 3] must be classified according to Brazilian guidelines, as RDC 222/2018 and CONAMA Resolution 358, as a biological residue (group A, subgroup A1), which are considered residues with the presence of biological agents that present a potential risk of infection. The residues must be packed in red or milky-white bags with the infectious substance sign and adequately closed with a seal or double knot. The temporary and external storage of waste from health services must be stored in specific containers identified for storing biological waste and kept safely to avoid contact with people or animals [26].

The importance of eliminating or restricting the use of items that individuals can share is emphasized and includes drinking fountains, glasses, cups, pens, clipboards, and telephones. Objects that have restricted use must be sanitized after each use [2, 3]. Bathrooms should be kept clean and disinfected at least every 2 h, and liquid soap and paper towels should be provided. All contaminated disposable

materials must be packed in proper containers, tightly closed, and removed frequently. All waste containing tissues, masks, and materials with secretions/excretions from individuals who may be contaminated with the novel coronavirus must be disposed of as infectious waste [32]. This waste must be removed by specialized companies that are licensed to collect, transport, and dispose of these residues.

Products for disinfecting environments

Disinfectants with virucidal activity should be used to clean laboratories, outpatient clinics, veterinary clinics, hospitals, furniture, utensils, and equipment [7, 27, 33]. These substances have the purpose of eliminating the virus from the environment and surfaces and may contain chemical substances that affect the members of the Coronaviridae family [3]. Ethyl alcohol in the form of gel or liquid must be in a concentration between 62 and 71% (v/v), as it will have a denaturing action and dissolve the external lipid membrane of the virus, thus inactivating it [17]. The use of liquid ethyl alcohol should be used to disinfect everyday use surfaces by rubbing it on them for 30 s [34], although gel-based alcohol is indicated to clean hands and body surfaces due to its hydration properties depending on the concentration and substance used as a vehicle [17, 35].

Other products that can be used as disinfectants include sodium hypochlorite (0.1%), glutaraldehyde (2%), povidone-iodine (1%), hydrogen peroxide (0.5%), peracetic acid (0.5%), quaternary ammonium, and phenolic compounds [25, 36–38]. If the surface is dirty, wet cleaning must be performed first using water and soap or detergent followed by chemical disinfection [32].

Conclusions

In general, it is emphasized that the work environments of the veterinarian, such as those discussed in this study, offer a greater possibility of risk of infection; therefore, it is important the transformation of the work routine, including adopting biosafety practices in laboratories, outpatient clinics, medical centers, and veterinary hospitals, is pivotal within the context of the COVID-19 pandemic, given such protocols provide better safety to professionals in their work environments as well as to people and animals. As a result, the spread of the novel coronavirus decreases and provides a reduction in viral circulation, thus minimizing the complications of the pandemic.

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Declarations

Ethics approval No ethical approval was sought or required for this work as it is a theoretical contribution.

Conflict of interest The authors declare no competing interests.

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