# Laboratory Biosafety Involving SARS-COV-2

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## Abstract

During the current crisis of the SARS-CoV-2/COVID-19 which threatens public health, it's crucial to know and assess the best laboratory conditions for biosafety and biosecurity to avoid and control any contamination and spread of this lethal virus. To date, there is no comprehensive and complete study focused on laboratory safety in dealing with emerging coronaviruses in Iran. Additionally, we have lost a large number of medical staff due to an emerging coronavirus. To reduce risks associated with emerging coronavirus treatment, the dimensions of laboratory biosafety were examined in this study. In addition, this research is primarily focused on the assessment of laboratory biosafety when it comes to emerging coronaviruses. We will discuss which aspects should be addressed to address the risks and how to implement them in the right order and at the right time in an effort to be as educative as possible.

Keywords: SARS-CoV-2 • Laboratory • Biosafety • Public health • Pneumonia

## Introduction

In Hubei province, multiple health facilities in Wuhan reported cases of pneumonia of unknown cause in late December 2019. These patients showed similar symptoms to those who had SARS1 and MERS2, such as fever, coughing, chest discomfort, dyspnea, and bilateral lung infiltration in severe cases. Huanan Seafood Whole sale Market, a wet market located downtown where you can find seafood and live animals, including poultry, appeared to be the most common epidemiological source among the first 27 documented hospitalized patients. Like a pandemic, human coronaviruses, especially COVID-19, is an emerging pandemic infectious disease with high morbidity and mortality. Coronaviruses are associated with comorbidities, along with their symptoms of it. SARS-CoV-2 is a highly pathogenic coronavirus that causes a high death rate compared to the SARS-CoV and MERS [1].

## Literature Review

### Severe acute respiratory syndrome 2 middle east respiratory syndrome

Risks have been posed by high human migration, air traffic, and trade between China and other countries. Some African countries are particularly vulnerable to the introduction and spread of the COVID-19. Travelers from China have primarily brought COVID-19 cases to other countries, including the United States of America (USA). Thailand reported the first case of COVID-19 outside mainland China. Egypt was the first country to report a case on the African continent. The COVID-19 outbreaks have put additional pressure on global health systems to invest extensively in disease diagnosis, care, control, and monitoring zoonotic risks. However, laboratory capacity is inadequate in low-income countries, and these facilities are poorly maintained. Unfortunately, after 2020, the emerging coronavirus outbreak affected almost all the countries on the planet; a significant number of people have died as a result of the virus [2]. This high-risk mutant virus infects a large number of people. In addition, a large number of ICU workers, including doctors and nurses, died in 2020 as a result of infection with this emerging virus. Since it's an airborne disease, it affects many people in a short period. Moreover, the ideal treatment option is ambiguous, and there are no appropriate treatments; prevention is the only way to combat this emerging virus. As a result, taking preventive measures and adhering to health protocols will decrease the number of cases. Therefore, to diagnose and treat such highly infectious pathogens as (SARS-CoV2/COVID-19), which can cause deadly diseases in humans, need well-established biosafety and biosecurity laboratories as well as the adoption of appropriate One Health approaches. The importance of biosafety practice), and engineering controls are the four pillars of biosafety that must be used for effective and safe practices in the clinical setting in general and laboratory settings in particular. Before meeting the COVID-19 diagnostic challenge, a risk assessment and necessary bio risk management measures must be implemented. In our resource-poor settings, we need to adapt safe but cost-effective and improvised solutions to ensure the secure handling of clinical samples from COVID-19 patients in the laboratories. The suitable PPE and suitable alternatives are available for selection. Disinfection of lab areas and safe disposal of clinical samples from such patients are also critical [3].

## Important characteristics of coronavirus

In both SARS-CoV and MERS-CoV, a large positive-sense-RNA genome is found. The two viruses are members of the Coronavirus genus of the Coronaviridae family in the order of Nidovirales. SARSCoV and MERS-CoV have similar coding strategies, as do all viruses in the order Nidovirales: Two-thirds of the viral RNA is translated into two large proteins. As a result, the virus produces polyproteins, and the rest of its genome is transcribed into an mRNA subgenomic nested set. There are two polyproteins, pp1a and pp1ab, that encode 16 nonstructural proteins that make up the viral Replicase Transcriptase Complex (RTC). Two proteases break down the polyproteins: Papain-like protease (PLPro; nsp3) and 3C [4].

Like protease (3CLPro; nsp5). The NSBS rearranges membranes derived from the RER1 into doublemembrane vesicles, in which viral replication and transcription occur. One9 unique feature of coronaviruses is the Exoribonuclease (ExoN) function of nsp14, which provides the capability to maintain a large RNA genome without accumulating detrimental mutations. SARS-CoV and MERS-CoV transcribe 12 and 9 subgenomic RNAs, respectively. In addition to the four structural proteins, which are Spike (S), Envelope (E), Membrane (M), and Nucleocapsid (N), these genes encode several accessory proteins that are not involved in viral replication but affect the host innate immune system that is not fully understood. It is generally understood that emerging viral infections are diseases that have infected new hosts, spread into new geographic regions, altered the course of their pathogenesis, or are caused by agents that were not previously recognized as pathogenic. Global health is at risk from many EIDs. The review of human disease risk factors identified 1415 types of infectious organisms known to cause human illness by Taylor and colleagues. In this group of 175 organisms, 77 (44%) were considered new pathogens, and viruses and prions made up the largest taxonomic group. The highest relative risk for emergence appears to be among viruses, among all taxonomic groups of microorganisms. Foshan, China, reported the first case of the SARS in November 2002. Within two months of the outbreak, more than 300 cases had been reported in mainland China, of which around one-third involved health care workers. The outbreak spread from Hong Kong to Vietnam, Canada, and a few other countries after infected individuals traveled there. The WHO established an international network of laboratories in March 2003 to determine the causal agent for SARS. In early April of that year, a remarkable global effort led to identifying and isolating the SARS Coronavirus (SARS-CoV). At the end of July 2003, when 8,096 reported cases were confirmed, including 774 deaths in 27 countries, there were no more infections detected, and SARS was declared over. From December 2003 to January 2004, there were five additional zoonotic cases of SARS, but no human cases of SARS since then. Medical interventions did not end the SARS pandemic, but rather infection control measures did. Recently, certain SARS-CoV-like viruses found in bats have been found to be capable of infecting human cells without further adaptation, which suggests that SARS could re-emerge [5].

Laboratory biosafety and laboratory biosecurity Biosafety and biosecurity measures should be included in the laboratory's assessment criteria for laboratories' biorisk. A specific objective and management strategy are needed as part of the assessment. Creating an integrated management team that implements biorisk policies, rules, and regulations for the operational laboratory level is key to successfully implementing these technologies. Some rules [6].

## Rough endoplasmic reticulum

Regulations must be followed by government authorities, along with how to manage liquid and solid waste. It is necessary to establish management and biorisk measures as well as appropriate physical facilities that assure a safe work environment, protect the environment, safeguard the product (research, diagnostics, and/or vaccines), and protect the biological pathogen. We are already trying to do that through strict physical distancing, which could flatten the epidemic curve and moderate demand on the health system. Nevertheless, since the United States is so late in its mitigation efforts, scarcity is likely to become a reality. What should we do? A World War II- type mobilization could ramp up the production of personal protective equipment, ventilators, and other essential supplies and equipment that could become scarce [7]. The president should exercise his full authority under the defense production act to mobilize industry to provide. Suspected samples should be handled at the initial phase in a BSC1 by well-trained staff in the standard facility of BSL-2. In all circumstances, National guidelines on laboratory biosafety should be followed. At present, all procedures should be undertaken based on risk assessment because of minimal available data on the risk posed by COVID-19. Specimen handling for molecular testing of COVID-19 requires BSL-2 or equivalent facilities, which includes separate hand and eye wash sinks, and these also need an automatic door locking system. The BSL-2 laboratories should have access to a decontamination facility, including an autoclave. All laboratories that handle SARS-CoV-2 virus-carrying specimens (sputum, throat swabs, nasopharyngeal swabs, oropharyngeal swabs, and stool) should follow good microbiological procedures, laboratory practices, and universal precautions. Laboratories should be staffed with people who understand how to handle infectious agents and adhere to established standard guidelines when working with suspected patient samples. To give laboratory diagnosis for COVID-19, a list of essential laboratory equipment and reagents is supplied. During the initial phase, the suspected samples should be handled in a BSC by well-trained personnel in a conventional BSL-2 facility. In all cases, national requirements on laboratory biosafety should be observed. At the moment, because there is currently very little information on the risk posed by COVID-19, all treatments should be carried out based on risk assessment. BSL-2 or comparable facilities would be required for specimen processing for COVID-19 molecular testing. Separate hand and eye wash sinks are also necessary, along with an automatic door locking mechanism. The BSL-2 laboratories should have access to a decontamination facility, including an autoclave [8].

## Biosafety cabinet

In all laboratories handling special specimens (such as throat swab, sputum, nasopharyngeal swab, oropharyngeal swab, and stool), adequate microbiological laboratory techniques and universal precautions should be followed may contain SARS-CoV-2 virus. Laboratory personnel should be supervised by knowledgeable professionals about infectious agents and established procedures while working with suspected patient samples. In order to give a laboratory diagnosis for COVID-19, a list of essential laboratory equipment and reagents is provided. Coronaviruses are primarily associated for respiratory infections that cause symptoms similar to the common flu. Respiratory samples, including clinical material from the upper and lower respiratory tracts, will be used for detection, depending on the patient's symptoms and condition. SARS-CoV-2 shedding patterns are unknown, and more research is needed to learn more about the timing, compartmentalization, and amount of virus shedding. However, as with SARS-CoV-1 and MERS-CoV, the virus may be detected in other specimens such as blood and urine. The mean incubation period for SARS-Co. Only trained staff should be allowed for appropriate specimen collection, storage, packaging, and transport ensuring that adequate standard operating procedures are in accordance with the national or the WHO guidelines. Are in use, and all specimens should be treated as potentially infectious.V-2 is 5.2 days; however, it may vary widely depending on the severity of illness. For the laboratories involved in diagnosing COVID-19, staff must be well trained in implementing appropriate biosafety measures. The rational, correct, and consistent use of available PPE and proper hand hygiene help reduce the spread of pathogens. Though PPE is considered a primary prevention strategy, it should not be wholly relied upon for the complete prevention of virus transmission. The effectiveness of PPE depends upon the proper handling of PPEs by trained staff, hand hygiene practices, and the human factor. Immunization policy for influenza would also help protect laboratory workers and reduce the staff's suspicion of getting an infection in such emergencies. Scientific reports about LAIs are rare, and there are numerous reports about traditional research laboratories published between 1982 and 2016. Inhalation, particularly by aerosols, percutaneous inoculation, and direct contact to adulterated/infected surfaces, or ingestion is the most prevalent routes of infection. The laboratory staff investigates the infective humans, which differs according to the inoculation route. The most-reported LAIs are pathogenic bacterial microorganisms, and virus-related LAIs have increased recently. Laboratory biosafety also contains personnel management, material accountability, transportation security, information security, and program management. A BSL contains a primary protective barrier that means safety equipment, and a secondary protective barrier means safety facilities. There are four levels of BSL for protection: BSL-1, BSL-2, BSL-3, and BSL-4 based on standard facilities and structure according to the infections and deadly agents they work on. According to PPE for healthcare systems [9].

Laboratories must be committed to the guidelines in the specific biosafety level they are working on. According to recent studies, asymptomatic individuals might be as high as 50-75%, and they may have a similar viral load in the upper respiratory system as symptomatic patients. Countries must use a biosecurity checklist. This list needs endless revision, updates, and customization to national guidelines [10]. A biosecurity culture is needed to implement successfully the guidelines, a scientific community, and a committed community. General recommendations for laboratory staffs from the starting vaccination in the world, the lab workers are one of the first groups of the people who were vaccinated. Based on the results of the various studies, the vaccination has reduced the rate of mortality and morbidly, but still people can infect by the coronavirus 2019. One of the most important aspects of COVID-19 is that health-care workers who work in COVID-19 handling laboratories are at the greatest risk of contracting the disease. Because of that, Laboratory personnel must maintain social distance since asymptomatic colleagues can infect others. Furthermore, good hand hygiene should be practiced. The Laboratory staffs should be monitored every day and suspected person must be quarantined. During all laboratory procedures PPE such as a lab coat or gown, face mask, face shield, gloves, goggles, and head cap should be worn. Utilizing mask in hospitals and laboratories is necessary because the coronavirus can spread to persons while talking [11]. To avoid infection, PPE should be worn within the laboratory at all times. Despite the fact that N95 face masks are advised for all laboratory work that produces aerosol droplets, there is a global shortage of N95 masks. While the N95 mask is not available, wearing surgical mask is suggested. PPE donning and doffing, as well as decontamination protocols, should be taught to all personnel in the event of a spill. When removing PPE, more caution should be exercised because contamination is a possibility. Centrifugation and vortexing during nucleic acid extraction can produce aerosols; therefore, during centrifuging, sealed rotor caps should be utilized, and contamination should be avoided. During centrifugation, the lids should be tightly closed, the speed limit should not be exceeded, plastic centrifuge tubes should be used rather than glass tubes because glass tubes can break, and centrifuges should be used inside a BSC class II if at all possible. Each laboratory should undertake a risk assessment, identify potential dangers, develop a standard operating procedure, and train laboratory staff to avoid the spread of COVID-19 before processing COVID-19 samples. Different guidelines during COVID-19 pandemic have been published regarding PPE and Laboratory equipment that you can see list of them [12].

## Discussion

Molecular test and a list of laboratory equipment and reagents required for laboratory diagnosis of COVID-19. Sr. No. Details of PPE and equipment:

- Disposable gloves
- Closed-toe footwear
- Protective eyewear
- Protective laboratory coats
- Disposable shoe covers
- Centrifuge tube 15 ml sterile (250 tubes/ pack)
- Centrifuge tube 50 ml sterile (150 tubes/ pack)
- Microcentrifuge tube (1.5 ml)
- Micropipettes of variable volumes
- Sterilized filter tips
- Vortex
- Mini spin
- Small high-speed centrifuge for RNA extraction process
- Cold centrifuge for sample processing
- Plate spinner
- Real-time PCR machine
- Biosafety cabinet class 2 type II [13].

### Considerations regarding COVID-19 samples

According to the declaration of the World Health Organization, all the specimens during pandemic must be considered potentially infectious. So, all the personnel of the laboratory must use proper PPE while collection, storage, etc. Personnel who handle samples must be trained in spill decontamination. Following receipt of the sample, it should be placed in leak-proof specimen bags, which are secondary containers with a separate sealable pocket for sample storage: A plastic biological hazard bag with proper labeling on the specimen's container and lab request form. Depending on the type of specimen being handled and transported, biosafety requirements must be followed. The sample should not be delivered using pneumatic tube systems. The patient's complete biodata must be submitted in the lab request form, including name, date of birth, and age, and the lab must be notified as quickly as possible when a sample is transferred [14].

### COVID-19 sample collection and processing

When the personnel of the laboratory work with COVID-19 sample, they should follow the Containment level 2 biosafety guidelines. To avoid infection, they must wear PPE1 such as gloves, mask, and face protector. They should ensure that the samples are properly classified and labeled based on their pathogenicity, and that the storage material is not compromised. If the storage material becomes damaged or leaks, the personnel must immediately execute the containment level 3 emergency procedures. Clean the surface of the storage material with alcohol, sodium hypochlorite, or similar disinfectant before handling and processing the sample. Using BSC class II in the diagnostic laboratory of COVID-19 is very important because it protects personnel, product, and the environment against infectious agents. While centrifugation the staffs must wear eye protector, face protector, mask, gloves and laboratory coat. It is very crucial that staff check the centrifuge for any damage or leaks of sample. Before working with COVID-19 specimens, the biosafety of cabinet must be validated by manager of laboratory. Sometimes there is need to more assess of the sample, so the sample must be stored in divided area to avoid contamination [15].

## Conclusion

This review gives a full summary of biosafety recommendations used in the handling of COVID-19 samples all around the world. Although guidelines must differ from nation to country depending on their environment and laboratory setup, there must be certain alterations or upgrades. SARSCoV2 is classified as risk group 3 organisms, according to all prior findings. To limit the danger of transmission in health professional employees, adequate biosafety procedures must be followed when handling, processing, and transporting these samples. The government or other relevant authorities should guarantee that these principles are followed in laboratories. Furthermore, they should provide particular training and awareness programs for health care professionals in order for them to appropriately employ PPE and biosafety measures in accordance with their work context and working environment.

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