

**SARS-COV-2 CORONAVIRUS: NOMENCLATURE,
CLASSIFICATION, STRUCTURE, HISTORY, SYMPTOMS
EPIDEMIOLOGY, PATHOGENESIS, ETIOLOGY,
DIAGNOSES, TREATMENT, AND PREVENTION**

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ABSTRACT

With the onset of the coronavirus pandemic in December 2019 in China, and the alarming rate at which it has spread across the world has unleashed not only fear, but has taken a toll on social, economic, health, and governing capabilities of the various countries infected with the virus. The pandemic is affecting all aspects of life, including industries such as the animal production industry all over the world. This includes plant, livestock and poultry production. Food security is accordingly impacted, as these industries are vital elements that are contributing to securing food to populations worldwide. In this review, light is shed on the origin of coronaviruses with special emphasis on COVID-19. It also includes introduction of symptoms, epidemiology and pathogenesis, etiology, and prevention. As the disease progresses, scientists are working around the clock in the hope of an effective vaccine, and they managed to introduce some to the worldwide populations. The world faces challenges on a day-to-day basis until most people are vaccinated.

Keywords: coronaviruses, COVID-19, epidemiology, vaccine

INTRODUCTION

The COVID-19 pandemic has affected people worldwide and is the fifth pandemic after the Spanish flu of 1918. It originated in Wuhan, China, and has now escalated to more than 200 countries and has infected individuals of almost all ages. The onset of the disease progresses with milder symptoms such as fever, upper respiratory tract symptoms, shortness of breath, and diarrhea and some individuals are asymptomatic. In those patients with severe infection, pneumonia, multiple organ failure, and death have been reported. The pandemic has now claimed the lives of millions and has gained the attention of public health researchers worldwide [1], [2], [3].

The world has previously also suffered epidemics due to coronaviruses in the form of severe acute respiratory syndrome (SARS)-CoV which emerged in Guangdong province of China and again, in September 2012, the Middle East respiratory syndrome (MERS)-CoV. These viruses have a natural and zoonotic



origin which can be reflected in the SARS-CoV-2. The Covid-19 pandemic has not only disrupted physical health but has also negatively impacted mental health, economy, and social framework and large healthcare systems of the world. Government authorities of the world are putting their heads together to determine the safety and precautionary measures. Scientists are continually and tirelessly researching probable diagnostics and vaccines to curb the spread of this pandemic which has proven to be more than a challenge. Currently, there exist only therapeutic and preventive ways to deal with the outbreak [4].

Nomenclature and classification

Coronaviruses belong to the largest group of RNA viruses and are enclosed with positive-strand genomes of 26-32 kb in length. They are abbreviated as “CoVs” due to their crown-like appearance when scanned under an electron microscope [5]. They are classified under the Nidovirales order and include other families such as Coronaviridae, Arteriviridae, Mesoniviridae, and Roniviridae. The Coronaviridae family is again subdivided into Coronavirinae and the Torovirinae [6]. Based on the genetic differences and serological cross-reactivity, the Orthocoronavirinae subfamily is further divided into Alphacoronavirus, Betacoronavirus, Gammacoronavirus, and Deltacoronavirus [7]. The Betacoronavirus group was earlier divided into four lineages: A, B, C, and D. Although recently these have been reclassified and renamed as Embecovirus, Sarbecovirus, Merbecovirus, and Nobecovirus. A fifth subgenus, Hibecovirus, has also been added [6].

The alpha-CoVs consists of human and animal viruses, the beta-CoVs, consists of murine and human viruses, the gamma-CoVs consists of viruses from cetaceans and birds and delta-CoVs consists of viruses from pigs and birds [8]. CoVs have traversed the species barriers and have become transmissible to humans. To date, seven human CoVs (HCoVs) have been identified from which two, HCoV-229E and HCoV-NL63 are α -CoVs and the rest β -CoVs which include HCoV-OC43, HCoV-HKU1, severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV) and SARS-CoV-2. These HCoVs have originated from bats, mice, or domestic animals [5].

Structure of coronaviruses

The coronaviruses have a diameter of about 120 nm along with club-shaped protein spikes protruding from the surface, appearing like a solar corona. They possess four principal structural proteins which are; spike (S; 1160–1400 amino acids), membrane (M; 250 amino acids), envelope (E; 74–109 amino acids), and nucleocapsid (N; 500 amino acids) proteins, all of which are encoded within the 3' end of the viral genome [6]. The S glycoprotein (~150 kDa) is a class I fusion protein and directs attachment to the host receptor. This S protein is cleaved by a host cell protease into distinct subunit, S1, and S2. The former constitutes the major receptor-binding domain of the S protein whereas the latter makes up the stalk of the spike molecule. The M protein is present in abundance, it is small (~25–30 kDa) and gives shape to the virion. The E protein (~8–12 kDa) is present in minute quantities in the virion and the N protein is unique due to its presence in the nucleocapsid [9].

A brief history of discovery of human coronaviruses (HCoVs)

One of the first strains to be isolated from infected individuals with respiratory problems in 1966 was HCoV-229E. The symptoms observed in infected patients were common cold, headache, sneezing, malaise, sore throat, fever, and cough. The following year, HCoV-OC43 strain was isolated from organ cultures. The infections caused by these strains were closely similar to those caused by HCoV-229E. These two strains are actively transmitted during winters. The incubation time of these viruses is on average less than a week and an illness period of two weeks. Studies on human volunteers showed that healthy and fit persons infected with the HCoV-229E strain showed mild flu-like symptoms and a few patients showed acute respiratory tract infection. Phylogenetic evidence has indicated that these strains have originated from bats or rodents [5].

The severe acute respiratory syndrome or more commonly known as SARS was the third HCoV to be discovered and the first to be well-documented. It is otherwise called atypical pneumonia. It was first traced back to Guangdong Province of China in November 2002. The World Health Organization (WHO) reported 8096 infections and 774 casualties in just a span of one year in more than 30 countries. There was a 50% mortality rate observed in the elderly subjects. This virus is believed to have originated from the SARS-CoV found in wild feline animals such as the palm civet in the markets of China and was transmitted to humans by contact when handling these creatures. However, it was later observed that palm civets from the wild or farms were negative for SARS-CoV which could be an indicator that they only served as intermediate hosts and the natural animal host was Chinese horseshoe bats [5]. It is transmitted in humans through cough droplets or mucosae which contain infected fomites. The virus originated in China and then spread to other parts of the world via interpersonal transmission from hospitals, medical institutions, homes, workplaces, and public transport [10]. The symptoms for SARS-CoV were muscular pain, headache, fever, weakness, and chills, followed by dyspnoea, cough, and respiratory discomfort as of late symptoms. On a cellular level, alveolar damage, epithelial cell proliferation, and an increase in macrophages were observed in infected individuals. About 20-30 % of patients needed intensive care and ventilation. The HCoVNL63 strain was more widespread among young children, the elderly, and those with respiratory sicknesses. The underlying symptoms observed were coryza, conjunctivitis, fever, and bronchiolitis. Its rate of incidence was high during early summer, spring, and winter. Another strain, HCoV-KKU1 was linked with acute asthmatic exacerbation in the elderly [5].

The MERS coronavirus (MERS-CoV) was initially isolated in Jeddah, Saudi Arabia from an infected person in September 2012 who was suffering from acute pneumonia and renal failure. The WHO reported 288 deaths, with a mortality rate of 34.5% between September 2012 till July 2014. The virus was contracted by a man returning from Saudi Arabia to South Korea and led to the outbreak of the disease with deaths numbering 36 and a mortality rate of 19.4%. The spread of the MERS-CoV infection is believed to be zoonotic as genomic analysis showed that the virus originated from a bat, which was then transmitted to dromedary camels, the intermediate hosts for transmission to humans [10].



The COVID-19 coronavirus- A pandemic

A brief background

The last twenty years have seen the emergence of several viral diseases as mentioned previously like the SARS-CoV, H1N1, and the MERS-CoV. We now know that these respiratory diseases caused by CoVs can cross species barriers and cause severe illnesses in humans [4].

The COVID-19 pandemic has taken the world by storm since its emergence in December 2019. It originated from Huanan Seafood Market in Wuhan City, Hubei province of China, one of the most densely populated cities with a population crossing 11 million. The wet market traded not only fish but various live animals such as poultry, bats, marmots, and snakes [11]. Hospitals started receiving patients showing severe pneumonia-like symptoms of unknown origin. Surveillance systems installed post the SARS epidemic were again set in motion and throat swab samples collected from infected individuals were tested and on December 31st, 2019, China through the WHO declared the outbreak of the virus. The virus was confirmed to be a CoV. It was found to have a similarity of more than 95% with the bat coronavirus and more than 70% with the SARS-CoV. Samples obtained from the seafood market confirmed the presence of the virus indicating its origin from that place. Cases of infected persons skyrocketed and several cases were reported even though they did not have any exposure to the market. The first fatality was reported on 11th January 2020. The epidemic became explosive during the Chinese New Year when reports of cases started emerging from people returning from Wuhan. Hubei province was soon placed under lockdown and extended to other cities as well. The infection was transmissible from those individuals who did not show any sign of sickness (asymptomatic) and also before the initiation of symptoms [12].

The upsurge of the COVID-19 pandemic which started in China was officially declared by WHO as a state of Public Health Emergency of International Concern (PHEIC) on 30th January 2020. They stated that the spread of the virus could be slowed down employing timely detection, isolation, quick and speedy treatment, and rapid and efficient system to trace contacts [12]. By this time, the virus had already extended to 18 countries and four countries reported cases that spread from human contact. The virus was previously termed 2019-nCoV, the ICTV termed it as the SARS-CoV-2 virus due to its similarity with SARS-CoVs that caused the SARs outbreak. The Director-General of WHO, Dr. Tedros Adhanom Ghebreyesus stated on February 11, 2020, that the disease would be termed 'COVID-19', which is the acronym of "coronavirus disease 2019". The situation spiraled out of control on the 11th of March when the number of cases out of China increased 13 times, the countries with infected individuals had tripled with 118,000 cases in 114 countries and more than 400 deaths. This is when the WHO declared the COVID-19 situation as a pandemic [4], [13].

Symptoms of COVID-19

The symptoms of the infection start appearing post-incubation interval of an average of 5.2 days. The onset of the symptoms until death (if happens) ranges from 6-41 days. This duration is conditioned based on the age and overall immune system of the patient. It is lower in older patients, greater than 60 years in comparison with younger individuals and people with underlying diseases (i.e., hypertension, chronic obstructive pulmonary disease, diabetes, cardiovascular disease). The familiar symptoms at the start of the disease are fever in some people, cough, fatigue, and varies with sputum production, headache, hemoptysis, diarrhea, dyspnoea, and lymphopenia [14]. The clinical features range from asymptomatic to acute respiratory distress syndrome (ARDS) and multiorgan failure [12]. The uniqueness of COVID-19 as compared to previous beta-CoVs is that it affected lower airways which resulted in rhinorrhoea, sneezing, and sore throat [14].

Epidemiology and pathogenesis

As per the report of the WHO COVID-19 dashboard, currently, there are 108,918 new cases, 7,127,753 confirmed cases and 407,159 deaths globally as of 10:47 am CEST June 2020. The data for case comparison of confirmed cases in the WHO regions is as follows: Americas- 3,415,174; Europe- 2,303,361; Eastern Mediterranean- 677,338; South-East Asia- 392,674; Western Pacific- 193,178 and Africa- 145,287. Infection is spread through numerous ways but most commonly from sizable droplets when coughing and sneezing from symptomatic and asymptomatic people, by touching contaminated surfaces and then touching the facial area. The virus may be found in the stools and contaminated water sources. It can remain viable on surfaces for several hours or days [12]. The duration for which the virus can last on several surfaces is plastic- 2-3 days, stainless steel- 2-3 days, cardboard- 1 day, copper- 4 hours. Aerosol transmission of the virus occurs in case of prolonged exposure in closed spaces. People who are either pre- or asymptomatic can be responsible for at least 80% transmission. In intensive care units (ICUs) contamination is dangerously higher than general wards and is known to be present on floors, computers, trash can, sickbed rails, and up to 4 meters from patients. These CoVs can be immobilized by the use of lipid solvents and fumigants like ether (5%), ethanol, and disinfection with chlorine, peroxyacetic acid, and chloroform. Data collected from primary investigations in Wuhan conducted by China CDCs showed that the doubles weekly and basic reproduction number (R_0 - R naught) is 2.2 [4].

Human-to-human transmission initially occurred in Wuhan within families, and also among relatives and friends who came in contact with infected persons. It was reported that 31.3% of patients were those who visited Wuhan and 72.3% of patients who came in contact with people from Wuhan. The rate of transmission among medical personnel took place at 3.8% COVID-19 patients [15].

Etiology of COVID-19

The SARS-CoV-2 originates from the betaCoV genus, it is round or elliptic with a diameter of about 60-140 nm. The genome isolated from a patient from Wuhan showed that the virus had an 89% nucleotide which identifies with bat



SARS-like- CoVZXC21 and 82% with human SARS-CoV which is why it is given the name SARS-CoV-2. It contains 29891 nucleotides encoding 9860 amino acids [4].

Diagnosis of COVID-19

Diagnosis is carried out by molecular testing on samples such as throat swabs, nasopharyngeal swab, sputum, endotracheal aspirates, and bronchoalveolar lavage. Some laboratory investigations are non-specific. The white blood cell count is generally less. A possibility of lymphopenia; a lymphocyte count of less than 1000 is normally indicative of chronic disease. The platelet count is either within range or low. The C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are slightly higher but procalcitonin levels are normal. A high procalcitonin level can indicate bacterial co-infection. The ALT/AST, prothrombin time, creatinine, D-dimer, CPK, and LDH may rise and high levels are associated with severe disease [12]. An X-ray of the chest area shows bilateral multifocal alveolar opacities, in advanced infection but is normal in early stages. Chest computed tomography (CT) is used for COVID-19 pneumonia in initial stages [4].

Treatment of COVID-19

To date, there is no antiviral treatment or vaccine available against COVID-19. Presently treatments that exist mainly rely on symptomatic and respiratory parameters. The detection and treatment of pneumonia caused by COVID-19 as issued by the National Health Commission of China recommend oxygen therapy and extracorporeal membrane oxygenation (ECMO) to patients with refractory hypoxemia. Several antiviral drugs and systemic corticosteroid treatments including oseltamivir, peramivir, zanamivir, ganciclovir, acyclovir, and ribavirin, as well as methylprednisolone, are not recommended. Based on previous experiences with dealing with the SARS-CoV and MERS-CoV, several drugs have been used for treating COVID-19. The US has reported that its first case of the virus was successfully treated using the drug Remdesivir. Chloroquine which is used to treat malaria in combination with Remdesivir had proven to be effective [15]. The use of non-invasive (NIV) and invasive mechanical ventilation (IMV) is required during times of respiratory failure caused due to resistance to oxygen therapy [4]. Besides all of the aforementioned, the first step that should be taken in isolation to prevent transmission of the virus to any other person. Mild symptoms can be controlled at home and through proper hydration and nutrient-rich diet [12].

Prevention of COVID-19

As there is no confirmed treatment for this disease, prevention is of utmost importance. For mild symptoms, isolation at home is recommended with proper ventilation and sufficient sunlight [12]. The WHO along with other organizations recommend the following [4]:

- Keep away from persons having acute respiratory infections
- Washing of hands for a minimum of twenty seconds, particularly after contact with infected individuals or environment

- Using sanitizer and avoiding contact with face or mouth after touching contaminated surfaces
- Avoid exposure to domestic or wild animals
- Persons with any respiratory symptoms should avoid crowds, wear a mask, follow proper etiquettes of covering their mouth when coughing or sneezing with disposable tissues or clothes

Healthcare workers face the biggest threat in COVID-19 transmission. They should take the utmost care by following all necessary protocols, starting with wearing a surgical mask or N95 masks and protective gear and goggles if they need to be near a patient and following the recommended hygiene practice of handwashing after a duration of 15 minutes or so. They should also be checked regularly for the onset of the symptoms. Patients can only be discharged if they have no fever for three days and two consecutive negative molecular tests of a one-day sampling interval. Lockdowns have been incorporated in all affected countries, people were asked to stay away from crowded places and limit travel. Although the use of masks for healthy people is not recommended by WHO as it has not been shown to protect against the disease but in China, the government has enforced wearing masks [12].

The COVID-19 outbreak has disrupted the economic, medical, and public health of the majority of the world. Health care workers are being overworked, frustrated, and exhausted besides facing high risks of infection [15]. The scenario brought about by the COVID-19 pandemic is constantly changing and is reflective of the mortality rates, research, and the never-ending search for a potential vaccine. The world will be able to normalize only as time progresses and every country is free of COVID-19.

CONCLUSION

Through the numerous literature sources and documents released since the outbreak of this pandemic in December 2019 in China, this paper offers a structured point of view of the CoVs, in terms of classification, history, and detailed review of the COVID-19 disease. Such publications introduce the newcomer to the public that should be aware of the current pandemic. With each day passing, the virus brings out a new angle of public and global health. It has wreaked havoc in the world with so many questions still unanswered and what seems to be a never-ending search for a vaccine making and development. The medical personnel has been facing the ever-challenging side of this virus along with governments to contain and provide all necessary resources to sustain human life and minimize losses. The public worldwide should be trained on practices to reduce infection and face the virus. All people with all ages and sectors should cooperate to face the pandemic and save their lives.

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