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A Knowledge Update on SARS-Coronavirus-2 (SARS-CoV-2)/COVID-19 and Its Global Public Health Implications

Mahendra Pal[1], Gemechu Berhanu Kerorsa[2], Venkataramana Kandi[3,*]

[1]Narayan Consultancy on Veterinary Public Health and Microbiology, Anand, India
[2]College of Agriculture and Veterinary Medicine, Dambi Dollo University, Dambi Dollo, Ethiopia
[3]Department of Microbiology, Pratima Institute of Medical Sciences, Karimnagar, India
*Corresponding author: ramana_20021@rediffmail.com, ramana20021@gmail.com

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Abstract The Coronavirus disease 2019 (COVID-19) is a globally declared pandemic viral disease caused by a novel virus, the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) affecting the respiratory tract. This disease has caused high morbidity as well as mortality in susceptible populations throughout the world. Currently, COVID-19 is spreading to most countries of the world including European, American, Asian, and African countries. In these countries, the death rates of the disease have been different. The possible mechanisms of transmission of the disease include droplet inhalation, direct contact with the person infected by the disease, and indirect contact transmission. Common clinical spectrum of the disease includes high fever, dry or productive cough, shortness, and difficulty of breathing, sore throat, general weakness, myalgia, and chills. The disease can be diagnosed using clinical history, travel history, contact history, clinical signs, and different laboratory tests. The emergence of COVID-19 resulted in health, social, economic, and political problems across the globe. There is no single specific antiviral therapy and a vaccine for COVID-19, and the current treatments are almost supportive. Therefore, proper control and preventive measures that include physical/social distancing, washing hands frequently with soap and water, disinfecting hands and objects with sanitizers and alcohol, avoiding contact of contaminated objects, using proper personal protective equipment, and public education could minimize the transmission.

Keywords: *COVID-19, Global threat, Pandemic, Public Health, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), control and preventive measures*

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1. Introduction & Background

Coronavirus disease 2019 (COVID-19) is a novel viral disease that affects the respiratory tract (upper and lower) in infected people. COVID-19 may result in mild, asymptomatic to life-threatening infections, equally affecting people living in both developing and developed countries [1,2]. After the outbreak in Wuhan, Hubei province, China, the disease has spread globally, affecting more than 200 countries, and was declared by the World Health Organization (WHO) as pandemic disease on January 11, 2020 [3,4]. This disease, caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has caused serious public health problems in humans more than its predecessors (SARS-CoV), and Middle East Respiratory Syndrome CoV (MERS-CoV)) [5].

Human CoVs and their infections are not rare as evidenced by the fact that they cause almost 20% of the seasonal cold episodes suffered by humans. Novel CoVs have been noted to emerge in the past decade. These CoVs can attach to the human cells, in contrast to the existing CoVs. Previous research had observed that the SARS-CoV-2 might have emerged from the Pangolins (ant-eater) rather than the bats. It was noted that the SARS-CoV-2 although it is 99% similar to the bat CoV, the receptor-binding domain (RBD) in the S-protein is only 60% similar. Whereas the CoV observed in the Pangolins although it is only 90% similar to the SARS-CoV-2, there was a 99% similarity in terms of the RBD of the S-protein. This RBD on the S-protein is used by the SARS-CoV-2 to attach to the Angiotensin-converting enzyme-2 (ACE2) receptors present on various human cells, including the cells of the respiratory tract [6].

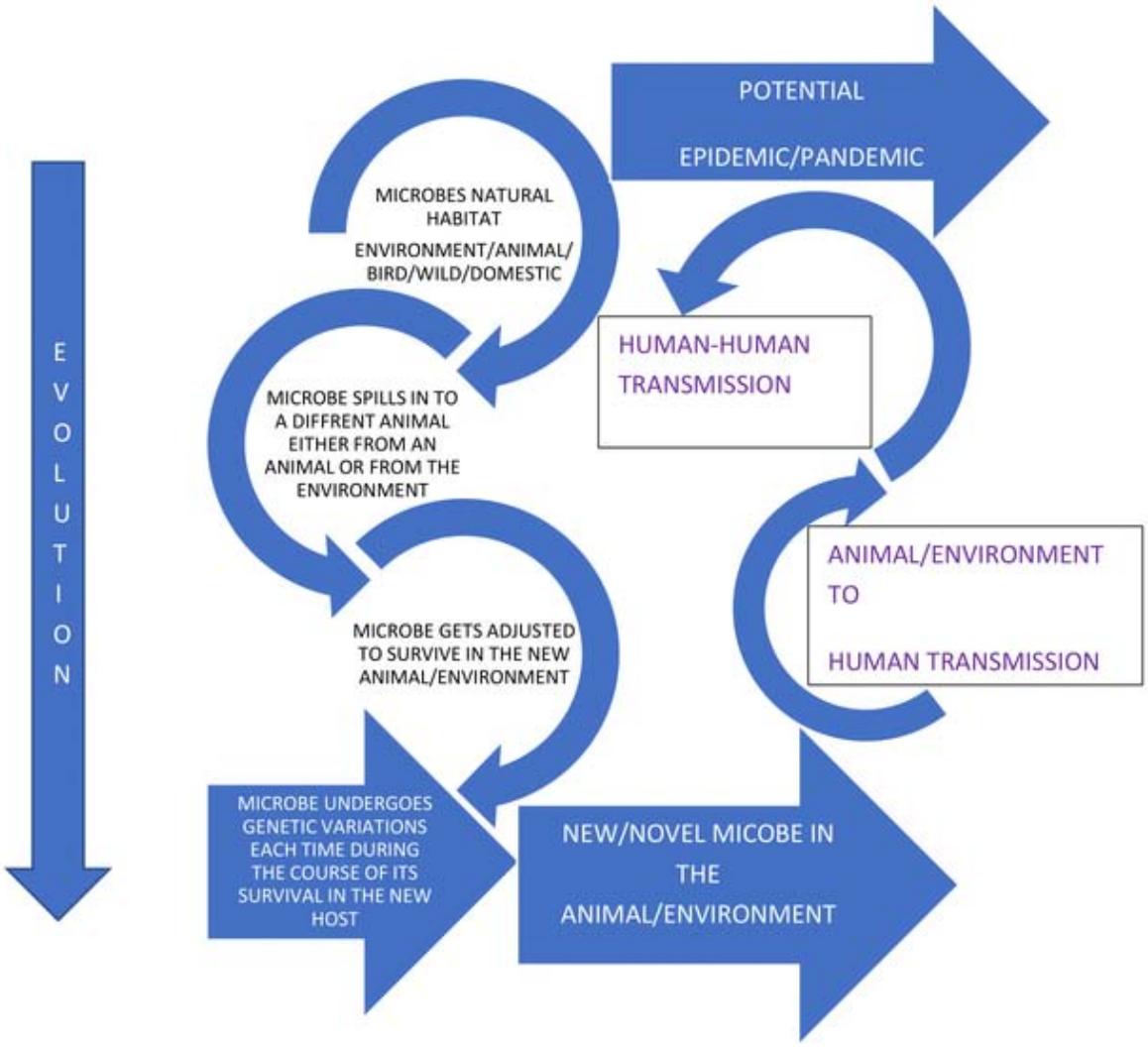

Figure 1. Potential mechanism behind the evolution of a novel microbial species

With wide host adaptability, and the ability to undergo mutations and genetic recombination, CoVs may continue to pose a potential threat to public health. The microbes, with their ability to undergo genetic variations, and survive inside different hosts may evolve into a novel species as evidenced from our previous experience with the Influenza virus. The novel CoV may have evolved in a similar fashion. The potential mechanism by which a novel microbial species may emerge on the earth and pose a threat to mankind is shown in Figure 1.

Studies thus far have noted that there may be two types of SARS-CoV-2 strains (L, and S type) circulating throughout the world. But the good news is that the SARS-CoV-2 is comparatively stable than its predecessor SARS-CoV in terms of the mutations and the genetic variations. SARS-CoV and its elimination from the humans were noted to be due to the 29-nucleotide deletion that occurred during the human-human transmission [7,8,9].

It is interesting to note that the mortality rates associated with the SARS-CoV-2 infection (<10%%), although are significantly lower than the mortality rates of both the SARS-CoV (10%) and the MERS CoV (>30%), the cause of concern is the potential public health threat that it poses globally with its increased transmission rates [10].

COVID-19 may result in severe morbidity, mortality, and poor obstetric effects, which include maternal morbidity, and loss of life as observed from a previous study [11]. The lockdown principles and a state of emergency implemented by many countries of the world have caused increased economic losses, affecting both developing and developed countries. Moreover, the emergence of COVID-19 could cause psychological, social, and political impacts globally [3,12]. Currently, the COVID-19 cases throughout the world surpass 30,00,000 with more than 210, 000 people losing their lives.

The present review provides a knowledge update on the epidemiology, transmission, clinical spectrum, diagnosis, treatment, and control of COVID-19, which is currently a major global public health concern.

2. Review

2.1. Epidemiology

Even though deadly cases have been occurring throughout the world, the medical severity of COVID-19 is exactly not known, especially in terms of the recurrence of the infection, and the effects of infection in pregnant women, children, and other vulnerable populations.

SARS-CoV-2 has wide host adaptability that includes humans, birds, livestock, masked palm civets, mice, dogs, cats, camels, pigs, chickens, and bats, wherein they typically cause respiratory illness [3,13]. COVID-19 continues to spread globally affecting most countries of the European, American, Asian, and African continents [4]. The confirmed cases of COVID-19 have been high in the United States of America (USA), Spain, Italy, Germany, France, China, Iran, the United Kingdom (UK), Turkey, and Belgium. Interestingly, these countries have revealed different mortality rates of the SARS-CoV-2 infection.

Globally, the mortality rate of SARS-CoV-2 infection stands at 7.05%. Varied mortality rates were noted in the WHO European Region (9.47%), American region (5.23%), Eastern Mediterranean region (4.08%), Western Pacific region (4.12%), South-East Asia region (3.86%), and African region (3.79%) as of April 30, 2020, as determined from the numbers reported by the WHO [14].

The WHO has categorized the SARS-CoV-2 transmission in the respective countries as a cluster of cases, sporadic cases, and community spread. The sporadic spread is when one or more cases are reported and most of them imported, and a few found locally. When cases are reported in a particular geographical region, in a cluster, and with common exposure history, it is considered as a cluster transmission. Community transmission is established when there are a greater number of cases reported with un-linkable transmission chains from various regions of a country. Of the 179 countries and 34 territories which have been affected by the SARS-CoV-2 infection, 73 (40.78%) countries including India, China, Japan, Australia, Russia, Saudi Arabia, Pakistan, reported cluster cases. Sporadic infections were reported by 37 (20.67%) countries which included several countries from the WHO African region, a few countries under the Americas, Bhutan, Nepal, and others. Community transmission was reported from most countries (28/53; 52.83%) under the European region that includes the United Kingdom, Spain, Italy, France, and others. Among the South-East Asian region, only Indonesia reported community spread. Many countries under the Americas (12/35; 34.28%) which include the USA, Brazil, Canada, Mexico, and others reported community spread of the SARS-CoV-2 infection. Only South Africa, Algeria, Nigeria, Guinea, Mauritius, and Burkina Faso under the African region reported community spread [14].

2.2. Transmission and Reservoir

There are different modes of transmission of the novel coronavirus disease (nCOVID), but the exact mechanisms of transmission are not yet identified, especially about the role of domestic and wild animals (zoonoses) in the disease transmission. The SARS-CoV, which emerged in the Chinese land in the year 2002, was thought to have spilled over to the humans from its natural animal reservoirs including the bats, Himalayan palm civets (*Paguma larvata*), and raccoon dogs (*Nyctereutes procyonoides*), as evidenced from the previous research study [15].

The possible mechanisms of transmission of SARS-CoV-2 include droplet inhalation; direct contact with the person infected by the disease, direct contact with the persons exposed to the virus (animal/meat handlers), infected animals, and indirect (fomites) contact transmission [3,5]. The potential reservoirs for SARS-CoV-2 are bats. Protein sequences alignment and phylogenetic analysis showed that turtles, pangolin, and snakes have been identified as alternative intermediate hosts for SARS-CoV-2 [16].

The SARS-CoV-2 appears to be less lethal and highly transmissible than its predecessor SARS-CoV, which was more lethal but had low transmissibility rates. It is important to understand the host adaptability, interspecies interactions, and the mechanisms underlying the ability of the virus to undergo genetic variations to predict and prevent the potential future emergence and re-emergence of the existing and novel viral infectious agents.

Interestingly, all the seven human CoVs (HCoV-229E, HCoV-NL63 HCoV-OC43, HKU1, SARS-CoV, Middle East respiratory syndrome coronavirus (MERS-CoV), SARS-CoV-2) discovered thus far have their origins from the bats, mice, Turkey, cow, pig, cats, and dogs [17].

The transmission rate, which is measured as R0 (R naught, is a mathematical representation of the average number of secondary infections that arise due to a single infected patient), is less than 1 (each infected person can transmit the infection to a maximum of 1 person) for the previously emerged SARS-COV, and the MERS-CoV, in contrast to an R0 >2 for the SARS-CoV-2. The R0 depends on the density of the population at a given area as observed in the case of the influenza viral infection (H1N1) transmission where the R0 (2.8-16.9) was significantly more in the school settings as compared to the R0 (1.2-2.4) in the community areas [18].

2.3. Clinical Spectrum

The incubation period of the nCOVID may range from 3-6 days, which is almost similar to most other HCoVs (2-4 days) except the SARS-CoV, and the MERS-CoV which have an incubation period of 2-14 days.

Clinical manifestation of nCOVID includes systemic symptoms such as high fever, chills, dry or productive cough, shortness and difficulty of breathing, sore throat, general weakness, malaise, myalgia or fatigue, expectoration, and hemoptysis. Some patients may develop pneumonia later as a complication of the infection. Serious complications, such as heart failure, respiratory failure, and liver failure are most likely to occur, and the infection may be severe in elderly and immunocompromised patients [5,19,20]. There is a significant difference in the clinical manifestations of the HCoVs which were present previously, and those which have emerged within the last decade. The nCoVs including the SARS-CoV, the MERS-CoV, and the SARS-CoV-2 infected patients present with fever, dry cough, and dyspnea in contrast to the symptoms like running nose/rhinorrhea or common cold-like illness which is observed in other HCoV infected patients [17].

SARS-CoV-2 infection in children was evaluated in a recent study which revealed that males (60.8%) were infected more than females (39.2%). This study had observed that 35% of the children infected either were asymptomatic or had only upper respiratory tract

symptoms, and 65% had shown symptoms of pneumonia. This study results have also noted that around 45% of patients developed signs and symptoms that include fever, cough, pharyngitis/pharyngeal erythema, and tachypnoea. Less than 10% of infected patients suffered from rhinorrhea, diarrhea, fatigue, and nasal congestion [21].

The adults infected with SARS-CoV-2 usually present with fever (78%) and cough (63%). Other clinical features include sore throat (26%), fatigue/weakness (21%), myalgia (28%), chills, headache, diarrhea, nausea, and vomiting [22].

2.4. Diagnosis

The initial diagnosis of COVID-19 includes consideration of clinical history, travel history, contact history, and clinical signs observed in the suspected patient. Other laboratory tests to confirm the diagnosis include molecular tests, such as the real-time polymerase chain reaction (rt-PCR), reverse transcription-polymerase chain reaction (RT-PCR) to detect the viral nucleic acid in the throat swab, and sputum specimens [20]. Virus isolation, serological tests, electron microscopy techniques are used to confirm the disease [19,23].

Radiological imaging features that include the chest computed tomography (CT) scanning may be crucial in the management of infected patients. A previous study had observed that more than 50% of infected patients had bilateral, multifocal, and multiple lobe involvement with more than 70% revealing ground-glass lung opacities. This study had also followed-up the patients for another 1-6 days and had noted that a repeat CT scan of the lungs showed progressive lesions in 73% of patients with only 8% patients revealing the resolution of the lesions. The patients had variable C-reactive protein (rised-42%; normal-58%), and total leucocyte counts (lowered-21%; normal-76%). All the infected patients (100%) were positive for the PCR test [22].

2.5. Treatment

Because of the unavailability of specific antiviral drugs, the therapeutic interventions in COVID-19 patients are almost always considered as supportive and most are repurposed drugs [3,4]. Antiviral treatment with interferon-alpha inhalation and Arbidol has been used [20]. Additionally, a protease inhibitor (Lopinavir/ritonavir) in combination with ribavirin may play a role as antiviral therapy in the early phase whereas nelfinavir is a promising alternative. Other anti-viral treatments such as RNA interference, monoclonal antibody, synthetic peptides, and corticosteroids are used to suppress excessive lung damage due to an inflammatory response. The high flow oxygen supplementation and mechanical ventilation can be used for respiratory failure, and tracheotomy is required in patients requiring prolonged mechanical ventilation and intensive care [4,16,24].

Other therapeutic options include antiviral agents like remdesivir, fevipiravir, and EIDD-2801, rhACE2 (ACE-2 inhibitor), antimalarials (chloroquine, hydroxychloroquine), and vitamin supplementation (vitamin C, D, Zinc, and others). Convalescent plasma transfusion was found effective in the treatment and management of COVID-19 patients, although there is not much concrete evidence to establish its efficacy. It has been observed that the SARS-CoV-2 infection may affect various body systems that include the gastrointestinal system, the cardiovascular system, central nervous system, the kidneys, and liver apart from affecting the lungs to produce acute respiratory distress syndrome (ARDS). Also, it was noted that the infection with SARS-CoV-2 may result in immune dysfunction (spleen and lymph node atrophy, myelocytopenia) [25].

2.6. Control

Given the unavailability of a specific antiviral drug, and due to the lack of a preventive vaccine, measures to prevent the infection and control its spread remain the mainstay. Infected people should cover their nose and mouth while coughing or sneezing, using tissues to contain respiratory secretions, getting rid of tissues within the nearest waste depot after use, avoiding contact with a diseased and suspected person, avoiding contact with different objects with hands and then touching eye, nose, and mouth, social/physical distancing, staying home during an outbreak, using different alcohols and sanitizers to disinfect our hands and different objects before using in our daily life [4,5]. Effective staff education and public awareness regarding infection control measures, using personal protective equipment during handling of an infected case, using masks, washing our hands frequently with water and soap, disinfecting the environment, controlling patient transport, especially from epidemic areas, early diagnosis, isolation and quarantine of the confirmed and suspected/contact cases [3,4]. It is important to identify and reduce transmission from human and animal sources [5]. Communities throughout the world should collaborate and prepare themselves to collectively fight the disease.

There are a few vaccine candidates, which are currently in different phases of clinical trials, and their availability in the market is still awaited. Ad5-nCoV (S-protein of SARS-CoV-2), PittCoVacc (S-protein of SARS-CoV-2), and NVX-CoV2373 (perfusion protein and nanotechnology) are a few vaccines in their phase-1 of the clinical trial [25].

3. Conclusions

COVID-19 is a deadly viral disease that is caused by a novel Coronavirus, SARS-CoV-2. The disease has been declared as a pandemic disease by the WHO, and it affected more than 200 countries of the world with different rates of morbidity and mortality. The disease is majorly transmitted from person to person through aerosol droplets during coughing and sneezing. Other modes of transmission include direct contact/indirect contact with infected/exposed people and fomites. Healthcare workers may get the infection while handling clinical cases and biological specimens in the medical practice. Also, it can be transmitted from animals to humans signifying the zoonotic implications. Clinical signs of the disease include fever, chills, sore throat, dry or productive cough, shortness, and difficulty of breathing. Diagnosis of COVID-19 depends on the clinical history, travel history,

and confirmation of the disease is done using different laboratory techniques that include PCR. COVID-19 has a huge public health, psychological, political, and economic impact. Because of the unavailability of a specific treatment and a vaccine against COVID-19, proper preventive and control measures are particularly important.

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There is nothing to declare.

Author's Contribution

All the authors contributed equally. They read the final version and approved it for publication.

Conflict of Interest

The authors declare that they have no conflict of interest.

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