Open Access Research Journal of
Life Sciences
Journals home page: https://oarjpublication/journals/oarjls/
ISSN: 2783-025X (Online)

(REVIEW ARTICLE)

COVID – 19 Infection: Origin, epidemiology, and clinical features of human coronavirus

Philip Asumang [1,*], Patrick Atta Poku Senior [3], Emmanuel Oppong [1,4], Gadafi Iddrisu Balali [1,2] and Samuel Eguasi Inkabi [5]

[1] *Department of Science, Seventh–Day Adventist College of Education, Agona – Ashanti, Ghana.*
[2] *Department of Theoretical and Applied Biology, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.*
[3] *Department of Agriculture, Sunyani Technical University, Sunyani, Ghana.*
[4] *Department of Science Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Mampong, Ashanti-Ghana.*
[5] *Health Professions Education, College of Graduate Health Studies, A.T. Still University, Kirksville, MO, USA.*

Open Access Research Journal of Life Sciences, 2023, 05(01), 001–009

Publication history: Received on 21 September 2022; revised on 31 October 2022; accepted on 03 November 2022

Article DOI: https://doi.org/10.53022/oarjls.2023.5.1.0073

Abstract

Background: With the onset and spread of the 2019 novel coronavirus (2019-nCoV), a new public health disaster threatened the world. In December 2019, the virus was suggested to have originated from bats and had been transmitted to humans via unidentified intermediary species in Wuhan, Hubei Province, China. There have been about 469, 212, 705 confirmed cases across the globe with about 6, 077, 255 reported deaths as of 03/18/2022. Infection is contracted by inhaling droplets or touching infected surfaces and introducing pick-up viruses to the nose, mouth, and eyes. The coronavirus incubation time is currently believed to be between two and fourteen days after exposure, and the infection can cause the severity of illness, including the death of the patient.

Methods: The study employed a narrative review method to investigate literature and establish the current status of coronavirus and the most effective measures in curbing its infection rate and management of infected persons.

Results: The study revealed that Vitamin C, hydroxychloroquine, antibiotics, and antivirals such as remdesivir and sotrovimab are treatment remedies used in proven instances. At home, adequate ventilation and sunlight are suggested to facilitate the reduction in exposure to SARS-CoV-2. Other prevention strategies include rooms, surfaces, and equipment with regular decontamination preferably with sodium hypochlorite, Individuals are encouraged to take the COVID-19 vaccine.

Conclusion: Various measures outlined in this study have proven to decrease the spread of SARS-CoV-2 in Ghana, with the global consequences of this new disease still being explored.

Keywords: COVID-19; SARS COV-2; Novel Coronavirus; Pandemic

1. Introduction

Coronavirus is a member of the order Nidovirals Coronaviridae family [29]. For the crown-like spikes on the virus's outer surface, it was given the name coronavirus. Coronaviruses have single-stranded RNA as their nucleic material, measuring 65–125 nm in diameter [40]. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or 2019

* Corresponding author: Philip Asumang
Department of Science, Seventh–Day Adventist College of Education, Agona – Ashanti, Ghana.
Copyright © 2023 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution Liscense 4.0.

novel coronavirus (2019-nCoV) rapidly spread from its origin in Wuhan, Hubei Province, China, to the rest of the world [42]. Currently, 469, 212, 705 confirmed cases of coronavirus disease have been recorded worldwide with 6, 077, 252 deaths documented as of March 18, 2022, according to the World Health Organization report in 2021. With varying incidences of infection, India reported 43, 009, 390 cases and 516, 516 deaths, and a total recovery of 42, 467, 774. Ghana, a country in the West African sub-region recorded 160, 775 confirmed cases with 1, 445 deaths as of February 25, 2022, which is among the lowest occurrence rate around the globe with a total of 10, 925, 055, 390 vaccine doses have been administered so far [58]. Africa with the least occurrences and death rate has about 11, 467, 298 confirmed cases with over 251, 291 deaths recorded on March 22, 2022, [58]. However, the virus's future path may be unknown because knowledge about this virus is always evolving, and it is highly recommended for everyone to stay up to date on its transmission. The coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, and is predicted to peak if prevention guidelines are not adhered, without a significant reduction in transmissibility.

2. History

All coronaviruses originated from a common ancestry that lived between 190 and 489 million years ago, according to a phylogenetic study (with a mean of 293) [57]. The four genera split into bat and avian coronavirus ancestry around 2,400 to 3,300 years ago. Bat coronavirus produced Alphacoronavirus and Beta coronavirus which infect mammals, while avian coronavirus produced Gamma coronavirus and Delta coronavirus which infect birds. Zoonotic coronaviruses have recently emerged [39]. SARS-CoV was first transmitted by bats in 1998, although SARS-CoV-2 evolved from bat coronavirus around 1948 [17].

The coronavirus was discovered as a result of the study of virus-caused diseases, owing to a novel type of upper respiratory tract sickness in chickens that were first recorded in North Dakota, USA, in 1931. Later in 1933, the causal agent was discovered as a virus [31]. By 1936, the disease and virus has been identified as distinct from previous viral infections. Infectious bronchitis virus (IBV) was the first term given to it and was later renamed Avian coronavirus [5]. A novel mouse brain disease (murine encephalomyelitis) was discovered in 1947 at Harvard Medical School in Boston. The virus that caused murine encephalomyelitis was known as John Howard Mueller (JHM) [31]. Three years later, the National Institute for Medical Research in London found a novel mouse hepatitis. The causal virus has been identified as Mouse Hepatitis Virus (MHV).

In 1961, a virus was identified in a youngster suffering from a common cold in Epsom, England [2]. The sample (B814) was identified as a new virus in 1965. In 1966, medical students at the University of Chicago found new common cold viruses (designated 229E). IBV, MHV, B814, and 229E all belonged to the same viral family, according to structural studies using transmission electron microscopy [3]. The word coronavirus was coined by June Almeida and David Tyrrell in 1967 because all of the viruses exhibited solar corona-like projections (known as spikes) on their surfaces [17]. Coronaviruses have been found in pigs, dogs, cats, rats, cows, horses, camels, Beluga whales, birds, and bats. As of 2020, 39 species had been identified, with the most abundant source of coronaviruses suggested being originating from bats [32]. All coronaviruses have a common ancestry from about 293 million years ago, including zoonotic species, such as the COVID-19 pandemic's etiological agent, severe acute respiratory syndrome-related coronavirus (SARS-CoV), Middle East respiratory syndrome-related coronavirus (MERS-CoV), and severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV) (SARS-CoV2).

3. Origin and Spread of COVID-19

In different geographical areas, the number of infected cases and COVID-19 death rates differ. Three core variants (A, B, and C) were identified by amino acid variations in phylogenetic network analysis of 160 entire SARS-CoV-2 genomes [18]. Variant A was the abundant genome that was found in bats, with 96.2% sequence similarity to the human virus [60] and was therefore regarded as the original human SARS-CoV-2 genome. Although it was prevalent in Wuhan, where the pandemic had emerged, it was not the dominant genome in the city. Instead, the variant A genome was discovered in a substantial number of Americans who had resided in Wuhan, before being later detected in the United States and Australia. The most common genome in Wuhan and East Asia was variant B, which differs from variant A by two mutations; the fact that it did not spread much beyond China and Southeast Asia without further modification suggests a founder event in Wuhan and/or East Asia [63]. Variant C is predominant in Europe that was initially detected in patients from France, Italy, England, and Sweden, and differed from its parent variant B by a GV mutation [18]. The variant C is not present in mainland China, but has been discovered in Singapore, Hong Kong, Taiwan, and South Korea; variant C was first detected in Italy on January 27, 2020, following a first documented German case and a Singapore cluster. The German COVID-19-infected individual contracted the disease from a Webasto Company employee in

Munich, who had gotten infected by a Chinese colleague in Shanghai when her parents residing in Wuhan visited her. From Italy, the variant then spread to Brazil and Mexico by people who had visited Italy; the virus had undergone 10 mutations during its journey from Wuhan to Italy, Brazil, and Mexico [18].

3.1 Epidemiology and Pathogenesis

COVID-19 can be passed from person to person or through contact with contaminated things [20]. SARS-CoV-2 is passed from person to person mostly through respiratory droplets spread by coughs, sneezes, or even talking. Droplets are normally limited to a distance of six feet, making humans of all ages susceptible [64].

Although COVID-19 infection is spread by symptomatic individuals through coughing and sneezing, it can also be spread by asymptomatic persons even before the symptoms develop [12]. SARS-CoV-2 is contagious in droplets and lasts up to 3 hours in the air [45]. According to studies, the nasal cavity has larger viral loads than the throat, with no change in viral burden between symptomatic and asymptomatic persons [19, 37]. Patients can be infectious for as long as they have symptoms and even after they have recovered clinically [19]. In favorable climatic circumstances, that is, a low temperature and low humidity environment, the virus can survive on surfaces for days, but standard disinfectants such as sodium hypochlorite and hydrogen peroxide can inhibit it in less than an hour [22]. A UK resident who attended a conference in Singapore infected 11 additional persons while vacationing in a resort in the French Alps on returning to the UK [28]. Although it has been reported that COVID-19 RNA has been isolated from blood and stool samples, certain patients who have had positive stool cultures for viable COVID-19, fecal-oral transmission is not a known transmission pathway, according to a WHO-China report [30].

However, a recent study in China using 1070 specimens from 205 COVID-19 patients found that 29% of positive COVID-19 patients were infected through fecal transmission [54]. Xio et al also recorded evidence of SARS-CoV-2 infection in the gastrointestinal tract and depicted the danger of virus transmission via the fecal-oral route, which could be a plausible pathway for SARS-CoV-2 transmission [59]. It appears that the risk of virus transmission is higher than previously thought. SARS-CoV-2 transplacental transmission from a pregnant woman infected with COVID-19 during late pregnancy to her fetus was described by Schwartz and Morotti [47]. Results presented by the European Centre for Disease Control revealed that the viral load in placental tissue was substantially higher than in amniotic fluid or maternal blood, observing the presence of both the "E" and "S" genes in SARS-CoV-2 confirmed the positive outcome. Therefore, the placental tissue had a substantially greater viral load than amniotic fluid or maternal blood [8].

Infected droplets can travel up to about 2 meters before settling on a surface [64]. Infection is contracted by inhaling these droplets or contacting infected surfaces and touching the nose, mouth, and eyes. Neonatal illness caused by postnatal transmission, on the other hand, has been documented [48]. The incubation period for the coronavirus is currently estimated to be between 2- and 14-days following exposure, according to Linton, et al. [34]. More than 97% of persons who get SARS-CoV-2 show symptoms within 11.5 days after contact, according to Walsh, et al. [53]. Incubation time is calculated to be around 5 days on average [62]. However, with the introduction of the Delta variant of SARS-CoV-2, the incubation period appeared to have reduced [26]. This variation of the coronavirus replicates at a faster rate and in more numbers than prior coronavirus strains. The Delta variant of SARS-CoV-2 was compared to the original strain and researchers discovered that the Delta variant's incubation period was 4 days, which was 2 days shorter than the original SARS-CoV-2 strain's incubation period of 6 days [56]. Angiotensin receptor 2 (ACE2) has been identified as the virus's receptor that enters the respiratory mucosa [52]. Various modeling studies estimate the basic case reproduction rate (BCR) to be between 2 and 6.47. SARS had a BCR of 2 and pandemic flu H1N1 2009 had a BCR of 1.3 [7].

3.2 Clinical Features

COVID-19 has a wide range of clinical outcomes, and there is no comprehensive research on its genuine clinical characteristics. Although SARS-CoV-2 is classified as a respiratory virus due to the presence of cellular receptors (ACE2) for virus entrance into host cells in most organs, the infection is not limited to the lungs and could be classified as a multi-organ infection with pulmonary and extrapulmonary consequences [6]. Adults infected with COVID-19 can experience a wide range of symptoms and severity of illness, ranging from asymptomatic to mild, moderate, or severe disease. In about 80 % of patients, infection is asymptomatic or mild, while in 20 % of infected patients, the disease advances to a severe stage with severe respiratory signs [43]. Fever, cough, headache, lethargy, myalgia, malaise, shortness of breath, or difficulty breathing are the most common symptoms of COVID-19 [1]. Sore throats, muscle aches, disorientation, sputum production, rhinorrhea, chest discomfort, conjunctivitis, diarrhea, nausea, and vomiting, on the other hand, are less common in infected people. Therefore, this disease cannot be distinguished from other respiratory diseases. COVID-19 is categorized into four levels according to the severity of clinical symptoms: mild, moderate, severe, and critical [23, 51] as shown in Table 1 below.

Table 1 Clinical symptoms of four COVID-19 levels

Disease Name	Level of COVID-19 symptoms	Clinical symptoms
COVID-19	Mild	The patients have relatively minor symptoms that are not detectable on radiographs.
	Moderate	Fever, loss of taste and smell, respiratory symptoms, and radiographic features such as ground-glass opacity.
	Severe	Severe respiratory symptoms may include oxygen saturation <93 % in ambient air and Dyspnea.
	Critical	A condition known as ARDS (acute respiratory distress syndrome) can occur, the most severe of all is, patients may develop sepsis, and other physiological organs cease to function, posing a serious health risk, even death.

Interestingly, patients outside Hubei province were reported to have milder diseases than those from Wuhan [49]. Similarly, outside of China, the severity and the case fatality rate were found to be lower [33]. This could be owing to selection bias, with only the most severe cases reported from Wuhan, or a propensity of the Asian population to the virus due to increased expression of ACE2 receptors on the respiratory mucosa [38].

Disease in neonates, babies, and children has also been found to be much less severe than in adults [35]. There were 14 males and 20 females among 34 youngsters hospitalized in a hospital in Shenzhen, China, between January 19th and February 7th, 2020 [55]. The median age of the youngsters was 8 to 11 years old, 28 of them had a family member infected, and 26 of them had visited or lived in China's Hubei region. All of the patients were asymptomatic (9 %) or had a minor form of the condition. There were no cases that were severe or critical. Fever (50%) and cough (25%) were the most frequent symptoms (38%). There were no deaths recorded, and all of the patients recovered treated based on their symptoms. There has also been one incidence of severe pneumonia and multiorgan dysfunction in a toddler [10]. Similarly, the recorded neonatal instances have all been mild [36]. Overall, the elderly and immunocompromised patients are more susceptible to COVID-19's severe manifestations, and their mortality rate is higher than that of young and middle-aged people [16, 41]. Furthermore, this virus has not been found in mothers' breast milk [14]; however, mothers who have been infected with SARS-CoV-2 are advised to utilize personal protective equipment while breastfeeding their children [21].

3.3 Treatment

The first step in managing COVID-19 was to provide proper isolation of suspected infected persons to prevent transmission to other contacts, patients, and healthcare professionals. Mild illnesses were mostly treated at home with education on warning signs. Maintaining hydration and nourishment, as well as controlling fever and cough, were common themes. In confirmed cases, vitamin C, Hydroxychloroquine, antibiotics, and antivirals such as remdesivir and sotrovimab were used for treatment [44]. While current worldwide consensus and the WHO suggest against the use of corticosteroids, the Chinese health ministry recommended short-term therapy with low-to-moderate dose corticosteroids in COVID-19 ARDS [9, 49]. COVID-19 has no approved treatment at this time, although various therapies such as have are being authorized for emergency use Ivermectin [61]. Based on the experience with SARS and MERS, antiviral medications such as ribavirin and lopinavir-ritonavir have been employed [4]. Patients treated with lopinavir-ritonavir with ribavirin showed better outcomes than those treated with ribavirin alone in a historical control trial in patients with SARS [13].

In a case series of 99 hospitalized patients with COVID-19 infection from Wuhan, oxygen was given to 76 %, non-invasive ventilation to 13 %, mechanical ventilation to 4 %, extracorporeal membrane oxygenation (ECMO) to 3 %, continuous renal replacement therapy (CRRT) to 9 %, antibiotics to 71 %, antifungals to 15 %, glucocorticoids to 19 %, and intravenous immunoglobulin therapy to 27 % [11]. 75 % of the patients received antiviral medication that included oseltamivir, ganciclovir, and lopinavir-ritonavir. Noninvasive ventilation lasted 4–22 days [median 9 days], while mechanical ventilation lasted 3–20 days [median 17 days]. All of the children in the case series reported earlier recovered with basic treatment and did not require intensive care [59]. More evidence is needed before these drugs are recommended. Other drugs proposed for therapy are arbidol (an antiviral drug available in Russia and China), intravenous immunoglobulin, interferons, chloroquine, and plasma of patients recovered from COVID-19 [46, 50]. Additionally, recommendations about using traditional Chinese herbs find a place in the Chinese treatment guidelines [25].

3.4 Prevention

Because there are now no approved therapies for this infection, it is critical to take precautions. Non-specific features of the disease, infectivity even before the onset of symptoms in the incubation period, transmission from asymptomatic people, long incubation period, tropism for mucosal surfaces such as the conjunctiva, prolonged duration of the illness, and transmission even after clinical recovery are just some of the characteristics of this virus that make prevention difficult [49].

It is suggested that confirmed or suspected cases of mild sickness must isolate themselves at home. To allow the virus to be destroyed, sufficient ventilation and sunlight should be provided at home and in habiting spaces [15]. Cough hygiene and the use of a basic surgical mask should be utilized by all patients. When in the same room as the patient, caregivers should wear a surgical mask and practice hand hygiene every 15–20 minutes.

The spread of COVID-19 to healthcare personnel poses the greatest danger. In the 2002 SARS pandemic, healthcare professionals accounted for 21 % of those afflicted [27]. Protecting healthcare personnel is critical to ensuring continuity of care and preventing infection transfer to other patients. Even though COVID-19 is a droplet pathogen classified as Category B (extremely pathogenic H5N1 and SARS), the China National Health Commission recommends infection control measures for Category A agents (cholera, plague) [24]. Patients should be put in different rooms or groups. Decontamination of the rooms, surfaces, and equipment should be done regularly, ideally using sodium hypochlorite. N95 respirators and protective equipment should be offered to healthcare professionals who have been fit-tested. COVID-19 symptoms should be closely evaluated in all interactions, including with healthcare staff. Patients can be released from isolation after three days of afebrile status and two consecutive negative molecular tests at a one-day sampling interval. This differs from the pandemic flu recommendation, which suggested that patients could return to work/school once afebrile for 24 hours or by day 7 of illness.

People should do well to avoid congested locations and postpone non-essential travel to areas where transmission is still active at the community level. They should be encouraged to cough into a sleeve or tissue rather than their hands, and to wash their hands every 15-20 minutes. Surgical masks should be required for patients with respiratory complaints. The use of a mask by healthy people in public settings has not been demonstrated to protect against respiratory virus infections, and the World Health Organization does not currently mandate its usage. In Ghana, however, the public is required to wear masks in public, particularly in congested areas, and large-scale gatherings (church and funeral activities) are permitted with no congestion of people.

The international outpouring of support has been overwhelming. People returning from Ghana or evacuated from Ghana are being assessed for clinical symptoms, isolated, and tested for COVID-19 for two weeks, even if asymptomatic. However, because of the COVID-19 pandemic, similar travel restrictions were extended to other countries. It has proven to be clear that these efforts have resulted in a reduction in the viral spread in Ghana.

COVID-19 prevention cannot be complete without stating the role that vaccine plays in managing the pandemic. The unprecedented response to the COVID-19 pandemic has made necessitated governments and WHO to call on people to get vaccinated as a preventive measure [65]. The vaccine developmental efforts and deployment for global access have seen a tremendous reduction in the incidence and mortality of COVID-19 patients.

4. Conclusion

This novel virus outbreak has posed a threat to the global economy, public health infrastructure, and medicine, as summarized in this overview of epidemiological studies on the COVID-19 outbreak. This review summarizes the most recent research on COVID-19, including its possible origins, epidemiology, and clinical features. To prevent this viral infectious pandemic, more research into all facets of the illness is urgently needed. We urge collective effort to address the various strains of COVID-19 through vaccination development as a strong base to effectively manage infection and mortality rates.

Compliance with ethical standards

Acknowledgments

The authors are grateful to the Department of Science, Seventh–Day Adventist College of Education, Agona – Ashanti, Ghana for their support.

Disclosure of conflict of interest

The authors declare they have no competing interests.

Statement of ethical approval

Ethical clearance or waiver was not required for this work. This is a literature research determined to be the use of recent publications.

Authors' Contributions

Atta-Poku Senior, Philip Asumang and Emmanuel Oppong participated in the conceptualization and designing of the research protocol. Philip Asumang, Atta-Poku Senior, and Gadafi Iddrisu Balali wrote the first and final draft of the manuscript. Samuel Eguasi Inkabi reviewed and revised the manuscript. All authors read and approved the final manuscript.

Data availability statement

All data used for the study are available upon a reasonable request.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] Al-Najjar, D., Al-Najjar, H. and Al-Rousan, N., 2020. CoVID-19 symptoms analysis of deceased and recovered cases using Chi-square test. *Eur Rev Med Pharmacol Sci*, *24*(21), pp.11428-11431.

[2] Barthold, S.W. and Smith, A.L., 2007. Mouse hepatitis virus. In *The mouse in biomedical research* (pp. 141-178). Academic Press.

[3] Berry, M., Gamieldien, J. and Fielding, B.C., 2015. Identification of new respiratory viruses in the new millennium. *Viruses*, *7*(3), pp.996-1019.

[4] Bimonte, S., Crispo, A., Amore, A., Celentano, E., Cuomo, A. and Cascella, M., 2020. Potential antiviral drugs for SARS-Cov-2 treatment: preclinical findings and ongoing clinical research. *in vivo*, *34*(3 suppl), pp.1597-1602.

[5] Bijlenga, G., Cook, J.K., Gelb, Jr, J. and Wit, J.D., 2004. Development and use of the H strain of avian infectious bronchitis virus from the Netherlands as a vaccine: a review. *Avian Pathology*, *33*(6), pp.550-557.

[6] Bourgonje, A.R., Abdulle, A.E., Timens, W., Hillebrands, J.L., Navis, G.J., Gordijn, S.J., Bolling, M.C., Dijkstra, G., Voors, A.A., Osterhaus, A.D. and van Der Voort, P.H., 2020. Angiotensin-converting enzyme 2 (ACE2), SARS-CoV-2 and the pathophysiology of coronavirus disease 2019 (COVID-19). *The Journal of pathology*, *251*(3), pp.228-248.

[7] Coronavirus, E., 2020. 13,968 Cases and 223 Deaths: https://www. worldometers. info/coronavirus/country /ethiopia. *Accessed on*, 27.

[8] Cai, J., Zhang, Y. and Tang, M., 2021. New evidences that discard the possible vertical transmission of SARS-CoV-2 during pregnancy. *Medicina Clinica (English Ed.)*, *156*(10), p.523.

[9] Chen, Q., Song, Y., Wang, L., Zhang, Y., Han, L., Liu, J., Yang, M., Ma, J. and Wang, T., 2021. Corticosteroids treatment in severe patients with COVID-19: a propensity score matching study. *Expert review of respiratory medicine*, *15*(4), pp.543-552.

[10] Chen, F., Liu, Z.S., Zhang, F.R., Xiong, R.H., Chen, Y., Cheng, X.F., Wang, W.Y. and Ren, J., 2020. First case of severe childhood novel coronavirus pneumonia in China. *Chinese Journal of Pediatrics*, pp.5-5.

[11] Chen, N., Zhou, M., Dong, X., Qu, J., Gong, F., Han, Y., Qiu, Y., Wang, J., Liu, Y., Wei, Y. and Yu, T., 2020. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *The lancet*, *395*(10223), pp.507-513.

[12] Chhikara, B.S., Rathi, B., Singh, J. and Poonam, F.N.U., 2020. Corona virus SARS-CoV-2 disease COVID-19: Infection, prevention and clinical advances of the prospective chemical drug therapeutics. *Chemical Biology Letters*, *7*(1), pp.63-72.

[13] Chu, C.M., Cheng, V.C.C., Hung, I.F.N., Wong, M.M.L., Chan, K.H., Chan, K.S., Kao, R.Y.T., Poon, L.L.M., Wong, C.L.P., Guan, Y. and Peiris, J.S.M., 2004. Role of lopinavir/ritonavir in the treatment of SARS: initial virological and clinical findings. *Thorax*, *59*(3), pp.252-256.

[14] Davanzo, R., Moro, G., Sandri, F., Agosti, M., Moretti, C. and Mosca, F., 2020. Breastfeeding and coronavirus disease-2019: Ad interim indications of the Italian Society of Neonatology endorsed by the Union of European Neonatal & Perinatal Societies. *Maternal & Child Nutrition*, *16*(3), p.e13010.

[15] Dehghannezhad, J., Zamanzadeh, V., Heydarpoor, D.Z., Hassankhani, H., Boyle, M. and Dadashzadeh, A., 2021. Review on home care recommendations for patients with suspected COVID-19 presenting with mild symptoms. *Acta Facultatis Medicae Naissensis*, *38*(4), pp.324-333.

[16] Docea, A.O., Tsatsakis, A., Albulescu, D., Cristea, O., Zlatian, O., Vinceti, M., Moschos, S.A., Tsoukalas, D., Goumenou, M., Drakoulis, N. and Dumanov, J.M., 2020. A new threat from an old enemy: Re-emergence of coronavirus. *International journal of molecular medicine*, *45*(6), pp.1631-1643.

[17] Etido, A., Obeagu, E.I., Okafor, C.J., Chijioke, U.O., Vincent, C.C.N. and Mojo-Eyes, G.C., 2021. The Dynamics of Innate and Adaptive Immune Response to Sars Cov-2 Infection and Its Limitations in Human Beings. *Journal of Pharmaceutical Research International*, pp.10-25.

[18] Forster, P., Forster, L., Renfrew, C. and Forster, M., 2020. Phylogenetic network analysis of SARS-CoV-2 genomes. *Proceedings of the National Academy of Sciences*, *117*(17), pp.9241-9243.

[19] Gengler, I., Wang, J.C., Speth, M.M. and Sedaghat, A.R., 2020. Sinonasal pathophysiology of SARS-CoV-2 and COVID-19: A systematic review of the current evidence. *Laryngoscope investigative otolaryngology*, *5*(3), pp.354-359.

[20] Halabchi, F., Ahmadinejad, Z. and Selk-Ghaffari, M., 2020. COVID-19 epidemic: exercise or not to exercise; that is the question. *Asian J Sports Med*, *11*(1), p.e102630.

[21] Halaji, M., Heiat, M., Faraji, N. and Ranjbar, R., 2021. Epidemiology of COVID-19: An updated review. *Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences*, *26*.

[22] Hudyono, R., Bramantoro, T., Benyamin, B., Dwiandhono, I., Soesilowati, P., Hudyono, A.P., Irmalia, W.R. and Nor, N.A.M., 2020. During and post COVID-19 pandemic: prevention of cross-infection at dental practices in the country with the tropical climate. *Dental Journal (Majalah Kedokteran Gigi)*, *53*(2), pp.81-87.

[23] Irmak, E., 2021. COVID-19 disease severity assessment using CNN model. *IET image processing*, *15*(8), p.1814.

[24] Jain, N., Choudhury, A., Sharma, J., Kumar, V., De, D. and Tiwari, R., 2020. A review of novel coronavirus infection (Coronavirus Disease-19). *Global Journal of Transfusion Medicine*, *5*(1), p.22.

[25] Jin, Y.H., Cai, L., Cheng, Z.S., Cheng, H., Deng, T., Fan, Y.P., Fang, C., Huang, D., Huang, L.Q., Huang, Q. and Han, Y., 2020. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Military Medical Research*, *7*(1), pp.1-23.

[26] Kang, M., Xin, H., Yuan, J., Ali, S.T., Liang, Z., Zhang, J., Hu, T., Lau, E.H., Zhang, Y., Zhang, M. and Cowling, B.J., 2022. Transmission dynamics and epidemiological characteristics of SARS-CoV-2 Delta variant infections in Guangdong, China, May to June 2021. *Eurosurveillance*, *27*(10), p.2100815.

[27] Koh, D., Lim, M.K., Chia, S.E., Ko, S.M., Qian, F., Ng, V., Tan, B.H., Wong, K.S., Chew, W.M., Tang, H.K. and Ng, W., 2005. Risk perception and impact of the severe acute respiratory syndrome (SARS) on work and personal lives of healthcare Workers in Singapore What can we Learn?. *Medical care*, pp.676-682.

[28] Kreidl, P., Schmid, D., Maritschnik, S., Richter, L., Borena, W., Genger, J.W., Popa, A., Penz, T., Bock, C., Bergthaler, A. and Allerberger, F., 2020. Emergence of coronavirus disease 2019 (COVID-19) in Austria. *Wiener Klinische Wochenschrift*, *132*(21), pp.645-652.

[29] Kuhn, J.H., Lauck, M., Bailey, A.L., Shchetinin, A.M., Vishnevskaya, T.V., Bào, Y., Ng, T.F.F., LeBreton, M., Schneider, B.S., Gillis, A. and Tamoufe, U., 2016. Reorganization and expansion of the nidoviral family Arteriviridae. *Archives of virology*, *161*(3), pp.755-768.

[30] Kumar, S., Singh, R., Kumari, N., Karmakar, S., Behera, M., Siddiqui, A.J., Rajput, V.D., Minkina, T., Bauddh, K. and Kumar, N., 2021. Current understanding of the influence of environmental factors on SARS-CoV-2 transmission, persistence, and infectivity. *Environmental Science and Pollution Research*, *28*(6), pp.6267-6288.

[31] Lalchhandama, K., 2020. The chronicles of coronaviruses: the bronchitis, the hepatitis and the common cold. *Science Vision*, *20*(1), pp.43-53.

[32] Latinne, A., Hu, B., Olival, K.J., Zhu, G., Zhang, L., Li, H., Chmura, A.A., Field, H.E., Zambrana-Torrelio, C., Epstein, J.H. and Li, B., 2020. Origin and cross-species transmission of bat coronaviruses in China. *Nature Communications*, *11*(1), pp.1-15.

[33] Leung, K., Wu, J.T., Liu, D. and Leung, G.M., 2020. First-wave COVID-19 transmissibility and severity in China outside Hubei after control measures, and second-wave scenario planning: a modelling impact assessment. *The Lancet*, *395*(10233), pp.1382-1393.

[34] Linton, N.M., Kobayashi, T., Yang, Y., Hayashi, K., Akhmetzhanov, A.R., Jung, S.M., Yuan, B., Kinoshita, R. and Nishiura, H., 2020. Incubation period and other epidemiological characteristics of 2019 novel coronavirus infections with right truncation: a statistical analysis of publicly available case data. *Journal of clinical medicine*, *9*(2), p.538.

[35] Ludvigsson, J.F., 2020. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. *Acta paediatrica*, *109*(6), pp.1088-1095.

[36] Lu, Q. and Shi, Y., 2020. Coronavirus disease (COVID-19) and neonate: What neonatologist need to know. *Journal of medical virology*, *92*(6), pp.564-567.

[37] Mawaddah, A., Genden, H.S., Lum, S.G. and Marina, M.B., 2020. Upper respiratory tract sampling in COVID-19. *The Malaysian journal of pathology*, *42*(1), pp.23-35.

[38] Mehta, N., Kalra, A., Nowacki, A.S., Anjewierden, S., Han, Z., Bhat, P., Carmona-Rubio, A.E., Jacob, M., Procop, G.W., Harrington, S. and Milinovich, A., 2020. Association of use of angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers with testing positive for coronavirus disease 2019 (COVID-19). *JAMA cardiology*, *5*(9), pp.1020-1026.

[39] Miłek, J. and Blicharz-Domańska, K., 2018. Coronaviruses in avian species–review with a focus on epidemiology and diagnosis in wild birds. *Journal of veterinary research*, *62*(3), p.249.

[40] Mukherjee, S., Bera, S. and Chakraborty, M., COVID–19 DIAGNOSIS: A SHORT REVIEW.

[41] Parlakpinar, H. and Gunata, M., 2021. SARS-COV-2 (COVID-19): Cellular and biochemical properties and pharmacological insights into new therapeutic developments. *Cell Biochemistry and Function*, *39*(1), pp.10-28.

[42] Park, S.E., 2020. Epidemiology, virology, and clinical features of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2; Coronavirus Disease-19). *Clinical and experimental pediatrics*, *63*(4), p.119.

[43] Perico, L., Benigni, A., Casiraghi, F., Ng, L.F., Renia, L. and Remuzzi, G., 2021. Immunity, endothelial injury and complement-induced coagulopathy in COVID-19. *Nature Reviews Nephrology*, *17*(1), pp.46-64.

[44] Pires, C., 2021. A Systematic Review on the Contribution of Artificial Intelligence in the Development of Medicines for COVID-2019. *Journal of Personalized Medicine*, *11*(9), p.926.

[45] Rabaan, A.A., Al-Ahmed, S.H., Al-Malkey, M., Alsubki, R., Ezzikouri, S., Al-Hababi, F.H., Sah, R., Al Mutair, A., Alhumaid, S., Al-Tawfiq, J.A. and Al-Omari, A., 2021. Airborne transmission of SARS-CoV-2 is the dominant route of transmission: droplets and aerosols. *Infez Med*, *29*(1), pp.10-19.

[46] Rosa, S.G.V. and Santos, W.C., 2020. Clinical trials on drug repositioning for COVID-19 treatment. *Revista Panamericana de Salud Pública*, *44*, p.e40.

[47] Schwartz, D.A. and Morotti, D., 2020. Placental pathology of COVID-19 with and without fetal and neonatal infection: trophoblast necrosis and chronic histiocytic intervillositis as risk factors for transplacental transmission of SARS-CoV-2. *Viruses*, *12*(11), p.1308.

[48] Salvatore, C.M., Han, J.Y., Acker, K.P., Tiwari, P., Jin, J., Brandler, M., Cangemi, C., Gordon, L., Parow, A., DiPace, J. and DeLaMora, P., 2020. Neonatal management and outcomes during the COVID-19 pandemic: an observation cohort study. *The Lancet Child & Adolescent Health*, *4*(10), pp.721-727.

[49] Singhal, T., 2020. A review of coronavirus disease-2019 (COVID-19). *The indian journal of pediatrics*, *87*(4), pp.281-286.

[50] Song, Y., Zhang, M., Yin, L., Wang, K., Zhou, Y., Zhou, M. and Lu, Y., 2020. COVID-19 treatment: close to a cure? A rapid review of pharmacotherapies for the novel coronavirus (SARS-CoV-2). *International journal of antimicrobial agents*, *56*(2), p.106080.

[51] Sun, Y., Dong, Y., Wang, L., Xie, H., Li, B., Chang, C. and Wang, F.S., 2020. Characteristics and prognostic factors of disease severity in patients with COVID-19: The Beijing experience. *Journal of autoimmunity*, *112*, p.102473.

[52] Verdecchia, P., Cavallini, C., Spanevello, A. and Angeli, F., 2020. The pivotal link between ACE2 deficiency and SARS-CoV-2 infection. *European journal of internal medicine*, *76*, pp.14-20.

[53] Walsh, K.A., Jordan, K., Clyne, B., Rohde, D., Drummond, L., Byrne, P., Ahern, S., Carty, P.G., O'Brien, K.K., O'Murchu, E. and O'Neill, M., 2020. SARS-CoV-2 detection, viral load and infectivity over the course of an infection. *Journal of Infection*, *81*(3), pp.357-371.

[54] Wang, W., Xu, Y., Gao, R., Lu, R., Han, K., Wu, G. and Tan, W., 2020. Detection of SARS-CoV-2 in different types of clinical specimens. *Jama*, *323*(18), pp.1843-1844.

[55] Wang, X.F., Yuan, J., Zheng, Y.J., Chen, J., Bao, Y.M., Wang, Y.R., Wang, L.F., Li, H., Zeng, J.X., Zhang, Y.H. and Liu, Y.X., 2020. Retracted: Clinical and epidemiological characteristics of 34 children with 2019 novel coronavirus infection in Shenzhen. *Zhonghua er ke za zhi= Chinese journal of pediatrics*, *58*, pp. E008-E008.

[56] Wang, Y., Chen, R., Hu, F., Lan, Y., Yang, Z., Zhan, C., Shi, J., Deng, X., Jiang, M., Zhong, S. and Liao, B., 2021. Transmission, viral kinetics and clinical characteristics of the emergent SARS-CoV-2 Delta VOC in Guangzhou, China. *EClinicalMedicine*, *40*, p.101129.

[57] Wertheim, J.O., Chu, D.K., Peiris, J.S., Kosakovsky Pond, S.L. and Poon, L.L., 2013. A case for the ancient origin of coronaviruses. *Journal of Virology*, *87*(12), pp.7039-7045.

[58] World Health Organization, 2021. *COVID-19 strategic preparedness and response plan: 1 February 2021 to 31 January 2022* (No. WHO/WHE/2021.02). World Health Organization.

[59] Xu, X.W., Wu, X.X., Jiang, X.G., Xu, K.J., Ying, L.J., Ma, C.L., Li, S.B., Wang, H.Y., Zhang, S., Gao, H.N. and Sheng, J.F., 2020. Clinical findings in a group of patients infected with the 2019 novel coronavirus (SARS-Cov-2) outside of Wuhan, China: retrospective case series. *bmj*, *368*.

[60] Zhou, P., Yang, X.L., Wang, X.G., Hu, B., Zhang, L., Zhang, W., Si, H.R., Zhu, Y., Li, B., Huang, C.L. and Chen, H.D., 2020. A pneumonia outbreak associated with a new coronavirus of probable bat origin. *nature*, *579*(7798), pp.270-273.

[61] López-Medina, E., López, P., Hurtado, I.C., Dávalos, D.M., Ramirez, O., Martínez, E., Díazgranados, J.A., Oñate, J.M., Chavarriaga, H., Herrera, S. and Parra, B., 2021. Effect of ivermectin on time to resolution of symptoms among adults with mild COVID-19: a randomized clinical trial. *Jama*, *325*(14), pp.1426-1435.

[62] Men, K., Wang, X., Yihao, L., Zhang, G., Hu, J., Gao, Y. and Han, H., 2020. Estimate the incubation period of coronavirus 2019 (COVID-19). *MedRxiv*.

[63] Forster, P., Forster, L., Renfrew, C. and Forster, M., 2020. Phylogenetic network analysis of SARS-CoV-2 genomes. *Proceedings of the National Academy of Sciences*, *117*(17), pp.9241-9243.

[64] Xie, X., Li, Y., Chwang, A.T., Ho, P.L. and Seto, W.H., 2007. How far droplets can move in indoor environments--revisiting the Wells evaporation-falling curve. *Indoor air*, *17*(3), pp.211-225.

[65] Le, T.T., Cramer, J.P., Chen, R. and Mayhew, S., 2020. Evolution of the COVID-19 vaccine development landscape. *Nat Rev Drug Discov*, *19*(10), pp.667-668.