Review Article

International Journal of Research in Pharmaceutical Sciences

Published by JK Welfare & Pharmascope Foundation Journal Home Page: www.ijrps.com

SARS-COV2 virus and Coronavirus disease (COVID-19)

Mohamed J. Saadh*[1], Bashar Haj Rashid M[1], Roa'a Matar[1], Sajeda Riyad Aldibs[1], Hala Sbaih[1], Saed Aldalaen[2]

[1]Faculty of Pharmacy, Middle East University, Amman- 11831, Jordan
[2]Department of Pharmacology, Faculty of Pharmacy, Mutah University, Jordan

Article History:

Received on: 13 Jun 2020
Revised on: 13 Jul 2020
Accepted on: 15 Jul 2020

Keywords:

Chloroquine,
COVID- 19,
SARS-COV2,
Wuhan,
Pneumonia

Abstract

SARS-COV2 virus causes Coronavirus disease (COVID-19) and represents the causative agent of a potentially fatal disease that is of great global public health concern. The novel coronavirus (2019) was discovered in 2019 in Wuhan, the market of the wet animal, China with viral pneumonia cases and is life-threatening. Today, WHO announces *COVID*-19 *outbreak* as *a pandemic*. COVID-19 is likely to be zoonotic. It is transmitted from bats as intermediary animals to human. Also, the virus is transmitted from human to human who is in close contact with others. The computerized tomographic chest scan is usually abnormal even in those with no symptoms or mild disease. Treatment is nearly supportive; the role of antiviral agents is yet to be established. The SARS-COV2 virus spreads faster than its two ancestors, the SARS-CoV and Middle East respiratory syndrome coronavirus (MERS-CoV), but has lower fatality. In this article, we aimed to summarize the transmission, symptoms, pathogenesis, diagnosis, treatment, and vaccine to control the spread of this fatal disease.

*Corresponding Author

Name: Mohamed J. Saadh
Phone: +962 78 6945883
Email: msaadeh@meu.edu.jo

ISSN: 0975-7538

DOI: https://doi.org/10.26452/ijrps.v11iSPL1.3401

Production and Hosted by

IJRPS | www.ijrps.com

INTRODUCTION

Coronaviruses (CoVs) are significant pathogens to humans and vertebrates. They can infect several human systems such as the gastrointestinal, respiratory, hepatic and central nervous system, livestock, avian, bat, mouse and many other wild animals. The reason behind their name comes from the crown-like spikes on the surface. Coronaviruses are divided into four main sub-groupings which are known as alpha, beta, gamma, and delta. The seven human coronaviruses that cause human respiratory diseases: 229E (alpha coronavirus), NL63 (alpha coronavirus), OC43 (beta coronavirus), HKU1 (beta coronavirus), MERS-CoV (beta coronavirus), SARS-CoV (beta coronavirus) and SARS-CoV-2 (beta coronavirus) (Killerby *et al.*, 2014).

Several patients were hospitalized in December 2019 with primary pneumonia diagnosis with aetiology related to seafood consumption in Wuhan, China. On January 5 2020, the World Health Organization (WHO) documented that 11 patients with complicated symptoms were in contact with the Wuhan wet animal market. Some of them had dyspnea, Fever and pulmonary infiltrates on chest radiography (Bogoch *et al.*, 2020). On January 2, 2020, 41 admitted hospital patients had been identified as having laboratory-confirmed severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection or novel coronavirus-2019 (2019-nCoV) (Huang *et al.*, 2020). As China crumbled with the crisis the world watched, it seemed distant to most, but a wave of infections began to appear. The

numbers are increasing exponentially worldwide in both infections and deaths, as it reaches (853,200 cases) with (41,887 deaths) with a mortality rate of (4.9%), while Italy is leading this crisis ranking 2nd in cases (105,792 cases) and 1st in deaths (12,430 deaths) with a mortality rate of (11.7) until April 1, 2020 (in Data, 2020).

Transmission

COVID-19 is likely to be zoonotic, came from bats to human (Andersen *et al.*, 2020). Also the virus transmission from human to human in direct contact with each other (within about 1.82 m) by a respiratory droplet that resulted from sneezing and coughing which cause infection via entering the mouths or noses of human in case of direct connection with less than 1-meter distance with the patient, or by contaminated the solid surfaces with virus particles As a human infected with COVID-19 through touch his nose, mouth, or perhaps his eyes, after touching a surface contaminated with the virus (CDC, 2020). The study is compared to SARS-CoV-2 and SARS-CoV-1 surface stability and aerosol. SARS-CoV-2 was stable in, stainless steel, plastic, copper, aerosols and cardboard as the results demonstrated that SARS-CoV-2 could stay in aerosols for hours and days on surfaces (Van Doremalen *et al.*, 2020).

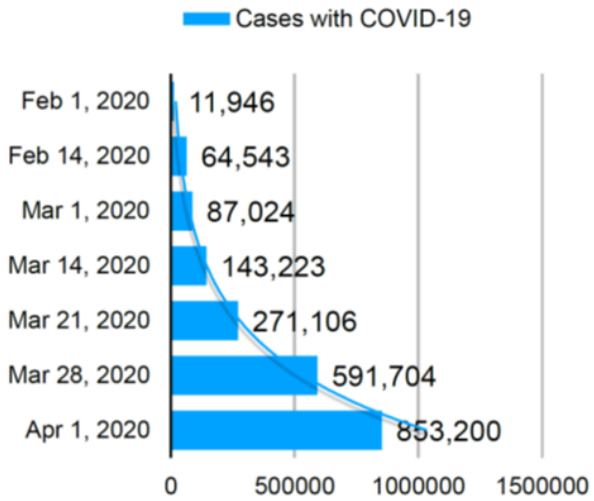

Figure 1: Incidence rate of COVID-*19*

People who have symptoms are the most infectious, but the most dangerous are those who haven't shown any symptoms yet or just anosmia (Mahase, 2020), as they can't feel any symptoms, they keep contacting others and spread the disease. This is one of the most important reasons for the spread of the disease Figure 1. The spread of this disease is severe because the value of R0 (R-nought) was 2.2 for the coronavirus in the initial studies which mean that a person with the disease can spread the virus to an average of 2.2 persons (Riou and Althaus, 2019). There are two futures for a pandemic like COVID-19, a fast pandemic which is terrible and will cause a lot of death, and a slow pandemic which can be managed, so countermeasures should be placed to slow it down like the action of many governments around the globe of imposing curfews and quarantine to slow this pandemic. By this, the health care system will be able to deal with severe cases and lowering the fatality rates (Danon *et al.*, 2020).

Symptoms and Pathogenesis

Most of the cases (55%) of COVID-19 that appeared before January 1, 2020, relate to the wet animal market in Wuhan, China (Li *et al.*, 2020a). The mean incubation period for SARS-CoV-2 was 5.2 days, the number of days from the incidence of the first symptom to death was ranging from six to forty-one days with a median of fourteen days (Wang *et al.*, 2020). So before symptoms began, it has to get to the host Mainly by droplet infection, when humans cough, or when you touch an infected human followed with touching your nose or eyes. The virus starts its journey here and then get deeper into the body so it can infect the entrails, the spleen, and the lungs where it can have the most exciting effect where it can find its target receptor-binding domain (RBD), comprehensive structural analyses have elucidated the interactions atomic-level among spike protein receptor-binding domain (RBD) of SARS-CoV and its host receptor angiotensin-converting enzyme 2 (ACE2) in the organ tissues (Wan *et al.*, 2020). Since the lung is lined by billions of epithelial cells, SARS-CoV-2 connects to ACE2 receptor and inject it's genetic material, the cell fills up with copies of the original virus until it reaches a critical point and the cell lyse releasing viruses ready to infect new cells, by this process the amount of infected cells grows in an exponential way, millions of body cells can be infected after a days, at this point the virus has not caused too much damage yet, until the activation of the immune system, and as immune cells fight the virus, some of them got infected and the infected cells over react releasing chemicals attracting more immune cells causing damage to the health lung tissue causing fibrosis in some cases at this stage most healthy patents start recovering and the body regulates the immune systems, but it nay becomes sever or critical especially elderly patients and those with chronic diseases like hypertension and diabetes, At this time, the immune system needs to recover because it fought at full capacity, here bacteria comes into the picture causing pneumonia making patients needs ventilators to survive, some cases even goes into septicemia which is fetal at this point. Even children have infected

with this virus had shown different degrees of symptoms ranging from Fever to vomiting as we saw in a study conducted in early January in China (Liu *et al.*, 2020). Other patients who have a disadvantage with COVID-19 are those on hypertension medications and with diabetes, SARS- CoV-2 bind to their target cells through angiotensin-converting enzyme 2 (ACE2) which is substantially increased in patients with type 1 or type 2 diabetes and for hypertensive patients. The latter are treated with ACE inhibitors, and angiotensin II type I receptor blockers (ARBs) (Fang *et al.*, 2020).

One non-synonymous SNP was detected in gene encodes S (spike) protein. This SNP replaced Serine amino acid by Leucine, and for this reason, they called the two new strains (S strain) and (L Strain). The former (S) is the wild type which is milder while the latter (L) is the novel one which resulted in high binding affinity between SARS COV-2 virus with ACE2 receptor in human cells. L strain is responsible for pandemic infection and never be seen in any previous version of corona (SARS, MERS) and never be seen in bat, pangolin, civet, and camel (Tang *et al.*, 2020).

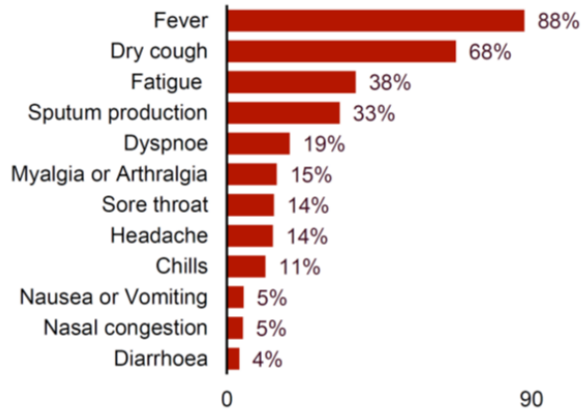

Figure 2: The percentage of symptoms associated with COVID-19

The symptoms of COVID-19 can gradually be developed from Fever, dry cough, followed with shortness of breath, end with pneumonia, respiratory failure, septic shock, and multiple organ failure. The percentage of symptoms from the WHO study see in Figure 2. 30% of positive results of COVID-19 tests in South Korea had anosmia that it is a good indication that COVID-19 patients have anosmia and hyposmia (Antonio and Silvia, 2020). Also, the most cases have similar symptoms to common cold or flu, but as this epidemic spread around the globe and more new cases develop more critical symptoms, we are looking at a significant increase in mortality rate Figure 3.

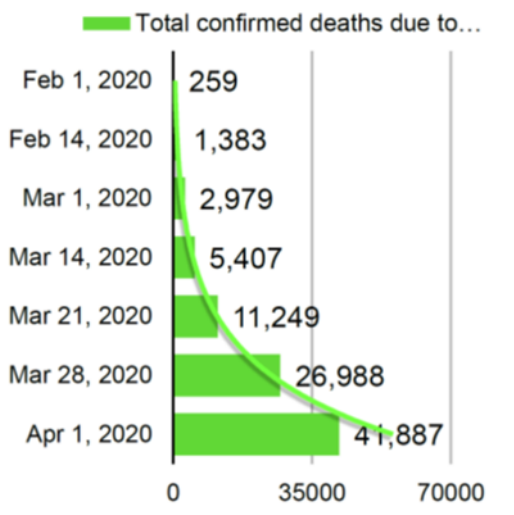

Figure 3: The mortality rate of COVID 19

Diagnosis of Covid-19

IgG/IgM Antibody ELISA

The human IgG/IgM Antibody ELISA for COVID-19 is made from the SARS-CoV-2 N protein-coated microtiter plate, Goat-anti human Antibody-HRP. Indirect ELSA principle is used to test the antibodies against SARS-CoV-2 in human serum. Here, the coated N protein combines with COVID-19 IgG/IgM Antibody in serum, then add secondary antibody-HRP to bind with a complex of antibody-antigens on the microplate specifically, With the TMB substrate, it will generate an amount of colour, The intensity of the colour is relative with the concentration of the COVID-19 IgG/IgM Antibody when the value is greater than the cut-off value, the human has been infected with the SARS-CoV-2 (Li *et al.*, 2020b).

Rapid COVID-19 test

The rapid lateral flow test for COVID-19 used immunochromatography techniques. The card contains colloidal gold-labelled recombinant new coronavirus antigen and quality control antibody gold markers, two detection lines (G and M lines) and one quality Control line (C line) of nitrocellulose membrane, The M line is immobilized with a monoclonal anti-human IgM antibody for detecting a new coronavirus IgM antibody, the G line is immobilized with a reagent for detecting a new Coronavirus IgG antibody, and the C line immobilized with a quality control antibody. If the sample contains an IgG antibody, the antibody will bind to the colloidal gold-labelled new coronavirus antigen, and the immune complex will be captured by the reagent immobilized on the membrane to form a purple-red G line, Indicating that the new Coronavirus IgG antibody is positive. The overall testing specificity was 90.63%, and sensitivity was 88.66% (Li *et al.*, 2020d).

Polymerase chain reaction (PCR)

Real-time reverse-transcription polymerase chain reaction assay for a novel human coronavirus. The confirmation of COVID-19 is accomplished by RT-PCR detection of throat swab samples of suspected patients. Two target genes, including open reading frame 1 lab (ORF1ab) and nucleoside protein (N), and at the same time amplified and tested during the real-time RT-PCR assay. Target 1 (ORF1ab): forward primer CCCTGTGGGTTTTACACTTAA; reverse primer ACGATTGTGCATCAGCTGA; probe 5'-FAM-CCGTCTGCGGTATGTGGAAAGGTTATGG-BHQ1-3'. Target 2 (N): forward Primer GGGGAACTTCTCCTGCTAGAAT; reverse primer CAGACATTTTGCTCTCAAGCTG; probe 5'-FAM TTGCTGCTGCTTGACAGATT- TAMRA-3'. A cycle threshold value (Ct value) less than 37 was defined as a positive record, and a Ct- value exceeds 40 was defined as a negative test (Corman *et al.*, 2020; Zhou *et al.*, 2020).

Inflammatory Markers

In a viral infection, the neutrophils increased. Still, the blood counts of COVID-19 on admission showed a decrease in neutrophils in 39% of patients, lymphocytes in 42% of patients, and eosinophils 72% of patients (Li *et al.*, 2020c). The SARS-CoV-2 infections enhance expression of cytokines and chemokines that can be activated by viral surface glycoproteins, double-stranded RNA, and intracellular viral proteins via signal transduction pathways. CoV infects lung cells via its Spike (S) glycoprotein that binds receptor present on macrophages. Infection of macrophages with CoV S glycoprotein results in suppression of macrophage responses since it reduced the capacity of macrophage to produce TNF-α and IL-6 In naive and led to producing the cytokine IL-10 as immunosuppressive. The erythrocyte sedimentation rate was increased in 57.6 % of patients, and the concentration of C-reactive protein was increased in 68% of patients (Al-Qahtani *et al.*, 2017). Besides, the COVID-19 patients showed an increase in both alanine aminotransferase in 33% of patients and aspartate aminotransferase in 28% of patients. Still, most of the patients count less than 100U/L, and also the lactate dehydrogenase was increased by 41% of COVID-19 patients (Zheng *et al.*, 2019).

Treatment of Covid-19

SARS-CoV-2 surrounded by a lipid envelope bind to the plasma membrane of target cells by attaching to specific proteins on the cell surface. These viruses entry to the cell by receptor-mediated endocytosis and transported to lysosomes. At acid pH the membrane surrounding the virus fuses with the membrane of the lysosome, allowing the nucleic acid of the virus to arrive the cytoplasm to start the virus replicates.

The chloroquine prevents cell infections by blocking the function of lysosomes.

Chloroquine that diffuses into lysosomes and becomes protonated because it has weak base properties, raising the pH and the ionic strength of the lysosome. When the pH rises, the lysosomal enzymes fail to function. With chloroquine, cells are protected from infection because viruses can no longer integrate with cell membranes that require an acid condition—Amantadine, which is used to prevent viral infection in vitro by a similar mechanism. Recently, Zinc sulphate and azithromycin were added to hydroxychloroquine to increase its effectiveness in eliminating the virus (Gautret *et al.*, 2020). Besides, the different antiviral agents have examined their efficacy for the treatment of COVID-19. New Research showed that lopinavir and ritonavir have significant efficacy in controlling the condition. Four volunteers patients with COVID-19 were recruited using a combination of lopinavir and ritonavir. These agents can cause adverse effects such as nausea, vomiting, or diarrhoea, and elevated liver function test results (Wu *et al.*, 2020). Remdesivir, neuraminidase inhibitors, and arbidol were suggested to be clinically studied (Wu *et al.*, 2020). Other studies suggest monoclonal antibodies as a good alternative as it was effective against SARS-COV-1 (Shanmugaraj *et al.*, 2020) or by Immunoglobulin Collected From Recovered Coronavirus in the same area to increase the affinity of neutralizing the virus (intravenous immunoglobulin (IVIg) treatment) (Tang *et al.*, 2020).

Vaccine and Vaccination

One of the reasons why there is no effective vaccine for COVID-19 yet is the high rate of mutations in the because the polymerases of RNA virus lacks the proofreading (Shanmugaraj *et al.*, 2020). But, Some genes of RNA virus are essential to the viral replication cycles, and mutations are not tolerated (Jawhara, 2020). Similarly, One component of the spike protein for SARS-CoV-2 is the receptor-binding domain (RBD) which be useful as a vaccine against this infectious disease. Therefore, one of the most important methods is to either develop a vaccine that contains spike protein antigens or to develop monoclonal antibodies that interacted to the spike protein of the coronavirus and to prevent interaction with human cells (Tian *et al.*, 2020). Also, the most important proteins for the entry and spread of the coronavirus is serine protease across membrane 2, so it can play an important role in

inhibiting the activity of coronavirus (Henrickson, 2020).

CONCLUSION

Coronavirus outbreaks have led to a downturn in the global economy and the impact on public medical and health infrastructures in countries where the disease is prevalent also. The outbreak of this disease may continue until the summer of 2021, so more efforts should be made to prevent future disease outbreaks and to know the methods of diagnosis and treatment.

ACKNOWLEDGEMENT

The author is grateful to the Middle East University, Amman, Jordan, for the financial support granted to cover the publication fee of this research article.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

Funding Support

The authors declare that they have no funding support for this study.

REFERENCES

Al-Qahtani, A. A., Lyroni, K., Aznaourova, M., Tseliou, M., Al-Anazi, M. R., Al-Ahdal, M. N., Alkahtani, S., Sourvinos, G., Tsatsanis, C. 2017. Middle east respiratory syndrome corona virus spike glycoprotein suppresses macrophage responses via DPP4-mediated induction of IRAK-M and PPARγ. *Oncotarget*, 8(6):9053–9066.

Andersen, K. G., Rambaut, A., Lipkin, W. I., Holmes, E. C., Garry, R. F. 2020. The proximal origin of SARS-CoV-2. *Nature Medicine*, 26(4):450–452.

Antonio, R., Silvia, M. 2020. Immunosuppression drug-related and clinical manifestation of Coronavirus disease 2019: a therapeutical hypothesis. *Am J Transplant*, 20(7):1947–1948.

Bogoch, I. I., Watts, A., Thomas-Bachli, A., Huber, C., Kraemer, M. U. G., Khan, K. 2020. Pneumonia of unknown aetiology in Wuhan, China: potential for international spread via commercial air travel. *Journal of Travel Medicine*, 27(2):27–27.

CDC 2020. How COVID-19 Spreads ? Accessed on: 23 Aug 2020.

Corman, V. M., Landt, O., Kaiser, M., Molenkamp, R., Meijer, A., Chu, D. K. W., Bleicker, T., Brünink, S., Schneider, J., Schmidt, M. L., Mulders, D. G. J. C., Haagmans, B. L., Van Der Veer, B., Van Den Brink, S., Wijsman, L., Goderski, G., Romette, J. L., Ellis, J., Zambon, M., Peiris, M., Goossens, H., Reusken, C., Koopmans, M. P. G., Drosten, C. 2020. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro Surveill*, 25.

Danon, L., Brooks-Pollock, E., Bailey, M., Keeling, M. J. 2020. A spatial model of CoVID-19 transmission in England and Wales: early spread and peak timing. The present serves for health science. *MedRxiv*.

Fang, L., Karakiulakis, G., Roth, M. 2020. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *The Lancet Respiratory Medicine*, 8(4):e21–e21.

Gautret, P., Lagier, J. C., Parola, P., Hoang, V. T., Meddeb, L., Mailhe, M., Doudier, B., Courjon, J., Giordanengo, V., Vieira, V. E., Dupont, H. T., Honoré, S., Colson, P., Chabrière, E., Scola, B. L., Rolain, J. M., Brouqui, P., Raoult, D. 2020. Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial. *Int J Antimicrob Agents*, 20:105949–105949.

Henrickson, S. E. 2020. Learning from our immunological history: What can SARS-CoV teach us about SARS-CoV-2? *Science Immunology*, 5(46):eabb8618–eabb8618.

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M., Xiao, Y., Gao, H., Guo, L., Xie, J., Wang, G., Jiang, R., Gao, Z., Jin, Q., Wang, J., Cao, B. 2020. Clinical features of patients infected with 2019 novel coronavirus in Wuhan. *China. Lancet*, 395:497–506.

in Data, O. W. 2020. Coronavirus disease (COVID-19)-Statistics and Research. The University of Oxford, Accessed on: 23 Aug 2020.

Jawhara, S. 2020. Could Intravenous Immunoglobulin Collected from Recovered Coronavirus Patients Protect against COVID-19 and Strengthen the Immune System of New Patients? *International Journal of Molecular Sciences*, 21(7):2272–2272.

Killerby, M. E., Biggs, H. M., Haynes, A., Dahl, R. M., Mustaquim, D., Gerber, S. I., Watson, J. T. 2014. Human coronavirus circulation in the United States. *J Clin Virol*, 101:52–56.

Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., Ren, R., Leung, K. S. M., Lau, E. H. Y., Wong, J. Y., Xing, X., Xiang, N., Wu, Y., Li, C., Chen, Q., Li, D., Liu, T., Zhao, J., Liu, M., Tu, W., Chen, C., Jin, L., Yang, R., Wang, Q., Zhou, S., Wang, R., Liu, H., Luo, Y., Liu, Y., Shao, G., Li, H., Tao, Z., Yang, Y., Deng, Z., Liu, B., Ma, Z., Zhang, Y., Shi, G., Lam, T. T. Y., Wu, J. T., Gao, G. F., Cowling, B. J., Yang, B., Feng, Z. 2020a. Early Transmission

Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. *N Engl J Med*, 26:1199–1207.

Li, X., Geng, M., Peng, Y., Meng, L., Lu, S. 2020b. Molecular immune pathogenesis and diagnosis of COVID-19. *Journal of Pharmaceutical Analysis*, 10(2):102–108.

Li, Y. X., Wu, W., Yang, T., Zhou, W., Fu, Y. M., Feng, Q. M., Ye, J. M. 2020c. Characteristics of peripheral blood leukocyte differential counts in patients with COVID-19. *Zhonghua Nei Ke Za Zhi*, 59:E003–E003.

Li, Z., Yi, Y., Luo, X., Xiong, N., Liu, Y., Li, S., Sun, R., Wang, Y., Hu, B., Chen, W., Zhang, Y., Wang, J., Huang, B., Lin, Y., Yang, J., Cai, W., Wang, X., Cheng, J., Chen, Z., Sun, K., Pan, W., Zhan, Z., Chen, L. 2020d. Development and Clinical Application of Rapid IgM-IgG Combined Antibody Test for SARS-CoV-2 Infection Diagnosis. *J Med Virol*, 92(9):1518–1524.

Liu, W., Zhang, Q., Chen, J., Xiang, R., Song, H., Shu, S., Chen, L., Liang, L., Zhou, J., Yu, L., Wu, P., Zhang, B., Lu, Y., Xia, L., Huang, L., Yang, Y., Liu, F., Semple, M. G., Cowling, B. J., Lan, K., Sun, Z., Yu, H., Liu, Y. 2020. Detection of Covid 19 in Children in Early January 2020 in Wuhan, China. *N Engl J Med*, 382:1370–1371.

Mahase, E. 2020. Coronavirus: what do we know so far? *BMJ*, 368:308–308.

Riou, J., Althaus, C. L. 2019. The pattern of first human-to-human transmission of Wuhan. *Euro Surveill*, pages 25–25.

Shanmugaraj, B., Siriwattananon, K., Wangkanont, K., Phoolcharoen, W. 2020. Perspectives on monoclonal antibody therapy as a potential therapeutic intervention for Coronavirus disease-19 (COVID-19). *Asian Pac J Allergy Immunol*, 38:10–18.

Tang, X., Wu, C., Xiang, L., Song, Y., Yao, X., Wu, X., Duan, Y., Zhang, H., Wang, Y., Qian, Z., Cui, J., Lu, J. 2020. On the origin and continuing evolution of SARS-CoV-2. *Natl Sci Rev*, pages 36–36.

Tian, X., Li, C., Huang, A., Xia, S., Lu, S., Shi, Z., Lu, L., Jiang, S., Yang, Z., Wu, Y., Ying, T. 2020. Potent binding of 2019 novel coronavirus spike protein by a SARS coronavirus-specific human monoclonal antibody. *Emerg Microbes Infect*, 9(1):382–385.

Van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., Taemin, A., Harcour, J. L., Thornburg, N. J., Gerber, S. I., Lloyd-Smith, J. O., De Wit, E., Munster, V. J. 2020. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med*. Published on: 17 March 2020.

Wan, Y., Shang, J., Graham, R., Baric, R. S., Li, F. 2020. Receptor Recognition by the Novel Coronavirus from Wuhan: an Analysis Based on Decade-Long Structural Studies of SARS Coronavirus. *Journal of Virology*, 94(7):3–12.

Wang, W., Tang, J., Wei, F. 2020. An updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan. *China. J Med Virol*, 92:441–447.

Wu, P., Hao, X., Lau, E. H. Y., Wong, J. Y., Leung, K. S. M., Wu, J. T., Cowling, B. J., Leung, G. M. 2020. Real-time tentative assessment of the epidemiological characteristics of novel coronavirus infections in Wuhan, China, as at 22 January 2020. *Eurosurveillance*, 25(3):25–25.

Zheng, F., Liao, C., Fan, Q. H., Chen, H. B., Zhao, X. G., Xie, Z. G., Li, X. L., Chen, C. X., Lu, X. X., Liu, Z. S., Lu, W., Chen, C. B., Jiao, R., Zhang, A. M., Wang, J. T., Ding, X. W., Zeng, Y. G., Cheng, L. P., Huang, Q. F., Wu, J., Luo, X. C., Wang, Z. J., Zhong, Y. Y., Bai, Y., Wu, X. Y., Jin, R. M. 2019. Clinical Characteristics of Children with Coronavirus Disease. *Curr Med Sci*, 40(2):275–280.

Zhou, S., Wang, Y., Zhu, T., Xia, L. 2020. CT Features of Coronavirus Disease 2019 (COVID-19) Pneumonia in 62 Patients in Wuhan, China. *AJR Am J Roentgenol*, 5:1–8.