Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 13 [2] January 2024: 217-224

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW STUDY **OPEN ACCESS**

Comprehensive Review on SARS-CoV-2: Morphology, Organization, Infection Mechanisms, Diagnostic Approaches, and Supportive Therapies

Brinda Patel[1],Prasad Happy[2],Maitri Patel[2],Kruti Dave[1*]
Department of Biotechnology, Mehsana Urban Institute of Sciences, Faculty of Science, Ganpat University, Gujarat, India
Email: davekruti2@gmail.com

ABSTRACT
One of the breath-taking pandemic have been observed since 2019 named as SARS cov-2 which is a part of family coronaviridae having 30 kb gene size and +ss RNA viruses. In this paper we will get to know about the morphology, organization level, immunological reactions of the SARS COV -2 on the host. Foremost the diagnosis approaches and the treatment with the help of ayurvedic medications and the major preventive steps which a personage needs to inculcate for being healthy.
Keywords: *SARS cov-2, morphology, organization, immunological reaction, clinical analysis, diagnosis, supportive therapy*

Received 19.10.2023 Revised 21.11.2023 Accepted 24.12.2023

INTRODUCTION

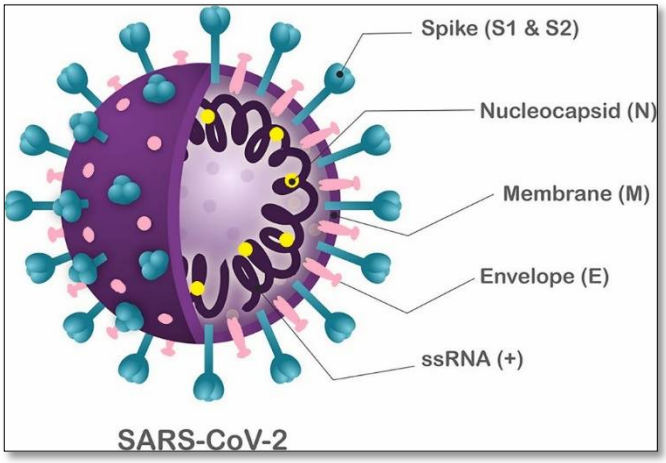
SARS COV-2, a new coronaviridae family strain, was previously discovered since pandemic in 2020 in personage. Ethnological study gives us an ideation that SARS-COV-2 spreads quickly, person to person transmission and may have evolved from the zoonotic cycle. (1). SARS-responsible COV-2's source has not yet been established. Varied organisms have different transmission methods, but infected humans can spread the disease through close contact and the releasing the gasping drips during whooping/sneezing in a radius of 1.829 meters(6 foot). (2).The medicinal signs of infection include fever, un productive cough, myodynia, breathless, and occasionally even leukocyte counts may be normal/lessen. (3). In worst cases of cov's infection the vital organs stop responding properly such as kidney failure, SARS, pneumonitis and even death happens in drastic cases.(4;5).As researchers work to comprehend the genome level and the origins of COVID-19, they also use highly specialized diagnostic technologies to identify SARS-cov-2 infections. (6)

Morphology of SARS-Cov-2:

The SARS- Cov-2 virus has a gene size of 30 kb and is a part of the coronavirus 's hierarchy. Its genome has been classified as having zoonotic origin. SARS-Cov-2 and SARS-Cov share structural correspondence within its few micrometer viron size. (7).The ingrained components are the viral proteins on the exterior envelope, membrane as well as on the spike that can be discovered in the lipid bilayer membrane of host cells.These integrated proteins enclose the viral RNA that makes up the helical nucleocapsid. Significant changes between the ORFs and non-structural proteins of SARS-Cov and SARS-Cov-2 are absent. The genome contains open reading frames (6-11) which has flanking untranslated regions of 50&30. The major role of the 2 viral cysteine proteases which is part of non-structural proteins are in different activities such as transcription, duplication of SARS-Cov-2, helicase (unwinding of genetic material), papain-like proteases even RNA-dependent RNA polymerase or major protease and others.

The vero cells were exposed to SARS-Cov-2 that was isolated from nasopharyngeal & oropharyngeal tissues. Inoculated cells were pre-treated with 2% Polyoxymethylene (paraformaldehyde) and 2.5%Glutaric acid dialdehyde (glutaraldehyde), and transmission electron microscopy was used to detect SARS-Cov-2.SARS-Cov-2 structure as seen by studying infected cells 72hours after infection. The coronavirus-specific morphology of SARS-Cov-2 was disclosed by electron microscopy, with virus particle sizes ranging from 0.07 to 0.09 µm seen under a range of intracellular organelles, most notably in vesicles.

(8).The coronavirus's surface viral protein (spike, membrane, and envelope) are encased in a lipid's bilayer produced from the host membrane that also houses the viral RNA-containing helical nucleocapsid. (9)



[Figure 1: The morphological properties of SARS-Cov-2]

The coronavirus family:

The family known as coronaviridae (CoVs) contains several respiratory illness-causing viruses that may infect both humans and other species (not all CoVs). (10).The four genera under which CoVs are classed as of late December 2019 are [11]:

- Alpha CoVs (HCoV-NL63, HCoV-229
- Beta CoVs (HCoV-OC43, Sars Cov, HCoV-HKU1, and Mers-CoV)
- Gamma CoVs,
- Delta CoVs

The family Coronaviridae includes enclosed +ss RNA viruses known as coronaviruses (CoVs). They have been grouped into further subfamily *Coronavirinae*, which comprises of 4 genera, based on genomic organization and evolutionary relationships. The Coronavirus (CoV) family includes the β-coronavirus, Gamma coronavirus (CoV), Delta coronavirus (CoV), and Alphacoronavirus (CoV). (12). While γ CoV and δ CoV were discovered to have come from bird's species, α CoV and βCoV were determined to have come from bats and rodents. (13). Some of the pathogenic CoVs are the result of CoVs' capacity to breach the barrier between species. The Middle East respiratory syndrome CoV (Mers-Cov) and severe acute respiratory syndrome CoV (SARS-Cov) are known to produce severe illness, but HKU1, NL63, OC43, and 229E CoVs are linked with minor signs in humans. (11). Both viruses were determined to have their roots in bats before spreading to intermediate mammalian hosts like civets for SARS-Cov & camels for Mers-Cov before infecting humans. (14).

ORGANIZATION OF SARS-Cov-2 GENOME:

The coronavirus genome is between 26 &32 kb in size and has 6 to 11 open reading frames (ORFs) that translates 9680 amino acid polyproteins. (15).The first ORF, which encodes 16 non-structural proteins (nsps), makes up around 67% of the genome. The left over ORFs code for accessory and structural proteins. The gene for hemagglutinin esterase is absent from the SARS-Cov-2 genome. It does, however, include 2 flanking UTRs at the ends of 265 and 358 nucleotides, respectively. There were no discernible differences in ORFs and nsps inSARS-Cov-2 and SARS-Cov, according to sequence variation. (16).

The other 4 primary structure proteins are encoded by the open reading frames in addition to NSPS are the outer surface proteins such as peplomer (spike), nucleocapsid, membrane, envelope & even auxiliary proteins. The amino(N)-terminal end of the M-protein, which consists of 3 transmembrane domains (TM) and a lengthy Carbon(C) -terminal CT domain, has an N-terminal glycosylated ectodomain. For virus morphogenesis, assembly, and budding, the M and E proteins are necessary, but the S glycoprotein is a fusion viral protein made up of the S1 and S2 subunits. The S1 subunit consists of a signal peptide, an Amino(N)-terminal domain (NTD), &a receptor-binding domain. It shares 70% of its sequence with human SARS-Cov & bat SARS-like CoVs (RBD) (17).

For the full generation of a viral particle, the external surface proteins are required. S protein performs, primary distinctive role of SARS-Cov-2 anchorage(attaching) and entrance into the host cell receptor, most likely angiotensin-converting enzyme 2 (ACE II). The expression is seen in extrapulmonary organs.(18).The

new glycosylation sites has been demonstrated in the glycoprotein of spike of covid-19 bySARS-Cov-2. It implies that the virus might be interacting with its receptors by using several glycosylation sites.(19).By various studies it has been shown that the SARS-Cov-2 peplomer protein has a greater interactivity for ACE II than the SARS protein. (20)

The exterior subdomain, which is essentially in charge of how well the spike interactions goes with the ACE II receptor, was where the majority of the changes were discovered. To determine the spike glycoprotein structure of SARS-Cov-2, the ectodomain of the pleomer (S)protein (1–1208 amino acid residues) was cloned, produced, and crystallised. With an RMSD of 3.8, the spike glycoprotein structure of SARSCoV-2 is similar to the spike protein of SARS-Cov. The most structural diversity has been shown by the receptor-binding region according to the analysis.(21).

The HR-N & HR-C heptad repeat sections, which generate the coiled-coil structures around the protein ectodomain, are part of the S2 subunit, which has 99% sequence similarity with human and bat SARS-like CoVs.At the junction of the S1 and S2 subunits, the S protein features a furin cleavage site (PRRARS'V) that is processed during biogenesis.(22)

Immunological reaction of SARS-cov-2 infection in host:

The disease Covid-19 is brought on by SARS-Cov-2. An individual with this illness has highly unsettling immune system agitation, which can occasionally result in death. The machinery of immune evasion engaged during the pathogenic attack and CSS during infection in the patient, against which a medicine named Hydroxychloroquine has been produced, is one of the newest discoveries addressing the knowledge of SARS-Cov-2 infection. (1).The Latin word "corona," which may mean either "halo" or "crown," refers to the structure that the RNA and capsid view. Because the virus itself is circular, the word "coronavirus" was initially coined during the imaging of the viral family Coronaviridae. (23). The unique SARS-Cov-2 coronavirus strain that causes Covid-19, which has been identified by the WHO as a pandemic, is responsible for the disease on March 2020. (10).When this new strain of CoV first infected a human host, it caused respiratory problems and severe pneumonia. Similar to its predecessor (SARS-Cov), who is from the same hierarchy, SARS-Cov-2 is believed to have originated from a type of bat. (24). Since the starting case was recorded, Covid-19 has transmitted quickly and caused a higher number of fatalities because of this coronavirus strain's high contagiousness.(6).

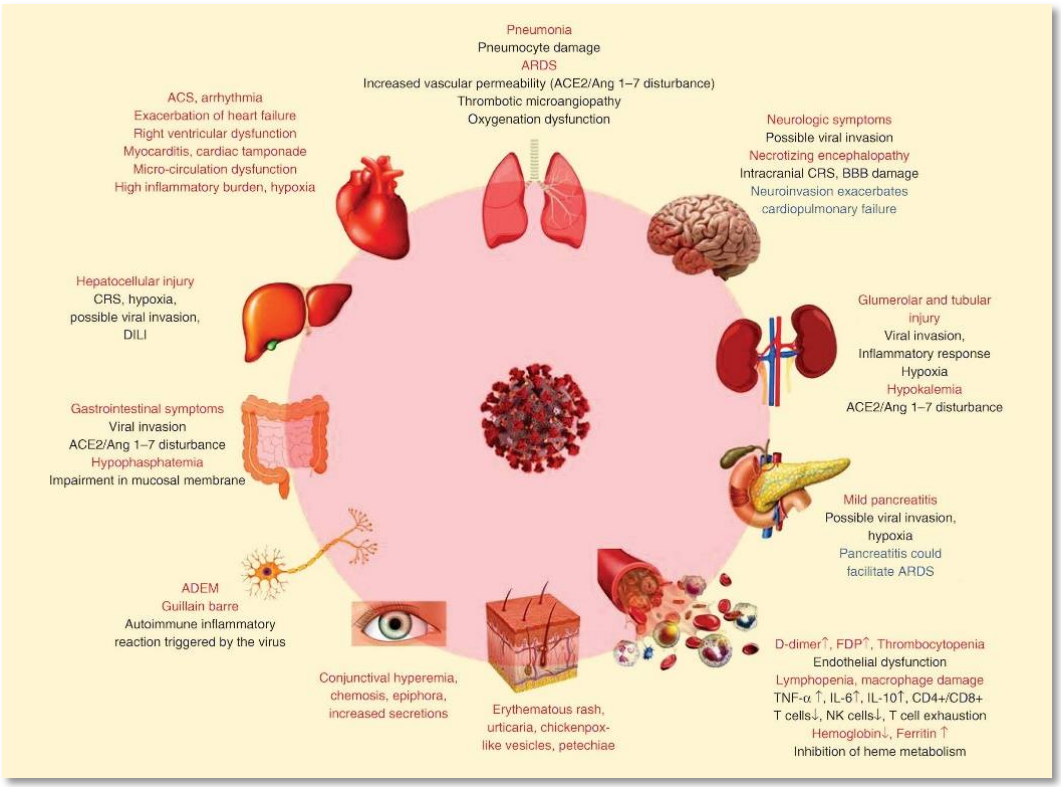
Clinic Features & Diverse Clinical analysis of (Covid-19):

The 7th member of the human coronavirus family and a subgenus of the SARS virus known as SARS-Cov-2 is the pathogen in charge of this zoonotic illness. It produces constitutional and respiratory symptoms by attaching to the human ACE II receptor. In person transmission is the major method of transmission, and the median incubation time is 4 days. Fever (83–98%), weariness (70%) and a dry cough (59%) are the most frequent symptoms among the cohorts of Covid-19 patients that have been investigated. In contrast to SARS and MERS, gastrointestinal symptoms are rather infrequent. Fever, dry cough, tiredness, and myalgia are the first symptoms of the illness, which progresses to dyspnea and ARDS six and eight days after exposure, respectively. Mortality in COVID-19 is elevated by underlying co-morbidities. Since other viral & bacterial pneumonias affect healthier individuals more frequently, COVID-19 must be distinguished from them.(25).

It was isolated from human airway epithelial cells, and after the viral genome was sequenced, it was determined to be the 7th member of the beta coronavirus family infecting humans. Since the illness first appeared, our understanding of it has constantly changed. Given the close contact between humans and animals, crowded cities, international trade, and tourism, the disease SARSCoV-2 poses a potential threat to all of humanity. (3).

hACE II on type II alveolar and intestinal cells is where SARS-Cov-2, a SARS-like virus, interacts. (26).By employing surgical face masks and other airborne measures, infection can be contained due to massive droplet-borne transmission. The other method of transmission between people is by contact with fomites, which must be decontaminated and proper hand hygiene practiced due to the huge droplets that land on surfaces and infect them. (25).

So the Pandemic status for SARS-Cov-2 has been announced, with 1,844,683 confirmed cases and 117,021 fatalities worldwide by April 14, 2020. (27). For viral isolation, special human airway epithelial (HAE) cells that are devoid of pathogens were utilised. Through the Upper (apical) surfaces of the HAE cells, the obtained samples were injected. RT-PCR experiments were carried out for observation of HAE cells for its cytopathic effects. Combining Sanger, Illumina, and Oxford nanopore sequencing techniques resulted in the generation of the SARS-Cov-2 whole-genome sequences. (28). Analyzing the outer patterns of SARS-Cov-2, genomic organisation, and replication is essential for understanding the process of duplication(replication) and developing efficient preventative and treatment measures. (6)



[Figure 2: extrapulmonary symptoms of SARS-Cov-2]

The outcome show that SARS-Cov-2 may infect multiple body locations by focusing on ACE II receptors, hence the various infected organs express distinct symptoms even though Covid-19 is mostly a lung related illness.

The Infection in pupils & teenagers with Coronavirus:

Elderly persons& those who have medical co-morbidities are most affected, it has been found. Corona infection in children and teenagers has a low fatality rate and less severe symptoms. Coronavirus infections are most likely to occur in kids and teenagers with immunosuppressed states, malnutrition, medical co-morbidities, and inadequate cleanliness. (29). Despite having a reduced fatality rate, kids and teenagers can still spread the disease. Due to their greater level of mobility, people in this age range are more likely to develop an infection and spread it to others, especially the elderly, who are a high-risk demographic. Children who have the coronavirus frequently exhibit fever, coughing, and breathing problems. Along with the aforementioned symptoms, many children also have vomiting and diarrhoea.

Children with coronavirus frequently exhibit fever, coughing, and breathing problems. Along with the aforementioned symptoms, many children also have vomiting and diarrhoea. The risk of mother-transmitted illness is greater among children born to infected moms. Children with coronavirus infection frequently have clinical symptoms and investigation results similar to those of viral pneumonia. Children with a coronavirus infection have different biochemical alterations and chest computed tomography (CT) modifications than adults. (3).

Children frequently have major upper than lower respiratory infections, may rather enhances the capacity to spread the illness. (3). Most possible risk factor for developing highly infectious illnesses like a new coronavirus infection is an immunocompromised condition. Due to their immunocompromised status, preterm infants and new-born's with lesser weight during birth are also at danger. Malnutrition is still a major issue in impoverished and emerging nations. Since the coronavirus primarily affects the respiratory system, mid schooling children &teenagers with heart related disorders and respiratory diseases (infection in bronchioles) are more susceptible. In addition to having a weakened immune system, patients with haemoglobin related illnesses including low RBC count, low WBC count, etc. are more susceptible to coronavirus infection. (29). Kids are frequently playful. They speak out loud and freely express themselves. According to available data, yelling and loud speech may contribute to the transmission of the virus through drops nearby. (3).

Most probably, youngsters frequently touch their face, nose, and mouth when playing. (29). Additionally, it raises the possibility of coronavirus infection transmission.(3).In order to raise public knowledge of coronavirus infection and how to avoid it in children, the CDC published a number of directives. To lowering the spread of the coronavirus infection to other people, especially the aged people & those who are unwell, it is crucial to teach kids how to properly sterilise themselves before they interact with them. (29).
Children should also refrain from interacting with adults or other children who have recently travelled, as well as those who have respiratory illnesses or fevers. Researchers discovered potential uses for interferon, hydroxychloroquine, and anti-retroviral drugs in the treatment of covid infection.. Pneumonia and subsequent bacterial infections are treated with antibiotics. Except in rare circumstances like septic shock(blood inflammation), rapidly worsening chest imaging, & the presence of obviously hazardous symptoms like encephalitis (brain inflammation), corticosteroids should be avoided. (3). Convalescent plasma (if available) may have a role in curing process of Covid-19 infection. (30)

Human SARS-Cov-2 Infection Diagnosis:
Variety of techniques have been used for identifying SARS-Cov-2 infected individuals such as blood, lavages of lungs region, sputums, aspirates of nasal,ortho and tracheal and even swabs of mucosal regions.(31).ELISA(enzyme assay test), CT (computed tomography)scan, and blood cultures may all be used to identify SARS Cov-2, however nucleic acid assays, including RT-qPCR, which is simple and efficient for detection of deadly pathogenic viruses and blood, are the most common methods . For the detection of SARS-Cov-2 certain primers and probes (short complementary sequence) which targets the N gene &ORF (open reading frames) lab. (32). IgM and IgG immunological detection is the important method used to analyseCovid-19 patients. (33). Patients being evaluated by CT scan have complained of respiratory discomfort.(34).

SARS Cov-2 Infection: Early Supportive Therapy:
In respect to administer prompt supportive care in the event of a severe infective, patients related to severe respiration diseases must be constantly watched for clinic indications such blood infection and fast respiring failure. For the treatment of severe respiration infections caused by pathogens, antibiotics should be administered. When treating people with viral pneumonitis & ADRS, systemic corticosteroid therapy should be avoided.(35)
Coronavirus Therapy with Ayurvedic Medicines:
Cyperus rotundus, Fumaria indica, Vetiveria zizanioides, Pterocarpus santalinus, Pavonia odorata, 10 Therapy related Development & Drugs for the TreatingtheCovid-19, and *Zingiber officinale* make up the majority of the herbal formula known as Shadanga Paniya.High temperature, shivering, muscular pains, headaches, food aversion, dehydrated, exhaustion, anxious, thirsty, irritative behaviour, and fiery feeling are among the symptoms that this herbal remedy is advised for treating. Additionally, Shadanga Paniya possesses antibacterial and antibiotic properties. Most recently, the Ministry of Ayush has suggested using this medication to treat coronaviruses.
Popular polyherbal Ayurvedic medication Agastya Harityaki is mostly advised for respiratory conditions including choking, pneumonitis, & obstructive pulmonary disease. This drug is said to possess properties against viruses, bacteria, fungi, oxidative reactions, age related, cancerous, diabetics, ulcer, heart diseases, liver diseases, wounds. Anaemia and acute to chronic fevers are treated with shamani vati (500 mg twice a day). The primary component of Samshamani Vati, *Tinospora cordifolia*, is what gives it its anti-inflammatory and antipyretic qualities. *Pratimarsha nasya* (Anu taila/sesame oil), which treats naso-bronchial illnesses and strengthens respiratory immunity, has both preventative and curative effects.
The Ministry of Ayush in India also advises using *Vyosh* (*long pepper,kali mirch)* and *holy basil* for treating the infection caused by coronavirus.(6)
Herbal Medicines Effective Against Coronavirus in Cultured Cells Model:
Numerous herbal extracts, including those of Nigella sativa, *Acanthopanacis cortex, Citrus sinensis, Sophorae radix, &Sanguisorbae radix*, have been shown to suppress coronavirus multiplication in laboratory condition. Similar to this, research have indicated that historically used medicinal plant extracts such *Cimicifugarhizoma, Coptidis rhizoma, Phellodendron cortex, and Meliae cortex*are similarly proven to limit corona's duplication in cell culture model. Additionally, demonstrated to inhibit SARSCov (S) protein binding with ACE II in a dosage-dependency pattern are Polygonum and the chemical component of the genus Rheum called emodin. Since the herbal medications showed potential antiviral action against CoVs, it is imperative to confirm their efficacy in people and obtain approval from different agencies like the Food and Drug Administration in a dose-dependent way (FDA). When there is no particular antiviral medication or vaccine available, using complementary and alternative medicines may be helpful. (6).

Techniques for Preventing and Treating SARS-Cov-2 Infection:

Due of its great potency for infection &unusual structure, Covid-19 has created a buzz in both researchers & healthcare providers. Research fellows discovered stability SARS-Cov-2 on diverse layer& compared it to SARS-Cov-1.(6)There are several likely causes for the high infection rate, making it difficult to manage, including high concentration of viral content in the upper alveolar tract of the sufferer & there is possibility for Covid-19-infective people to transfer and disseminate the virus while they are asymptomatic. (34). Researchers has noticed that SARS Cov-2's protein is longer and more complex than SARS Cov & bat SARS Cov, which is a significant difference. These S proteins are essential for host array, internalisation of the SARS-Cov-2, internalization of the receptor, and tissue tropism. This S protein serves as a crucial prey for the creation of vaccines . Meanwhile simply maintaining personal health, social isolation, &a robust immune system can the COVID-19 outbreak be curbed and contained until a vaccine or viable treatment is discovered. (35)

[Figure 3: Steps to maintain personal hygiene]

In the last 20 years, virus related illnesses have started to pose a severe danger to public health. Numerous viral outbreaks that have been recognised as posing a risk to public health, such as Covid-19, SARS-Cov, H1N1, H5N1, Mers-Cov, Zika, and Ebola, have spread to 168 countries. In mild infections, symptomatic treatment works well, while in serious infections, oxygen therapy works well. Some data indicate that some medicines, both alone and in combination, such as ritonavir, chloroquine, lopinavir, BCX-4430 (salt version of galidesivir), nitazoxanide, and ribavirin, have favourable effects. (35)

[Figure 4: Steps to avoid spreading of COVID infection]

CONCLUSION

As per its morphology and the pathology the virus seems extremely contagious and may spread from one person to another. Numerous academics from around the world have earlier anticipated that COVID-19 would become pandemic. In the meanwhile, it is everyone's moral and social responsibility to abide by the rules and recommendations issued by the authorities, the WHO, and other relevant organisations. Meanwhile it's our responsibility to mostly focus on work on to boost our immunity and ensure preventive measures to avoid the spreading of infection.

REFERENCES

1. Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, Xing F, Liu J, Yip CC, Poon RW, Tsoi HW, Lo SK, Chan KH, Poon VK, Chan WM, Ip JD, Cai JP, Cheng VC, Chen H, Hui CK, Yuen KY (2020a) A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet 395(10223):514–523. https:// doi.org/10.1016/S0140-6736(20)30154-9
2. Ghinai I, McPherson TD, Hunter JC, Kirking HL, Christiansen D, Joshi K, Rubin R, MoralesEstrada S, Black SR, Pacilli M, Fricchione MJ, Chugh RK, Walblay KA, Ahmed NS, Stoecker WC, Hasan NF, Burdsall DP, Reese HE, Wallace M, Wang C, Moeller D, Korpics J, Novosad SA, Benowitz I, Jacobs MW, Dasari VS, Patel MT, Kauerauf J, Charles EM, Ezike NO, Chu V, Midgley CM, Rolfes MA, Gerber SI, Lu X, Lindstrom S, Verani JR, Layden JE; Illinois COVID-19 Investigation Team (2020) First known person-to-person transmission of severe acute respiratory syndrome

coronavirus 2 (SARS-CoV-2) in the USA. Lancet. pii: S0140-6736 (20)30607-3. https://doi.org/10.1016/S0140-6736(20)30607-3
3. Sujita Kumar Kar, Nishant Verma, and Shailendra K. Saxena
4. Zhao D, Yao F, Wang L, Zheng L, Gao Y, Ye J, Guo F, Zhao H, Gao R (2020) A comparative study on the clinical features of COVID-19 pneumonia to other pneumonias. Clin Infect Dis. pii: ciaa247. https://doi.org/10.1093/cid/ciaa247
5. Xiong Y, Sun D, Liu Y, Fan Y, Zhao L, Li X, Zhu W (2020) Clinical and high-resolution CT features of the COVID-19 infection: comparison of the initial and follow-up changes. InvestigRadiol. https://doi.org/10.1097/RLI.0000000000000674
6. Swatantra Kumar, Rajni Nyodu, Vimal K. Maurya, and Shailendra K. Saxena)
7. Kim JM, Chung YS, Jo HJ, Lee NJ, Kim MS, Woo SH, Park S, Kim JW, Kim HM, Han MG (2020) Identification of coronavirus isolated from a patient in Korea with COVID-19
8. Park WB, Kwon NJ, Choi SJ, Kang CK, Choe PG, Kim JY, Yun J, Lee GW, Seong MW, Kim NJ, Seo JS, Oh MD (2020) Virus isolation from the first patient with SARS-CoV-2 in Korea. J Korean Med Sci 35(7):e84. https://doi.org/10.3346/ jkms.2020.35.e84
9. Finlay BB, See RH, Brunham RC (2004) Rapid response research to emerging infectious diseases: lessons from SARS. Nat Rev Microbiol 2(7):602–607
10. World Health Organization (2020) Coronavirus disease 2019 (COVID-19) situation report—85. World Health Organization.
11. Fehr AR, Perlman S (2015) Coronaviruses: an overview of their replication and pathogenesis. Methods Mol Biol 1282:1–23. https://doi.org/10.1007/978-1-4939-2438-7_1
12. Cui J, Li F, Shi ZL (2019) Origin and evolution of pathogenic coronaviruses. Nat Rev Microbiol 17 (3):181–192. https://doi.org/10.1038/s41579-018-0118-9
13. Ge XY, Yang WH, Zhou JH, Li B, Zhang W, Shi ZL, Zhang YZ (2017) Detection of alpha- and betacoronaviruses in rodents from Yunnan, China. Virol J 14(1):98. https://doi.org/10.1186/ s12985-017-0766-9
14. Song Z, Xu Y, Bao L, Zhang L, Yu P, Qu Y, Zhu H, Zhao W, Han Y, Qin C (2019) From SARS to MERS, thrusting coronaviruses into the spotlight. Viruses 11(1). pii: E59. https://doi.org/10.3390/v11010059
15. Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, Tan KS, Wang DY, Yan Y (2020) The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak— an update on the status. Mil Med Res 7(1):11. https://doi.org/10.1186/s40779-020-00240-0
16. Centre for Disease Control and Prevention (2020c) Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings. Centre for Disease Control andPrevention. https://www. cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations. html. Accessed 18 Mar 2020
17. Walls AC, Park YJ, Tortorici MA, Wall A, McGuire AT, Veesler D (2020) Structure, function, and antigenicity of the SARS-CoV-2 spike glycoprotein. Cell. pii: S0092-8674(20)30262-2. https:// doi.org/10.1016/j.cell.2020.02.058
18. Yan R, Zhang Y, Li Y, Xia L, Guo Y, Zhou Q (2020) Structural basis for the recognition of the SARS-CoV-2 by full-length human ACE2. Science. pii: eabb2762. https://doi.org/10.1126/ science.abb2762
19. Kumar S, Maurya VK, Prasad AK et al (2020) Structural, glycosylation and antigenic variation between 2019 novel coronavirus (2019-nCoV) and SARS coronavirus (SARS-CoV). Virus Dis 31(1):13–21. https://doi.org/10.1007/s13337-020-00571-5
20. World Health Organization (2020) Coronavirus disease 2019 (COVID-19) situation report—51. World Health Organization.
21. Wrapp D, Wang N, Corbett KS, Goldsmith JA, Hsieh CL, Abiona O, Graham BS, McLellan JS (2020) Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation. Science 367 (6483):1260–1263. https://doi.org/10.1126/science.abb2507
22. Coleman CM, Sisk JM, Halasz G, Zhong J, Beck SE, Matthews KL, Venkataraman T, Rajagopalan S, Kyratsous CA, Frieman MB (2016) CD8+ T cells and macrophages regulate pathogenesis in a mouse model of Middle East respiratory syndrome. J Virol. 91(1). pii: e01825- 16. https://doi.org/10.1128/JVI.01825-16
23. Li F (2016) Structure, function, and evolution of coronavirus spike proteins. Annu Rev Virol 3 (1):237–261
24. Li X, Zai J, Zhao Q et al (2020) Evolutionary history, potential intermediate animal host, and cross species analyses of SARS-CoV-2. J Med Virol 2020:1–10. https://doi.org/10.1002/jmv.25731.
25. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, Yu J, Kang M, Song Y, Xia J, Guo Q, Song T, He J, Yen H-L, Peiris M, Wu J (2020) SARS-CoV-2 viral load in upper respiratory specimens of infected patients. N Engl J Med 382(12):1177–1179
26. World Health Organization (2020) Coronavirus disease 2019 (COVID-19) situation report—51.World Health Organization.
27. Lu R, Zhao X, Li J et al (2020) Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 395(10224):565–574. https://doi.org/10.1016/S0140-6736(20)30251-8
28. Sujita Kumar Kar, Nishant Verma, and Shailendra K. Saxena
29. Xia W, Shao J, Guo Y, Peng X, Li Z, Hu D (2020) Clinical and CT features in pediatric patients with COVID-19 infection: different points from adults. PediatrPulmonol 55(5):1169–1174. https://doi.org/10.1002/ppul.24718.
30. Center for Disease Control and Prevention (2020a) Coronavirus disease 2019 (COVID-19) – transmission. In: Center for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/prepare/transmission.html. Accessed 15 Mar 2020

31. Wang Y, Kang H, Liu X, Tong Z (2020a) Combination of RT-qPCR testing and clinical features for diagnosis of COVID-19 facilitates management of SARS-CoV-2 outbreak. J Med Virol. https:// doi.org/10.1002/jmv.25721.
32. 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, Ye F (2020b) Development and clinical application of a rapid IgM-IgG combined antibody test for SARS-CoV-2 infection diagnosis. J Med Virol. https://doi.org/10.1002/jmv.25727
33. 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 1–8. https://doi.org/10.2214/ AJR.20.22975
34. World Health Organization (2020b) Clinical management of severe acute respiratory infection when novel coronavirus (nCoV) infection is suspected. Interim guidance. 12 Jan 2020
35. Liu C, Zhou Q, Li Y, Garner LV, Watkins SP, Carter LJ, Smoot J, Gregg AC, Daniels AD, Jervey S, Albaiu D (2020) Research and development on therapeutic agents and vaccines for COVID-19 and related human coronavirus diseases. ACS Cent Sci 6(3):315–331
36. 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 1–8. https://doi.org/10.2214/ AJR.20.22975

CITATION OF THIS ARTICLE

Brinda P,Prasad H,Maitri P,Kruti D· Comprehensive Review on SARS-CoV-2: Morphology, Organization, Infection Mechanisms, Diagnostic Approaches, and Supportive Therapies. Bull. Env. Pharmacol. Life Sci., Vol 13 [2] January 2024: 217-224