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Review Article

Understanding COVID-19: An overview of the virus, variants, vaccines, and treatment strategies

Asia Manzoor [#], Umme-e-Aiman [#], Maqsood Maryam [#*]

Department of Zoology, Faculty of Life Sciences, SBKW University, 87300 Quetta, Pakistan

[#] All authors contributed equally.
Correspondence to: Maryam Maqsood, Email: maryam.umar1@yahoo.com

Abstract: The outbreak of coronavirus disease 2019 (COVID-19) has greatly impacted society and health care worldwide. This narrative review provides an in-depth understanding of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), including its structure, life cycle, possible origins and mechanisms of infection. The potential pathophysiology of COVID-19 disease and the comparison of various detection techniques are discussed, highlighting the effectiveness of RT-PCR tests. In particular, this paper examined the treatments options available for COVID-19, with a focus on antiviral agents and immune modulators. Vaccine strategies are discussed, with mRNA vaccines, particularly Moderna and Pfizer-BioNTech, being the most promising. Finally, the review analyzed the emergence of new variants and their impacts on the effectiveness of immunization against this specific pandemic disease. We can only understand COVID-19 when we unmask its intricacies in our fight against it, which requires a multi-pronged approach, such as continued research into viral variants and targeted therapeutics while maintaining effective therapies and mass vaccination campaigns in addition to other public health interventions aimed at controlling the pandemic.

Keywords: SARS-CoV-2, Variants, COVID-19 Vaccines, Virology, Diagnosis and treatment

Introduction

COVID-19 is a viral infectious disease with a high transmission rate caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and leads to serious disease in humans [1]. The COVID-19 pandemic has caused harmful effects on public health and has affected all aspects of life [2]. This disease has spread all over the world within a very short period of time. This pandemic has led to serious challenges in social and economic life [3]. Many countries worldwide are trying to promote the development of the COVID-19 vaccine to control and prevent COVID-19. Although some countries have made great progress, many countries are still facing significant challenges regarding future vaccination against COVID-19. One of challenges is the unpredictable behavior of the public regarding the acceptance of COVID-19 vaccination [4]. According to previous observations on vaccine acceptance, many factors have been identified that influence the acceptance

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of the COVID-19 vaccine, such as socio-demographic characteristics, the efficacy and safety of vaccine, the history of past vaccinations, the cost of vaccine, physician recommendations, the risk of disease, and the convenience of vaccination. Compared with the past pandemics, COVID-19 has shown a high rate of mortality and transmission. Therefore, more attention needs to be paid to prevent this disease as compared to other pandemics. The aim of the work is to comprehensively investigate the different parts of coronavirus infection, including its empirical values, the study of disease transmission, historical underpinnings, scientific classification, structure, life cycle, viral infections, findings and treatment. The study also aims to investigate how the COVID-19 pandemic has impacted society and health worldwide. The in-depth analysis of the study aims to provide valuable insights into the understanding, prevention and management of COVID-19, raise public awareness and lay the groundwork for future research and international collaboration to address public health issues.

Etymology of the virus

The word COVID-19 is derived from the combination of four words: CO, VI, D, and 19. CO stands for corona (Latin word corona: means crown, due to the presence of spikes on the cell membrane of the virus, which resemble a crown-like shape, hence named coronavirus), VI stands for virus, D stands for for disease or disorder, and 19 is used for the year 2019, when the virus emerged [5].

History of the virus

Coronaviruses have been around much longer than we initially thought. The first strains were identified in chickens in the 1930s, but these viruses likely predate human discovery by a significant margin. Throughout the 20th and 21st centuries, scientific advancements led to the identification of more coronaviruses, including strains responsible for the common colds. In the 1960s, these viruses were classified as a distinct group called coronaviruses. However, our growing understanding also revealed more concerning aspects. Coronaviruses such as the severe acute respiratory syndrome (SARS) caused by SARS-CoV in 2002-2003, the Middle East respiratory syndrome coronavirus (MERS-CoV) identified in 2012 and most recently SARS-CoV-2, which emerged in China in 2019 and caused the ongoing COVID-19 pandemic, have significantly impacted global public health [6].

Epidemiology of the virus

The first case of COVID-19 caused by the SARS-CoV-2 was identified in Wuhan, China, in December 2019 [7]. The virus spread rapidly worldwide through respiratory droplets, prompting the World Health Organization (WHO) to declare a pandemic in March 2020. The wide spread of the virus is further emphasized by a recent WHO report highlighting the devastating impact of COVID-19 on global mortality rates [8]. The study investigated "excess mortality," the increase in the total deaths from all causes compared to the expected number in a normal year. The findings are stark: over two years (2020-2021), COVID-19 was estimated to have caused a staggering 14.83 million excess deaths globally. Notably, the reported COVID-19 deaths significantly underestimate the true toll of the pandemic, highlighting the importance of excess mortality data for a more comprehensive picture.

The situation worsened in 2021 as excess mortality exceeded that of 2020. The limited data available in many countries makes precise calculations difficult, and incomplete reporting and the varying quality of data further complicate the issue. However, despite these hurdles, the study reveals a grim reality: the impact of COVID-19 is more severe than that of the recent influenza pandemics. The estimated global per capita excess mortality rate for 2021 (0.13%) exceeds that of 1957, 1968, and 2009. The WHO emphasizes the urgent need for improved data collection and health information systems worldwide. Robust surveillance systems are crucial for the effective monitoring of future public health emergencies. This includes strengthening routine disease surveillance and integrating it with health information systems to create a more comprehensive picture. The COVID-19 pandemic serves as a stark reminder of the importance of data collection and global collaboration in combating infectious diseases. By prioritizing these areas, countries can be better prepared to respond to future health threats [8]. As of May 17, 2023, the total confirmed cases of COVID-19 worldwide were reported to be 766,440,796, with 6,932,591 deaths recorded [9].

Taxonomy of the virus

SARS-CoV-2 belongs to the genus Betacoronavirus, within the subfamily Orthocoronaviriae of the Coronaviridae family. This subfamily also includes the genera Alphacoronavirus, Gammacoronavirus and Deltacoronavirus, which primarily infect mammals and birds [10]. In addition, different types of SARS-CoV-2 variants have been identified in many countries, the most important variants of which are as follows:

The Beta variant (B.1.351 or GH/501Y.V2) of the SARS-CoV-2 virus was first identified in South Africa in October 2020 and has since been detected in several countries, including the United States. It has 9 mutations, with important mutations being on the spike proteins K417N, E484K and N501Y. The Beta variant has been associated with a high rate of transmission [10].

The Gamma variant (P.1 or GR/501Y.V3), also known as the Brazilian variant, was first identified in Brazil in December 2020. It has 10 mutations, similar to the Beta variant, with important mutations being on the spike proteins K417T, E848K and N501Y. The Gamma variant was also detected in the United States [10].

The Delta variant (B.1.617.2), also known as the double mutant, was first identified in India and has 10 mutations in the same virus, E484Q and L452R. It was identified in the United States in April 2021 and has been associated with a high risk of transmission [10].

The Omicron variant (B.1.1.529) was first identified in Botswana, South Africa, in November 2021 and has since been detected in several countries. It varies by 21 amino acids on the spike protein S1 subunit in the RBD region and has important mutations such as N501Y and Q498R. The Omicron variant has spawned several sublineages, including BA.1, BA.2, BA.3, BA.4 and BA.5 [10].

These variants of the SARS-CoV-2 virus have emerged and spread globally, with important mutations on the spike proteins that may affect their transmissibility and resistance to antibodies. It is important to continue monitoring the spread and impact of these variants to inform public health responses.

Structure of the virus

The SARS-COV-2 virus (COVID-19) is a spherical, enveloped, single-stranded RNA virus. It has a crown-like appearance. It contains four structural proteins, namely S (spike), N (nucleocapsid), E (envelope) and M (membrane protein) [11]. The S-protein of the virion is the main infection-causing factor which, together with the HE protein, assists the virus in entering the human cell. The S protein is composed of 2 subunits, the S1 subunit and the S2 subunit. The S1 subunit comprises an N-terminal domain (14-305 residues) and a receptor-binding domain (RBD, 319-541 residues), while the S2 subunit is composed of the FP (fusion peptide, 788-806), HR1 (heptapeptide repeat sequence 1, 912-984 residues), HR2 (1163-1213), TM domain (1213-1237 residues) and cytoplasm domain (1237-1273, residues) [12]. The receptor binding domain of the S1 subunit binds to the host receptor cell angiotensin-converting enzyme 2 (ACE2) of alveoli type 2 pneumocyte cells, which are responsible for host cell recognition, and the S2 subunit assists viral fusion and entry into the host cell [12].

The N protein is a ribonucleoprotein that forms a complex with RNA that supports the entry and assembly of viruses. The envelope protein is a membrane protein. It produces viroporin, which is hydrophobic. The viroporins help in viral assembly and release. The M protein is found in large amounts in viruses and forms a viral envelope [13].

COVID-19 is a positive-sense RNA virus as the ribonucleic acid of this virus is oriented in the 5'-3' direction, which makes it a positive-sense mRNA and is therefore directly translated into proteins [14]. It is highly infectious and can be transmitted from one person to another [15]. The single-stranded RNA viral genome consists of ~30,000 genomes. It is an mRNA with a 5' terminal cap (7-methylguanosine) and a 3' polyA tail. The open reading frames (ORFs) 1a, 1b, 3a, 3b, 6, 7a, 7b, 8a, 8b and 9b are present in SARS-COV-2. ORF1a and 1b comprise ~20,000 bases that encode non-structural proteins, while the other ORFs consist of ~10,000 bases that encode structural proteins. The sequence of the viral genome is 5'-cap-5'UTR-coding (replicase enzyme-S-E-M-N)-3'UTR-Poly (A). Figure 1 illustrates the genetic makeup of SARS-CoV-2.

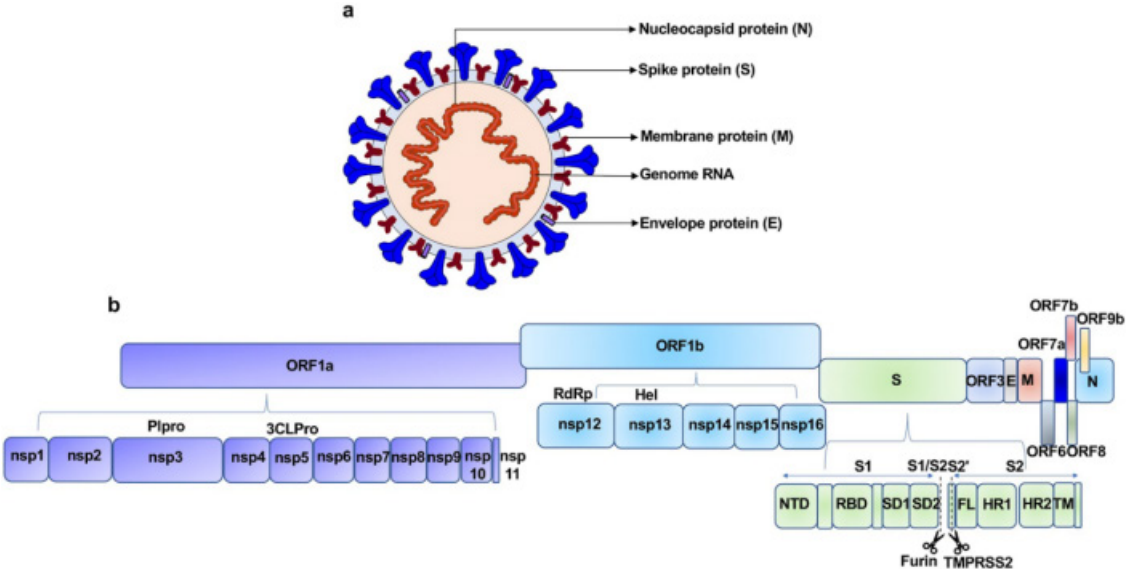

Figure 1. (a) A virus particle and its genetic make-up; (b) The viral genome sequence with colored representation
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Figure 1(a) illustrates the nucleocapsid (N), spike (S), membrane (M) and envelope (E) structural proteins of the virus. As shown in Figure 1(b), the viral genome sequence with colored representation consists of 16 nonstructural proteins (nsp1-11, 12-16) encoded by ORF1a and ORF1b. Some essential proteins, such as PLpro (Papain-like protease), 3CLPro (3C-like proteinase), RdRp (RNA-dependent RNA polymerase), Hel (Helicase), and S, play important functions. The N-terminal domain (NTD), receptor-binding domain (RBD), subdomain 1 (SD1), subdomain 2 (SD2), fusion loop (FL), heptad repeat (HR1), heptad repeat (HR2), and transmembrane domain (TM) are only a few of the domains that are encoded by the S protein. Furin and TMPRSS2 cleave the S protein at the S1/S2 and S2' sites, as shown by the dotted line with scissors.

The Life cycle of the virus

SARS-CoV-2 replicates within host cells and follows a specific life cycle. The breakdown of the key steps are as follows:

Attachment: The spike (S) protein on the virus surface recognizes and binds to angiotensin-converting enzyme 2 (ACE2) receptors on the host cell membrane [17]. This S protein is crucial for triggering infection.

Entry: Following attachment, the S protein undergoes a shape change triggered by host proteases (e.g. TMPRSS2). This allows the fusion of the viral and cellular membranes so that the viral nucleocapsid (containing the viral RNA genome) can enter the cytoplasm of the host cell [18].

Replication: Inside the cell, the viral RNA is released and serves as a template for viral RNA synthesis. In contrast to cellular processes, this replication is mediated by a viral enzyme called RNA-dependent RNA polymerase (RdRp). Viral replication also involves the formation of specialized structures within the cell called replication-transcription complexes (RTCs) [19].

Protein synthesis: The newly synthesized viral RNA molecules are translated by the host ribosomes into viral proteins that are essential for the virus [20]. These proteins include structural components for new virus particles.

Assembly: Viral RNA and proteins are assembled in the cell and form new complete SARS-CoV-2 virions [20].

Release: Mature virions are released from the host cell by a process called exocytosis, allowing them to infect new cells and continue the life cycle. Recent studies suggest an alternative release pathway involving lysosomes, which are cellular compartments that degrade waste products [20].

Important SARS-CoV-2 specifics:

- The ability of the S protein to bind the ACE2 receptor is crucial for SARS-CoV-2 infection.
- The furin cleavage site within the S protein enhances viral infectivity.
- The viral nucleocapsid protein (N protein) plays a multifaceted role in viral RNA replication and the host immune response.

Pathogenesis of SARS-CoV-2 infection

SARS-CoV-2 enter into the human body primarily through the respiratory tract. The virus utilizes the angiotensin-converting enzyme 2 (ACE2) receptor, which is expressed abundantly on lung epithelial cells for cellular attachment and internalization [21]. This initial interaction, mediated by the viral spike protein, establishes the foundation for productive infection. While the respiratory tract serves as the main route of entry for the virus, SARS-CoV-2 has also been detected to a lesser extent in other tissues, suggesting a potential for broader systemic effects.

The clinical course of COVID-19, the disease caused by SARS-CoV-2, can vary significantly, ranging from asymptomatic or mild illness to severe respiratory complications. A critical factor influencing the severity of the disease is the host's immune response. In some cases, there can be an excessive release of inflammatory mediators, known as a cytokine storm. This dysregulated immune response is characterized by elevated levels of cytokines such as interleukin-6 (IL-6), interleukin-1 (IL-1), interleukin-17 (IL-17) and tumor necrosis factor-alpha (TNF-α) [22]. The cytokine storm can lead to a life-threatening complication known as Acute Respiratory Distress Syndrome (ARDS). ARDS is characterized by inflammation and fluid accumulation in the lungs, which significantly impairs gas exchange and oxygen delivery to vital organs.

Understanding the intricate interplay between SARS-CoV-2, the host's immune response and particularly the role of cytokine signaling is crucial for the development of effective therapeutic strategies to manage severe COVID-19 cases.

Modules involved in the severe stages of COVID-19, such as the acute phase of SARS-CoV-2 infection in the lung, represented by element 10, which stands for Acute Respiratory Distress Syndrome (ARDS) (Figure 2 (a)). Element 11 represents vasodilation, increased capillary permeability and apoptosis/necrosis of endothelial cells. Element 12 shows how ARDS can cause a "cytokine storm" that can make it easier for viruses to enter the bloodstream. Due to the widespread organotropism of the virus in tissues with elevated ACE2 levels (such as the heart and kidneys), this process could result in systemic failure. On the other hand, the severe inflammation of the "cytokine storm" could lead to systemic failure. The sites where digestive tract organs and accessory organs, including salivary glands, liver, gallbladder and pancreas, may be potentially infected by SARS-CoV-2 are presented in Figure 2(b). Notably, ACE2 expression is relatively high in the duodenum, small and large intestines, rectum

and gallbladder. Consequently, the virus probably enters the stomach passively after consumption of contaminated food. The adverse effects reported in other accessory organs such as the liver or pancreas are likely due to excessive inflammation during severe COVID-19 infection. As shown in Figure 2(c), the central (brain, spinal cord) and peripheral nervous systems have been identified as possible routes of SARS-CoV-2 infection. The presence of ACE2, neuropilin-1 (NRP1) and CD147, which have been reported to increase the infectivity of the virus in the central nervous system, is illustrated.

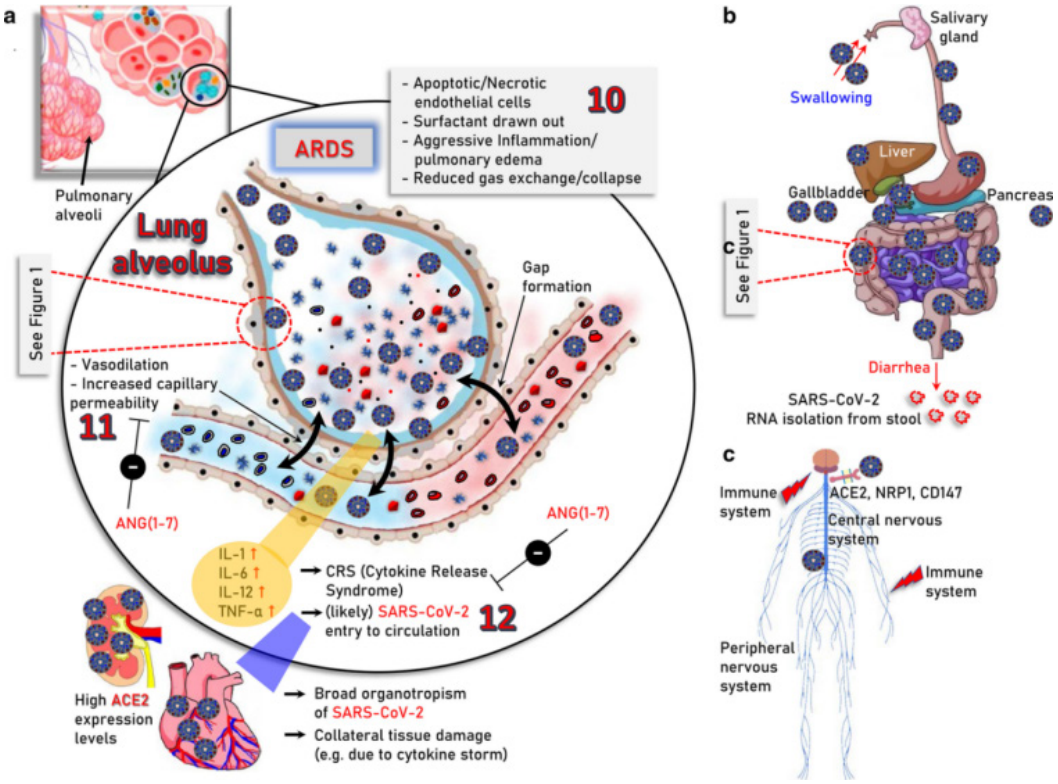

Figure 2. (a). Modules involved in the severe stages of COVID-19; (b). Sites where organs in the alimentary tract of the digestive system and accessory organs may be potentially infected by SARS-CoV-2; (c). The central (brain, spinal cord) and peripheral nervous systems identified as possible routes of SARS-CoV-2 infection
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Diagnosis of COVID-19

Prompt diagnosis of COVID-19 infection is essential for optimal patient care and public health interventions. Individuals who present with symptoms potentially suggestive of COVID-19 infection, including fever, cough, dyspnea (shortness of breath), upper respiratory tract infection (URI), or gastrointestinal (GI) symptoms, should seek immediate medical attention [24].

Clinical evaluation and exposure history

During a clinical evaluation, healthcare professionals will gather information on the patient's presenting symptoms, possible exposures to confirmed COVID-19 cases and recent travel history to high-risk areas. This information will help in decision-making for diagnostic testing.

Diagnostic testing methods

The diagnosis of COVID-19 primarily relies on viral tests using respiratory samples. The two main diagnostic tests are:

Real-time reverse transcriptase polymerase chain reaction (RT-PCR): This highly sensitive test remains the gold standard for the detection of SARS-CoV-2 viral RNA in respiratory swabs (nasopharyngeal or oropharyngeal) or saliva samples collected by healthcare professionals [25].

Rapid antigen tests: These point-of-care tests offer a faster turnaround time (often within minutes), but may have lower sensitivity compared to RT-PCR tests. They can be valuable for initial screening or in situations where rapid results are crucial [26].

Imaging techniques

While CT scans and ultrasounds are valuable tools for visualizing internal structures, they are not used for definitive diagnosis of COVID-19. However, these imaging modalities may be employed in hospitalized patients to assess the extent of lung involvement and potential complications associated with COVID-19. It is important to note that abnormalities observed on CT scans and ultrasounds can also occur in other respiratory diseases and should be interpreted in conjunction with the clinical presentation and viral tests [27].

Additional considerations for diagnosis of COVID-19

Public health authorities may recommend supplementary testing strategies based on local COVID-19 transmission dynamics and available testing resources. As the understanding of COVID-19 continues to evolve, new diagnostic tests are continually being evaluated and may be incorporated into clinical practice in the future.

By adhering to established diagnostic guidelines and following the latest testing recommendations, healthcare professionals can effectively diagnose COVID-19 cases and initiate appropriate management strategies.

Treatment of COVID-19

The treatment approach for COVID-19 depends on the severity of illness and individual risk factors. For mild to moderate cases, antiviral medications such as Paxlovid and molnupiravir can be taken orally within the first 5 days of symptoms [28]. These FDA-approved medications have shown effectiveness in preventing disease progression, but must be discussed with a physician due to potential interactions with other drugs. For high-risk children and adults with mild to moderate infection of COVID-19, remdesivir (an intravenous medication) may be recommended to reduce disease severity.

Additional considerations for treatment of COVID-19

- Antibiotics are ineffective against COVID-19, a viral infection.
- People with COVID-19 should isolate themselves to prevent the virus from spreading.
- Seek immediate medical attention to patients with severe symptoms such as trouble breathing, chest pain, confusion or bluish skin discoloration. Home pulse oximeters can help monitor patients' oxygen levels.

Preventing COVID-19 spread

Practice social distancing, wear well-fitting masks, improve indoors ventilation, wash hands frequently, cover coughs/sneezes, clean surfaces regularly, avoid sharing personal items, wash clothes/linens thoroughly, and maintain distance from pets during illness. Following the guidance from healthcare providers and public health authorities is crucial for the safe and effective treatment and prevention of COVID-19.

FDA-approved medications for COVID-19 treatment

Several FDA-approved medications (as shown in Table 1) play a crucial role in the treatment of COVID-19 by targeting the virus itself (antivirals) or modulating the immune response to reduce inflammation and disease severity. Early initiation of treatment with antiviral drugs (within 5-7 days of the onset of symptoms) is generally recommended for optimal efficacy. However, it is important to note that some medications listed here may have specific prescribing criteria or potential side effects. Consulting a healthcare professional is crucial to determine the most appropriate treatment approach for each individual case.

Vaccination against virus

Vaccination can help prevent COVID-19 infection. The most effective vaccines against COVID-19 are the Pfizer, Moderna, Oxford and Janssen vaccines, which are recommended by the WHO [38]. Table 2 lists some of the WHO-approved vaccines that are the most effective in preventing severe disease.

Changes and enhancements in vaccination procedures against SARS-CoV-2 variations

Effectiveness against delta variant

Studies showed that existing the vaccines used in the US, including Pfizer-BioNTech, Moderna and Janssen, have higher efficacy against hospitalization and lower mortality for the Delta variant compared to earlier virus strains. The Moderna vaccine displayed the highest efficacy (95%) against Delta, followed by Pfizer-BioNTech (92%) and Janssen (77%) [39].

However, a separate study suggested that immunity with the Pfizer-BioNTech vaccine wanes in younger people. The protection against infection offered by this vaccine ranged from 59% to 66% in the weeks after the first dose, but increased significantly to 90% within 7-14 days after the second dose [40].

Table 1. This table provides a summary of FDA-approved or authorized medications used to treat COVID-19. The medications target different aspects of the disease by affecting viral replication or the inflammatory response [29, 30].

Category	Name of Drug	Mechanism of Action	FDA Approval Status	Probable Side Effects	References
Antiviral Drugs	Paxlovid (Nirmatrelvir/ Ritonavir)	Inhibits a specific enzyme essential for viral replication	Approved for adults with high-risk mild-to-moderate infection of COVID-19	Headache, diarrhea, vomiting, dysgeusia (altered taste)	[31]
	Paxlovid (Nirmatrelvir/ Ritonavir)	Inhibits a specific enzyme essential for viral replication	Approved for adults with high-risk mild-to-moderate infection of COVID-19	Headache, diarrhea, vomiting, dysgeusia (altered taste)	[31]
	Molnupiravir (Lagevrio)	Introduces errors into viral genome	EUA for adults with high-risk mild-to-moderate infection of COVID-19 who cannot access other treatments	Dizziness, rash, diarrhea, nausea	[33]
Immunomodulators	Baricitinib (Olumiant)	Reduces inflammation	Approved for certain hospitalized adults with COVID-19 pneumonia	Vein thrombosis	[34]
	Tocilizumab (Actemra)	Reduces inflammation	Approved for certain hospitalized adults with COVID-19 pneumonia	No side effect in initial studies, enhancement of liver enzymes in the case of infliximab/ tocilizumab	[35]
	Kineret (anakinra)	Inhibition of interleukin-1 (IL-1) receptor	Authorized by the FDA for people who need supplemental oxygen	Reaction at injection site, increased liver enzymes, hypertension	[36]
Other FDA-Approved Treatments	Golihic (Vilobelimab)	Anti-inflammatory agent by antagonizing complement component 5a (C5-a) receptor	Authorized by the FDA for hospitalized adults with severe infection of COVID-19 who need mechanical ventilation or extracorporeal membrane oxygenation (ECMO)	Hypertension, pneumonia, pulmonary embolism, delirium, sepsis	[37]

Effectiveness against Omicron variant

Emerging evidence suggested that the Omicron variant may partially evade protection from the initial two-dose regimen of some vaccines, particularly the Pfizer-BioNTech's mRNA vaccine. Studies in South Africa revealed that the efficacy of this vaccine against hospitalization caused by Omicron was approximately 70% in the initial phase of Omicron dominance, although mortality rates were significantly lower compared to previous variants [41].

A recent study published in the Journal of medical virology (by Suresh Kumar et.al, [41]) which analyzed data from 50 countries, found that the median case fatality rate (CFR) for the Omicron variant was substantially lower (3.04%) compared to the Delta variant (8.56%). This finding suggests a decrease in the inherent severity of the Omicron variant, although it may be more transmissible.

A summary of the efficacy of vaccines against the Omicron variant in England is summarized in Table 3.

Table 2. The most effective vaccines against COVID-19 disease approved by WHO [38]

Vaccine Type	Examples	Nature	Nature	Trail	Efficacy	Limitations
Messenger RNA (mRNA) Vaccines	Pfizer	Lipid-nano-Particle-formulated, nucleoside-modified RNA vaccine.	Damage to the protein of the SARS-CoV-2 virus creates the antibody that neutralizes the virus's damaging effect.	The random study contains 43548 participants, divided into two groups one is vaccinated, while the other is a non-vaccinated group.	180 cases of COVID-19 disease were confirmed, 8 from the vaccinated group, while 172 from the non-vaccinated group showed 95% efficacy.	Shoulder injury, right axillary, paroxysmal ventricular, and arrhythmia were reported among the vaccinated group.
	Moderna	Lipid-nanoparticle-encapsulated nucleoside-modified mRNA-based vaccine.	Stabilized full-length SARS-CoV-2 virus helps to eliminate the virus.	A randomized and placebo-controlled study contained 30420 healthy adult participants, who were divided into two groups: the placebo group and the Moderna group.	196 cases of COVID-19 were confirmed, 185 from saline and placebo and 11 from the Moderna group, Moderna. The vaccine showed 94.12% efficacy.	Injection site pain, fatigue, myalgia, erythema, tenderness, and headaches were reported among the Moderna group.
Viral Vector Vaccines	Oxford/ Astra Zeneca	Oxford/Astra Zeneca vaccine, a viral vector that uses a chimpanzee adenovirus (ChAdox1)	Creates an antibody that prevents the invasion of the SARS-CoV-2 virus in the alveolar cells of the lungs.	A random study, selecting three countries—the UK, Brazil, and South Africa—was done in four phases.	It showed an efficacy of 70.4%.	Feeling tired, pain at the injection site, Muscle pain, joint pain, and nausea were reported among the vaccinated group.
Non-replicating Viral Vector Vaccines	Jansson	Non-replicating-recombinant human adenovirus type 26.	It works against the spike protein of coronavirus.	The random study contains 43783 participants, divided into placebo and vaccinated groups.	It showed an efficacy of 66.9%.	Tiredness, muscle pain, headaches, fever, and nausea were reported among the vaccinated group.

Table 3. The overview of the adequacy of the immunization against the BA.1 and BA.2 Omicron sub-variants in individuals in the UK who received immunizations from Pfizer-BioNTech, Moderna, or Oxford-AstraZeneca as their underlying and supporter portions, alongside half-portion Moderna antibodies as promoter shots [41].

Vaccination Regimen	Efficacy of Vaccines BA.1	Efficacy of Vaccines BA.2
Pfizer-BioNTech 1st and 2nd doses	36%	26%
Doses 1 and 2 of Moderna	54%	50%
Doses 1 and 2 of Oxford-Astr aZeneca	29%	17%
Half-dose Moderna booster or Pfizer-BioNTech	64%	62%

These results demonstrate the importance of booster shots in supporting resistance and reveal the viability of immunizations against the Omicron variant over time [41].

Toxicity of medicines and antibodies

It is essential to consider the expected secondary effects and toxicity related to different medicines and antibodies utilized in the administration of coronaviruses. It is

important that both those who provide healthcare and those who receive the interventions should have an understanding of these aspects.

Antiviral Medications

Although antiviral drugs (such as Favipiravir, Lopinavir/Ritonavir, Remdesivir, Ribavirin and Umifenovir) have been proposed for their potential antiviral properties, their safety and efficacy in treating COVID-19 are still the subject of ongoing research. Although inconsistent, two antagonistic impacts have been identified: gastrointestinal problems and hypersensitive reactions [40]. The specific assessments and conceivable unpleasant effects of these drugs could change. It is basic for clinical services specialists to screen patients diligently for any signs of hostile reactions.

Coronavirus immunizations

The four vaccines examined, Moderna (mRNA-1273), Pfizer/BioNtech (BNT162b2), AstraZeneca/Oxford (ChAdOx1 nCoV-19) and Sputnik V (rAd26)/rAd5, seem to be compelling in preventing coronavirus contamination or side effects. Particularly important is their viability in anticipating serious sickness caused by the infection. The vaccines exhibit relatively minor and common side effects, such as irritation at the injection site, fatigue, myalgia, migraine and occasionally hypersensitive reactions. Close monitoring for severe adverse events is crucial. Overall, the benefits of each vaccine outweigh the risks, and adverse events are generally rare. Notwithstanding, people should check with medical providers about any concerns or previous circumstances before going through inoculation. The consideration on distribution and capacity, particularly the capacity of AstraZeneca/Oxford and Sputnik V immunizations to be stored at typical refrigeration temperatures, may assume an essential part in the borderless circulation of vaccines, especially in remote or financially disadvantaged areas [42].

To prevent the severe disease from spreading globally, the preventive measures from WHO must be followed. The general public needs to be informed about preventive measures they can take to protect themselves and others, such as maintaining social distancing, staying away from COVID-19 patients, wearing masks, washing hands and avoiding unnecessary outdoor activities.

Worldwide public health and social effects of COVID-19

The COVID-19 pandemic has demonstrably exerted a profound impact on global health and society. Since its emergence, the virus has disrupted daily life on a wide scale, affecting over 754 million people across 218 countries [43]. Beyond the immediate health consequences, the pandemic has also triggered significant economic repercussions, with companies facing revenue losses and operational difficulties [44]. Socially, COVID-19 has been associated with heightened anxiety, fear, loneliness and altered behavior patterns across communities and individuals [45]. Furthermore, vulnerable populations, such as those with chronic diseases, cancer, or end-of-life care needs, have experienced direct and indirect health consequences due to the pandemic, including delayed treatments and mental health concerns [46]. To sum up, the COVID-19 pandemic has ushered in a period of substantial global changes and challenges that impact diverse facets of society and health.

Conclusion

Since 2019, the COVID-19 pandemic has had an enormous impact on the world's population and healthcare systems. It has infected millions of individuals globally and has a high incidence of transmission and mortality. The virus has four structural proteins that give it a spherical, crown-like appearance and make it a member of the Coronaviridae family. The majority of patients have minor symptoms; a sizable portion may need specialized treatment to recover. Numerous methods can be used to diagnose the disease, and general care, additional oxygen, antiviral drugs and prophylaxis are all part of the treatment. The COVID-19 pandemic has emphasized the need for more intensive research and the importance of international cooperation in addressing public health catastrophes.

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Conflict of interest

The authors declare no conflicts of interest that could potentially bias the objectivity or interpretation of this review.

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