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Global COVID-19 Pandemic: Prevention and Protection Techniques

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Abstract: *The COVID-19 is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2). It has been identified as the causative agent of the viral pneumonia outbreak in Wuhan, China, at the end of 2019. It has a high human to human transmission capability and primarily targets the human respiratory system. Healthcare providers to common people are in high risks of the contamination of this fatal disease. It spreads person to person through respiratory droplets that produced during talking, coughing and sneezing. It is associated with severe and fatal respiratory disease in humans. At present it becomes great global public health concern. On 11 March 2020, the WHO declared the global COVID-19 outbreak as a pandemic. The COVID-19 pandemic has entered in a very dangerous phase in April and May 2020, and the severity is increasing day by day. On 26 July 2020, about 216 countries and territories are infected worldwide; total global infections become more than 16.3 million and total recovered about 9.9 million with total deaths 648,477. The disease have not abolished even in the 2021. On 27 March 2021, the disease spread up to 219 countries and territories globally; total confirmed deaths become 2,783,591, total confirmed cases 127,025,229, with total recovery 102,370,710. The paper discusses the social, economic, and health impacts in the world's poorest countries due to COVID-19 pandemic outbreak. The study also presents the current economic situation of the world and analyses the potential consequences on global economy. An attempt has been taken here to create consciousness among the common people to reduce the fatality of this killer disease. From the beginning of 2021, COVID-19 vaccines are distributed worldwide and all nations are united to abolish the virus completely.*

Keywords: COVID-19, SARS-CoV-2, SARS-CoV, MERS-CoV, Wuhan, pandemic, vaccines, variants

JEL Codes: I11, I12, I15, I18

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1. Introduction

The SARS-CoV-2 is a new human coronavirus which emerged at the end of December 2019 in Wuhan, Hubei Province, China. At the late December 2019, the diseases spread outward from Wuhan [Li et al., 2020]. From China the outbreak of COVID-19 has spread quickly in most of the countries of the world [Zhu et al., 2020]. On 01 December 2019 first case of COVID-19 has been identified in a person who had not had any exposure to the Huanan Seafood Wholesale Market of Wuhan [WHO, 2020f]. At the end of December 2019, about 41 cases of 'pneumonia of unknown etiology' were reported by the Wuhan Municipal Health Committee [Zhu et al., 2020; WHO, 2020c]. The first confirmed death was on 9 January 2020 in Wuhan, China. On 22 January 2020, novel CoV has been declared to be originated from wild bats and belonged to Group 2B of β-CoV [Gralinski & Menachery, 2020]. The origin and evolution of SARS-CoV-2 is not fully clear yet, it is identified that the virus is related to viruses in *Malayan pangolins*, native in

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Southeast Asia, that were smuggled into Southern China [Lam et al., 2020]. The first death outside China occurred in the Philippines, and the first death outside Asia was in France [Holm & Moritsugu, 2020].

On 11 February 2020, the World Health Organization (WHO) named the zoonotic coronavirus disease as COVID-19 ("CO" stands for "corona", "VI" for "virus" and "D" for "disease", while "19" was for the year), which belongs to the sarbecovirus subgenus of Coronaviridae family, subfamily Coronavirinae [Enserink, 2020; Zhao et al., 2020]. On 7 January 2020, the causative pathogen was identified as a novel coronavirus, which is distinct from both Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), and Middle East Respiratory Syndrome Coronavirus (MERS-CoV). This virus was named as 2019-nCoV by WHO on January 12 and the disease as COVID-19 on 11 February 2020 [WHO, 2020a]. Researchers sequenced the genome of COVID-19 and observed that 86.9% of the genome is the same as SARS-CoV genome [Chang et al., 2020]. The Coronavirus Study Group (CSG) of the International Committee on Taxonomy of Viruses renames 2019-nCoV to SARS-CoV-2. It is a new illness that is caused a novel severe acute respiratory syndrome coronavirus, which infects both humans and animals. It is infectious dieses and spread from one person to others by respiratory droplets that produced during talking, coughing or sneezing. It is closely related to the original SARS-CoV [ECDC, 2020] and more contagious than both SARS-CoV and MERS-CoV [Wang et al., 2020a].

The epidemic has spread from Hubei to the rest of Mainland China only within 30 days [WHO, 2020a]. On 30 January, the WHO declared the outbreak a "*Public-Health Emergency of International Concern (PHEIC)*" as the outbreak paralyzed the whole global healthcare systems [Callaway, 2020]. On 11 March 2020, the WHO declared the global outbreak as a pandemic to minimize the infection and mortality rate [WHO, 2020g]. On 25 March it globally infected more than 465,000 people with more than 21,000 deaths. On 5 April total infected people became 1,225,360 (124,632 in Italy, 130,759 in Spain, 311,889 in the USA, 97,351 in Germany, 81,669 in China, 68,605 in France, 58,226 in Iran, 47,806 in the UK, etc.), total recovered 252,615 (20,996 in Italy, 38,080 in Spain, 14,967 in the USA, 23,192 in Germany, 76,964 in China, 14,008 in France, 22,011 in Iran, etc.), and total deaths became 66,542 (15,362 in Italy, 12,418 in Spain, 8,492 in the USA, 7,560 in France, 4,932 in the UK, 3,603 in Iran, 3,329 in China, 1,479 in Germany, etc.). Since December 2019 to 8 May 2020, more than 3.85 million people of the world are infected from this disease, more than 1.28 million are recovered, and more than 270,000 died. The infections are moving to new locations, such as Brazil. The infections and deaths are decreasing in some countries of Europe; but are increasing in some countries of Asia, North and South America. On 25 May Brazil becomes second most infected country in the world after the USA. On 25 May 2020, total deaths in the world reached to 344,760 (the USA 98,024, the UK 36,793, Italy 32,785, Spain 28,752, France 28,367, Brazil 22,746, etc.) and total infected person became more than 5,400,608 (the USA 1,677,436, Brazil 365,213, Russia 344,481, the UK 259,559, Spain 235,772, Italy 229,858, Germany 180,328, Turkey 156,827, France 144,921, India 138,845, Iran 135,701, etc.) with total recovery 2,165,782. On 26 July total infections reached to 16,205,503 with total deaths 648,477 and total recovered 9,914,063 [Worldometer, 2020].

On 27 March 2021, the disease spread up to 219 countries and territories globally; total confirmed deaths become 2,783,591, total confirmed cases 127,025,229, with total recovery 102,370,710. On 27 March, ten most infected countries in the world are the USA (30,889,740 confirmed cases, 23,277,311 recovery, and 561,422 death); Brazil (12,407,323 confirmed cases, 10,824,095 recovery, and 307,326 death); India (12,024,393 confirmed cases, 11,320,563 recovery, and 161,565 death); Russia (4,519,629 confirmed cases, 4,130,498 recovery, and 97,791 death); France (4,465,956 confirmed cases, 288,062 recovery, and 94,275 death); UK (4,325,315 confirmed cases, 3,768,434 recovery, and 126,515 death); Italy

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(3,536,292 confirmed cases, 2,832,939 recovery, and 108,016 death); Spain (3,255,324 confirmed cases, 3,016,247 recovery, and 75,010 death); Turkey (3,209,136 confirmed cases, 2,939,929 recovery, and 31,074 death); and Germany (2,761,796 confirmed cases, 2,477,500 recovery, and 76,321 death) [Worldometer, 2021].

SARS-CoV-2 affects lungs, with severe acute respiratory illness that develop a fever, dry cough, fatigue, and shortness of breath. Public health responses for SARS-CoV-2 are isolation, quarantines, travel restriction, stop of workplace, closures of educational institution, and ultimately lockdown [Rothan & Byrareddy, 2020].

2. Literature Review

J. S. M. Peiris and his coauthors followed up 75 patients for 3 weeks to investigate the temporal progression of the clinical, radiological, and virological changes in a community outbreak of SARS-CoV [Peiris et al., 2003]. Yang Yang and his coauthors have analyzed the spreads in humans and causes of MERS-CoV. They have believed that this virus originated from bats and transmitted to humans [Yang et al., 2014]. Abdullah Assiri and his coauthors analyze epidemiological, demographic, clinical, and laboratory data from confirmed 47 cases of sporadic, household, community, and healthcare associated MERS-CoV infections reported from Saudi Arabia by identifying knowledge gaps [Assiri et al., 2013].

Paul S. Masters has discussed the different models for the mechanism of genomic RNA packaging. He also discusses the recent exciting discovery that selective coronavirus genome packaging is critical for in vivo evasion of the host innate immune response [Masters, 2019]. Rozhgar A. Khailany, Muhamad Safdar, and Mehmet Ozaslan characterize the genomic structure of SARS-CoV-2 using bioinformatics programs. They have considered medical and biological impacts on the prevention, diagnosis, and therapy of COVID-19 infectious diseases. The genomic signature analysis demonstrates that a strong association between the time of sample collection, location of sample and accumulation of genetic diversity [Khailany et al., 2020]. Young-Il Kim and his coauthors provide ferret model of SARS-CoV-2 infection and transmission that recapitulates aspects of human disease. They observe that the virus was found in nasal washes, saliva, urine, and feces up to 8 days post-infection. A few naive indirect contact ferrets were positive for viral RNA, suggesting airborne transmission of the disease [Kim et al., 2020]. Haradhan Kumar Mohajan has discussed the global economic consequences of COVID-19. He also tried to highlight on the coronavirus infections in Italy and the techniques to reduce both infections and deaths in the country [Mohajan, 2020a, b].

Hussin A. Rothan and Siddappa N. Byrareddy emphasize on the epidemiology, symptoms, transmission, pathogenesis, phylogenetic analysis and future directions to control the spread of COVID-19 [Rothan & Byrareddy, 2020]. Shio-Shin Jean, Ping-Ing Lee, and Po-Ren Hsueh indicate that no drugs are validated to have significant efficacy in clinical treatment of COVID-19 patients [Jean et al., 2020]. Muhammad Adnan Shereen and his coauthors have discussed origin, transmission, and characteristics of COVID-19 diseases. According to them, SARS-CoV-2 is phylogenetically related to SARS-like bat viruses; therefore bats could be the possible primary reservoir [Shereen et al., 2020]. Stephen E. Moore and Eric Okyere consider an optimal control of COVID-19 transmission mathematical model to reduce of exposed and infectious persons. They investigate three control strategies for personal protection, i) treatment when individuals are early diagnosed, ii) treatment when individuals are delay diagnosed, and iii) effective spraying of the environment and cleaning possible infected surfaces can help to reduce the quantity of the virus [Moore & Okyere, 2020].

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Jieliang Chen discusses the pathogenicity and transmissibility of 2019-nCoV. He also shows the relationship between viral pathogenicity and transmissibility of this virus. He has shown the basic reproduction number R_0 for 2019-nCoV is 1.4–5.5, for SARS-CoV is 2–5, and MERS-CoV is less than 1 [Chen, 2020]. Daniele Di Mascio and her coauthors believe that very little is known about the effect of CoV-related infections during pregnancy. At this period the CoV infection is associated with higher rates of miscarriage, preterm birth, preeclampsia, cesarean delivery and perinatal death (7-11%). But there were no reported cases of vertical transmission [Mascio et al., 2020].

Stefan E. Pambuccian offers an estimation of the current state of knowledge about the COVID-19 disease and its pathology, and the potential presence of the virus in cytology specimens [Pambuccian, 2020]. Richard Baldwin and Beatrice Weder di Mauro in their editorial report indicate that global supply chains have been disrupted when the COVID-19 outbreak was triggered in December 2019 in the city of Wuhan, Hubei province of China. They confirm that every country of the world will face short to long-terms economic impacts, and global GDP will decrease extremely (Baldwin & di Mauro, 2020). International Labour Organization (ILO) shows the economic impacts of global labor markets due to COVID-19 [ILO, 2020].

3. Methodology of the Study

Research is an essential and powerful tool in leading a researcher towards progress [Pandey & Pandey, 2015]. In research, 'method' is a strategy and technique employed to acquire knowledge and categorizes to study, and manipulates the collected data. Therefore, a research method is a way of conducting and implementing research efficiently [Punch, 2013]. Methodology is the guidelines to approach and perform activities. Research methodology provides us the principles for organizing, planning, designing and conducting a good research. Therefore, we consider that it is the science and philosophy behind all researches [Legesse, 2014].

The methodology of this article is to discuss the aspects of global pandemic outbreak of COVID-19. In this study we have observed that the disease is spreading in every country, and both infection and deaths are increasing in a geometrical rate. This study is descriptive nature having quantitative as well as qualitative merits. We tried to discuss the global pandemic COVID-19, along with the impact on global economy. Reliability and validity are essential parts for a good research. In this study we have tried our best to maintain reliability and validity in a concise, but precise manner [Mohajan, 2017, 2018]. In this review work we have used the secondary data. The data are collected and designed the article from books of famous authors, published, submitted and preprint articles, conference papers, websites, theses, case studies, and various research reports.

In the study, we have tried to discuss the various sides of noble coronavirus which becomes most fatal pandemic in the 21st century. The virus spreads almost in every country of the world. The fatality of this disease is increasing day by day. The North and South America, Europe and Asia are the most affected regions in the world. On 09 February 2021, the disease spread up to 223 countries and territories globally; total confirmed deaths become 2,337,368, total confirmed cases 107,037,441, with total recovery 78,913,746 [Worldometer, 2021].

In this study we have tried to enrich the research of global pandemic of COVID-19. We have tried to discuss the origin, morphology and structure, historical evidence, symptoms, and transmission of SARS-

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CoV-2. We have also briefly discussed the prevention and treatment techniques, vaccinations, high risk people and reduction of the risk, and financing of this disease.

4. Objective of the Study

The main objective of this study is to reduce ongoing global outbreak of the COVID-19 virus by the prevention and treatment of the disease. The other specific objectives are as follows:

- to highlight the knowledge gaps for the transmission of this disease,
- to provide the morphology, structure, and history of coronavirus, and
- to analyze the symptoms, transmission, prevention and vaccinations of the disease.

5. Types of Coronaviruses

Coronaviruses (CoV) are a large family of non-segmented, enveloped, positive-sense, single-stranded RNA viruses that typically cause mild to severe respiratory disease in humans. There are seven known types of human CoV. Four types, i) HCoV-229E, ii) HCoV-NL63, iii) HCoV-OC43, and iv) HCoV-KHU1 are common and cause mild to moderate respiratory infections in human (e.g., the common cold) and there is no evidence of death from these viruses. Among these four types, HCoV-229E and HCoV-NL63, belong to the α coronavirus genus [Chen, 2020; Crossley et al., 2012]. Other two types, v) Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) likened to Cinderella [Li, 2013], and vi) Middle East Respiratory Syndrome Coronavirus (MERS-CoV), can cause severe respiratory infections [Assiri et al., 2013; de Groot et al., 2013]. It is confirmed that HCoV-OC43, HCoV-KHU1, SARS-CoV and MERS-CoV, belong to the β coronavirus genus. The seventh type, a novel coronavirus vii) 2019-nCoV or SARS-CoV-2 is a new coronavirus recently discovered in China that has not been previously found in people. The SARS-CoV-2 belongs to the subgenus Sarbecovirus and mostly resembles a bat coronavirus, with which it shares 96.2% sequence homology [Chan et al., 2020]. The SARS-CoV and MERS-CoV are the two major causes of severe pneumonia in human [Song et al., 2019]. The MERS-CoV, SARS-CoV and SARS-CoV-2 viruses have their origins in birds (e.g., bats) and animals (e.g., camels) and can transform from human to human that create common flu [Li et al., 2020]. In the advanced stage, the symptoms of SARS-CoV-2 show pneumonia which progresses to severe pneumonia and acute respiratory distress syndrome (ARDS). At this stage the patient need life-support to sustain the life [Heymann & Shindo, 2020].

6. Historical Evidence of Coronavirus

Coronaviruses were first discovered in the 1960s in chickens infected by bronchitis virus and human patients by two viruses HCoV-229E and HCoV-OC43 [Crossley et al., 2012]. In 2001, more than 500 patients presented with flu-like symptoms in Canada. Virological analyses showed that 3.6% of these cases were positive for the HCoV-NL63 strain by polymerase chain reaction (PCR) [Al-Osail & Al-Wazzah, 2017]. Severe Acute Respiratory Syndrome (SARS) is a type of coronavirus infection discovered in Guangdong province in China in 2002 [Li, 2013]. Nosocomial transmission of SARS-CoV was common while the primary reservoir was putatively bats and it was transmitted from civet cats to humans [Hui & Zumla, 2019]. The virus of this fever SARS-CoV has been identified in 2003. It is transmitted from person to person through respiratory droplets when they come in close contact [Heymann et al., 2013; Li et al., 2005]. The 2002-2003 outbreaks became a global health threat; about 8,100 people infected in 37 countries of North America, South America, Europe, and Southeast Asia, over a period of 8 months (from 16 November 2002 to July 2003),

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about 10% (800 patients) died. The Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) declared a state of emergency in this regard [CDC, 2003; Peiris et al., 2003; WHO, 2003; Hui & Zumla, 2019]. Experience of SARS-CoV infectious disease enables China to respond more effectively to subsequent health threats, such as H7N9 avian influenza and COVID-19 [Zhang et al., 2013; Hui et al., 2020].

Other two members HCoV-NL63 discovered in 2004 and HKU1 discovered in 2005. Another type of coronavirus infection is Middle East Respiratory Syndrome (MERS) which is a novel lethal zoonotic (animal to human) disease, discovered in 2012. The novel β-CoV is responsible for the disease that appears to have originated in bats and uses dromedary camels as intermediate hosts [Zaki et al., 2012; Cho et al., 2018; CDC, 2019]. The first cases of MERS-CoV infection in Jeddah of Saudi Arabia were reported on 13 June 2012 and continued to spread overseas to many countries in Asia, Africa, Europe, and America [Zumla et al., 2015; Al-Osail & Al-Wazzah, 2017]. It is transmitted to humans from bats or camels', as it is related to bat or camels' coronaviruses HKU4 and HKU5, and had the capability for human to human transmission through respiratory droplets when come in close contact [Yang et al., 2014]. This virus causes severe viral infections with high mortality rates. About 2,500 people of Bahrain, Iraq, Iran, Israel, The West Bank and Gaza, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, The United Arab Emirates (UAB), Egypt, and Yemen have been identified with MERS and more than 850 (36%) died. The virus also spread in France and the UK [Geller et al., 2012; Assiri et al., 2013; de Groot et al., 2013; Azhar et al., 2019]. On 30 December 2019, a cluster of patients with pneumonia of unknown etiology was observed in Wuhan, China. On 7 January 2020, a new coronavirus SARS-CoV-2 is discovered which spread globally through person to person contact. On 11 February 2020, WHO named it COVID-19 [Guarner, 2020; Li et al., 2020].

7. Morphology and Structure of CoV

Coronaviruses (CoV) are a large family of viruses which may cause illness in humans or animals (camels, cattle, and bats). The name 'coronavirus' is derived from the Latin *corona*, meaning "crown" or "halo" or "wreath", which refers to the characteristic appearance reminiscent of a crown or a solar corona around the virions when viewed under two-dimensional transmission electron microscopy (Figure 1). This appearance is produced by the peplomers of the spike (S) glycoprotein radiating from the virus lipid envelope. The genome size of coronaviruses ranges 80–160 nM and 27–34 kilobases (kbs) in length with positive polarity (Figure 1) [Woo et al., 2010; Masters, 2019]. International Committee on Taxonomy of Viruses (ICTV) recently classified 39 different species of CoV, belong to the family Coronaviridae, suborder Cornidovirineae and order Nidovirales, are known and have been divided into four genera ($\alpha, \beta, \gamma, \delta$) characterized by different antigenic cross-reactivity and genetic makeup. Only the α and β coronavirus genera include strains pathogenic to humans and infect humans [Cleri et al., 2010; Paules et al., 2020].

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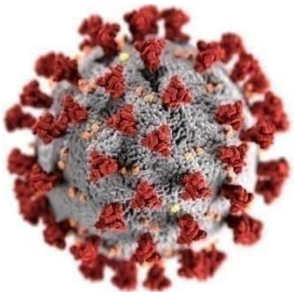

Figure 1: Shape of SARS-CoV-2. Source: [CDC, 2020].

There are four conserved viral genome structural proteins across CoVs (Figure 2): the spike (S), membrane (M), envelope (E), and nucleocapsid (N). These four structural proteins beside other helper proteins account for one-third of the genome; the other two-third encodes viral polymerase (RdRp), RNA synthesis materials and ORF1a-ORF1b (two types of huge nonstructural proteins) [Sahin et al., 2019]. The S glycoprotein is located outside the virion and gives the virion the typical crown shape. It forms homotrimers, which allow the formation of sun-like morphologies for the name of coronavirus. It governs binding to host cell receptors and virus entry into cells [Graham & Baric, 2010]. The M glycoprotein has three transmembrane regions and glycosylated in the Golgi apparatus. It is crucial for the virion to fuse into the cell and to make protein antigenic. It is involved in budding and envelope formation [de Haan et al., 2003]. The E glycoprotein is small protein that is composed of 76 to 109 amino acids. It is a part of the nucleocapsid of viral particles. It plays a critical role in the assembly and morphogenesis of virions within the cell [Raamsman et al., 1998]. The N protein is phosphoproteins that is capable of binding to helix and has flexible structure of viral genomic RNA (gRNA). It plays an important role in virion structure, replication and transcription of coronaviruses [Raamsman et al., 1998].

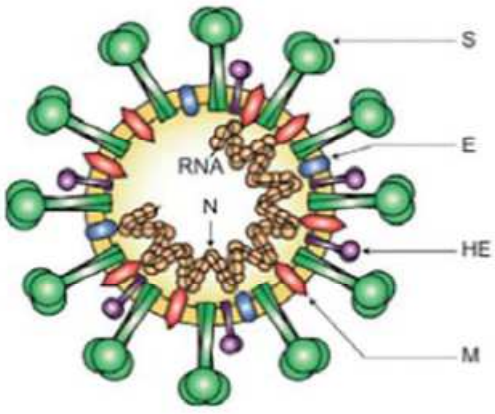

Figure 2: Virion structure of the coronavirus. Source: [Tok & Tatar, 2017].

The S, E, and M are embedded in a membrane envelope derived from the site of budding, the Golgi-endoplasmic reticulum intermediate compartment. SARS-CoV-2 is a single stranded enveloped RNA virus

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which possess a positive-sense RNA genome also known as (+ssRNA). The RNA molecule has a 5'-cap, 5'-untranslated region (UTR), open reading frames, a 3'-UTR, and 3'-poly (A) tail [Ziebuhr, 2005; Lo et al., 2019; Masters, 2019]. The 2019-nCoV is a β-CoV of group 2B with over 70% similarity in genetic sequence to SARS-nCoV [Hui et al., 2020]. The S protein of both SARS-CoV and SARS-CoV-2 is most closely related to bat coronaviruses BatCoV and RaTG13 [Benvenuto et al., 2020; Robertson, 2020]. Three new human coronavirus species are SARS-CoV, MERS-CoV and SARS-CoV-2 [Chen, 2020].

During the infection, the receptor binding motif (RBM) of the S protein gets directly attached to the Angiotension Converting Enzyme 2 (ACE2) in the host cells. The ACE2 protein is expressed in various organs of the human body mainly in the lungs, kidney and intestine, the prime targets of the coronavirus [Zhao et al., 2020].

8. Symptoms of CoV

COVID-19 is a new illness that is caused by a virus called SARS-CoV-2. The outbreaks of it usually happen in the winter and spring. The period from the onset of COVID-19 symptoms to death ranged from 6 to 41 days with a median of 14 days [Li et al., 2020]. Most patients infected with COVID-19 virus have mild disease and recover. The symptoms are divided into two disorder categories: systematic disorder and respiratory disorder (Figure 3). The most common symptoms are; fever, coughing, shortness of breath or difficulty in breathing [Lu et al., 2020]. Minor or major symptoms of this illness are fever (>100.4°F/38°C), dry cough, fatigue, sputum production, dyspnoea, shortness of breath, lymphopenia, anorexia, headache, hypoxemia, chills, nausea or vomiting, rhinorrhoea, muscle or joint pain, grand-glass opacities, myalgia, haemoptysis, sore throat, sneezing, nasal congestion, RNAaemia, diarrhea, etc. A COVID-19 infected patient may experience one or more symptoms. In some cases infection happened without any symptoms. Some patients experienced loss of taste, appetite or smell [Carlos et al., 2020; Huang et al. 2020; Ren, et al., 2020; Wang et al., 2020a]. According to scientific observations, as the status of patient gets worse, urea and creatinine blood levels gradually raised. Symptoms depend on the type of coronavirus and age, stamina of patient, and generally seen between 2 and 14 days of expose, on an average 5.2 days. In some cases the symptoms transform to pneumonia (infection of the lungs), multi-organ failure (e.g., kidney, heart, etc.), and even to death [Pan et al., 2020]. The period from the onset of COVID-19 symptoms to death ranged from 6 to 41 days with a median of 14 days [Wang et al., 2020b].

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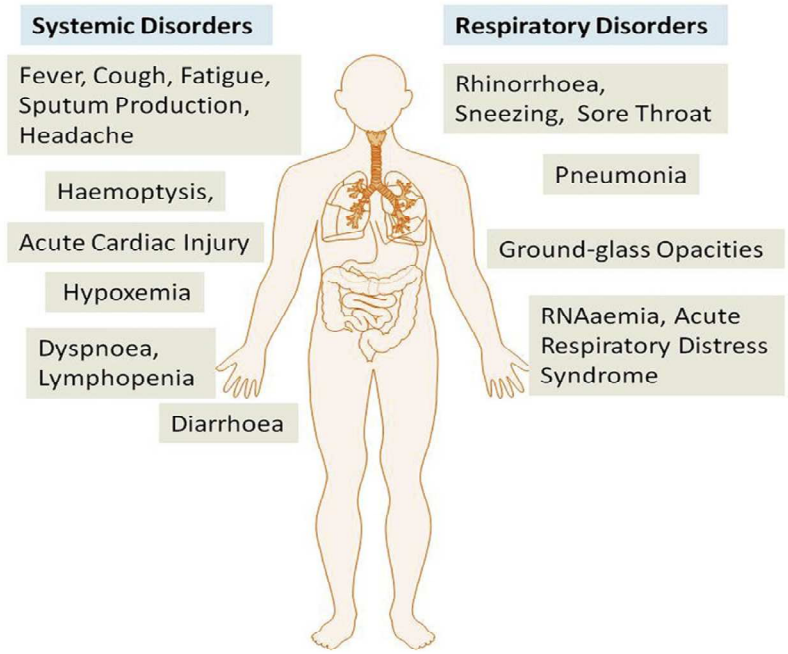

Figure 3: The systemic and respiratory disorders caused by COVID-19. **Source:** [Rothan & Byrareddy, 2020].

9. Transmission of CoV

The 2019-nCoV outbreak was started from a local Huanan Seafood Wholesale Market (also sold live animals) of Wuhan, China which was shut down and disinfected. Three human coronaviruses; SARS-CoV, MERS-CoV, and SARSCoV-2 are thought to spread from infected animals to people through contact [Guarner, 2020; Wang et al., 2020a]. It is now quite clear that large-scale human to human transmission of this virus appears (Chan et al., 2020). In China, men had a death rate of 2.8% while women had a death rate of 1.7%. In every country both infections and death rates are more in men than women [Feng et al., 2020].

The virus accesses host cells through angiotensin-converting enzyme 2 (ACE2), which is found in various organs of the body, but it is most abundant in the type II alveolar cells of the lungs (Figure 4). That is why lungs are the most affected organs and severe acute respiratory syndrome (SARS) develops; as a consequence respiratory failure happens and finally died [Zhang et al., 2020; Xu et al., 2020].

The fatality rate is defined as number of deaths in persons who tested positive for SARS-CoV-2 divided by number of SARS-CoV-2 cases in percent [Livingston & Bucher, 2020]. The basic reproduction number (from mathematical equation), R_0, is the average number of people who will catch a disease from one contagious person, i.e., how contagious an infectious disease is. If $R_0 < 1$ (e.g., for MERS-CoV), the disease will decline and eventually disappear, if $R_0 = 1$, the disease will stay alive, but there will not be an epidemic. If $R_0 > 1$, cases could grow exponentially and cause an epidemic to a pandemic. It is experimentally found that R_0 value for 2019-nCoV is 1.4–2.5 [WHO, 2020h]. The range of R_0 value for SARS-CoV is 2–5. The R_0 value of SARS-CoV-2 is increasing very rapidly. Some researchers found that the

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range of R_0 values are 3.3–5.5 [Zhao et al., 2020], 3.6–4.0 [Read. et al., 2020], and 4.5–4.9 [Shen et al., 2020], respectively. Later, it is calculated that the R_0 value is more infectious than initially estimated and it is likely to be 4.7–6.6 [Tang et al., 2020].

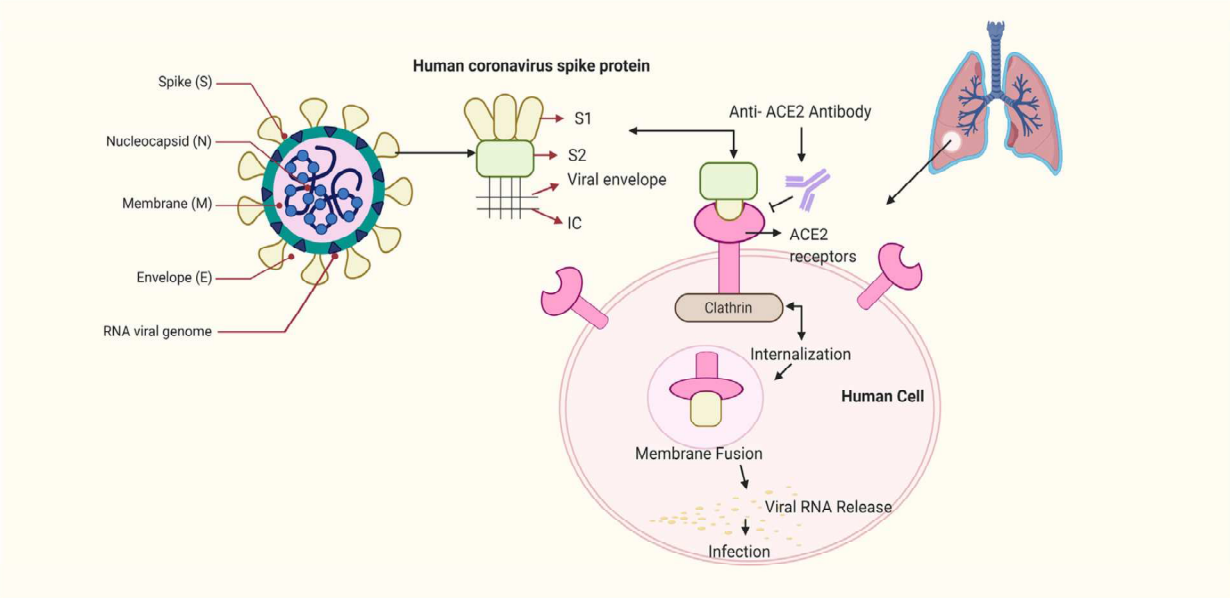

Figure 4: Structure and binding of COVID-19 virus to ACE2. Source: [Vellingiri et al., 2020].

The virus is transmitted mainly from person to person in close contact with others. Respiratory droplets transform from infected person by coughs or sneezes, touching an object or surface with the virus on it and then touching mouth or eyes before washing hands [Chan, et al., 2020; WHO, 2020i]. Droplets only stay suspended in the air for a short time but may stay viable and contagious on metal, glass, plastic or any solid surface [Kampf et al., 2020]. Most of these droplets fall on nearby surfaces and objects, such as desks, tables, mouse, keyboards, telephones, etc. People may infect by touching contaminated surfaces or objects, and then touching their eyes, nose or mouth. If people stand within one meter of a COVID-19 infected person, they can infect catch by droplets through breathing [WHO, 2020g].

On 13 January 2020 the virus was infected outside China in Thailand. On 26 February 2020, it suddenly increased in Italy, Iran, Japan, and South Korea, all of which were exported from China [WHO, 2020d]. The virus has infected in the North and South America, Europe and the rest of the world [Holshue et al., 2020]. The current COVID-19 outbreak caused about 7,000 patients in China during the first month after initial reports (January 2020), with a further 80,000 patients globally during the second month (February 2020). Of these first 87,000 patients, about 4,000 died [Feng et al., 2020].

On 10 March 2020, about 115 countries and territories were affected around the world; about 114,431 patients were identified and about 4,027 died and 64,099 recovered. On 19 March 161 countries and territories were affected; about 230,000 (about 36,000 in Italy) patients were identified and about 10,000 (about 3,000 in Italy) died [The Prothom Alo, 20 March 2020]. On 21 March 161 countries and territories

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were affected; about 275,000 (about 36,000 in Italy) patients were identified and about 12,787 (about 4,885 in Italy) died. Record 793 had died in a day in Italy. On 26 March 500,000 people are infected and death reached to 21,000+ [Channel 24, 2020]. Both infections and deaths increase very rapidly. On 8 April 2020, total 209 countries and territories around the world are affected; global total infection reached to 1,455,987, total recovered 310,108, and total death became 83,687. On 8 May 2020, total infections of the world reached to 3.85 million, more than 1.28 million are recovered, and more than 270,000 died. On 26 July total infections reached to 16,205,503 with total deaths 648,477 and total recovered 9,914,063 [Worldometer, 2020]. On 09 February 2021, the disease spread up to 223 countries and territories globally; total confirmed deaths become 2,337,368, total confirmed cases 107,037,441, with total recovery 78,913,746 [Worldometer, 2021].

10. Diagnosis of CoV

Diagnostic test for SARS-CoV-2 is undertaken using two approaches; i) whole genome sequencing, and ii) real-time reverse transcriptase-Polymerase Chain Reaction PCR (RT-PCR), which is standard method of testing. Protocols for RT-PCR tests kits are developed by Germany, Hong Kong, China CDC, Thailand, and Japan; almost all diagnostic tests are done by using this kit [Center for Health Security, 2020b].

The RT-PCR laboratory tests for respiratory secretions, such as nasal or oral swabs or sputum blood samples are needed to diagnose of SARS-CoV-2, with results within a few hours to 2 days. Lower respiratory tract samples are better than upper ones because they have higher viral load [WHO, 2020b]. The first laboratory test of SARS-CoV-2 was at the Wuhan Institute of Virology, Wuhan, Hubei Province, China; a team led by virologist Zheng-Li Shi. The virus can kill cultured human cells [Callaway, 2020]. Laboratory diagnosis of SARS-CoV-2 infections relies on nucleic acid based testing early in the clinical course and serology later on. Serology tests are blood-based tests that can be used to identify whether people have been exposed to a particular pathogen that analyze the serum (antibodies to specific components of pathogens, called antigens) component of whole blood. At present no serology tests are available for COVID-19 [Center for Health Security, 2020c]. An alternative method of diagnosis is looking for visual signature patterns of COVID-19 in X-rays or Computed Tomography (CT) scans of the lungs, respiratory secretions, blood, urine, and fecal samples for diagnostic testing. CT scan is the main way for diagnosis because RT-PCR may have some errors in samples. Signs of pneumonia may be confirmed through RT-PCR [BioFire, 2020; CDC, 2020; Zhu et al., 2020].

11. Prevention from COVID-19

Before December 2020 there was no full effective vaccine or specific antiviral treatment of SARS-CoV-2 virus. Antibiotics do not work against this virus. The infected patients must contact with healthcare providers to take treatment. The patient must take diagnosis, treatment according to the advice of healthcare providers. Treatment consists of supportive care and relief of symptoms. Supportive treatments are; i) rest isolate, ii) take pain and fever medications except aspirin, iii) drink plenty of liquids, iv) use a room humidifier, and v) take a hot shower to help ease a sore throat and cough. Other supportive treatments for critically ill patients are supplemental oxygen, fluid administration, being managed in intensive care units (ICUs) and receiving rescue therapies, such as extracorporeal membrane oxygenation [Center for Health Security, 2020a].

To prevention COVID-19 many measures should be taken, such as timely publication of epidemic information for elimination of the source of infection, early diagnosis, reporting, isolation, supportive

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treatments, avoid of unnecessary panic, etc. Precautionary actions, such as the provision of medicines supply chains, personal protective equipment (PPE), and hospital supplies are necessary in a short time for the protection of the disease [Sahin et al., 2020]. Separates sick people with a contagious disease from people who are not sick is called isolation. Separates and restricts the movement of people who are not sick but may have exposed to a contagious disease (the people who are in contact of an infected person or have come from an infected area) to see if they become sick is called quarantine. Isolation and quarantine help to protect the public by preventing exposure to people who have or may have an infection of COVID-19 [CDC, 2020].

Prevention is the best way to protect this virus [CDC, 2020]. The prevention techniques are as follows [Kampf et al., 2020; WHO, 2020e; UK, 2020]:

- Wash hands vigorously with soap and water for at least 20 seconds after going to the toilet, after coughing and sneezing, before and after caring for an ill person, after caring healthy or sick animals, before preparing and serving foods, and before eating. After hand washing, dry with tissue, clean towel or hand dryer. Hand washing must continue at least one time in an hour even a person is at home.
- If soap and water is not available, use a 62–71% alcohol-based hand sanitizer.
- Avoid close contact, such as kissing, sharing cups, or sharing eating utensils with sick people.
- Isolate quarantine at home or hospital if anybody feels sick.
- Cover nose and mouth with a tissue when coughing or sneezing, cannot use this tissue for several times and throw the tissue in the covered trash immediately.
- Avoid touching eyes, nose, or mouth with unwashed hands.
- Avoid hand shaking.
- Avoid contact with sick animals and infected people if possible. Use PPEs if care them.
- Wash hands after animal contact and after visiting farms, markets, barns, petting zoos and agricultural fairs, and then touch the nose, eyes or mouth.
- Maintain healthy habits, such as get enough exercise, a well-balanced diet, eat healthy foods, thoroughly cooked meat and animal products, drink sufficient water and fruit juices, get sufficient sleep, manage stress, and avoid smoking and alcohol taking.
- If any healthy person has traveled from an affected area, there may be restrictions on movements for up to 2 weeks.
- Clean and disinfect objects (e.g., doorknobs, desks, counter parts (tops, keyboards, and mouse), light switches, water tap, phones, toys, railings of stairs, etc., touched surfaces, and clean floor where the patients stay.
- Maintain at least one meter (3 feet) distance from other people at all times, not touching face with unwashed hands, etc.
- Everybody infected or uninfected must cover nose and mouth with a tissue or a bent elbow when coughing.
- Masks use who are infected with the virus, who are taking care of the patients, who go to any public place but no need for the healthy family members at home. Avoid touching the mask while using it, remove the mask using the lace from behind, do not touch the front of a mask and do not reuse single use masks.

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12. Vaccination Treatment of COVID-19

Vaccines contain tiny fragments of the disease-causing organism or the blueprints for making the tiny fragments. They also contain other ingredients to keep the vaccine safe and effective [WHO, 2021]. A COVID-19 vaccine is a vaccine intended to provide acquired immunity against SARS-CoV-2 that causes COVID-19. Beginning of 2020 most of the countries has taken attempts to invent COVID-19 vaccine. In December 2020, COVID-19 vaccines are effectively using globally. Vaccines stimulate an immune response without causing illness. Each type of vaccine for COVID-19 works differently to introduce antigens, which are unique features of the SARS-CoV-2 virus to our body. The antigen generates a specific immune response and our body can fight against COVID-19 in future [CDC, 2021a, b].

12.1 Historical Background of Vaccine

On 24 June 2020, China approved the CanSino vaccine for limited use in the military and two inactivated virus COVID-19 vaccines for emergency use in high-risk professions. On 11 August 2020, Russia announced the approval of its Sputnik V COVID-19 vaccine for emergency use [Kramer, 2020]. Pfizer, Inc., and BioNTech manufactured mRNA type of vaccine, named BNT162b2. It is recommended for people aged 16 years and older. On 2 December 2020, the Medicine and Healthcare Products Regulatory Agency (MHRA) of the UK gave temporary regulatory approval for the Pfizer-BioNTech vaccine. It is the first country in the Western world to approve the use of any COVID-19 vaccine [Mueller, 2020]. As of 21 December 2020, many countries and the EU have authorized or approved the Pfizer–BioNTech COVID-19 vaccine, Bahrain and the United Arab Emirates granted emergency marketing authorization for BBIBP-CorV, manufactured by Sinpharm. On 11 December 2020, the United States Food and Drug Administration (FDA) granted an Emergency Use Authorization (EUA) for the Pfizer–BioNTech COVID-19 vaccine. A week later, they granted an EUA formRNA-1273, the Moderna vaccine [Thomas et al., 2020].

12.2 Invention of Vaccines

As of February 2021, total 66 COVID-19 vaccine candidates are in clinical research, including 17 in Phase I trials, 23 in Phase I-II trials, 6 in Phase II trials, and 20 in Phase III trials. As of March 2021, total 308 vaccine candidates were in various stages of development, with 73 in clinical research, including 24 in Phase I trials, 33 in Phase I-II trials, and 16 in Phase III development [Shrotri et al., 2021]. As of March 2021, total 12 vaccines are authorized by at least one national regulatory authority for public use as; two RNA vaccines (the Pfizer-BioNTech vaccine and the ModernaTX vaccine), 4 conventional inactivated vaccines (BBIBP-CorV from Sinopharm, BBV152 from Bharat Biotech, CoronaVac from Sinovac, and WIBP from Sinopharm), 4 viral vector vaccines (Sputnik from the Gamaleya Research Institute, the Oxford-AstraZeneca vaccine, Convidecia, and Ad5-nCoV from CanSino Biologics), and two peptide vaccine (EpiVacCorona from the Vector Institute and RBD-Dimer). As of March 2021, total 308 vaccine candidates were in various stages of development, with 73 in clinical research, including 24 in Phase I trials, 33 in in Phase I-II trials, and 16 in in Phase III development [COVID-19, 2021]. ModernaTX, Inc. manufactured mRNA type of vaccine, named mRNA-1273. The Moderna and Pfizer/BioNTech COVID-19 vaccines use the genetic type of technology to train the immune system. The genetic material, RNA in the case of Moderna and Pfizer/BioNTech vaccine, codes for a specific viral protein. The genetic material from the vaccines makes the protein to immune system and triggers a specific response that builds immune memory, so our body can fight off SARS-CoV-2 in future [CDC, 2021a; Moderna, 2021].

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WHO is working in collaboration with scientists, business, and global health organizations for the recovery and abolish of this fatal disease. Many countries have implemented to give vaccines to the elderly, healthcare workers at first and later to all [Beaumont, 2020]. COVAX (led by WHO, GAVI and CEPI) will facilitate the equitable access and distribution of these vaccines to protect people in all countries. It is the vaccines pillar of the Access to COVID-19 Tools (ACT) Accelerator. ACT Accelerator accelerates the development, production, and equitable access to COVID-19 tests, treatments, and vaccines. WHO is expecting that 2 billion doses can be fairly distributed globally by the end of 2021 [WHO, 2021].

As of 01 February 2021, 101.31 million doses of COVID-19 vaccine have been managed worldwide. Pfizer, Moderna, and AstraZeneca predicted a manufacturing capacity of 5.3 billion doses in 2021, which could be used to vaccinate about 3 billion people. By December 2021, more than 10 billion vaccine doses will be sending to 14% of the world population [So & Woo, 2020]. As of 26 March 2021, 526.89 million doses of COVID-19 vaccine have been administered worldwide based on official reports from national health agencies [WHO, 2021].

12.3 Efficiency and Effectiveness of Vaccines

Efficacy of vaccines is the degree to which a vaccine prevents disease, and possibly also transmission, under ideal and controlled circumstances. It is measured in controlled clinical trials. On the other hand, effectiveness of vaccines is measured how well it performs in the real world, i.e., it is approved for use in the general population. The determinants for the effectiveness are, genetics, age, obesity, and environmental factors, health status, such as nutrition, pregnancy, and sensitivities or allergies, immune competence, etc. The viral mutations altering its structure may have impact on the vaccine efficacy [Thielen, 2020, McNeil, 2020].

No vaccine is 100% effective. In the case of COVID-19, a vaccine efficiency of 67% may be enough to slow the pandemic. As of 7 January, authorized and approved vaccines have shown efficacies ranging from 62–90% for the Oxford-AstraZeneca vaccine (various dosage regimens) to 95% for the Pfizer-BioNTech COVID-19 vaccine [Corum & Zimmer, 2021; CDC, 2021a]. The efficacy of the Moderna COVID-19 vaccine is 96% for those aged 18 to 64 [Moderna, 2021]. The Novavax vaccine was found to be 89% effective in the UK [Wadman & Cohen, 2021].

12.4 Restriction for Vaccination

People who have a severe allergic reaction (anaphylaxis) or an immediate allergic reaction cannot take any kind of COVID-19 vaccine. There are no known safety issues for pregnant and breastfeeding women, and COVID-19 positive persons. So they should not take COVID-19 vaccine before confirmation by WHO and other elite health organizations. At present, the COVID-19 vaccine has not been studied in children and adolescents, and they should not receive the vaccines [Pratt, 2021].

13. High Risk People and Reduction of the Risk

All people are in the risk of SARS-CoV-2. Children seem to handle the disease better than adults as the symptoms are usually milder to children. People at higher risk for severe disease and death are i) who had weakened immune systems, ii) older people whose age are more than 50 years, iii) hypertension, cardiovascular disease, chronic respiratory illness, asthma, cancer and diabetes patients, and iv) pregnant women [WHO, 2020e; CDC, 2020].

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After taking vaccine, non-pharmaceutical interventions (NPIs) are strategies to combat COVID-19. The infected persons should isolate at home or in hospital and cannot go to work, stores, tea stall, rally, stadiums, theatres, bars and other social venues, educational institutions (e.g., school, college, university, etc.), busy prayer places (e.g., church, mosque, temple, etc.), public transport or any public congregation. The suspected persons must avoid using public transportation, ride-sharing, or taxis; avoid migration, should stay in a specific room and away from other people in home (home quarantine), and also should use a separate bathroom [WHO, 2020e; CDC, 2020]. Healthcare providers must wear personal protective equipments (PPEs), such as waterproof disposable gown, cap, gloves, a face shield, goggles or eye masks and N95 face mask or respirator during the COVID-19 examination of patients or travel of highly infected area [Chen et al., 2020].

14. SARS-CoV-2 Variants

SARS-CoV-2 variant (B.1.1.207) has detected in August 2020 in Nigeria for the first time, which has a P681H mutation. In mid-December 2020, a new SARS-CoV-2 variant (VOC-02012/01) was identified with a large number of mutations in the UK. Its reproductive number (R_0) is estimated increase by 0.4 or greater and increased transmissibility of up to 70%. The new variant is defined by multiple spike protein mutations (deletion 69-70, deletion 144, N501Y, A570D, D614G, P681H, T716I, S982A, D1118H) present as well as mutations in other genomic regions. But there is as yet no evidence for lower vaccine effectiveness of it [ECDC, 2020]. The new strain lineage B.1.1.7 (501Y.V1) is characterized by 17 mutations that cause amino acid changes, 8 of which occur in the gene for the spike (S) protein [Thermofisher, 2020].

A South African variant (20H/501Y.V2 or B.1.351) has also emerged. There is no evidence that this variant causes more serious illness. But there are concerns that it can spread more readily and vaccines may not work quite as well against it [Roberts, 2021]. In Brazil, a variant of SARS-CoV-2 (known as P.1) which has 17 unique mutations emerged that was first was identified in four travelers from Brazil, who were tested during routine screening at Haneda airport by the National Institute of Infectious Diseases (NIID) outside Tokyo, Japan [CDC, 2021b].

Variant B.1.429/CAL.20C was first observed by researchers at Cedals-Sinai Medical Centre in July 2020 in Los Angeles County. There is no evidence that it is more lethal than other variants [Zimmer, 2021].

15. Economic Impacts

The COVID-19 will create both short-term and long-term global economic losses [Mohajan, 2020a]. Home quarantines, lockdown, widespread restrictions on labor mobility and travel, border closings and closing of economic activities, such as closing of shops, business firms and industries; make the global economy shamble and less healthy [Haider et al., 2020]. From the spread of COVID-19 national and international airlines remain partially or fully closed. Global tourism and travel are reduced for the COVID-19 outbreak. The airline industry has experienced a decrease in capacity of roughly 60–80% at major carriers. The International Air Transport Association (IATA) estimated $30 billion loss of revenue for airline and tourist companies [Josephs, 2020]. COVID-19 creates a substantial adverse impact on financial stock markets globally. Since the COVID-19 outbreak to April about $23 trillion value has been destroyed in global stock market [Ramelli & Wagner, 2020a]. More than 1.2 billion global populations will be extremely poor whose per capita income is $1.90 per day or less [Oxfam, 2020]. Use of a vaccine will prevent the loss of $375 billion to the global economy every month [WHO, 2021].

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16. Conclusions and Recommendations

In this study we have tried to discuss aspects of COVID-19 to reduce the fatality of this pandemic disease. We have introduced different techniques how both infections and deaths of the disease can be reduced. We have seen that COVID-19 epidemic has spread very quickly within 30 days to expand from Wuhan, Hubei Province to the rest of Mainland China. In March 2020, the disease spread very quickly, both infection and mortally rate increase very rapidly. Sometimes asymptomatic contacts spread COVID-19 largely. For example, estimated asymptomatic proportion was 18% for the outbreak on the Diamond Princess Cruise ship in Japan. On 11 March 2020, the WHO declared the global outbreak as a pandemic. On 11 April 2020, in 100 days of outbreak of COVID-19, total deaths in the world reached to 100,000 and total infected persons became more than 1,700,000. On 11 May total infections reached to 4,132,365 with total deaths 283,387, and total recovery became 1,422,745. Everyday new infections and deaths are adding in the previous list. On 09 February 2021, the disease spread up to 223 countries and territories globally; total confirmed deaths become 2,337,368, total confirmed cases 107,037,441, with total recovery 78,913,746. It is uncertain about when COVID-19 will abolish completely.

In this study we have briefly discussed the morphology and structure, types, and historical evidence of coronaviruses. We have further taken an endeavor to discuss the symptoms, transmission, diagnosis, prevention, and treatment of this fatal disease. At present vaccines are invented. Vaccines, supportive treatments and prevention techniques are better ways to escape from the attack of this disease. Many countries, such as the UK, the USA, Germany, Canada, Russia, India, etc. are already invented the vaccine of COVID-19. After spreading the COVID-19, affected countries impose home quarantine and lockdown to save lives of the humanities. As most industries, business firms, public transports, aviation, etc. are partially or completely closed, the world must face severely economic losses. The impacts of these economic losses cannot be recovered within very limited periods. Of course the global GDP will decrease remarkably and government taxes will be down fall and foreign currency reserves will be affected adversely in many countries. The developing and lower developing countries mostly in Africa and Asia will suffer miserably due to this pandemic.

At present the global infections and deaths due to COVID-19 are not decreasing. The WHO has stressed on the quarantine and lockdown to reduce to zero infection and deaths. But thinking on their economic depression most of the countries are not following advice of WHO. As a result, the fatality of COVID-19 is not decreasing. We hope within very short time the world will return in its usual known situation. The fatality and infections of COVID-19 are changing in every moment. The future researchers may find the data in my work have not presented properly. So the future researchers of course most accurately present their data in their works.

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