

Exponential growth impact of COVID-19 pandemic-world scenario, preventive measures and drug preferences

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Abstract

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Original Manuscript

Exponential growth impact of COVID-19 pandemic-world scenario, preventive measures and drug preferences

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Abstract

World Health Organization (WHO) has announced the COVID-19 outbreak as a global public health emergency and pandemic, spreading fast with an increasing number of infected patients worldwide. Almost 210 countries and territories are severely affected by the deadly disease caused by a new coronavirus (SARS-CoV-2) and still it is uncontrollable. The detailed mechanism of the virus remains unknown, and specific drugs have not been developed. According to the current published evidence, we precisely summarize the disease, characteristics of the virus, current world scenario, available treatment options and preventive measures to be taken against COVID-19. A case study was conducted to provide the dangerous picture of exponential growth of infected people around the world to inculcate the awareness of maintaining social distancing and hand hygiene. This effort is made in view of providing awareness to the public effectively to understand and deal with the novel coronavirus situation worldwide. It is also anticipated to provide a reference to future advances in medical anti-virus related studies.

Keywords: SARS-CoV-2; COVID-19; coronavirus; vaccine; pandemic; exponential growth.

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1. Introduction

The World Health Organization (WHO) declared 2019-20 coronavirus outbreak as a Public

Health Emergency of International Concern (PHEIC) on 30 January 2020 and pandemic on 11 March 2020 [1,2]. Wide local transmissions of the disease have been reported around 210 countries across all six WHO regions [2,3]. The coronavirus disease is an infectious newly discovered coronavirus caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [3,4]. This disease was first identified in 2019, seafood market from Wuhan, China, and has since spread globally uncontrollable. In February 2020, WHO announced that COVID-19 is the official name of the disease. These viruses were named in 1968 for their appearance in electron micrographs which was reminiscent of the solar corona [5]. The name coronavirus is derived from the Latin word *corona*, meaning *crown*.

As of today, 17 May 2020 around 3,16,520 death and 47,99,266 coronavirus infected cases are reported worldwide. There is about 26,25,463 active cases are now under treatment and several lakhs of people are under quarantine. The COVID-19 rapidly spread from Wuhan city, China to the entire country in just 30 days by destroying all the conventional concepts of medical science. At present, no vaccines are available for the treatment of patients with SARS-CoV-2 infection; only symptomatic treatments are available [6,7]. The SARC, G-20 summit members and all other world leaders decided to fight against the disease together. Based on the current scenario, we both physicist and biologist decided to provide information about this disease based on the current circumstances to avoid panic situation among the citizens around the world. Moreover, the first reported COVID-19 death in Kalaburagi, India enforced the authors to create awareness about the deadly disease. Therefore, an attempt has been made to explain briefly about the characteristics of the virus, current review, COVID-19 symptoms, precautions, available vaccines etc. In addition, a case study was also conducted to provide the dangerous picture of drastic growth of infected people around the world during the span of time.

2. Methods

The number of reported COVID-19 cases and deaths has soared globally, requires special attention owing to its future epidemics and possible universal threats. On this outbreak, we have undertaken a comparative study on the dangerous transmission and interventional effects of coronavirus in some of the severely affected countries. For our study, we preferred five most coronavirus affected countries in the world viz., China, Itali, USA, Spain, India in the month of February and March 2020, and later extended to 17 May 2020. The information about the number of persons infected the virus and death occurred during the period 15 February to 17 May 2020 are collected from the websites [8,9]. In addition to this, we made a simple estimate regarding the fast spreading chain mechanism begins by considering a virus infected person. The effect of shocking chain of spreading of Covid-19 from an infected person during the time of incubation period is discussed.

3. Results and Discussion

3.1. *Characteristics of coronavirus*

The virus that is responsible for the deadly disease COVID-19 is named severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2 [10,11]. The virus was initially referred to the 2019 novel coronavirus or 2019-nCoV. Generally the virus is not a living organism, but a protein molecule (DNA) covered by a protective layer of lipid or fat which when absorbed by the cells of the ocular, nasal or buccal mucosa, changes their genetic code and convert them in to aggressive multiplier cells. The SARS-CoV-2 has spike protein on its surface. Several analyses revealed that SARS-CoV-2 uses angiotensin converting enzyme 2 (ACE-2) as receptor, which is present in the kidney, endothelium, lungs and in the heart. Coronavirus mainly recognizes the corresponding receptor on the target cell through the S protein on its surface and enters into the cell, resulting in infection [12]. The decay time of the virus depends on the temperature, humidity and type of the material where it lies and it can live up to 72-75 hours on surfaces [12]. Time from exposure to onset

of symptoms is between 2 to 14 days, with an average of five days. Studies from the Chinese university showed that bats are considered to be the natural hosts of SARS-CoV-2 [13]. However, the exact source of coronavirus is still unknown [2,7].

The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes [7,14]. It is typically multiply during close contact and via respiratory droplets produced when people cough or sneeze. It may also spread when one person touches a contaminated surface and then their face. It is most contagious when people are symptomatic, although spread may be possible before symptoms appear. As of now, the exact mechanism of the dangerous coronavirus remains unknown, and definite drugs for the virus have not been developed.

3.2. COVID-19 symptoms

Most of the people infected with COVID-19 virus experience mild to moderate respiratory illness and recover without requiring any special treatment. Older people and those with underlying medical problems like diabetes, cardiovascular disease, chronic respiratory disease, and cancer are more likely to develop serious illness [15,16]. The common symptoms include 87.9 % fever, 67.7 % cough, breathing problem, tightness of chest, running nose, headache, muscle pain, sputum production, diarrhea, sore throat and loss of taste and/or loss of smell [17]. While the majority of cases result in mild symptoms, some progress to pneumonia and multi-organ and kidney failure.

3.3. Current scenario- The world wide challenge

The COVID-19 pandemic has brought the entire nation to a halt. The UN secretary general recently announced that it is the most challenging crisis faced by the human since World War 2. This quick outbreak is first and foremost a human tragedy, affecting hundreds of thousands of people and the pandemic continues to expand. Health officials and medical professionals are struggling with the

disease, and testing and treating affected people. More than 210 countries and territories have reported positive infected cases of COVID-19. The reported case growth has accelerated to more than 8,58,361 infective positive cases and around 42,309 deaths as of March 31. Moreover, the infected growth rate is also increasing drastically day by day. For our study we have selected five most virus hit countries viz, China, Itali, USA, Spain and India for two span of time up to 31 March 2020, and 1 April to 17 May 2020. Fig. 1 (a,b,c) represents the plot of number of people affected the coronavirus in Itali, USA, Spain, China and India respectively till 31 March 2020.

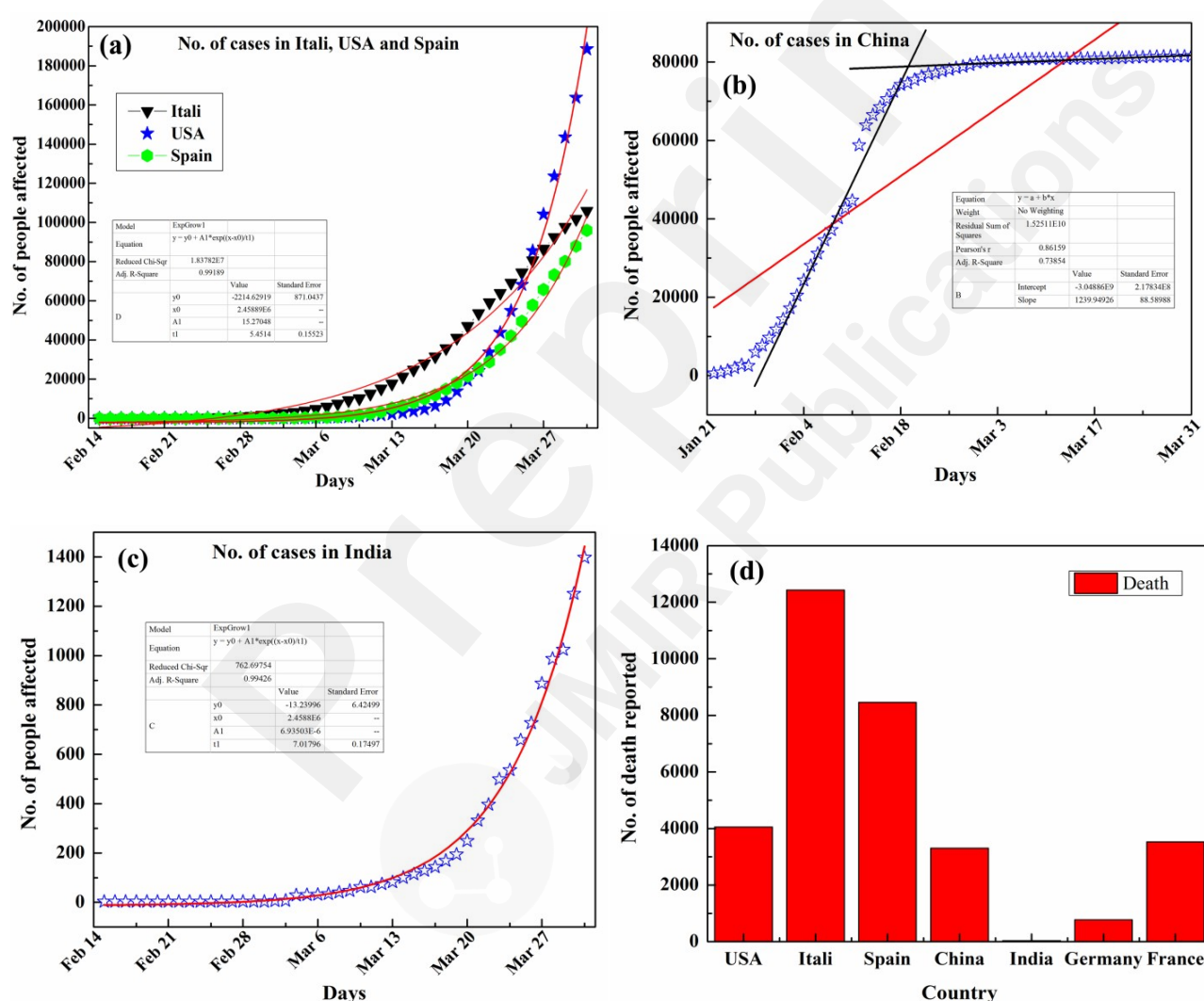


Fig. 1 (a,b,c). The plots of number of people affected the coronavirus in Itali, USA, Spain, China and India respectively till 31 March 2020. **(d)** Number of death cases reported earlier in some of the COVID-19 infected countries.

The plots of number of coronavirus infected cases in all the countries over a span of time follows increasing exponential growth model [18]. The figure clearly explains the exponential growth of fast and wide spreading of the deadly disease. China severely affected at the early stages itself through community transmission leads around 81,554 positive cases with 3,332 death cases. Significant increase in growth rate is not observed in China after 18 February 2020, and it's almost saturated as of today. USA and Itali are the most affected countries: both the infected and death cases are drastically growing exponentially. Spain also hardly affected and fighting strongly against the virus with 8,464 reported positive cases. The bar diagram of number of death reported in various countries till 31 March 2020 are shown in Fig. 1d. Even though the origin of the disease is reported in china, Itali (12,428) and Spain (8,464) are the most death reported countries in the world till 31 March 2020. However, it is evident from Fig. 1a that after 24th of March onwards in USA the infected and death rates are increasing drastically day by day.

A comparative study was also carried out in the second stage of our study by collecting the data of active cases of coronavirus and the deceased in these countries up to 17 May 2020, which was shown in Fig. 2a, and Fig. 2b respectively. The reported results were terrible; especially the present condition in USA is very dangerous and painful. China flattened the graph after 28 February and USA reported maximum 15,27,664 infected cases with 90,978 deaths, spreading rapidly uncontrollably. It is observed from Fig. 2a that 27 March 2020 onwards COVID-19 cases are drastically increased exponentially worldwide. The bar diagram (Fig. 2b) of recent death reported in ten most infected countries as of 17 May 2020 is hurting and created panic situation among the public. The reported death cases in some of the countries viz., Itali (31,908), China (4,634), India (3,025), Spain (27,650), Germany (8,049), France (28,108), Russia (2,631), UK (34,636) and Brazil (16,118) are pointing towards the need of fast development of vaccines against the deadly virus.

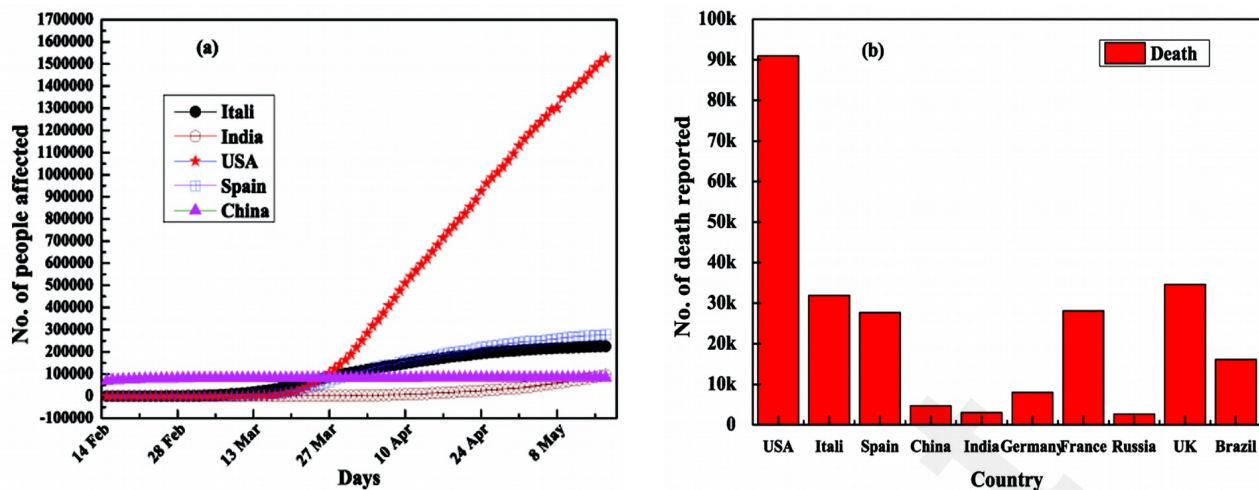


Fig. 2 (a). The overall picture of coronavirus infected cases in Itali, India, USA, Spain and China respectively till 17 May 2020. **(b)** Number of death cases reported in ten most affected countries in the world.

The instantaneous and drastic exponential growth plots explains the rate of fast spreading of virus and the increased cases of infected persons over time in the countries. Theoretically, if the constant of proportionality obtained from exponential fitting is positive with increased number of cases over time then, it is said to be exponential growth or geometric growth [18]. It is also reported earlier that SARS virus typically spread exponentially in the absence of suitable artificial immunization [3,19]. Therefore, the tools needed to make predictions about future coronavirus effect cases are growth models like the exponential function.

One of the major reasons for the exponential growth in many countries is due to negligence of the virus in the primary stages. It is also reported that the patient will show positive case after 14 days of incubation [20,21]. Therefore at the initial stages, the virus affected person may travel and spread every where he visited and touches without knowing the consequences. We made a simple mathematical calculation about the fast spreading chain mechanism and is shown in Table I. The chain mechanism begins by considering a coronavirus affected person, but he is unaware of it. Consider a simple case in which each person touches 2 other persons per day. So the first day the

chain starts with 2 infected cases. Second day the previously affected 2 persons will spread other 4 members by raising the tally 6. The chain continuous and the total infected persons by the time of first person realize the infection is very large. If the first person recovered even after 14 days of incubation, the second and third effected persons will continue the spread chain. If we are not in a position to control this exponential growth, the virus will wipe out several lives from the earth. Rigorous, at-scale physical-distancing measures can drive a significant reduction in the number of new COVID-19 cases all over the world. Therefore, social distancing and the complete lockdown are the only way to keep the person safe since there is no suitable vaccine for the disease.

Table I. The chain of spreading of corona virus from an infected person during the time of incubation.

No. of infected person =1 Each person touches 2 other persons per day															
Day															
1	2														2
2	2	4													6
3	2	4	8												14
4	2	4	8	16											30
					3										
5	2	4	8	16	2										62
					3										
6	2	4	8	16	2	64									126
					3										
7	2	4	8	16	2	64	128								254
					3										
8	2	4	8	16	2	64	128	256							510
					3										
9	2	4	8	16	2	64	128	256	512						1022
					3										
10	2	4	8	16	2	64	128	256	512	1024					2046
					3										
11	2	4	8	16	2	64	128	256	512	1024	2048				4094
					3										
12	2	4	8	16	2	64	128	256	512	1024	2048	4096			8190
					3										
13	2	4	8	16	2	64	128	256	512	1024	2048	4096	8192		16382
14	2	4	8	16	3	64	128	256	512	1024	2048	4096	8192	16384	32766

					2										
Total infected persons by the time of first person realized the infection															65504

3.4. Impact of COVID-19 in India

In India the Prime Minister announced a three-week, nation-wide complete lockdown from 25 March 2020 to 14 April 2020 as a protective measure against COVID-19. WHO complemented that India is having high potential to fight and find resolution against this crisis. In Ernakulum Medical College, Kerala the doctors took great risk of initiative and tested the HIV antiretroviral drugs to a COVID-19 person, and he is now recovered and discharged [22]. The complete lockdown fully controlled early community transmission of the virus (Second stage spreading) in India. However, many developed countries viz., China, Itali and USA are failed to control the second stage spreading. Since, India is the second populated country in the world, more over all cities are densely crowded, all Medias and critics across the world mentioned that the next corona centre is in India. However, the reported positive and death cases in India are 1397 and 35 respectively as of March 31, less compared to other developed countries. However, the number of corona cases is increased to 95,698 with 3,025 death as of 17 May 2020 with 3.29 % mortality and 39 % recovery rate.

The first phase of lockdown was introduced when the number of confirmed cases was just 500. This is one of the brilliant steps undertaken by Government of Indian to control the fast spreading of the virus. However, from the Figure 2a it is clear that, May 27 onwards the number of positive cases increased rapidly. Therefore, the government was forced to extend the lockdown later to second (15 April 2020 to 3 May 2020) and third (4 May 2020 to 17 May 2020) phases due to the exponential growth of coronavirus outbreak. The fourth phase of lockdown is also announced today till 31 May 2020 with some conditional relaxation. Out of 95,698 positive active cases, 37,975 patients are recovered from the disease, which is a good sign of hope towards the future.

India achieved this remarkable status through maintaining 'social distancing' by staying inside the home and 'break the chain' program through frequent hand washing with soap or sanitizers

for minimum 20 seconds. This is an indication of good administration as well as strong and healthy Indian medical system. Recently, WHO Director General secretary also praised India for the social welfare measures taken in leading the social outbreak. The idea of converting trains and house boats into quarantine centers with all medical capacity due to the lack of hospital facility is highly appreciated worldwide. Later, Plasma therapy is also started in some of the medical colleges in various states of India

3.5. Testing and diagnosis of Covid-19

The diagnostic guidelines released by Wuhan University, China suggests some methods for identifying infections based on clinical features and epidemiological risk [23,24]. The primary step is the identification of people who had at least two of the following symptoms in addition to a solid travel history to abroad. Close contact with other infected people, and exhibiting common symptoms like fever, imaging features of pneumonia, normal or reduced white blood cell count, or reduced lymphocyte count. The standard method of diagnosis is real-time reverse transcription polymerase chain reaction (rRT-PCR) from a nasopharyngeal swab. In addition, this test can be done on respiratory samples obtained by various methods, including a nasopharyngeal swab or sputum sample. The virus infection can also be diagnosed from a combination of symptoms, risk factors and a chest CT scan exhibiting features of pneumonia. Blood sample tests can also be used, but it require two blood samples taken two weeks apart and the results have little immediate value.

3.6. Preventive measures

The coronavirus cannot go through a healthy body and healthy skin. At this time, there are no specific vaccines or treatments for COVID-19. However, several ongoing clinical trials are evaluating the potential treatments. The WHO's research and development blueprint has been

activated to accelerate diagnostics, vaccines and therapeutics and soon expected to receive positive clinical findings [2]. The best way to prevent and slow down transmission is to provide awareness to the public about the COVID-19 virus, causes and spreading methods etc. Protect ourselves and others from the infection by washing hands with soap or alcohol based sanitizers frequently without touching face.

The recommended measures to prevent infection include frequent hand washing, maintaining physical distance from others (especially from those with symptoms), social distancing, covering coughs and sneezes with a tissue or inner elbow, and keeping unwashed hands away from the face. The use of masks is recommended by some national health authorities for those who suspect they have the virus and their caregivers. Mask is not compulsory for the general public, although simple cloth masks can be used for the desired [25]. Since, there is no proper specific available antiviral treatment; COVID-19 disease management involves treatment of symptoms, supportive care, isolation, and experimental measures. From the current situation except china and Itali, it is noticed that about 95 % of persons died due to this virus is above 60 years old owing to their reduced immunity power. Apart from the common preventive measures additional preventive measures are also have been discussed below.

1. Personal protective equipment

The CDC recommended specified tools for the use of personal protective equipment (PPE) during the pandemic are respirator or facemask, gown, medical gloves, eye protector etc.

2. Social distancing and the increasing immunity power in humane

Maintaining physical distance from those with symptoms and keeping social distancing are the best method of prevention. This is the reason why India announced lockdown in the very beginning stages of coronavirus. Previous studies revealed that the virus can't easily attack a healthy body. Therefore, by increasing the human body immunity at some extent we can protect ourselves from the

virus. It is also reported that that proper supplementation of vitamin D and vitamin E may enhance our resistance to SARS-CoV-2 [26]. The various methods to increase the immunity power in humane are discussed below.

- a. **Regular Walking:** Even in small spaces, walking around or walking on the spot (home), can help a person active. If the person chooses to go outside to walk, be sure to maintain at least 1 m distance from other people.
- b. **Stand up:** Reduce sedentary time by standing up whenever possible.
- c. **Proper exercises and relaxation:** Meditation and deep breaths can help a person remain calm and more concentric. Home-based Yoga and exercise methods viz., to elbow, plank, back extensions, squats, side knee lifts, superman, bridge, chest opener and legs up the wall are to be practiced in staying physically active while at home.
- d. **Hygienic food:** Eating healthy food and stay hydrated are the important tips for good health. Limit or avoid alcoholic beverages for adults and strictly avoid these in youngsters, pregnant, and breastfeeding women for other health reasons. Include plenty of fruits and green vegetables, and limit the intake of salt, sugar and fat [26].

3.7. *Misconcepts and rumors*

It is very difficult to compare the growth and development of coronavirus in humans with the characteristics of any other known viruses. Even though, several false rumors are spreading around the map without proper evidences. Some of them are listed below,

1. The effect of coronavirus in people with blood groups A, B or AB is more than O group.
2. Drinking alcohol prevents COVID-19.
3. At higher temperature the coronavirus is inactive etc.

It is advised not to believe these types of rumors. There is no sufficient scientific study or proper evidence reported related to these aspects as of now.

3.8. Vaccines

No medicines or vaccines are approved to prevent the COVID-19 disease by the World Health Organization (WHO). However, some protective medicines are recommended by individual national medical authorities. Tremendous research effort into potential treatments is started in January 2020, and several antiviral drugs are in clinical trials. Since, the exact mechanism and the source of coronavirus remains unknown, the development of an anti-virus for this disease is not an easy task. This is the first and foremost problem faced by the researcher all over the world. The main aim is to find a solution to stop the fast spreading of coronavirus, and then to develop a preventive anti-virus/ vaccine to destroy the virus.

The development of an anti-virus is like a key and lock mechanism. First it has to be tested on animals, if it satisfies the desired properties and then only in humans. The proposed new anti-virus should be inactive or dead, aims to elicit to prompt immune response of the human body to a new infection with COVID-19. Another novel technique for creating a vaccination is that of the nucleic acid vaccines (DNA or RNA vaccines). Experimental vaccines from any of these strategies would have to be tested for safety and efficacy. According to WHO, this may take minimum 8-12 months for the development of vaccine, testing and other medical formalities to complete. It is also important to notice that, many of those who died due to COVID-19 have some pre-existing conditions viz., including hypertension, diabetes mellitus, and cardiovascular disease. Therefore, it is very essential to perform more scientific research on medicines/vaccine before applying in humans.

3.9. Available and future medicines to treat COVID-19

The first clinical trial of a vaccine started with four volunteers in Seattle on 16 March 2020.

The vaccine contains a harmless genetic code copied from the virus that causes the disease. The major difficulty in vaccine development is that in older people, who are more vulnerable to the disease, are often poorly vaccinated due to age-related degradation of the thymus. Therefore, an alternative method needs to be developed to enhance immunity in elders [27]. The treatment with recombinant **interleukin 7** plays an important role in the maturation and reproduction of lymphoid cells [28]. Using **interleukin 7** along with vaccines can boost the immune system's response to infections and increase the growth of restoration cells, thus lowering the risk of death in older people.

The medicines like, **Remdesivir, chloroquine and hydroxychloroquine, ritonavir/lopinavir** and combined with **Interferon beta** are the experimental treatments currently being researched under Solidarity Trial [28,29]. Remdesivir inhibits SARS-CoV-2 *in vitro*. Phase 3 clinical trials are being conducted in US, China, Italy and India. The Chinese 7th edition guidelines also include **interferon, ribavirin, or umifenovir** for use against COVID-19 [29].

The preliminary results from trials suggested that **chloroquine** is effective and safe in treating COVID-19 associated pneumonia [28-30]. But it is also reported that **chloroquine phosphate** improves the success rate of treatment and recommended it for people diagnosed with mild, moderate and severe cases of novel coronavirus pneumonia. **Favipiravir** also have been tested in China for experimental treatment of the most dangerous COVID-19 disease.

According to Korean physicians, antiviral medications are not recommended in young, healthy patients with mild symptoms and no underlying comorbid conditions. Treatment with **lopinavir** 400 mg; **ritonavir** 100 mg (2 tablets by mouth twice daily) or **chloroquine** (500 mg by mouth twice daily) should be recommended in older patients with serious symptoms [28]. In the absence of **chloroquine**, it is advised to consider **hydroxychloroquine** (400 mg by mouth once daily). Due to the risk for side effects, the use of **ribavirin and interferon** were not suggested as a first-line treatment. However, if the COVID-19 treatment with lopinavir; ritonavir, chloroquine, or hydroxyl chloroquine are ineffective, then it may be considered [28,29,31].

Scientific medical research progress towards future

1. It was reported from China that the scientists were succeeded to isolate a stain of the coronavirus and brought out the genetic sequence of the virus. Motivated by this, laboratories across the world especially in USA, Spain and India, succeeded to develop independently polymerase chain reaction (PCR) tests to detect the infection caused by the virus. The comprehensive effort for the development of antibody against the virus is ongoing.
2. It is possible to collect liquid plasma antibody from the persons who already recovered from the coronavirus disease. Conducting systematic research on this aspect may be possible to produce antibody which will help to develop medicines against COVID-19.
3. Conduct scientific research in both plants and animals to develop antibodies against this virus. The future vaccines may be produced from microbes like fungi, bacteria, penicillin, gentamicin, etc.
4. The readymade antibodies produced by another person or animal, which has been actively immunized are transferred to the recipient by imparting passive immunity using Hepatitis -B immunoglobulin is also possible for the treatment.
5. Antihypertensive drugs like Angiotensin converting enzyme inhibitors (ACE inhibitors) could be an option, since SARS-CoV-2 acts through ACE-2. Captopril is a sulfhydryl containing dipeptide surrogate of proline which inhibits ACE.

4. Conclusions

COVID-19 is a serious disease caused by the novel coronavirus, SARS-CoV-2 with initial symptoms like fever, cough and fatigue similar to that of SARS. The specific source, mechanism of the virus is unknown and no suitable drugs have been developed as of today. This has dangerously affected all the countries around the globe and hence a great threat to global health and safety. The

medicines like Remdesivir, Chloroquine and Hydroxychloroquine, Ritonavir/Lopinavir and combined with Interferon beta are the experimental treatments currently being researched. Treatment with Lopinavir and Ritonavir or Chloroquine should be recommended in older patients with serious symptoms. The main risk factor of COVID-19 is travel and exposure to the virus. Lockdown, quarantine and thereby maintaining the 'social distancing' are the suitable method for controlling the out spread of coronavirus. Moreover, it is individual's responsibility to take prompt measures to control the fast spreading of this virus disease. Simultaneously, strive to develop suitable drugs and vaccines through proper scientific research against the disease to save the human life on the earth.

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Specific author's contribution

All authors contributed to data collection, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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