Review Article

THE CURRENT STATUS AND PERSPECTIVES FOR THE EMERGING PANDEMIC: COVID-19

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ABSTRACT

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the causative agent of the extremely communicable viral infection coronavirus disease 19 (covid-19). Initially the virus was found at Wuhan, china which spread across the world exponentially and in a very short span. This outbreak has turned out to be a global health crisis and recently WHO regarded it as pandemic. The origin of the virus is predicted as end to an incremental selection in animal host prior to the transmission of the pathogen from animals to humans or the natural selection in humans and following transfer. Nevertheless, there is an extensive spread of virus by human to human transfer in the form of droplets. A few antiviral drugs are at the stage of clinical trials to eradicate the covid-19. In this, a comprehensive approach is put forth to scrutinize the etiology, pathogenicity and transmission of SARS CoV-2. The review also deliberates broadly on the diagnosis and status of therapeutic treatment developed. It also focuses on the preventive and controlling measures from different sectors of the society. The review covers the details reported in 70 studies which were chosen after keyword searches carried out leading to over 884 resulting articles.

Keywords: SARS-CoV-2, Coronavirus disease 19 (covid-19), Transmission, Diagnosis, Therapeutics

INTRODUCTION

The world has witnessed an array of contagious outbreaks since time immemorial. These outbreaks were caused by a series of bacteria, viruses and other pathogens [1]. These outbreaks were either epidemic, where a small population or community gets affected for a limited duration of time or pandemic, when the whole world might be at risk [2]. Thus, a pandemic is more contagious and dangerous compared to an epidemic and emphasized in this review primarily due to the misinterpretation of the disease in discussion as epidemic at the first mention, which was later declared to be a pandemic [3, 4]. Covid-19 or commonly known as coronavirus disease, is caused by a virus, known as Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2) [5]. Owing to the health and economic crisis it has created around the globe from a past few months, it can be declared that covid-19 is one of the most pernicious outbreaks of all time [6]. The history dates to 2003, when China officially reported the first outbreak of SARS-CoV-1. It was first spotted in humans in the Guangdong province of southern China in 2002 [7]. Another relative virus, Middle East Respiratory Syndrome Coronavirus (MERS-CoV), was first reported in Arabian Peninsula of Saudi Arabia in 2012 [8]. Both virus outbreaks resulted in significant number of deaths around the globe. In December 2019, China had a cluster of unidentified cause of pneumonia patients in Wuhan, with clinical characteristics significantly like viral pneumonia [9, 10]. According to one study, an exotic animal market in Wuhan city became the centre of the outbreak and there was a rapid increase in the rate of transmission [11]. This led to an immediate examination to determine the cause of the disease and was identified to be due to novel coronavirus (nCoV). Later, it was named as SARS-CoV-2, by International Committee on Taxonomy of Viruses (ICTV) on 11th February 2020 which is also called as covid-19[12].

The severity of SARS-CoV-2 is attributed to its life cycle which involves potential natural hosts, intermediate hosts and final hosts. SARS-CoV-2 has great transmissibility and infection causing ability [13] compared to its relative viruses, MERS-CoV and SARS-CoV-1. β-coronaviruses are a large family of enveloped, diverse-natured, positive-sense and possess single stranded RNA. It is reported to affect both animals and humans, resulting in neuronal, hepatic, gastrointestinal abnormalities chiefly affecting respiratory system [14-16]. Both MERS-CoV and SARS-CoV-1 are responsible for highest reported mortality rates (10% and 40%) in human beings [5]. Being the centre of the pandemic, initially China reported more than 90% of the cases and deaths. However, eventually an outbreak of the disease was observed in places such as Italy, Spain and USA bringing these countries to the brink with that of China. Most of the reported cases were associated with symptoms resembling pneumonia, including cough, fever, myalgia or fatigue [10]. Up to 23rd April, WHO reported 30,90,445 confirmed active cases with 2,17,769 deaths and 12,004,375 recoveries. As of 23rd April 2020, 16,264,369 active cases were reported, resulting in 3,02,680 deaths [17].

The review was planned to report the status of covid-19 pandemic, including its origination and transmission. As it was designed to highlight the available therapeutics, preventive and control measures, a systematic search was conducted using two major databases. Both Google Scholar and PubMed were used to identify published studies related with details about Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Severe Acute Respiratory Syndrome-1 (SARS-CoV-1), and Severe Acute Respiratory Syndrome-2 (SARS-CoV-2). It was completed in accordance with the guidelines given by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

The objectives of the review were planned and independently written by all the 8 authors. The corresponding author was engaged to resolve the conflicting interest in the article. For the collection of published studies, we used the key-words like “SARS-CoV-1”, “Covid-19”, “SARS-CoV-2”, “Detection”, “Diagnosis”, “Clinical Symptoms”, “Infection”, “Transmission”, “Pharmacotherapy”, “Immunotherapy”, “Vaccines”, “Prevention” and “Controlling measures”. In this manner, individual studies were collected and further screened according to relevance to suit the requirement. A total of 884 of studies resulted in...
Current issues and global scenario

It was reported that a total of 44 cases of pneumonia patients of unknown causal agent, from 31 December 2019 through 3 January 2020 in Wuhan city. As the cause was known to be a viral infection there was confirmed cases of SARS-CoV-2, 278 cases in China, 2 cases in Thailand and 1 each case in Japan and Republic of Korea by 20 January 2020 [18]. First case in India was reported on 30 January 2020, almost 649 cases and 13 deaths were reported by 26 March 2020 [19]. Covid-19 is extremely infectious disease with an estimated R0 value of about 2.28 (2.06-2.52), which indicates SARS-CoV-2 is in the epidemic phase and has very strong transmission capacity [20]. Presently, there are about 3 million cases confirmed globally; 1,406,899 infected with 129,311 deaths in European region, 1,213,088 confirmed and 62,404 deaths in America, 176,928 confirmed and 7304 deaths in the Eastern Mediterranean region, 146,449 confirmed and 6037 deaths in Western Pacific region, 51,351 confirmed and 2001 deaths in South-East Asia region and 23,254 confirmed and 903 deaths in Africa as on 29 April 2020 [21]. In India, as on 1 May 2020, there are 250,07 active cases with 1147 deaths [22].

Origin and evolution of SARS-CoV-2

COVID-19 is a well known disease as 2019 novel coronavirus, otherwise it is also referred as 2019-nCoV. It was first recognised in Wuhan China and the World Health Organization declared the coronavirus outbreak with an official name covid-19 on 11 February 2020. This virus causes the upper-respiratory tract illness, which was not found to be infecting humans when first identified [23]. In 1937, corona type of virus was first isolated from chickens. Later in the mid-1960s, human coronaviruses were identified for the first time.

Coronavirus is a sense-strand RNA virus; single-stranded enveloped consisting genome of 30Kb [16]. Based on the Coronaviridae family, genera can be divided into four: α, β, γ, and δ. The birds get infected usually by y and δ genera of coronavirus, whereas the humans and mammals are infected by α and β genera. The novel Severe Acute Respiratory Syndrome coronavirus-2 (SARS-CoV-2) infecting the humans are the β-coronavirus that appears as oval or round and crown shape when observed under electron microscope [24]. Further studies on the genera of coronavirus elucidated that the bats usually are the reservoirs of α and β genera while birds carry y and δ genera of coronavirus. The studies also reported the progenies of the lineage of β-coronavirus within rhodents [25, 26].

SARS-CoV, MERS-CoV, NL63, HKU1, OC43 and 229E are human coronavirus, among this SARS-CoV-2 is the 7th coronavirus infecting humans. Infections by HKU1, OC43, NL63 and 229E cause mild symptoms but the SARS-CoV, MERS-CoV and SARS-CoV-2 are associated with severe symptoms and causes disease [27]. Origin of the SARS-CoV-2 can have two prospects, firstly its can be predicted that natural selection in animal host prior to the transfer of pathogen from animals to humans. Secondly, we can predict as the natural selection in humans and resulting animal to human transfer. Covid-19 cases were reported initially in Huanan market located in Wuhan, T, which most likely emerged from the animal source owing to its resemblance of SARS-CoV-2 to several other coronaviruses. The bat seems to be reservoirs of SARS-CoV-like coronaviruses, which were unable to efficiently invade the humans. The mutations in structural covering of spike protein of the virus enabled the access to bind the humans with the aid of ACE2 receptors. As per the first perspective, the animal host would have allowed the natural selection process to effectively cause the necessary changes in order
to escape its host and dwell within the human hosts. There is also a possibility as per the second perspective, that the progenies of SARS CoV-2 hurled into humans and adapted its genomic characteristics and then spread the infection rapidly through human to human transfer [28].

**Infection and transmission**

**Mode of transmission**

The phylogenetic analysis and the protein sequencing from COVID-19 virus exhibited similarity with ACE2 receptors in turtles and pangolins which are genetically closer to humans and bat. It is suspected that these species can be an alternate intervening hosts transmitting SARS CoV-2 to human [29]. The virus can be transmitted through droplets of saliva, nose discharge and aerosols either from short or long distance by talking, breathing, sneezing and coughing respectively [30]. The person infected can cause transmission through droplets within 1m proximity either by cough or sneeze and the pathogen can enter the healthy person through mouth, nose and eyes. The objects or materials which encountered the infected person or the environment surrounding can also transmit the infection of virus [31]. The virus is present within the droplet mostly reflected as a particle and it cannot be an airborne transmission [32]. Consumption of milk from an infected animal and urine of the animal may also contain virus. The uncooked or undercooked meat consumed directly were also theorised to be main course of transmission [33]. The mode of transmission from primary host to humans has been depicted in fig. 2. [13].

![Image](https://example.com/image1)

**Fig. 2: Mode of transmission of Covid-19 [13] Created with "BioRender.com"**

**Mode of infection**

Structurally, the outermost layer SARS CoV-2 consists of spikes made up of glycoprotein on the surface that helps the virus to invade host cells [34]. The S protein which is recognised by the host ACE2 receptor initiates the virus life cycle in host cell through endocytosis. The endosomal pathway fusion takes place between the viral envelope and the host cell membrane with the release of viral nucleocapsid into the cytoplasm. The RNA of SARS-CoV-2 is released, which gets translated to polyproteins pp1a and 1ab (viral replicase). Later, the viral proteinase cleaves the RNA replicase to smaller fragments which persuade the structural rearrangements in the cell membrane to form double-membrane vesicles (DMVs). A chain of sub genomic mRNAs is produced by polymerase during the process of discontinuous transcription and the viral proteins are translated pertinently. The combination of viral proteins and RNA genome successively accumulate to form a virion in ER-Golgi intermediate complex (ERGIC). Finally, through secretory pathway, the mature virions are transported and released out of the cell in smooth-walled vesicles as shown in the fig. 3 [13, 35].

![Image](https://example.com/image2)

**Fig. 3: Mode of infection of Covid-19 [35] Created with "BioRender.com"**
Symptoms of infection

Incubation period for covid-19 is 14 d and within 4-5 d one can observe the onset of symptoms. SARS-CoV-2 infection would develop symptoms within 11.5 d in the infected person and although vary between individuals at the onset, most common symptoms are fever, cough, tiredness, eating disorder or also known as anorexia, shortness of breath, excess of sputum production and muscle pain [36]. Least commonly reported symptoms are headache, disorientation, mucus fluid secretions in nasal cavity, sore throat, mucus containing blood stains from the bronchi, larynx, trachea, or lungs, vomiting, and diarrhea [10, 11, 37, 38]. In certain cases, patients also exhibit other common symptoms rarely such as pain in the abdominal region, abdominal distension and recurrent inclination to evacuate the bowels [39]. According to patient’s analysis nausea, vomiting and diarrhea appear at variable percentages [40]. The patients admitted initially of heart palpitation and chest tightness were also found to be infected with covid-19. The patients associated with cardiovascular disease will have high secretion of ACE2 compared to a healthy person [41, 42]. Lately, with close observation of patients infected with covid-19 also exhibited loss of smell that is anosmia, associated with or without parageusia means confusion of the sense of taste [43]. There are also possibility of asymptomatic infections and the transmission of SARS CoV-2, although confirmed yet [44].

Table 1: Available pharmacotherapeutic agents against covid-19

| Pharmacotherapeutic agents | Possible covid-19 indication | Mechanism of action | Original indication | Dosage information | References |
|---------------------------|-------------------------------|---------------------|--------------------|-------------------|------------|
| Hydroxychloroquine/Chloroquine | Off-label use for anti-viral treatment | Increases intracellular pH in host cells, thus inhibiting RNA synthesis. Facilitates the glycosylation impairment of ACE2, by disrupting viral S protein thereby preventing the entry of SARS-CoV-2 into the host cell. Also known to possess anti-inflammatory and immunomodulatory effects. | Malaria, HIV, Autoimmune Diseases | Hydroxychloroquine: 400 mg on first day followed by 200 mg for four days, twice, orally. Chloroquine: 500 mg twice for 5 d, orally. | Barlow et al. 2020; Tu et al. 2020; McCreary et al. 2020 [53-55]. |
| Remdesivir | Off-label use for anti-viral treatment | Guanosine nucleoside that specifically inhibits viral RNA replication using molecular mimicry mechanism. Also acts as an aspartic acid protease inhibitor that inhibits viral replication hence its life cycle. | Ebola virus, MERS-CoV | 200 mg on first day, followed by 100 mg for up to 10 d intravenously 200 mg-100 mg for 14 d through oral consumption | Barlow et al. 2020; Tu et al. 2020; McCreary et al. 2020 [53-55]. |
| Lopinavir and Ritonavir | Off-label use for HIV-1 treatment | Acts as an aspartic acid protease inhibitor that inhibits viral replication hence its life cycle. | HIV-1 | 400 mg for 14 d; twice a day | Barlow et al. 2020; Tu et al. 2020; McCreary et al. 2020 [53-55]. |
| Ribavirin | Off-label use for anti-viral treatment | Nucleoside analog that specifically inhibits viral RNA replication using molecular mimicry mechanism. | Hepatitis-A, Hepatitis-B, SARS | 500 mg-100 mg for 14 d through oral consumption | Barlow et al. 2020; Tu et al. 2020; McCreary et al. 2020 [53-55]. |
| Nitazoxanide | Off-label use for anti-protozoal treatment | Inhibits hemagglutinin formation hence interferes with viral life cycle. It may also act on the electron transfer activity of pyruvate ferredoxin oxidoreductase enzyme, thus interfering in the protozoan energy metabolism. | Diarrhea | Doses recommended for SARS were based on age groups; 1-3-year-old were recommended with 100 mg, 4-11 y with 200 mg, above 12 y with 300 mg for 5 d, orally. | Barlow et al. 2020; McCreary et al. 2020 [53-55]. |
| Nelfinavir | Off-label use for HIV-1 and anti-viral treatment | Drug binds to the active site of HIV-1 protease enzyme and inhibits the cleavage of precursors of Gag-Pol polyprotein chain, that are essential for the survival of HIV-1 inside the host. The residues left after the ribonuclease A cleavage of precursor polyprotein and polyprotein chain, that are essential for the survival of HIV-2 and polypolyprotein chain, that are essential for the survival of HIV-1 inside the host. | HIV-1 | Unknown | Barlow et al. 2020; Shetty et al. 2020; McCreary et al. 2020 [54-56]. |
| Favipiravir | Off-label use for anti-viral treatment | It structurally resembles guanine, and through competitive inhibition, reduces the efficacy of viral replication like remdesivir. | Influenza | Unknown | Tu et al. 2020; Shetty et al. 2020 [53, 56]. |
| Ivermectin | Off-label use for HIV-1 and anti-viral treatment | It can dissociate the preformed IMPz β1 heterodimer, which aids in the protein displacement. As the protein displacement is essential for the maintenance of viral replication, targeting the protein displacement across the host cell would be a feasible option to inhibit viral life cycle. | HIV-1, Dengue | Unknown | Tu et al. 2020 [53]. |
| Nafamostat | Off-label use for anti-viral treatment | Acts as a serine protease inhibitor, inhibits TMPRSS2 associated fusion process, may prevent the entry of d | Pancreatitis | Unknown | Shetty et al. 2020 [56]. |
Table 2: Available immunotherapeutic agents against COVID-19

| Immunotherapeutic agents | Possible covid-19 indication | Mechanism of action | Original indication | Dosage information | References |
|--------------------------|-----------------------------|---------------------|-------------------|-------------------|-----------|
| Anti-interleukin (IL)-6 | Against Acute respiratory distress syndrome | IL-6 can bind to its IL-6 receptor and alternative mRNA splicing. Increased IL-6 content results in reduced lung elasticity and increased bronchoalveolar inflammation. Inhibiting IL-6 may hamper effects of COVID-19. | Acute respiratory distress syndrome | Unknown | Tu et al. 2020 [53]. |
| TNF-α inhibitors | Anti-inflammatory | Reduces lung inflammation caused by tumor necrosis factor-α. Blocking these factors would resume normal lung function. | Psoriasis, Rheumatoid Arthritis, and Inflammatory Bowel Diseases | Unknown | Tu et al. 2020 [53]. |
| Methylprednisolone | Anti-inflammatory | Consumption would suppress the unwanted immune reactions | Arthritis, Blood disorders | Unknown | Tu et al. 2020 [53]. |
| Fingolimod | Immuno-modulating Drug | Through molecular mimicry, it binds to sphingosine-1-phosphate (S1P1) receptors to reduce the T-lymphocytes in lymph nodes, to attenuate the unwanted immunopathogenesis | Refractory multiple sclerosis | Unknown | Tu et al. 2020 [53]. |
| Tocilizumab | Off-label use to hamper unwanted immune response | Monoclonal antibody that binds to IL-6 receptors to block IL-6 pathway | Rheumatoid Arthritis | Unknown | Tu et al. 2020 [53]. |
| NK-Cells | Boosting Anti-Viral Response | Increases the number of cytokines and chemokines, without the help of CD8+ and antibodies. Migration towards viral site reduces viral activity. | SARS-CoV-2 | Unknown | Tu et al. 2020 [53]. |
| Anti-C5a Monoclonal Antibody | Anti-inflammatory | Anti-C5a treatment could reduce lung injury by reducing vascular leakage and influx of neutrophils into the damaged site. | SARS-CoV-2 | Unknown | Tu et al. 2020 [53]. |
| Convalescent Plasma Therapy | Anti-viral response | Antibodies present in the sera from convalescent patients would suppress viremia | Reducing infection | Unknown | Shetty et al. 2020; McCrea et al. 2020 [55, 56]. |
| Thalidomide | Anti-angiogenic, Anti-inflamatory, Anti-fibrotic | Along with the reduction of TNF-α, it reduces multiple inflammatory conditions by suppressing inflammatory cells and pro-inflammatory cytokines. | Crohn’s Disease, Behcets Disease Neurological, Dermatological and Rheumatological Disorders | 500 mg for 5 d | Tu et al. 2020 [53]. |
| Intravenous Immunoglobulin | Activity | Boosts immune system by attenuating the proliferation of inflammatory cells, inhibition of phagocytosis, and interfering antibody mediated cytotoxicity | 500 mg for 5 d | SARS-CoV-2 | Tu et al. 2020 [53]. |

Table 3: Available cellular therapeutic agents against COVID-19

| Cellular Therapeutic agents | Possible covid-19 indication | Mechanism of action | Original indication | Dosage information | References |
|----------------------------|-----------------------------|---------------------|-------------------|-------------------|-----------|
| Antibodies | Neutralizing | Recovered from patients of COVID-19, these antibodies would significantly reduce the viral infection. | Unknown | Unknown | Tu et al. 2020 [53]. |
Table 4: Ongoing vaccine developments against COVID-19

| Company/Institution | Estimated timeline | Technology | Stage/Funding | References |
|--------------------|-------------------|------------|---------------|------------|
| Moderna Therapeutics—US National Institute of Allergy and Infectious Diseases Inovio Pharmaceuticals | 3 mo to early Stage (phase 1) clinical trial in US (earliest); much longer for full testing and regulatory approval | Human testing in the next few months | Messenger RNA vaccine | Preclinical Awaiting preclinical tests and phase 1 study by NIAID, Funding by CEPI. | Pang et al. 2020 [52]. |
| Novavax University of Queensland | 3 mo | 6 mo | Nanoparticle vaccine | Preclinical Funding by Coalition for Epidemic Preparedness Innovations (CEPI), up to $9 million | Pang et al. 2020 [52]. |
| Vir Biotechnology | Not available | Anti-coronavirus monoclonal antibodies. Additionally, using "whole-genome CRISPR-based screening capabilities to identify the host receptor for Wuhan coronavirus" | Preclinical | Pang et al. 2020 [52]. |
| Chinese Centre for Disease Control and Prevention (CDC) Shanghai East Hospital (Tongji University)—Sternirna Therapeutics Johnson and Johnson | At least 1 mo for development, 2–3 y before availability for use | <40 d for manufacture of vaccine samples | Not available Inactivated virus vaccine (postulated, not verified) | Preclinical; virus successfully isolated, currently selecting strain | Pang et al. 2020 [52]. |
| University of Hong Kong | Months for animal testing | Not available | Adenovirus—vectored technology used for Ebola vaccine (and Zika and HIV vaccine candidates) | Preclinical | Pang et al. 2020 [52]. |
| University of Saskatchewan (VIDO-InterVac) GeoVax—BravoVax Clover Biopharmaceuticals CureVac Texas Children’s Hospital Center for Vaccine Development at Baylor College of Medicine Codagenix | Target for animal testing in 6–8 w, human trials in at least a year | Not available | Modified nasal spray influenza vaccine (with surface antigen of coronavirus) prevents both influenza and coronavirus | Preclinical | Pang et al. 2020 [52]. |
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Detection and diagnosis

After the outbreak of covid-19 in Wuhan(China), WHO has recommended that samples should be taken from suspects of SARS-CoV-2 of respiratory tract specimens like bronchoalveolar lavage fluid, pharyngeal and nasal swabs which are subjected to nucleic acid amplification diagnostic test, RT-PCR assay and specific method to identify patients with respiratory pathogens/infection [45]. To detect the infected cases of covid-19, molecular-based approaches (Nucleic acid test) are important. Other techniques like serological
antibody test are also used, which takes shorter time to detect the infection [46, 47]. RT-PCR and next-generation sequencing techniques are used to check for the presence of SARS-CoV-2 in the specimens of respiratory tract, which are time consuming but far more sensitive and efficient. Sequencing of genome is performed to design primers and probes that are specific to detect SARS-CoV-2. Viral RNA extract of COVID-19 is used as positive control in all assays. In real time RT-PCR assay primers and probes that specifically target gene of SARS-CoV-2 is used. For SARS-CoV-2 identification, open reading frames (ORF 1a and 1b), RNA-dependent RNA polymerase gene (RdRp), envelope (E), and nucleocapsid(N) are key sequences for diagnose [17].

Advancements in therapeutics treating COVID-19

One must accept with anguish that there is no specific treatment option found to treat COVID-19 till date [5, 48]. All the therapeutics now used to treat COVID-19 were once used to treat similar viruses named SARS-CoV or MERS-CoV, the outbreaks reported in 2003 and 2012, respectively [49]. Although they possess an array of working mechanisms, these drugs are not ‘specifically’ designed for the said infection [48]. Medical professionals are using these drugs either separately or in combination for specific duration. In the following sections, we have briefly discussed about the ongoing therapeutics for covid-19.

The first and important step that comes into light in case of viral or any infectious disease is to be away from the infected person or patients termed as social distancing. covid-19 is highly infectious and can enter the host through aerosols, just like tuberculosis [50, 51]. Therefore, it becomes essential to maintain adequate isolation to control the viral transmission. Care should be taken that even mild symptoms should be reported to medical professionals, so that further transmission can be prevented from confirmed patients. The medical treatment involves usage of pharmacotherapy, immunotherapy, cell therapy and vaccines [52-54]. Tables 1-4 briefly depict the details of all the therapeutics currently being used.

Apart from pharmacotherapy and other modes of treating covid-19, there is no available vaccine against the pandemic. Though it takes significant time to develop vaccines many of the firms and institutions have joined hands for the development of vaccines against COVID-19 [52, 53]. They are working around the globe to ensure that they explore every part of the virus characteristics. It should be taken care that cross-contaminations of other vaccines can occur, and the effect may be even worse than covid-19 [54].

Preventive and control measures

Every health malady outbreak results in the initiation of preventive measures at different levels inside a region, apart from the medications. Following these preventive measures would help in saving lives; hence would maintain the population levels at constant rate [56]. In case of COVID-19, as no specific medications are available, preventon would be the best opportunity to survive against this global pandemic [50]. The preventive measures can be followed in 3 levels including personal level, community level and population level. Laws should be made to facilitate the strict implementation of preventive measures at every level.

Role of individuals in the prevention of covid-19

The transmission of COVID-19 occurs through the exchange of aerosols when a healthy individual receives them from a sick person [60]. As it belongs to the category of severe acute respiratory syndrome (SARS), the highest viral content is possessed by the sputum and upper airway secretions [60]. The virus can even remain for days on the surface and can result in further complications and upper airway secretions (63%). After 2 exchanges, the viral load reduces to 14% and after 5th exchange, <1%, which becomes an optimum environment for the patients [51]. Thus, it also becomes important to maintain regular room ventilation protocols. Apart from ventilation, it also becomes essential to maintain protocols to avoid cross-infection, through the only available way, that is PPE. Avoidance of patients, staff or visitors exposed to the virus, repeated handwashing, isolation of patients, cleaning the equipment regularly and proper disposal of PPE can help in the effective prevention of covid-19 transmission [48, 51].

Role of society in the prevention of covid-19

Along with personal efforts to stay away from the pandemic, efforts from other two levels, i.e., community and population are also essential. In the middle of the pandemic without availability of proper and specific therapeutic options, social distancing and quarantine prove efficient options to control the further spreading of the disease [63]. Social distancing refers to the maintenance of safe distance from individuals during interactions in public places like utility stores, hotels, theatres etc [64]. While quarantine can be defined as the restriction on infected persons in an isolated place from the public [63]. It is one of the most misunderstood and feared methods of controlling covid-19, because it may affect both infected and non-infected individuals with psychological, economical, and emotional complications such as post-traumatic stress disorder, depression, insomnia, mood swings etc [65]. From the economical point of view, quarantine reduces the productivity, hence minimalizes the economic growth [66]. According one study, the restrictions on travelling and traffic significantly reduced the transmission of the virus. Another study showed that quarantine strategies are more effective than traffic restrictions. According to them, it is estimated to reduce the number of cases by 89.7% [50]. Similarly, the idea of city lockdown was proved to be effective when a study reported 72% drop in the number of infected people. They also suggested that, postponing lockdown would worsen the situation by 5 times [56]. Owing to these factors, it becomes clear that quarantine can be the best self-preventive method that can be practiced at community and national level.

Contribution of pharmacy and healthline services

Being in the front line against the pandemic, a lot can be expected from the pharmacy and healthline services. Preventive and control measures can be at their best with the combination of quarantine and activity of healthline services [67]. The pharmacists can develop guidance for providing pharmacy services, where researchers across the globe, epidemiologists and clinics can share their views and studies on the virus’ characters and controlling methods [68]. This hub can result in the development of preventive and control methods. Also, on the other hand, pharmacists can put forward their formulary manuals and medicine news. Through this approach,
FUNDING

The effect of the pandemic s diagnosing kits, ample production and distribution of PPE can reduce the efforts, one health approach is recommended. Along with this, opening medical helplines, telecommunication for remote areas to provide information about available treatment information and preventive measures would be helpful [68]. It would be better if mobile health services get into the front, edifying as well as providing medical assistance. This would be considered as a better option in conditions like lock-down. Fig. 5 depicts the role of pharmacy and healthcare in the prevention of covid-19.

Essentials in research and development

Owing to the considerable impact of ongoing covid-19 pandemic on health security and global economy, one of the major problems raised was inadequate diagnostic and medical equipment, including test kits, face masks, sanitizers and therapeutic drugs [69]. It has now become necessary for scientists to standardize and develop the diagnostic test strips and enzyme linked immunosorbent assay (ELISA) kits as additional procurement [70]. Computational biological tools and bio-informatics analysis of covid-19 can be the resourceful keys to develop the molecular imaging of structural proteins and possible mutations [70]. The detection of possible reservoir and carriers of the virus can be done with serological surveys of suspected animals. This would surely help in the controlling the pandemic [70]. On the other hand, it is still essential to consider factors like temperature, UV, humidity, behaviour of aerosols and biophysical evaluation of all these factors for the effective study of covid-19, thus finding a pavement for its permanent cure [70].

CONCLUSION

The covid-19 pandemic has been the most dreadful disease in the history so far, accounting for loss of millions of lives. It has also resulted in the complete halt of importing and exporting essential things across the worlds, thus has impaired the global economy. The similarity of the virus with the already known viruses is considered because of the therapies working on it. Compared to the other viruses from the same family, it appears that covid-19 has been evolved to withstand all those therapeutics once effective against MERS-CoV and SARS-CoV-1. The ongoing therapeutics are used as a combination to reduce the viral load in patients, as no specific drug is available and many of them are yet to clear the clinical trials, including vaccines.

Though it possesses symptoms like pneumonia, it is lethal and highly contagious. Thus, it becomes utmost important to maintain the social distancing through lockdown. As no specific drug is available, it is better to avoid the exposure by maintaining social distancing. Every citizen of the country must play his/her role in the prevention and control of the pandemic. It is recommended that both lock-down would result in significant decrease of mortality rate. The pharmacy and healthcare services are already doing their best to fight the pandemic. To boost up the efforts, one health approach is recommended. Along with the good practices, effective treatment, development of quick and precise diagnostic kits, ample production and distribution of PPE can reduce the effect of the pandemic significantly.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. Mack A, Choppin ES, Hamburg MA, Relman DA, editors. Microbial evolution and co-adaptation: a tribute to the life and scientific legacies of Joshua Lederberg: workshop summary. Nat Acad Press; 2009.
2. Fischer R, What’s the difference between pandemic, Epidemic, and Outbreak. JSTOR Daily; 2020.
3. Singhal T. A review of coronavirus disease-2019 (Covid-19). The Indian J Ped 2020;13:1-6.
4. Luan RS, Wang Y, Su X, Chen XS, Zhou T, Liu QH, et al. Epidemiology, treatment, and epidemic prevention and control of the Coronavirus disease 2019; A review. Schuan da xue xuebao. Yi xue ban y] Schuan Uni. Med Sci Ed 2020;51:131-8.
5. Muniruzz MR, Khan NA, Siddiqui N, Novel coronavirus: current understanding of clinical features, diagnosis, pathogenesis, and treatment options. Pathogen 2020;9:297.
6. World Health Organization. Novel Coronavirus disease 2019 (COVID-19) Situation Update Report. No 101. Available from:...
probable outbreak size on the diamond princess cruise ship: a data-driven analysis. Int J Infectious Diseases 2020;93:20 1-4.

21. World Health Organization. Novel Coronavirus disease 2019 (Covid-19) Situation Update Report. No 100. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200429-sitrep-100-covid-19-delta?sfvrsn=bblbfz1_6 [Last accessed on 29 Apr 2020]

22. MOHFW. Govt of India. Available from: https://www.mohfw.gov.in/ [Last accessed on 01 May 2020]

23. World Health Organization. Coronavirus (Covid-19). Available from: https://www.cdc.gov/coronavirus/2019-ncov/index.html [Last accessed on 30 Apr 2020]

24. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China. 2019. New England J Med 2020;382:727-33.

25. Woo PC, Lau SK, Li KS, Poon RW, Wong BH, Tsoi HW, et al. Molecular diversity of coronaviruses in bats. Virology 2006;351:180-7.

26. Lau SK, Woo PC, Li KS, Tsang AK, Fan RY, Luk HK, et al. Discovery of a novel coronavirus, China rat coronavirus HBR24, from norway rats supports the murine origin of betacoronavirus 1 and has implications for the ancestor of Betacoronavirus lineage. A J Virol 2015;89:3076–92.

27. Corman VM, Muth D, Niemeyer D, Drosten C. Hosts and sources of endemic human coronavirus. Indiavites in virus research. Acad Press; 2018. p. 16-88.

28. Andersen KG, Rambaut A, Lipkin WI, Holmes EC, Garry RF. The proximal origin of SARS-CoV-2. Nat Med 2020;26:450-2.

29. Liu Z, Xiao X, Wei X, Li J, Yang T, Tan H, et al. Composition and divergence of coronavirus spike proteins and host ACE2 receptors predict potential intermediate hosts of SARS-CoV-2. J Med Virol 2020;92:595-601.

30. Lewis D. Is the coronavirus airborne? Experts can’t agree. Nature 2020;580:175.

31. Al-Tameemi KA, Kabakli R. Novel coronavirus (2019-nCoV): disease briefings. Asian J Pharm Clin Res 2020;13:22-7.

32. World Health Organization. Modes of transmission of virus causing (Covid-19): implications for IPC precaution recommendations: scientific brief. Available from: https://www.who.int/news-room/details/modest-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations- [Last accessed on 30 Apr 2020]

33. Yin Y, Wunderink RG. SARS and other coronaviruses as causes of pneumonia. Respiriology 2018;23:130-7.

34. Van Boeckeman S, de Graaf M, Lauber C, Besterbroer TM, Raj VS, Zaki AM, et al. Genomic characterization of a newly discovered coronavirus associated with acute respiratory distress syndrome in humans. Med Biol 2012;3:473–512.

35. Fung TS, Liu DX. Human coronavirus: host-pathogen interaction. Annual Rev Micro 2019;73:5-29-7.

36. Centers for Disease Control. Interim clinical guidance for management of patients with confirmed coronavirus disease (COVID-19). Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients/ [Last accessed on 30 Apr 2020]

37. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020;323:1061-9.

38. Xu XW, Wu XX, Jiang XG, Xu KJ, Ying LJ, Ma CL, et al. Clinical findings in a group of patients infected with the 2019 novel coronavirus (SARS-CoV-2) outside of Wuhan, China: a retrospective study. Br Med J 2020;368:24.

39. Wei XS, Wang X, Niu YR, Ye LL, Peng WB, Wang ZH, et al. Clinical characteristics of SARS-CoV-2 infected pneumonia with diarrhea. New England J Med 2020;1708-20.

40. Lai CC, Shih TP, Ko WC, Tang HJ, Hsiue PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and corona virus disease-2019 (Covid-19): the epidemic and the challenges Int J Antimicrob Agents 2020;55:105924.

41. Zheng YY, Ma YT, Zhang JJ, Xie X. Covid-19 and the cardiovascular system. Nat Rev Cardiol 2020;17:259-60.

42. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of 2019 novel coronavirus infection in China. Med Rev 2020. https://doi.org/10.1101/2020.02.06.20020974

43. Xydakis MS, Dehgan Mobaraki P, Holbrook EH, Geisthoff UW, Bauer C, Hauertert C, et al. Smell and taste dysfunction in patients with COVID-19. The Lancet Infect Dis 2020. https://doi.org/10.1016/S1473-3099(20)30293-0

44. Mizumoto K, Kagaya K, Zarebski A, Chowell G. Estimating the asymptomatic proportion of coronavirus disease 2019 (Covid-19) cases on board the diamond princess cruise ship, Yokohama, Japan, 2020. Eurosurveillance 2020;25:2000045.

45. Chen Y, Chan KH, Kang Y, Chen H, Luk HK, Poon RW, et al. A sensitive and specific antigen detection assay for Middle East respiratory syndrome coronavirus. Emerging Micro Infec 2015;4:1-5.

46. Meyer B, Drosten C, Müller MA. Serological assays for emerging coronaviruses: challenges and pitfalls. Virus Res 2014;194:175-83.

47. Hamid S, Mir MOY, Rohela GK. Novel coronavirus disease (Covid-19): a pandemic epidemiology, pathogenesis and potential therapeutics. New Microl New Infec 2020;35:100679.

48. Xie Y, Layton PN, Ye S, Li X, Xu RH. Covid-19: what has been learned and to be learned about the novel coronavirus disease. Int J Bio Sci 2020;16:1753-6.

49. Cook TM. Personal protective equipment during the Covid-19 pandemic—a narrative review. Anaesthesia 2020. https://doi.org/10.1111/anae.15071

50. Pang J, Wang MX, Ang IY, Tan SH, Lewis RF, Chen JI, et al. Potential rapid diagnostics, vaccine and therapeutics for 2019 novel coronavirus (2019-nCoV): a systematic review. J Clin Med 2020;9:623.

51. Tu YF, Chien CS, Yarmishyn AA, Lin YY, Lau YH, Lin YT, et al. Review of SARS-CoV-2 and the ongoing clinical trials. Int J Mol Sci 2021;22:2657.

52. Barlow A, Landolf KM, Barlow B, Yeung SY, Heaver J, Claassen CW, et al. Review of emerging pharmacotherapy for the treatment of coronavirus disease 2019. Pharmacotherapy: Human Pharmacol Drug Thera 2020. https://doi.org/10.1002/phar.2398

53. McCready EK, Pogue JM. Coronavirus disease 2019 treatment: a review of early and emerging options. In: Open Forum Infectious Diseases; 2020. p. 7.

54. Shetty R, Ghosh A, Honavar SG, Khamar P, Sethu S. Therapeutic opportunities to manage COVID-19-SARS-CoV-2 infection: present and future. Indian J Ophthalmol 2020;68:693-702.

55. Golchin A, SeyediJafar E, ArdestharyaJi A, Mesenchymal stem cell therapy for Covid-19: present or future. Stem Cell Res Rev 2020;17:1. https://doi.org/10.1007/s11205-020-09973-w

56. Bachanova V, Bishop MR, Dahi P, Driulio B, Grupp SA, Hayes Lattin B, et al. CAR T cell therapy during the Covid-19 pandemic. Biol Blood Marrow Transplantation; 2020. p. 1-8.

57. Amanat F, Krammer F. SARS-CoV-2 vaccines: status report. Immunity 2020;52:583-9.

58. Wang W, Xu Y, Gao B, Lu R, Han K, Wu G, et al. Detection of SARS-CoV-2 in different types of clinical specimens. JAMA 2020;323:1843-4.

59. Wei Q, Ren Z. Disinfection measures for pneumonia foci causing COVID-19 and the law and limits of disinfection measures. J Int J Oral Surg 2020;47:163

60. Butler MJ, Barrientos RM. The impact of nutrition on COVID-19 susceptibility and long-term consequences. Brain, Behaviour, and Immunity 2020;30899-1591.30537-7

61. Parmet WE, Sinha MS. Covid-19 the law and limits of quarantine. New England J Med 2020;15:382.

62. Nicola M, O’Neill N, Srohbi C, Khan M, Agha M, Agha R. Evidence based management guideline for the Covid-19 pandemic review article. Int J Onl Surg 2020;7:206-16.

Ramu et al. Int J Pharm Pharm Sci, Vol 12, Issue 8, 1-10.
65. Brooke SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 2020;395:912-20.

66. Smith KM, Machalaba CC, Seifman R, Pfefferholtz Y, Karesh WB. Infectious disease and economics: the case for considering multi-sectoral impacts. One Health 2019;7:100080.

67. Shashank MP, Chandana KVB, Prithvi SS, Sujay S, Tejaswini M, Lakshmi VR, et al. Covid-19 infection: the prospects of pharmacotherapy. Int J Heal Allie Sci 2020;9:S111-3.

68. Li H, Zheng S, Liu F, Liu W, Zhao R. Fighting against Covid-19: innovative strategies for clinical pharmacists. Res Soc Admin Pharm 2020;S1551-7411:30328-4.

69. Phua J, Weng L, Ling L, Egi M, Lim OM, Divatia JV, et al. Intensive care management of coronavirus disease 2019 (Covid-19): challenges and recommendations. Lancet Resp Med 2020;8:506-17.

70. Rabaan AA, Al-Ahmed SH, Haque S, Sah R, Tiwari R, Malik YS, et al. Exploring the genetics, ecology of SARS-CoV-2 and climatic factors as possible control strategies against Covid-19. Le Infezioni Med 2020;28:174-84.