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SARS-COV-2 and COVID-19: A Global Pandemic

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The evolution of COVID-19 across the globe is rapid due to increased mobility which spreads and evolves continuously among human population. Based on phylogenetic analysis the virus is termed as SARS-COV-2 (Severe acute respiratory syndrome coronavirus 2) which spreads rapidly among human beings. The article focuses on aspects of virus structure, organization of genome, epidemiological characteristics, mode of transmission and global impact of Coronavirus. In addition to this, diagnosis and pharmacological approach, treatment, prevention procedures and vaccines that are currently in use were highlighted.

Keywords: Genome organization, Epidemiology, Transmission, Diagnosis and Prevention.

During the last two decades, several diseases such as H1N1(Influenza A), Zika virus, Severe acute respiratory syndrome(SARS),Middle East respiratory syndrome(MERS) and Ebola caused outbreak throughout the world. Most recently the outbreak of COVID-19 disease caused by SARS-COV-2 virus led to massive impact around the world in terms of strain on public health resources, economic crisis and well-being of humans[1]. The initial outbreak of Coronavirus was first noticed at Wuhan city , China ,where unknown source for the cause of respiratory infection was identified as Coronavirus i.e. SARS-C0V-2 which is quite closely related to outbreak of MERS in 2012 and SARS during the period of 2002 to 2004.The Coronavirus pandemic spread rapidly to 216 countries across the globe and World Health Organization (WHO) reported that 17.1 million people were infected so far, out of which 6,68,073 deaths were reported until July 2020[2]. Different types of pandemics circulated viruses globally since 1918 and WHO made an assessment on 11th March,2020 that Coronavirus as pandemic (Fig.1).

The process of evolution of Coronavirus to get transmitted into humans is still unclear but possible chances include either process of natural selection in human beings after zoonotic transmission or natural selection in animals before zoonotic transmission to human beings. The time period of incubation prior to onset of symptoms ranges from 1-14 days that include headache, myalgia, dry cough, loss of taste and smell, fever, rigor, shortness of breath, diarrhoea and sore throat[3]. Risk factors of COVID-19 include ethnicity ,obesity, diabetes, cancer, and weak immune system.

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The particles of SARS-COV-2 are spherical in shape and are comprised of protein spikes which protrudes from their surface. The protein spikes hold on to human cells and undergo changesin their structure which allow the membrane of virus to get fused with cell membrane. The spikes present on outer layer of virus provided the name Coronavirus which means Crown like(Fig.2). The protein spikes of viral genes enters the host cell and get copied resulting in more number of viruses and several research studies indicated that spikes of SARS-COV-2 binds to Angiotensin converting enzyme 2(ACE2) receptor present on cell surface of humans[4]. SARS-COV-2 consists of enveloped and single stranded RNA which shares 79% of genetic sequence with SARS-COV and 96% homology with coronavirus strain RATG13 in bats. The spike protein is found to bind more likely i.e. 10 to 20 times to ACE2 receptor present in human cells. The structure of SARS-COV-2 is comprised of four structural proteins include envelope, spike, membrane, single strand RNA and nucleocapsid(Fig.3). High affinity of spike protein associated with SARS-COV-2 will bind to ACE2 receptors and a functional cleavage site i.e. polybasic is present at the junction of spike

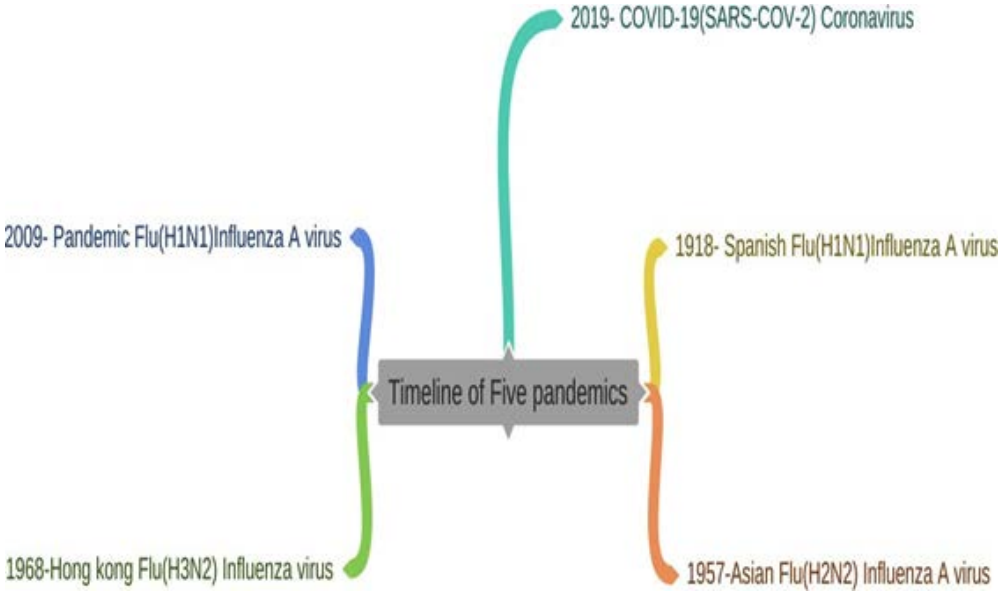

Fig. 1. Five pandemic viruses circulated globally from 1918-2019[1]

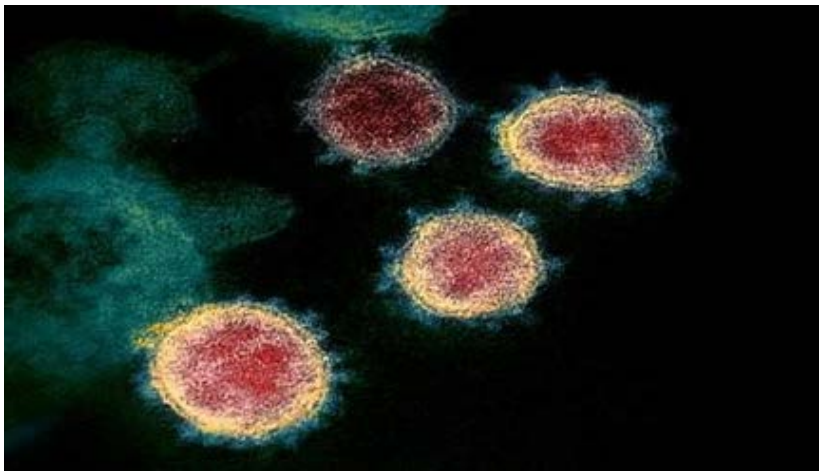

Fig. 2. Transmission electron microscope image of SARS-COV-2 virus[3]

protein subunits,S1 and S2 in humans[5]. This will further enhance the cleavage of spike protein and increase the virus infection.

SARS-COV-2 genome organization

SARS-C0V-2 is comprised of RNA genome which is larger in size and comprised of 29,903 nucleotides. A total of 1/3rd of genome is comprised of genes that codes for structural proteins and accessory proteins were encoded by 8 genes which inhibit host defense mechanism[6]. The remaining part of genome is comprised of replicase gene encodes for two polyproteins which are larger in size and further divided into a total of 16 non-structural proteins that contribute for proofreading on entire viral genome and replication process (Fig.4).

The virions of SARS-COV-2 bind to human cells with spike protein i.e. glycosylated in dense form and binds with greater affinity to ACE2 receptor present on human cells.S1 domain of spike protein manage the binding of receptor and S2 domain is associated with fusion of cell membrane. The receptor binding domain moderates the identification of ACE2 receptor which is generally present in different cell types all over the body which include liver, lungs, testes, blood vessels, heart and intestine[7]. All these cells have TMPRSS2 gene which encodes serine protease enzyme is used to divide the spike protein which facilitates the entry of cell by SARSCOV-2. This allows entry of virions and RNA gets released into the cells that are infected. Further replication and translation process is carried out to provide viral proteins. A total of 100-1000 virions are produced per day from infected cells[8]

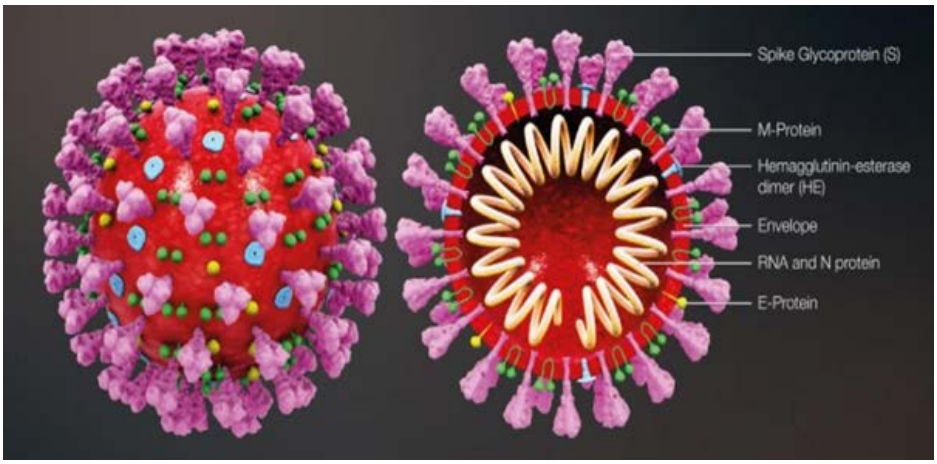

Fig. 3. Structure of SARS-COV-2[5]

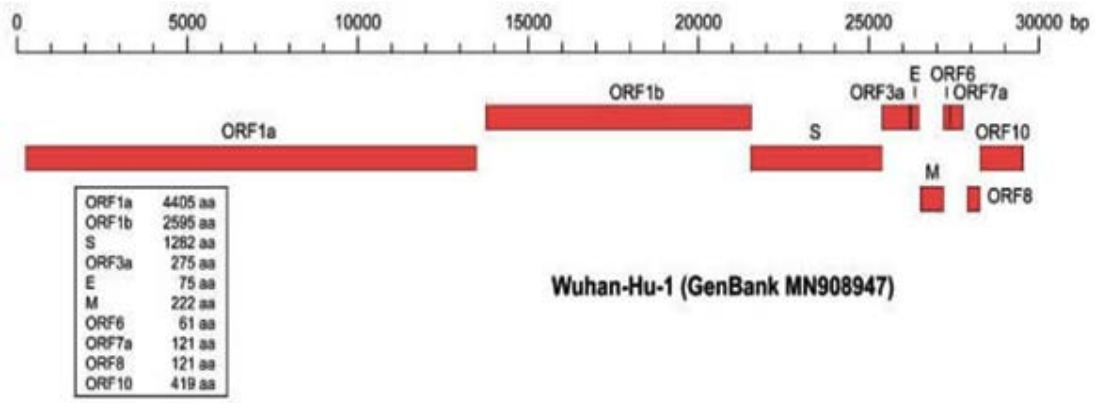

Fig. 4. Genome organization of SARS-COV-2[7]

Global impact of COVID-19 pandemic

The spread of Coronavirus infected millions of people across the world which halted the economic progress of countries due to restrictions that are imposed to prevent the spread of virus. As death toll is increasing which indicates world's largest economic turmoil faced ever since past decades. Due to Coronavirus pandemic it resulted in deep recession causing segmentation of trade and supply chain at global level. This resulted in economic crisis which is an indicator for immediate action to soften the pandemic's economic and health consequences[9]. It is critical to protect susceptible populations due to pandemic and stage should be set for long lasting recovery. Many countries affected due to COVID-19 in terms of access to efficient healthcare systems, loss of tourism and trade, decreased remittances and capital flows. Different sectors have been impacted due to Coronavirus pandemic of which the sectors-Automotive, oil and gas, Tourism and hospitality, Airlines/Aviation, semi-conductors, consumer electronics and consumer products face severe consequences (Fig.5)

Epidemiology of SARS-COV-2

Research studies were conducted to address the emergence of Coronavirus pandemic to identify potential therapeutic targets and vaccine development for management of Coronavirus. The primary studies on COVID-19 included a cohort of 99 subjects in which the percentage of infection rate is observed mainly in older male population present with comorbidities in which symptoms appeared were respiratory pathologies that is either serious or fatal[10]. The Chinese centre for disease control and prevention conducted epidemiological studies which showed increase in mortality rate from 0.2% to 14.8% in patients aged between 10-39 years to 80 years and also percentage of death rate is high in men than women[11,12].

There are several COVID19 cases reported with pre-existing diseases such as diabetes, cardiovascular problems, hypertension and chronic respiratory failure. The mortality rate during the time of infection in an healthy individual is 0.9% and early 80% of the infections are present with no or mild symptoms,13% were present with severe symptoms and pathological related

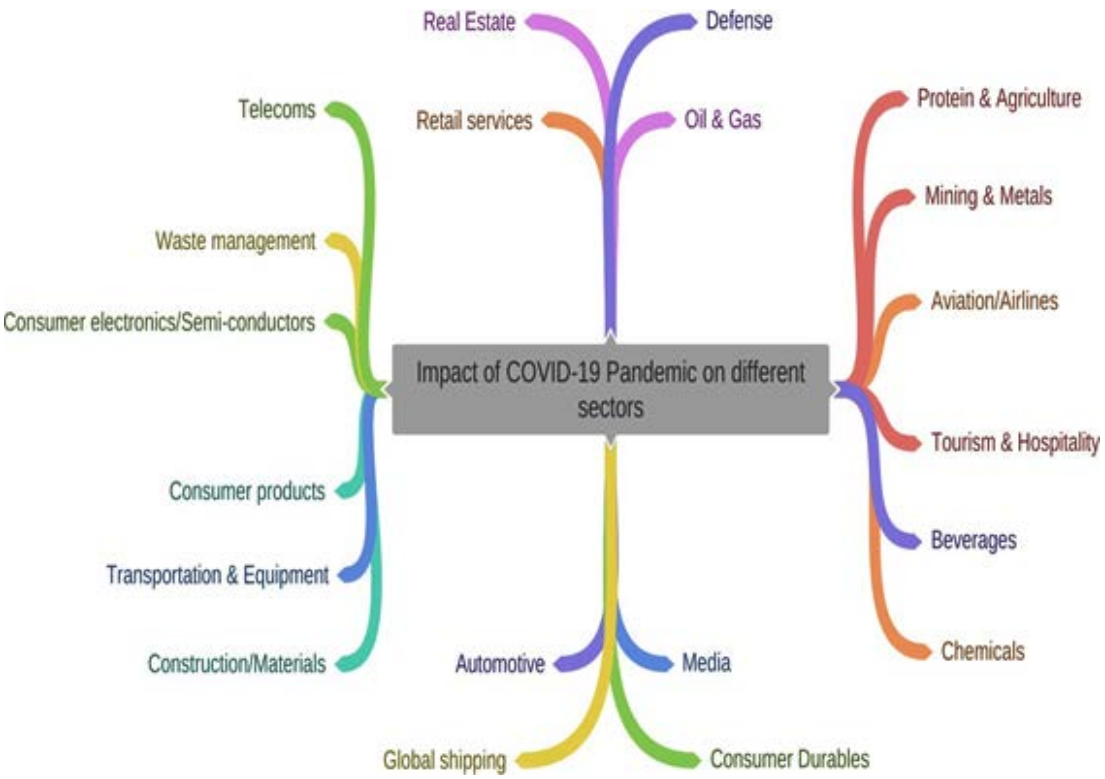

Fig. 5. Impact of COVID-19 on different industry sectors[9]

symptoms were exhibited among 4.7% of the patients which include multiple organ failure, septic shock or respiratory failure[13]. The infection spread to 216 countries across the globe and number of cases is still increasing on daily basis (Fig.6).

Transmission of COVID-19

World Health Organization reported the transmission route could be identical to earlier epidemics like MERS and SARS i.e. transmission occurs between human to human through direct

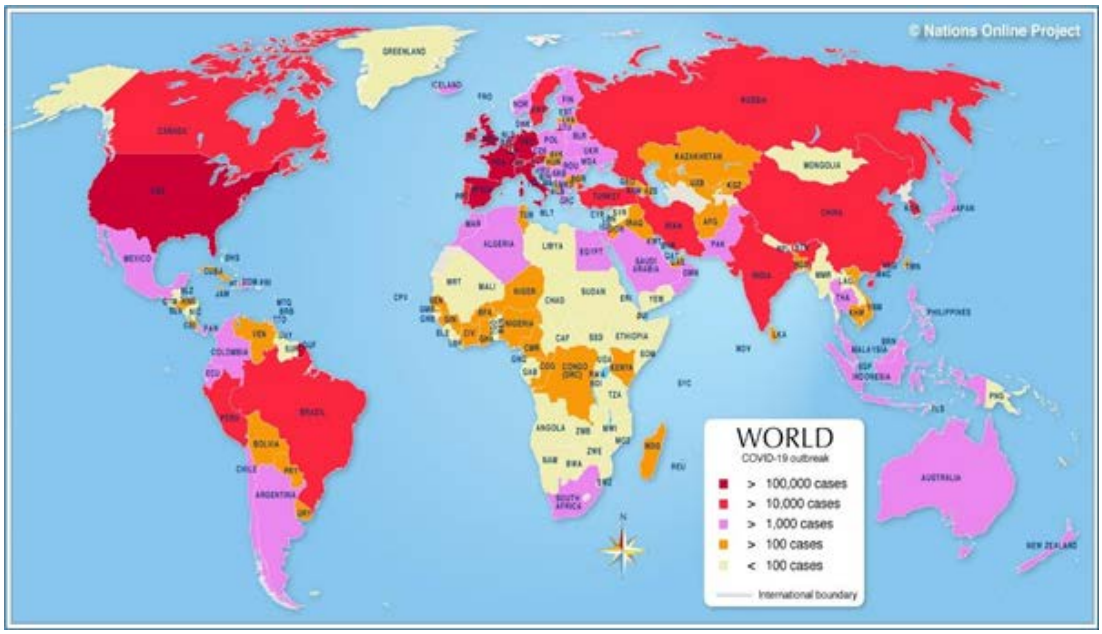

Fig. 6. Coronavirus cases reported across the globe[13]

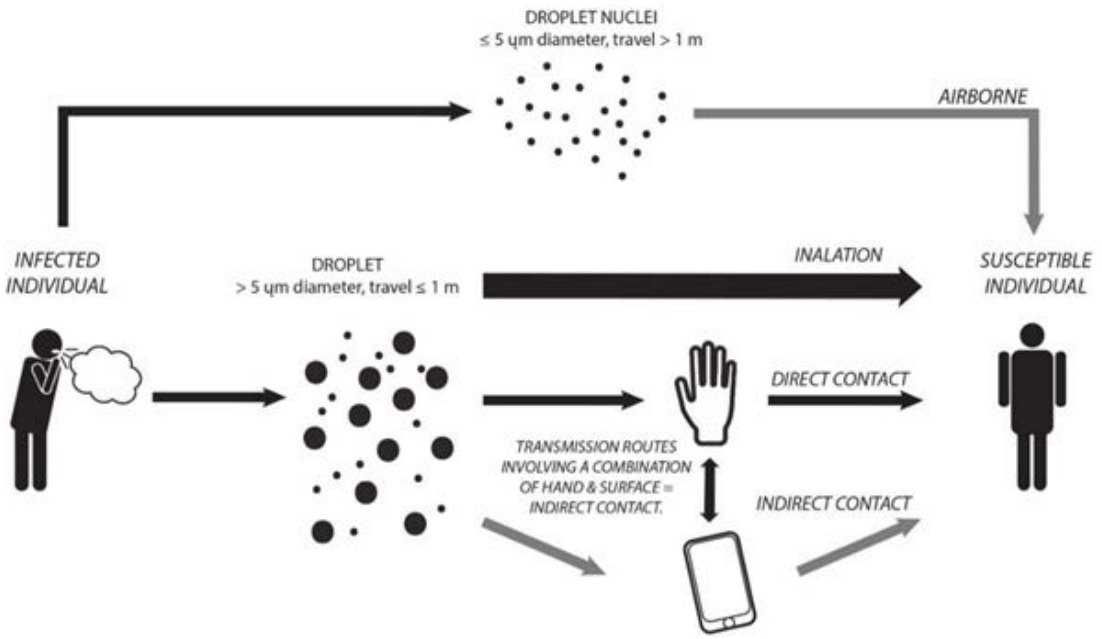

Fig. 7. COVID-19-Transmission ways[16]

Table 1. Therapeutic strategies for management of COVID-19

Therapeutic agents	Origin indication	Mechanism of action
Remdesivir	MERS-COV, Ebola virus	A nucleotide analogue inhibits RNA dependent RNA polymerase and prevent the process of viral replication
Azithromycin	Bacterial infections	Prevention of secondary bacterial infection and exhibits anti-viral activity
Interferon beta	Multiple sclerosis	Immunomodulatory and Anti-viral effects
Interferon alpha	Cancer and Viral infections	Innate anti-viral response ofbody is induced
Tocilizumab	Rheumatoid arthritis	Binding of monoclonal antibody specifically to membrane boundand soluble Interleukin 6 receptors to block the Interleukin 6 mediated responses.
Corticosteroids	Autoimmune andinflammatory conditions	Pain and immunesuppression
Convalescent sera	Infection prevention	Antibodies present in plasmafrom convalescent patients will supress viraemia
Zanamivir	Influenza	Inhibitor of Neuraminidase enzyme which prevents virus from entering host cell and decrease infection and shedding of virus
Oseltamivir	Influenza	Inhibitor of Neuraminidase enzyme which prevents virus from entering host cell and decrease infection and shedding of virus
Hydroxychloroquine	Autoimmune disease and Malaria	Changes in endosomal pH present in host cells and exhibit anti-inflammatoryand immunomodulatory effects

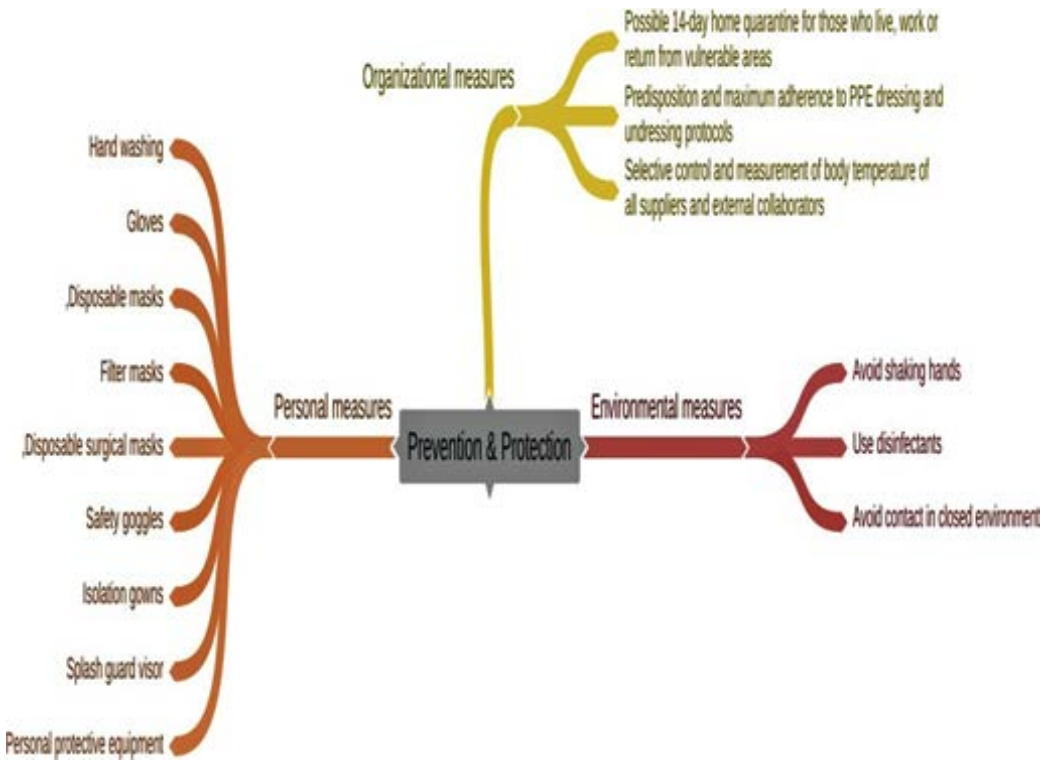

Fig. 8. Prevention and protection measures[25,26]

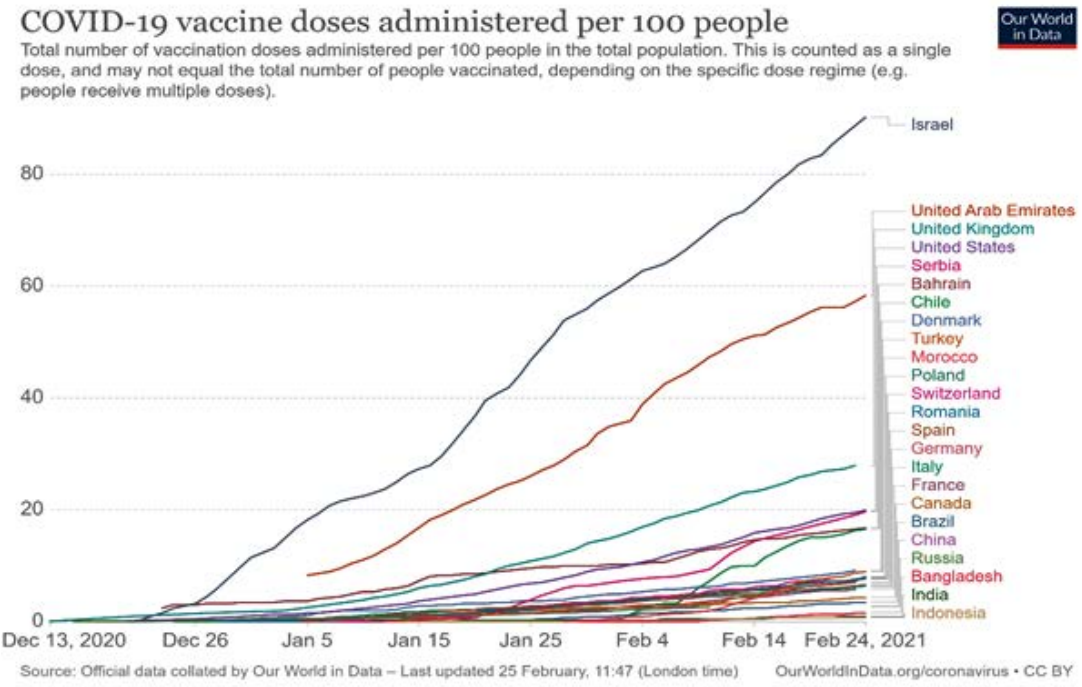

Fig. 9. Vaccination

contact, aerosols and droplets[14,15]. More specifically the spread of infection is up to 1-2m through droplets that occur during sneezing, coughing and speaking by patients with symptoms[16]. There are possible chances of people getting infected without any symptoms and prior to onset of symptoms. Other mode of transmission include the process of inhalation of aerosols which are referred as microparticles that are smaller in size with diameter around 5µm (Fig.7).

Diagnosis and pharmacological approach

Currently, PCR test is widely used diagnostic approach to detect the genetic material present within the virus[17]. In addition to this screening procedures were conducted worldwide using Nucleic acid amplification tests like rRT-PCR(real time reverse transcriptase polymerase chain reaction) is qualitative test used to identify the nucleic acid in lower and upper respiratory specimens which include sputum, nasopharyngeal swab and nasal aspirate etc[18,19]. Treatment procedures for Coronavirus infection is yet to be defined and development of vaccine is in progress. Different types of drugs are used for experimental purpose for treatment of patients suffering from COVID-19 and examples include Remdesivir, favipiravir and Chloroquine etc[20,21]. Further studies are required to evaluate the efficacy of drugs that are found to be suitable for treatment of COVID-19 infected patients. Currently, large scale efforts were carried out to develop vaccines against COVID-19 which include design, testing procedures and implementation procedures[22]. There are several therapeutic agents currently in use to manage the infection caused due to COVID-19 [Table 1].

Prevention and protective measures

The objective of prevention and protection measures is to decrease the probability of exposure to SARS-COV-2 virus[23,24]. Some of the measures to avoid spread of infection or virus include organizational, environmental, personal and other safety protective measures (Fig.8).

Vaccination

Researchers all over the world currently developing effective vaccines for COVID-19 which are designed to identify and block the virus by body's immune system.

There are different categories of vaccines currently in development phase,which include protein based,viral vector, RNA, DNA based and

inactivated virus vaccines.This will protect body's immune system and also from severe illness caused due to virus[26]. On December 31, 2020, the Pfizer/ BioNtech Comirnaty vaccine was added to the WHO's Emergency Use List (EUL). On February 16, EUL was provided to the SII/Covishield and AstraZeneca/AZD1222 vaccines (designed by AstraZeneca/Oxford and produced by the State Institute of India and SK Bio, respectively). Johnson & Johnson's Janssen/Ad26.COV 2.S was approved for EUL on March 12, 2021. On 30 April 2021, the Moderna COVID-19 vaccine (mRNA 1273) was approved for EUL, and on 7 May 2021, the Sinopharm COVID-19 vaccine was approved for EUL. Beijing Bio-Institute of Biological Products Co Ltd, a subsidiary of China National Biotec Group, manufactures the Sinopharm vaccine (CNBG). Sinovac-CoronaVac was a joint venture between Sinovac and CoronaVac.

CONCLUSION

The evolution of Coronavirus since December 2019 resulted in spread of virus and lead to cause 2,486,679 deaths globally as on 25thFebruary,2021 reported by WHO(World Health Organization).There are further possibilities for spread of virus to humans as treatment procedures and thorough development of vaccines is still in progress. The geographical patterns of Coronavirus needs to be further investigated for development of vaccine for wide variety of populations. Preventive measures such as social distancing, quarantine should be followed to prevent the spread of virus. As the virus mutates and evolves constantly it is critical to consider studies on pathogenicity of virus, treatment modalities and vaccine development by taking into consideration the genetic features of virus.Vaccines for medical workers and high-risk persons should be given first priority. Vaccine ownership, large-scale manufacturing financing, and supply chain issues must all be addressed. The monopolisation of global supply by high-income nations must be stopped.

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Conflicts of interest

There are no conflicts of interest.

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