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Corona virus disease (COVID-19): Epidemiology, Pathogenesis, Diagnosis, Therapeutics under trial and Prevention

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Abstract

The unforeseeable outbreak of novel coronavirus called Severe Acute Respiratory Disease Corona Virus-2 (SARS-CoV-2) from Wuhan city of China has become pandemic, associated with great mortality and morbidity across the globe. The virus is transmitted through air droplets from infected person to healthy person. Beta-coronavirus SARS-CoV-2 that shares common relativeness with Severe acute respiratory syndrome (SARS) and Middle East Respiratory syndrome (MERS) affects the lungs, which is manifested as pneumonia clinically characterized by; fever, dry cough, shortness of breath and fatigue. Real time-Polymerase chain reaction (RT-PCR) and Radiological methods such as Computerized Tomography of chest (CT-scan) are the most preferred diagnostic tools. In fact, the CT-scan of chest is considered to be most sensitive, accurate and a rapid diagnostic tool to remove false negative results, and hence stands to be an efficient diagnostic tool for confirming Corona Virus Disease-19 (COVID-19) infection. Therefore, RT-PCR along with CT-scan reports help to correctly confirm COVID-19, which in turn are effective in diagnosis, treatment and management of COVID-19 patients. This review aimed to understand the epidemiology, pathogenesis, diagnosis, therapeutics and preventive measures of COVID-19.

Keywords: SARS-CoV-2, Pathogenesis, COVID-19, Immunopathology, Diagnosis

1. Introduction

The outbreak of novel coronavirus 2019 (SARS-CoV-2) in Wuhan, China, caused pneumonia like respiratory illness, as reported by She *et al*., (2020). After multiple pneumonia cases with unknown etiology observed at the end of 2019, the Chinese National Health Commission provided more information on this epidemic in early 2020 (Wang *et al*., 2020a). Moreover, Guo *et al*., (2020) added that the causative virus was initially referred by the World Health Organization (WHO) as "Novel Coronavirus 2019" (2019-nCoV), but was later renamed by the International Committee of the Coronavirus Study Group (CSG) as "Severe Acute Respiratory Syndrome Coronavirus 2" (SARS-CoV-2), and by WHO as

"Coronavirus Disease 2019" (COVID-19). A previous study conducted by Pal *et al*., (2020) demonstrated that Coronaviruses are non-segmented positive-sense RNA viruses of the Coronaviridae family, the Orthocoronaviridae subfamily, order Nidovirales, and are widely distributed among humans and other mammals. According to Yang and Leibowitz, (2015), there are four genera within the sub-family Orthocoronavirinae namely; Alpha-coronavirus (α-CoV), Beta-coronavirus (β-CoV), Gamma-coronavirus (γ-CoV) and Delta-coronavirus (δ-CoV). The coronaviruses typically have a diameter of about 60 nm to 140 nm with spike-like projections on its surface giving it a crown-like appearance. Although most human coronavirus infections are mild, but the epidemics of the two beta-coronaviruses, severe acute respiratory syndrome coronavirus (SARS-CoV) (Wilder-Smith, 2006) and Middle East Respiratory syndrome coronavirus (MERS-CoV) (Zaki *et al*., 2012; de Groot *et al*., 2020), have caused more than 10, 000 cumulative cases in the past two decades, recording mortality rates of 10% for SARS-CoV and 37% for MERS-CoV, as reported by WHO. (2019); WHO. (2020a).

The SARS-CoV-2 protein-coding genes sequences were 79.5% similar to SARS-CoV and 51% identical to MERS-CoV, according to Guo *et al*., (2020). Recently, Lu *et al*., (2020) highlighted that corona virus is the largest known RNA virus identified yet, with a genome of 26-32 kilobase (kb). Li *et al*., (2020a) added that the SARS-CoV-2 genome encodes a large, non-structural poly protein (ORF1a/b) that is further proteolytically cleaved to generate mainly; 15/16 proteins, 4 structural proteins and 5 accessory proteins (ORF3a, ORF6, ORF7, ORF8 and ORF9). The four structural proteins consist of the spike (S) surface glycoprotein, the membrane (M) protein, the envelope (E) protein and the nucleocapsid (N) protein, which are all necessary for SARS-CoV-2 assembly and infection. An previous study of Yuan *et al*., (2017) stated that the spike surface glycoprotein plays a key role in viral attachment to the host cells, and can be further divided into an N-terminal subunit S1 and a membranous C-terminal S2 region by the host proteases. As reported by Guo *et al*., (2020); Paraskevis *et al*., (2020), the SARS-CoV-2 virus uses the Angiotensin-Converting Enzyme 2 (ACE2), a cell-entry receptor similar to SARS-CoV. The genome size of coronaviruses is considered as the largest of all known RNA viruses, and thus these viruses can be recombined (homologous and non-homologous), making them more vulnerable to mutations.

2. Epidemiology

The outbreak of COVID-19 pandemic led to major health problems for the global population. The virus has been found to be transmitted through aerosols released from coughing and sneezing (Dhand and Li, 2020). Hence, human-to-human transmission of this virus was confirmed through the dissemination of respiratory droplets or aerosols. Accordingly, Wu, (2020) reported that the disease is rapidly transmitted by infected travelers to the other geographical regions and territories. A recent study of Chen *et al*., (2020) revealed that examining of newborn babies from infected mothers, showed no signs of coronavirus in their neonates, demonstrating that there is no evidence for vertical transmission of COVID-19 infection.

Individuals initially diagnosed harboring this disease was exposed to a wet market in Wuhan, China. According to Huang *et al*., (2020), COVID-19 patients in China may have used tainted animals as food or visited the seafood markets. Hence, the Chinese public health authorities suspected that the outbreak is associated with seafood and wild animals. A study conducted by Jiang *et al*., (2020) suggested that the virus may have originated from bats after mutation in the spike glycoprotein. Genetic analysis of Corona virus genome revealed that the virus has 89.1% nucleotide similarity to Bat CoV (Hu *et al*., 2018). A recent study of Tang *et al*., (2020) added that SARS-CoV-2 is 96% identical to the Bat CoV at the genomic level. Results of these studies suggested that human SARS-CoV-2 and Bat-CoV might have the same ancestor, and Bats may be the primary source of this zoonotic spillover. Lam *et al*., (2020) revealed that

corona virus was also isolated from Pangolins, and the Receptor Binding Domain in S protein of SARS-COV-2 was almost the same as pangolin-CoV, which suggests Pangolins as an intermediate host of SARS-CoV-2.

Fatal cases of COVID-19 are mostly found in children with comorbidities (Oualha *et al*., 2020). Compared to young and middle aged people, lethality with COVID-19 is high in older people (Liu *et al*., 2020a). This is attributed to the physiological changes that come with ageing and underlying potential health conditions, as revealed by WHO. (2020a). According to Grundy *et al*., (2020), there is a significant association between COVID-19 severity and smoking. Current smokers have high risk of severe complications as compared to ex-smokers (Aqahtani *et al*., 2020). Recently, Li *et al*., (2020b) reported that patients with previous cardiovascular metabolic disease may have high risk of severe conditions. Abdi *et al*., (2020) showed that the risk of a fatal outcome from COVID-19 is higher in diabetic than non-diabetic patients. According to WHO. (2020b), total infected cases of 61593, recovered cases of 43880, recovery rate of 71.1% and deaths of 390, have been recorded in Nepal. Whereas, Italy has confirmed cases of 293,658 with deaths of 35,658. Similarly, India bears infected cases of 5,214,677 with 84,372 deaths. In USA, about 6,571,119 cases were reported with 195,638 deaths. To date, over 30.6 million COVID-19 cases and 9, 50,000 deaths are recorded worldwide.

3. Pathogenesis

Understanding of the pathogenesis of SARS-CoV-2 virus is still at its beginning and there is much more to be discovered. A recent study conducted by Yuki *et al*., (2020) revealed that attachment, penetration, biosynthesis, maturation and release are the major stages in the life cycle of the virus. After the virus gets attached to the host cell surface, it penetrates into the cell through endocytosis, and then the released viral RNA replicates inside the host cell nucleus. Viral proteins are synthesized by mRNA, and finally, large numbers of virus particles are produced. Yuki *et al*., (2020) added that the structural spike (S) protein of Corona virus is a trans-membrane trimetric glycoprotein which has two sub-units including; S1 sub-unit that helps in attachment, and S2 subunit that plays an important role in the fusion of the viral and the host cellular membranes. According to Zhou *et al*., (2020), RBD (Receptor Binding Domain) of S1 subunit and the presence of furin cleavage site (RPPA sequence) may have major roles in the transmission and the observed high pathogenicity of SARS-CoV-2 virus. Once binding of the RBD of 'S' protein (S1 subunit) with ACE2 receptor in the lung cell is complete, angiostensin-2 (AT2) are released in the huge numbers. As a result, the pulmonary vascular permeability is increased and the lungs may be injured (Kuba *et al*., 2005; Imai *et al*., 2005; Xu *et al*., 2020a). Recent study of Samudrala *et al*., (2020) demonstrated that severe immunological reactions are induced by SARS-CoV-2 with abnormally high production of cytokines and chemokines (CCL2, CCL3, CCL5, CXCL8, CXCL9, CXCL10 etc.). Other organs may also be damaged when these inflammatory factors enter into the blood streams.

4. Immunopathology

A recent report of Mortaz *et al*., (2020) suggested that the mechanism of entry and invasion of the host cells by SARS-CoV-2 is similar to that of SARS-CoV. According to Wan *et al*., (2020); Lu *et al*., (2020), human ACE2 acts as a receptor for SARS-CoV-2. Human organs such as the heart, kidney, and the testes largely express ACE, which has a significant role in controlling the Cardio-renal functions and blood pressure. Beta coronaviruses anchor to the host cell with the help of spike (S) protein present on its exterior surface. But some studies report that the RBD of SARS-CoV-2 shows stronger affinity to ACE2 than the RBD of SARS-CoV-2 (Tai *et al*., 2020). In contrast, Lu *et al*., (2020) revealed that the viral 'S' protein binding of SARS-CoV-2 is comparatively weaker than that of SARS-CoV. Mortaz *et al*., (2020) demonstrated that after viral adherence to the respiratory tract, ACE2 is released and both of the Inflammatory Nuclear Factor Kappa B (NF- KB) and

the Signal Transducer and Activator of Transcription 3 (STAT3) are activated by the SARS-CoV-2 (IL-6 amplifier or IL-6 Amp), resulting in autoimmune and multiple inflammatory diseases. Usually, the Pattern recognition receptors (PRRs) identify the pathogen–associated molecular patterns (PAMPs) such as the viral RNA. A recent study conducted by Guo *et al*., (2020) highlighted that the human immune system is triggered by the SARS-CoV-2 to release inflammatory factors and interferons (IFNS), to control multiplication of the virus. The viral infected cells are destroyed by the $CD8^+$ T cells, and these $CD4^+$ T cells induce the B cells to produce antibodies against the virus. In addition, the T helper cells play important roles in producing the cytokines. The host immune response is usually suppressed by SARS-CoV-2 through elucidating apoptosis of the T cells, as suggested by Mortaz *et al*., (2020). According to Huang *et al*., (2020); Qin *et al*., (2020); Tan *et al*., (2020), the number of $CD4^+$, $CD8^+$, NK, B cells and the memory helper T cells ($CD3^+$, CD45, RO^+) were recorded to be significantly decreased in severe COVID-19 patients. These facts specify that the severity of COVID-19 patients could be compared on the basis of lymphopenia. Furthermore one analysis stipulated a number of COVID-19 patients with T cell activation (Ni *et al*., 2020). The level of interferon (IFN-γ), interleukin (IL-2) and tumor necrosis factor (TNF- α) was increased in critical cases of COVID-19 (Li *et al*., 2008c). Moreover, it was also investigated that $CD4^+$ and $CD8^+$ T cells highly express CD69, CD38 and CD44 in COVID-19 patients than in healthy ones (Zhou *et al*., 2020). Recently, Yang *et al*., (2020) revealed that acute cases of COVID-19 presented a considerable increase in inflammatory cytokines including; IL-1β, IL-2, IL-6, IL-7, IL-8, IL-10, granulocyte colony stimulating factor (G-CSF), inducible protein-10 (IP-10) and macrophage inflammatory protein-1α, thus indicating a "Cytokine storm". Accordingly, this increased synthesis of cytokines may be an important factor for pathological severity of COVID-19 infection.

5. Clinical manifestation

Initially, the main symptoms of COVID-19 include fever, cough and shortness of breath (Hui *et al*., 2020). Later, other signs are observed such as; sore throat, sneezing, nasal congestion, sputum, ageusia, anosmia and dyspepsia, skin rash or finger or toe discoloration, and viral conjunctivitis (Cascella *et al*., 2020). In older people and patients with other health conditions including; respiratory diseases, heart disorders, diabetes and cancer, the risk and complicated severity of COVID-19 is more. Recent reports of Huang *et al*., (2020); Yuen *et al*., (2020); WHO. (2020c) highlighted that patients with COVID-19 clinically manifest fever over 38.5 °C, dry cough, shortness of breath and diarrhea. On the other hand, Chen *et al*., (2020) revealed that SARS-CoV-2 infected patients have several clinical outcomes including; fever, cough, shortness of breath followed by muscle ache, fatigue, headache, sore throat, rhinorrhea, chest pain, diarrhea, nausea and vomiting.

6. Antiviral drugs

Currently, huge efforts are being done to recognize potential drugs against Coronavirus. After the permission granted by WHO, scientists and doctors are busy to conduct trial tests with Food and Drug Administration (FDA)-approved drugs for the treatment of COVID-19. Boopathi *et al*., (2020) revealed that the present alarming situation made all scientists to focus on reusing the previously approved clinical drugs to test in COVID-19 patients. For instance, chloroquine and hydroxychloroquine have been widely used for treatment of malaria and chronic inflammatory diseases, and are currently being used as clinical trial drugs for COVID-19 patients. Both of these drugs inhibit glycosylation of the host receptors and block the entry of virus into cells (Sanders *et al*., 2020). According to Guo *et al*., (2020), the potential of hydrogen (ph)-dependent steps of replication of many viruses including SARS-CoV have been found to be inhibited by chloroquines. Some of the findings of Sanders *et al*., (2020) suggest the efficacy of choloroquine/ hydroxychloroquine in COVID-19 treatment, with improved reports of radiological analysis and viral clearance. No any adverse effects of

chloroquine have been reported for COVID-19 cases till date of this literature review. Initially, Lopinavir-Ritonavir was developed to treat Human immunodeficiency virus (HIV), which showed *in vitro* activity against other corona viruses, by inhibiting the non-structural protein 3-chymo trypsin like protease, as reported by Totura and Bavari, (2019); Sanders *et al*., (2020). Moreover, Totura and Bavari, (2019) added that the combined use of lopinavir-ritonavir with ribavirin resulted in reduced viral loads and controlled clinical outcomes during SARS epidemic. However, Sanders *et al*., (2020) reported that nearly 50% of COVID-19 patient's experienced adverse effects of lopinavir/ritonavir treatment including gastrointestinal distress (14%), according to a recent Randomized controlled clinical trials (RCT). This study demonstrated the limited significance of these drugs in treatment of COVID-19.

One *in vitro* study conducted by Heidary and Gharebaghi, (2020) on vero/hSLAM cells infected with SARS-CoV-2 virus suggested that a drug called ivermectin may have potential benefit in COVID-19 treatment in humans. The study discovered this drug to inhibit the importin (IMP) α/β receptor, which transports viral proteins into the nucleus of the host cell. Ramdesivir also known as GS-5734 is a 1'-cyano-substituted adenosine analog pro drug. It was first discovered to demonstrate the activity against RNA viruses such as Coronaviridae and flaviviridae (Guo *et al*., 2020). Clinically, ramdesivir was used during the outbreak of Ebola (Sanders *et al*., 2020; Guo *et al*., 2020). However, since it showed potent broad spectrum in-vitro activity against different types of Corona viruses and SARS-CoV-2, ramdesivir has been considered to be a potential drug for the treatment of COVID-19, as highlighted by Sanders *et al*., (2020). Also, a recent study of Guo *et al*., (2020) reported the successful treatment of COVID-19 case in USA using ramdesivir. According to Wang *et al*., (2020b), chloroquine and ramdesivir are very promising drugs for the in vitro treatment and control of COVID-19 infection.

7. Vaccines

Vaccines are regarded as the most reliable therapy for the development of life long immunity and preventing or completely eliminating any infections (Totura and Bavari, 2019). At present, about 180 different types of COVID-19 vaccines are being developed, and 35 different vaccines have performed human trials. SARS-CoV-2 is an enveloped single stranded RNA virus with 4 major viral structural proteins including; Spike (S), Membrane (M), Envelop (E) and Nucleo capsid (N). Wu *et al*., (2020) revealed that for the production of COVID-19 vaccine, 'S' protein is the main target to evoke virus neutralizing antibodies. Recently, Ong *et al*., (2020) added that 'S' protein is not the only factor that determine the pathogenicity of human coronavirus, and that there are non-structural protein such as; nsp3, 3CL-pro, nsp8, nsp9 and nsp10, which are anticipated to be potential alternative vaccine candidates for COVID-19. A study conducted by Chugh, (2020) highlighted that there are four different phases of vaccine development;

Phase 1: In this phase, a few numbers of human volunteers are given vaccines with major focus on safety and study of the immune response.

Phase 2: Vaccines are provided to nearly hundreds of volunteers of different age groups in order to analyze its safety and effectiveness.

Phase 3: Thousands of volunteers are under trials to detect the protection level of vaccines. Eventually, these data are accessed for the approval by the concerned authority.

Phase 4: This phase involves the post-retailing inspection for any adverse effects and security of the vaccine.

Out of hundreds of vaccines under development, only 11 are in phase 1, 8 in phase 2, and 3 in phase 2/3. The remaining vaccines are in the pre-clinical phase (Chugh, 2020). After gene sequencing of SARS-CoV-2, many pharmaceutical companies and research institutions are actively working to produce efficient vaccine for COVID-19, as reported by Zhang *et al*.,

(2020). There are different types of vaccines including;

7.1. Nucleic acid vaccines

Unlike the other vaccines that involve recombinant organisms, nucleic acid vaccines include DNA or RNA. A previous study of Restifo *et al*., (2000) documented that these genetic materials are then translated by the host cells to produce the desired transgenic product. Recently, Zhang *et al*., (2020) reported that Moderna/NIH cure-Vac is one of the biotechnological companies targeting to produce mRNA vaccines.

7.2. Inactivated/ Live attenuated vaccine

Heat or a chemical is used to inactivate the virus but the surface proteins are left unharmed in the inactivated vaccines. On the other hand, the virus is made avirulent but immunogenic in the live vaccine (Chugh, 2020). Scientists of the University of Hong-Kong and Codagenix have developed techniques to produce live attenuated vaccines (Zhang *et al*., 2020).

7.3. Sub-unit vaccine

According to Chugh, (2020), the sub-unit vaccine administers viral proteins and induces the human immune system to produce antibodies.

7.4. Re-purposed vaccine

Bacillus Calmette-Guerin (BCG) is a live attenuated vaccine which normally protects us from tuberculosis. However, several epidemiological studies suggest that BCG also works against unrelated respiratory pathogens and neonatal sepsis, as proposed by Chugh, (2020). Few ecological findings anticipate that this vaccine induced immunity may decrease the number of viruses in COVID-19 patients, and may reduce also the cytokine storm.

8. Diagnosis of COVID-19

8.1. Sample collection

Sample collection is the first and foremost step that requires strict measures to ensure safety to both the research team member and the patient. It is necessary to obtain informed consent and verify the risk to the patient associated with sample collection. The sample collecting personnel must follow the Centers for Disease Control and Prevention (CDC. 2020) guidance that directs to use of Personal Protective Equipment (PPE), which include; a gown, double gloves, hair net, an N95 respirator, eye protector and face shield or goggles (CDC. 2020). Upon collection of samples the outer set of gloves should be discarded in a waste container to reduce the risk of contaminating the other samples. Peripheral blood is preferred to be obtained using venous catheter. All the samples should be wrapped and kept in a plastic biohazard bag, wiped using a disinfectant, and then transported to a Biological safety level-2 (BSL-2) laboratory for further processing.

8.2. Types of samples

The sample of choice for diagnosis of COVID-19 is sputum and BAL (Bronchoalveolar lavage) for patients with severe cases of COVID-19. However, for mild cases, the respiratory materials such as nasopharyngeal and oropharyngeal swabs are obtained. Blood serum could be collected for serological testing's. Other samples including blood and urine could be examined for detection of the other pathogens in unresolved cases (WHO. 2011; WHO. 2018; WHO. 2020c).

8.3. Sample collection and transport

Nasopharyngeal and oropharyngeal swabs should be collected by a Dacron or polyester flocked swabs in the same viral transport medium (VTM) tube, and then should be transported to the laboratory; maintained at 4 °C for less than 5 days. On the other hand, the bronchoalveolar lavage, sputum should be transported and stored at 4 °C for 48 hours, as advised by WHO. (2018).

8.4. Laboratory diagnosis

8.4.1. Microscopy

Corona viruses could be examined microscopically through an Electron microscope (EM). The light microscope could be used for carrying the histo-pathological studies generated by the viral infection.

8.4.2. Viral culture

Culture of virus in Vero E6 cells is considered as a standard method for isolation and identification. However, Mathuria and Yadav, (2020) reported this method requires additional requirements and time, thus might not offer rapid detection of the virus in the clinical settings.

8.4.3. Molecular identification

The Real time RT–PCR is a nucleic acid based method for detecting specific gene of SARS-CoV-2. This technology involves viral RNA extraction from the sample, conversion of RNA to complementary DNA, such process is known as Reverse transcription. Amplification using a fluorescent dye through RT-PCR is manipulated to detect a specific gene. Sethuraman *et al*., (2020) demonstrated that this technique provides results immediately in real time while the process is still ongoing, whereas conventional RT–PCR only provides results at the end of the process. COVID-19 results are interpreted using computer based software, available with Real-time PCR instrument. This software monitors the increased fluorescence during the amplification cycles and reports the results in terms of Ct value. The Ct value is the total number of amplification cycles used to detect a fluorescent signal above a given threshold, which is inversely proportional to the amount of target nucleic acid in the sample (Yagci *et al*., 2020).

8.4.4. Serological testing

A recent study conducted by Kubina and Dziedzic, (2020) revealed that the serological test also known as COVID-19 antibody test detects the presence of IgG and IgM antibodies against the SARS-CoV-2 in the patient's blood. This test is not too much sensitive, as the antibodies are not detected in the early phase of infection. However, this test is of known importance to screen large population in pandemic.

8.4.5. Radiological diagnosis

According to Li *et al*., (2020d), the molecular approach for detecting SARS-CoV-2 is time consuming and bears possibility of generating false-negative results. On the other hand, the chest computerized tomography (CT) scan is one of the effective radiological techniques to detect viral infection in both symptomatic and asymptomatic patients. Moreover, Ai *et al*., (2020) added that CT provides comprehensive information on the severity of infection, and further it helps the molecular diagnostic method to confirm the infection. The CT scan images of COVID-19 patients demonstrates the abnormalities in the lungs including; the ground-glass opacities (GGO), consolidation, centrilobular nodules, architectural distortion, bronchial wall thickening, vascular enlargement, traction bronchiectasis, reticulation, crazy paving pattern, intrathoracic lymph node enlargement and sub-pleural bands, as highlighted by Huang *et al*., (2020); Xie *et al*., (2020); Ojha *et al*., (2020). This may cause pulmonary discomfort that requires immediate ventilator support for breathing. Although the radiological evidences are sensitive; however, is less specific, as the scan report may overlap with other viral infections. On the other hand, several studies of He *et al*., (2020); Xu *et al*., (2020b) suggest that CT scan bears higher sensitivity than RT-PCR in COVID-19 diagnosis. Therefore, He *et al*., (2020); Lv *et al*., (2020) recently recommended that to overcome the false negative results of RT-PCR, the suspected patients with symptoms of COVID-19 should make chest CT scan. Accordingly, the use of both technologies is advised for confirming the COVID-19 infection.

8.4.6. Hematological detection

Hematological profile of COVID-19 patient's exhibits increased myohemoglobin, liver enzymes and decreased WBC count in the early stages, which progresses with lymphocytopenia in severe cases (Liu *et al*., 2020b).

8.5. False-positive and false-negative diagnosis

The failure of diagnostic methods induces false-positive and false negative results that leads to false reporting of COVID-19. The reasonable cause behind these false results are improper collection of samples, contamination of samples from the environment during sampling, inadequate samples collection, samples collection from inappropriate sites of throat, inadequate viral load during collection of samples, improper lab resources, improper storage, improper diagnostic equipment and methods (Ozma *et al*., 2020; Sohrabi *et al*., 2020).

9. Preventive measures

Though efforts for vaccine development and search for effective treatment are going on, but effective treatment of the disease has not been discovered till now. Thus, to reduce the number of infected cases, efforts on the personal level could be done through following the preventive measures to prevent transmission of the disease;

a. Use of mask: The WHO recommended using face masks, to reduce COVID-19 transmission from potentially asymptomatic or pre-symptomatic people (WHO. 2020d).

b. Hand washing: Frequently hand washing and avoiding contact with face and mouth after interacting with a possibly contaminated environment is the most important strategy for the population to undertake (WHO. 2020d).

c. Social distancing: As the disease transmits from human to human, thus social distancing or avoiding overcrowded places is one the effective methods to prevent transmission of the disease (WHO. 2020d).

d. Quarantine: This is one of the most effective ways for controlling the transmission of virus from infected person to healthy person, as well as to reduce the mortality rate due to viral infection (Pan *et al*., 2020; Iwasaki and Grubaugh, 2020).

e. Use of hand sanitizer: Hand hygiene is a simple and effective method for reducing transmission of infections in public or healthcare settings. Alcohol based hand sanitizer is predominate in health care settings, due to its low cost and efficacy of reducing infectious transmission (La Fleur and Jones, 2017). However, CDC. (2020) recommended washing hands with soap and water whenever possible over hand sanitizers.

f. Disinfecting home and working area: The use of a disinfectant with 70% alcohol content is highly suggested for disinfecting the household and office materials such as; furniture, utensils, and door handle etc. (WHO. 2020d).

g. Use of disposable gloves: Use of disposable gloves is a must while handling the materials contaminated with body fluids (WHO. 2020d).

h. Increase the number of testing's by contact tracing: Increasing the number of tests and identifying more cases; isolating them, and tracing those who have been in contact is one of the important strategies for preventing transmission of the disease (WHO. 2020d).

Conclusion

The COVID-19 pandemic becomes a global public health issue that has caused great morbidity and mortality. Many research studies are reporting pathogenesis and clinical outcomes of the disease. Since this virus is transmitted through droplets, immediate preparedness and surveillance are necessary for controlling the contagious spread of this viral infection. Rapid diagnosis that includes chest CT scan of symptomatic and suspected patients should be applied to compensate the false results of RT-PCR. Finally, awareness and implementation of the CDC

and WHO formulated preventive and protective guidelines are necessary to ensure safety from this disease.

Conflict of interest

Authors declare no conflict of interest

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Ethics approval

Non applicable.

10. References

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