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Review Article

Coronavirus and Ways to Stop its Transmission

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Abstract

Background: SARS-COV-2 was transmitted from animals to humans in China and through air transport to almost all countries of the world, including Iran, creating the first pandemic of the 21st century. It is important to find out the transmission routes of this virus among humans and prevention approaches.

Methods: We reviewed the literature on various strategies to prevent coronavirus transmission. The virus was spread through droplets from sneezing, coughing, loud talking, and exhalation of sick and asymptomatic people, even during incubation. It was transmitted from human to human directly by inhalation of virus-laden droplets or indirectly through contact with infected surfaces, resulting in the death of a significant number of patients, especially the elderly and those with underlying diseases. The virus is more likely to be transmitted in places with high population densities.

Results: The chain of transmission of infection can be broken by observing the following rules: risk perception, reduced travel, complete quarantine in a particular area, home quarantine, social distancing, use of personal protective equipment (PPE), prevention of gatherings, cleaning and disinfection of public utilities and crowded places, identifying, isolating and treating infected people, tracking calls, continuing health education, following health principles by people, especially in poor areas, and washing hands frequently with soap and water or disinfecting them with 70% ethanol.

Conclusion: We have concluded that the most effective ways to prevent the spread of the virus are to educate the public and encourage strict adherence to government regulations.

Keywords: COVID-19, Transmission, Population density, Quarantine, Social distance, Disinfection

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Introduction

Wildlife trade and consumption led to the detection of a new coronavirus named SARS-CoV-2 in Wuhan, China, in people traveling to the Huanan seafood market.[1,2] The virus spread to other Chinese provinces through massive relocations on the Lunar New Year holiday during long journeys[3] and then spread rapidly from China to other countries.[4] SARS-CoV-2 belongs to beta-coronaviruses that causes COVID-19 as a respiratory illness. COVID-19 is the third most common coronavirus disease in humans in this century after severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).[5,6] Since the virus can be transmitted to others in the incubation[7] as well as recovery periods,[8] the disease spread rapidly. At first, the countries of the Northern Hemisphere, including Iran, faced a large number of infected people. Then, the virus spread rapidly all over the world and infected the majority of countries in the

world in a short time.[9] According to the World Health Organization (WHO), by November 16, 2020, more than 54 million people around the world were infected with the virus, and the number of deaths caused by this virus has been reported to be more than 1 million.[10] The mortality rate among the elderly and people with underlying diseases was significantly higher compared to healthy people.[11] The outbreak of SARS-CoV-2 has affected health, economic, social, and even political aspects of human life in all countries. In earlier phase, an effective antiviral drug and vaccine for the treatment of COVID-19 has not been clinically approved. Therefore, the most appropriate method to prevent the spread of the virus is to break the transmission chain. In this review, the process of virus transmission and ways to stop its transmission are studied to help prevent and make preventive decisions to reduce COVID-19 cases in the Middle East and the world by reviewing and analyzing these methods.

Transmission

Viruses are intracellular parasites that are transmitted from one host to another depending on the nature of the interaction between the virus and the host as well as the number of infected individuals. SARS-CoV-2 derived from bats is transmitted to humans through the intermediate host[12] and to replication, it binds to its receptor, the angiotensin-converting enzyme (ACE2), through S protein, to target cells in the lungs, especially alveolar epithelial cells, enterocytes of the small intestine,[13] and epithelial cells of the oral mucosa that express more ACE2.[14] SARS-CoV-2 protein S has about 10 times more affinity for the ACE2 receptor than SARS-CoV[15] and because people with COVID-19 excrete millions of viruses every hour, the virus is transmitted through respiratory droplets from sneezing, coughing, loud talking, and close contact.[6] SARS-CoV-2 is transmitted during the incubation period, which usually lasts 3-7 days, and may last up to 24 days in some cases.[7] This virus has high transmissibility and its reproduction number (Ro) is higher than the Ro of SARS and MERS viruses, which is about 3.28,[16] leading to its rapid spread in a short time in the world. SARS-CoV-2 was transmitted directly or indirectly from human to human[17] and has been isolated from urine and fecal samples, especially during the late period of the disease; therefore, fecal-oral transmission can be considered one of the transmission routes of SARS-CoV-2.[18] The virus could also be transmitted by asymptomatic people[19] and their role in the transmission of the disease alone is very small; however, because the number of these people is high compared to symptomatic people, they can play an important role in infecting other people. Viruses that are expelled from the mouth and nose of a person with COVID-19 can remain on surfaces such as steel, plastic, glass, Teflon, aluminum, ceramics, and gloves for a considerable period of time and be transmitted to the mucous membranes of the eyes, mouth, and nose through contact, suggesting a possibility that the virus can spread.[20] The use of devices such as air conditioners in closed places increases in the spread of viruses of infected people. The transmission dynamics of the virus were reported to depend on the degree of seasonal variation in SARS-CoV-2 transmission, duration of immunity, and degree of cross-immunity from other beta-coronaviruses.[21]

Strategies for Disrupting Transmission

Travel Restriction

SARS-CoV-2 was transported from Wuhan city, Hubei province, China, to other Chinese provinces[22] and other countries by air transportation.[4] Until January 23, 2020, China announced a travel ban and was able to reduce the spread of the virus.[23] The risk of transmission of SARS-CoV-2 during travel by train, plane, and bus was reported to be high and this risk differs significantly with the duration of travel and the distance of the seat from the index patient. The greater the distance between passengers and the index patient, the less the possibility of becoming infected, and the longer the journey, the higher the possibility of becoming infected.[24] Therefore, to control the prevalence of COVID-19, in addition to public awareness of how public health was observed, travel restrictions were also necessary.[25] In Iran, the SARS-CoV-2 entered Qom and Gilan provinces before being banned from traveling from Hubei province probably by businessmen and students, thus the primary centers of the disease in Iran were established in these two provinces and transmitted through close contact with other people. Qom province due to being a pilgrimage destination and Gilan due to being green and being located next to the Caspian Sea are places for people to travel from other provinces of Iran; therefore, the virus was transferred to other provinces by passengers, infecting all provinces of Iran by March 6, 2020. In order to control and reduce the incidence of the disease and the resulting mortality, it was necessary to reduce travel. However, it should be noted that travel restrictions and its reduction alone did not have a significant effect on reducing transmission of the virus and COVID-19. The implementation of travel restrictions could delay the progression of the epidemic, but when it was accompanied by changes in public behavior and public health, it could significantly reduce the transmission of the disease.[26]

Quarantine

Quarantine refers to the restriction of the movement of people who are in contact with people with an infectious disease, which is done to prevent the spread of the disease. The quarantine is different from isolation in that in isolation, patients with an infectious disease are isolated from healthy individuals to protect healthy ones and are usually treated in medical centers.[27] Quarantine is a general term that includes individual, home, smart, travel and traveler quarantine of a specific region, complete, optional, and mandatory. Quarantine can

restrict the freedom of individuals as well as trade. It can be concluded that the quarantine restrictions should be commensurate with the prevalence of the disease and that these restrictions should be implemented in the shortest time, within the law, and without any discrimination.[28] Quarantine was reported to be an effective way to control the epidemic, as it proved to be effective in controlling the SARS epidemic in 2003.[29] Therefore, where COVID-19 outbreaks occurred, quarantine appeared to be necessary, as quarantine for approximately 14 days could significantly reduce the number of COVID-19 cases. In areas where the incidence rate was high, the best way to combat SARS-CoV-2 was community quarantine[30] and if it started late, it could have little effect on reducing the transmission. In areas where the incidence was low, home quarantine was the best way, especially when the person had mild symptoms such as fever, cough, and headache. The ideal mental condition for the patient was to rest at home to fully recover; however, if shortness of breath developed, the patient could be transferred to a medical center and monitored by medical staff, and home quarantine for the patients could be continued at home after discharge from the hospital until the patient's COVID-19 test was negative. In home quarantine, the patient should be separated from the rest of the family and only one person should take care of the patient to follow the hygiene standards. Besides, it is better to do daily activities over the phone and the internet.[31] During the quarantine period, people should be given the opportunity to buy basic necessities; therefore, supermarkets were open at certain times of the day so that the citizens could provide their daily necessities. It was recommended that this be done by people aged 20-60, as long as they do not have an underlying disease, and for the sick and disabled, volunteers should do it. It was recommended that fresh products such as vegetables, fruits, and dairy products first and then foods with a long shelf life such as processed foods should be consumed. Home quarantine should not be prolonged, which could cause severe social and economic stress and job loss, as well as sleeplessness, restlessness, anger, boredom, impatience, anxiety, fear of illness, depression, lack of domestic support, and domestic violence.[32] In addition, people who previously had mental health problems should receive additional support to reduce post-quarantine complications.[33] Countries without quarantine were unable to control COVID-19; however, China was able to control it by quarantining cities in contaminated areas and restricting traffic for residents in those areas.[23] South Korea was able to reduce the number of new COVID-19 cases by the end of March 2020 with quarantine and mass testing.[34]

Social Distancing

For many years, physical distancing and having a safe environment and personal boundaries have been the favorite of sociologists and people around the world to protect its inhabitants, which has been considered as social distancing with the outbreak of COVID-19. Social distancing refers to the self-conscious demarcation of personal boundaries with others to protect the individual from others. Social distancing is a form of quarantine that reduces close contact between people in a large community.[35] On the one hand, there was a possibility of infection with SARS-CoV-2 in crowded environments. On the other hand, there was no confidence in the health of other people. The implementation of social distance reduces the risk of infection; in other words, a physical distance of 2 meters from other people was needed.[31] Thus, social distancing was essential to reduce SARS-CoV-2 transmission in cities. It seems to be the best way to stop the transmission of infection at a lower cost than other methods. Social distance had an effective role in delaying the peak of the epidemic, as the health care system was provided with ample opportunity to prepare centers and provide better services. Therefore, it was necessary to minimize the number of cases in subways, buses, supermarkets, banks, outpatient offices, and medical centers. After the sharp increase in COVID-19 cases in March 2020, Iran was able to control the disease to some extent by social distancing, banning intercity travel, and recommending home quarantine in April 2020. Unfortunately, since September 2020, due to the reduction of social distance by people, an increase in cases and then deaths due to COVID-19 has been observed.

Use of Personal Protective Equipment

In the absence of an effective vaccine, there was no definitive treatment for SARS-CoV-2 and treatment was mainly supportive. Considering the ability of the virus to survive in aerosols for three hours,[36] the use of personal protective equipment (PPE) was mandatory to prevent the spread of infection among people, while some of them were asymptomatic. The most important means of personal protection was the face mask. The role of protective masks in reducing the transmission and spread of the virus was crucial given that they significantly reduced the number of new infections.[37] The risk of developing SARS at a hospital in Hanoi, the capital of Vietnam, was 12.6 times lower in those who used medical masks than in those who did not.[38] In Japan, despite the dense population and the high average age of the population, due to the use of face masks by the majority of people and the lack of handshaking and hugging in Japanese culture in meetings, the number of confirmed cases of disease and deaths due to COVID-19 was low.[39] There were several types of masks, including home-made, cloth, medical, surgical, and respiratory masks, which could be effective in preventing the spread of the virus and infection. These masks could be used continuously or intermittently for about 8 hours. However, health-care workers dealing with COVID-19 were three times more likely to be infected with the SARS-CoV-2 than the general population, especially in cases where aerosol-generating procedures were performed. These procedures included intubation and endotracheal

suction, nose and throat surgeries, breast physiotherapy, and examination of patients with COVID-19, in which the use of respiratory masks was necessary.[40] In those people, masks were preferred whose minimum filtration efficiency for particles of 0.3 microns was not less than 95%. Masks named filtering face piece class 2 and filtering face piece class 3 respirators (FFP2 and FFP3) and their equivalents N95 and N99, respectively, were reported to be able to have adequate protection against airborne transmission; therefore, the filtration efficiency of N95 masks was reported to be 8-12 times higher than that of surgical masks.[41] The use of masks greatly increased the effectiveness of social distancing and reduced the exponential growth of the epidemic; therefore, for ordinary people in situations where there was a shortage of disposable medical masks, the use of home-made masks and cloth masks could be a good alternative. As those masks could prevent the passage of 70% of infected particles, they could be used several times after washing with detergent and hot water.[42] Cloth masks were simple, economical, and convenient alternatives to surgical masks that could be used in the general community to control SARS-CoV-2 transmission. It is necessary to use the face mask properly so that it can cover the mouth and nose. Experts advise avoiding touching the mask, removing the mask in the correct way, and washing hands after removing the mask and touching it.[43] Given that the transmission distance of SARS-CoV-2 was reported to be 4 m and that environmental contamination was higher in hospitals, as well as diagnostic and treatment centers, especially in the intensive care unit (ICU),[35] the use of level 3 and 4 gowns, face shield, goggles, gloves, shoe covers, and hair coverings was required.[40]

Prevention of Human Gatherings

Modern traffic systems have shortened the distance between people and led to large gatherings of people in a very short time. In gatherings, people were reported to be more in contact with each other and the transmission of SARS-CoV-2 infection occurred through contact; therefore, the most important way of transmitting this virus was the gatherings.[44] At the time of the COVID-19 outbreak, mass gatherings that occurred at short distances were a potential cause of infection. Public transportation such as subways, buses, trains, and airplanes could transmit the virus due to crowds,[45] thus closing crowded public places such as sports halls, gyms, swimming pools, shrines, universities, schools, kindergartens, reception halls, theater halls, cinemas, funerals, weddings, coffee houses, tourist centers, and museums was essential. Additionally, if there was a need to operate factories, shops, passages, churches, mosques, supermarkets, and congregational prayers, it was necessary to observe social distance and disinfect them daily. SARS-CoV-2 was initially detected in Qom, Iran, as the center of the disease outbreak, which was probably due to the crowds in clinics and doctors' offices and waiting for patients for several hours in small and crowded places. Another example was the Diamond Princess Cruise sailing off the coast of Japan, which carried a large number of passengers and a total of 712 people were infected with COVID-19 on it.[46] It was noticeable that in large and densely populated cities, there was a possibility of a long-term epidemic and subsequent longer COVID-19 waves.[47] For example, in the southern cities of Brazil, the abundance of air transportation caused the transmission of COVID-19 infection and the increase of patients and the resulting deaths in this country.[48]

Risk Perception

People's behavior in dealing with a problematic event depends on their understanding and perception of danger and vulnerability.[49] The more unfamiliar the risk factor is, the more uncontrollable it is, indicating that it needs better understanding and protection.[50] A better understanding of the risk of developing COVID-19 could lead to appropriate behaviors and preventive actions.[51] Therefore, one of the ways to reduce the risk of the disease in the community was to increase the risk perception in the majority of the community. Risk perception is not just an individual issue but rather it is a cultural, religious, political, and social issue.[52] To increase people's understanding of risk, health officials must trust the elite and the public and not blame failures on the people; therefore, the control of COVID-19 can be possible using the facilities of social media.

Prevention and Control of SARS-COV-2

Due to the rapid spread of SARS-COV-2, its transmission through contact with contaminated surfaces, and its persistence on inanimate surfaces such as metal, glass, and plastic from several hours to nine days, the selection of a suitable disinfectant was essential.[53,54] Sodium hypochlorite (0.5%-0.05%), ethanol 70%, povidone iodine 1%, and hydrogen peroxide 0.5% were used to disinfect surfaces and equipment.[55] Sodium hypochlorite 0.1% was used to disinfect crowded places, buses, and subways. In order to disinfect surfaces that had a lot of human contacts, as well as surfaces in the house, harmless disinfectants were used. To do this, there should be airflow in the house and also disinfectants should be kept out of reach of children.[56] To reduce the risk of COVID-19, the following individual measures have been recommended: (1) take care of yourself and your family health, (2) wash hands with soap and water for 20 seconds if hands are dirty; after each cough and sneeze, using W.C, before, during and after cooking, before eating, when touching animals and their excrement, when you get home, and when touching outdoor objects, (3) clean your hands with a solution containing 70% ethanol or similar substances in case of no access to soap and water, (4) do not touch your eyes, mouth or nose after touching somewhere with your hands, (5) avoid touching outdoor objects and public surfaces, (6) have disposable gloves when shopping, (7) keep personal belongings separate, (8) ensure proper

ventilation at work and at home, (9) do not shake hands or hug relatives, especially the elderly, (10) do not use cash, (11) use less public transportation, (12) leave home only when it is necessary, (13) hygienic disposal of masks and gloves, (14) avoid close contact with patients,[57] (15) do not spit in public places, (16) do not smoke, (17) disinfect food bags after purchase from stores, (18) dispose of shopping bags in the trash with a lid, (19) use telecommuting to do work activities as much as possible, and (20) be aware of COVID-19 developments in your area.

The following methods were used to stop the transmission of COVID-19 and eradicate it: (1) paying attention to all health principles by the people, especially in poor areas, which was possible under the supervision of the WHO, (2) providing continuous health education through social media and electronic visits. It was better to use mobile phones in primary health care, especially for people living in remote areas and in case of lack of access to medical services, (3) early diagnosis and early identification of patients through easy access to laboratory tests, which could also prevent the spread of the disease in the community in addition to affecting the recovery of patients, (4) isolation of infected people and providing a sufficient number of isolated rooms with proper ventilation and treatment, (5) call tracking as a complement to separation; it could identify potentially infected people before the appearance of symptoms using electronic maps, (6) using physical barriers such as nylon walls in emergency departments, pharmacies, stores, banks, and offices to reduce exposure to people suspected of having the disease, (7) preventing the spread of rumors and panic among the people, maintaining peace among them, and not creating stress and anxiety, which prevented the suppression of the immune system among the people (8) increasing the level of immunity by having a proper diet, adequate rest, and moderate or less intense physical activity and avoidance of factors that impair lung function, (9) using nutritional support and consuming probiotics to regulate microbiota balance, (10) imposing fines on those who do not take quarantine seriously and do not use PPE, (11) giving employees compulsory leave to stay home and work through telecommuting, (12) implementing financial support policies for businesses affected by workplace closures, (13) identifying people susceptible to psychological disorders, especially post-traumatic stress disorder at various levels of society, especially in recovered cases of COVID-19, so that their mental health was not endangered in the future, (14) increasing standards of prevention and control of infection in hospitals, and (15) promoting public participation. The effectiveness of the above-mentioned measures in controlling COVID-19 depended on the behavior of individuals in the community, the serious intention of officials, and the cooperation of various organizations to break the chain of infection transmission and ultimately control the pandemic.

Vaccination

The development of a vaccine was crucial to prevent the rapid and vast spread of this viral infection, which consequently led to a decline in mortality rate (9,10); thus, many countries prioritized developing an effective vaccine against COVID-19 disease. There were numerous effective COVID-19 vaccines authorized and validated for global use by the WHO. Besides being beneficial, COVID-19 vaccines had some side effects, but most were mild to moderate and usually had short-term duration. The most frequent side effects were fever, diarrhea, fatigue, shivering, headache, and myalgia at the vaccination site.[58] The likelihood of occurring any of the different side effects post-vaccination was strongly related to the type of vaccine. In several studies, controversial findings were reported on the safety, some adverse reactions, and clinical neuropathogenesis of COVID-19 vaccines.[59] However, developing different types of vaccines led to a significant reduction in the transmission and control of the COVID-19 outbreak worldwide.

Isolating and Treating Infected People

Studies have shown that about 50%–75% of the population routinely use dietary supplements, and over the last decade, this ratio has increased. However, a rapid growth in consuming the supplements was observed during the COVID-19 pandemic because of their perceived immune-boosting effects.[60] The most frequently used dietary supplement was vitamin C (74.7%), vitamin D (58.2%), and multivitamins (34.2%) in all countries.[61] A survey assessing the use of complementary and alternative medicine (CAM) during the COVID-19 outbreak in the general population of Iran reported that 84% of the participants (782) used at least one type of CAM during the COVID-19 outbreak, of which dietary supplements (61.3%) were used with the highest frequency.[62] Interestingly, the pilot study conducted in Iran to evaluate the effects of vitamin A on disease severity in hospitalized COVID-19 patients showed no significant effect.[63]

One of the effective drugs in the treatment of COVID-19 patients was Montelukast, as a potential adjuvant therapy, which improved lung injury, inflammations, and symptoms. Moreover, Montelukast could decrease both the severity of the disease and the mortality of these patients.[64] Several drugs such as hydroxychloroquine and chloroquine, with or without azithromycin, were proposed to be safe with high efficacy in treating these patients. However, it was later transpired that these therapeutic agents could be associated with critical cardiac adverse events.[65] Therefore, it was recommended to de-bias the data interpretations and decrease the burden of error in various scientific evidence.[66] Various studies investigated the association between medication use and the mortality risk in COVID-19 patients. One study showed that antidiabetic, antihypertensive, and respiratory disease drugs were not associated with a high rate of deaths in hospitalized patients with COVID-19.[67]

However, studies showed that patients who suffer from high blood pressure are more vulnerable to the serious impacts of COVID-19.[68]

Conclusion

Coronavirus was transmitted through the oral and nasal secretions of the patients, as well as by the exhalation of asymptomatic people. Additionally, it was transmitted directly or indirectly from human to human. Therefore, the most appropriate ways to overcome this issue and cut off transmission were to understand the risk perception in the majority of society, reduce travel, adhere to home quarantine, observe social distancing, use PPE, avoid gatherings, clean and disinfect the environment and equipment, and observe personal hygiene.

Ethics statement

Not applicable.

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Conflict of interests declaration

No potential conflict of interests relevant to this article was reported.

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No datasets were generated or analysed during the current study.

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Consent for publication

The authors declare that they have obtained all necessary approvals for publication of this review.

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