Microbes and Infectious Diseases 2021; 2(3): 407-414

Microbes and Infectious Diseases

Journal homepage: https://mid.journals.ekb.eg/

Review article

Rationale in prevention and evidence of SARS-CoV 2 transmission

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ARTICLE INFO

Article history:
Received 8 April 2021
Received in revised form 21 May 2021
Accepted 21 May 2021

Keywords:
COVID-19
Prevention measure
Personal protective equipment
Transmission mode

ABSTRACT

Background: The rationale of transmission prevention is related to transmission mechanisms, and evidence from observations has shown an improper use of personal protective equipment (PPE). **Objective:** We aim to describe the evidence on the transmission mechanisms of severe acute respiratory syndrome coronavirus 2 (SARS CoV-2) and related prevention practices. **Method:** Review of the published literature on coronavirus disease 2019 (COVID-19) in the Scopus, Science Direct, and PubMed databases. **Results:** Transmission of respiratory viruses, including SARS CoV-2, could be by aerosols, droplets and contact with contaminated surfaces. Evidence suggests that the primary route of transmission of these viruses is by droplet and short distance. Scientific evidence in relation to the transmission of COVID-19 assigns the highest risk to the aerosol-generating procedures and by droplets in closed environments with poor ventilation, and the lowest risk of transmission by direct contact with contaminated surfaces. **Conclusion:** Prevention practices must be in correspondence with the evidence about the transmission of COVID-19, which will facilitate the rational use of available resources.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, which began in late 2019, has probably been the largest and most shocking pandemic of infectious disease in human history [1]. The high transmissibility of the disease, which has generated millions of patients and high mortality, has had an effect on all aspects of society [2,3].

The last great world pandemic, which occurred in 1918-1920 and was known as the Spanish Flu, was caused by the influenza A H1N1 virus. During this pandemic, it was estimated that at least a third of the world's population fell ill, and between 50 and 100 million deaths occurred [4]. Exposure to a virus whose human-to-human transmission mechanism was highly efficient and affected a widely susceptible population were determining factors in the magnitude of this pandemic.

During the current century, three pandemic episodes related to beta coronavirus have been reported, including the current COVID-19. In 2002, the severe acute respiratory syndrome (SARS) related to a coronavirus (SARS CoV-1) affected 8096 cases and 774 deaths were confirmed in 27 countries until 2003, with no subsequent cases reported. In 2012 in Saudi Arabia the first case of Middle East Respiratory Syndrome related to a betacoronavirus (MERS CoV) was reported, after

DOI: 10.21608/MID.2021.75635.1152
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which an epidemic produced cases mainly in the countries of the region with a distinctive characteristic of high lethality (35%). After 2016, only sporadic cases are reported in countries of the Arabian Peninsula [5].

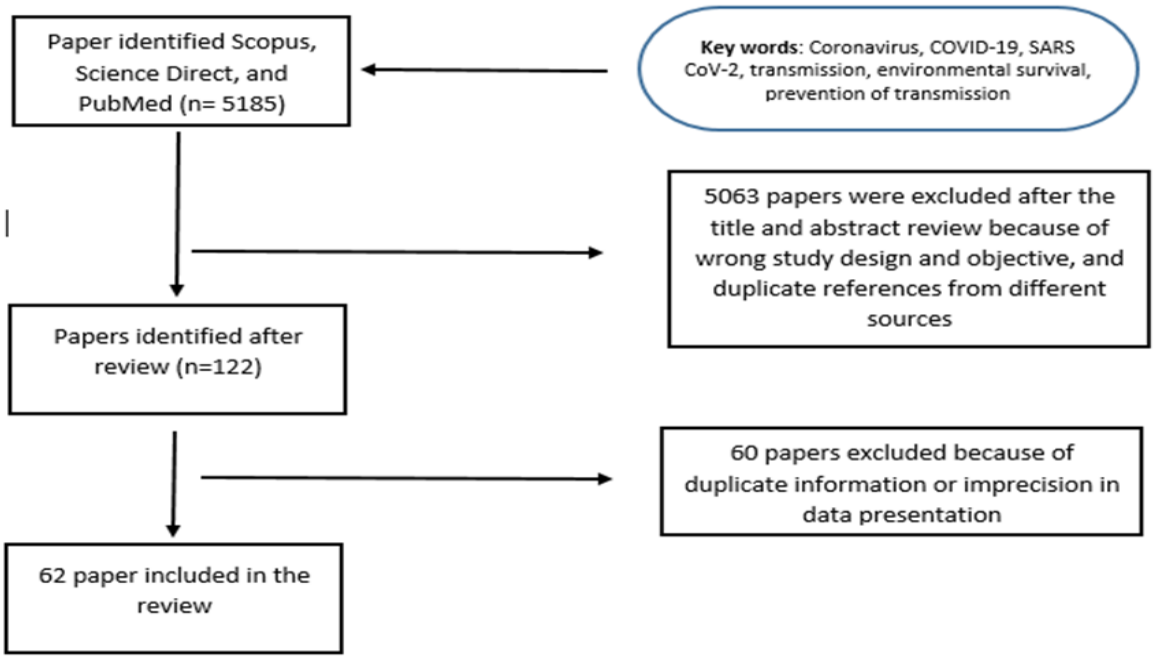
Infection prevention strategies, in community or healthcare settings, are related to transmission mechanisms, a knowledge that has evolved significantly as a result of the research carried out, especially during the recent coronavirus epidemics. We have observed the application of prevention measures or practices that, in addition to not being based on evidence about the transmission of COVID-19, can generate a false sense of security in the staff and the population. The excessive emphasis on the disinfection of environments (especially the fumigations of chemical products) and on the application of contact precautions over the respiratory protection are highlighted, which includes the excessive use of protective media in community environments (eg. use of gloves) or health setting (eg. use of double gloves, masks, gowns) We aim to describe the evidence on the transmission mechanisms of SARS CoV-2 and related prevention practices.

Method

We conducted a review of the published literature on COVID-19 in the Scopus, Science Direct, and PubMed databases **(Figure 1).** Also, were reviewed key documents published by the world health organization (WHO) (https://www.who.int/). The following keywords were used for the search: Coronavirus, COVID-19, SARS CoV-2, transmission, environmental survival, prevention of transmission.

The results of the review of the relevant information were summarized in the following:

Figure 1. Selection of paper for review.



Transmission of respiratory viruses

The transmission of respiratory viruses has been widely studied for decades, considering the transmission by aerosols, droplets and contact with contaminated surfaces. Aerosol transmission occurs when particles smaller than 5 microns carry the virus long distances from the source of infection to the susceptible host. The transmission by droplets is carried out by particles larger than 5 microns, which fall rapidly and are deposited on surfaces between one and two meters from the place of emission (the patient's mouth or nose). Indirect contact transmission usually requires contamination of the hands with surfaces where viruses have been deposited and subsequent contact with the mucosa of the susceptible host [6] **(Figure 2)**.

Evidence suggests that the primary route of transmission of influenza is by droplet and short distance. Aerosol transmission has been reported mainly as a consequence of aerosol-generating procedures in health institutions **(Figure 3)**. On the other hand, transmission by contact (direct or

indirect) with contaminated surfaces is questioned or considered low for influenza viruses and beta coronaviruses, for which there must usually be hand contamination and subsequent contact with mucous membranes (eyes, nose, mouth) [7-10].

Since the beginning of the COVID-19 epidemic (Wuhan, China, December 2019), the potential transmission routes were considered basically based on previous studies of the influenza viruses and beta coronavirus. The rapid transmission of SARS CoV2 in closed and poorly ventilated environments has been evident [11-13]. The Diamond Prince cruise ship epidemic constituted an early reference of high transmissibility in closed environments, where close contact between people and transmission by droplets were the fundamental factors associated with the confirmation of 17% of the passengers [12-14].

On the other hand, the high risk of transmission in health institutions and the risk of occupational exposure for health workers, already reported in the SARS and MERS epidemics, constitutes an element to be highlighted. In these environments, the greatest risk of transmission occurs during aerosol-generating procedures (AGP), which include procedures on the upper respiratory tract, dental, surgical, among others [11, 15, 16] **(Figure 3)**. The persistence of viruses in the air in health environments has been studied with results that generally do not confirm it or when they have been identified with low viral loads, which in general support the low probability of transmission non-related to AGP [17,18].

The environmental survival of the SARS CoV-2 virus has been studied, verifying the presence of viable viruses on various surfaces for up to 72 hours. Viral load on surfaces decreases over time with a half-life of 6 to 8 hours [19]. Viral survivals in addition to the type of surface (longer on plastic or metal surfaces) depends on other factors such as humidity and environmental temperature. Also, sunlight quickly inactivates viruses on surfaces [20,21]. Furthermore, studies that describe the presence of RNA on surfaces have generated interpretations that erroneously overestimate the risk of contact transmission. The infecting potential of the viral particles present on the surfaces has not been demonstrated, in addition to the impossibility of viral replication on the surfaces are elements to consider in the contact transmission potentialities [21-25].

Prevention of the transmission of COVID-19 with a special focus on health institutions

Prevention measures must correspond to the transmission mechanisms of COVID-19 and with greater emphasis on the most efficient routes of transmission. In table 1 we present the fundamental prevention practices in community settings and in health institutions **(Table 1)**.

For the prevention of respiratory transmission in health institutions, whether by aerosols or droplets, it is essential to implement a respiratory protection program that includes educational activities, monitoring compliance with the use of respiratory protection, among others. For the direct care of patients and the performance of aerosol-generating procedures, it is recommended to use N95 respirator, which requires a seal check test each time it is used to ensure that contaminated air does not enter through gaps between the mask and the skin of the users [26,27]. Taking into account the risk of exposure of health workers, the use of medical or surgical masks is not recommended for direct patient care, being reserved its use in general areas or open spaces in health institutions.

Prevention of droplet transmission requires the use of a medical or surgical mask, social distancing, and barrier measures. In community settings, the use of a fabric face mask, preferably with multiple layers of fabric, is recommended. The Centers for Infection Control and Prevention (USA) have recommended the use of medical masks together with a cloth mask to increase the level of protection [28]. Social distancing is a measure to be used in community settings and in selected places of the health services (eg patient waiting areas, food and meeting areas for staff) where separation of 1 meter may be sufficient, although, on selected conditions, infectious particles could be transported at distances greater than 1 meter and less than 2 meters. Barrier measures are recommended in health institutions, especially mucous membrane protectors (face shield or google), which constitute a key element to prevent transmission through droplets that are deposited on the mucosa of the eyes, nose, throat, and mouth of healthcare workers. This transmission can be considered a form of contact transmission **(Figure 2)**.

The prevention of transmission by contact includes hand hygiene, the use of barrier measures, and environmental hygiene as fundamental measures, which are applied in community settings and in health institutions. Regarding hand hygiene

for health institutions, there are guidelines defined in the WHO campaigns [29]. The use of barrier measures is applied mainly in health institutions to avoid the contact of droplets with the mucous membranes of health workers. It includes the use of face shields and goggles in the proximity of patients.

Environmental hygiene is an essential practice for transmission prevention by contact and includes the cleaning and disinfection of interior spaces in the community and in health institutions [30]. Outdoor spaces require general hygiene actions (eg waste collection) but not disinfection actions, given the probability of survival of the coronavirus and the very low risk for the transmission of infections. In health institutions, in addition to the general surfaces, those of the equipment and devices used in patient care should be considered.

The reduction of the microbial load through the use of water and detergent is essential before disinfection actions. In community settings, the use of sodium hypochlorite at concentrations of 0.1% (1000 ppm) from household chlorine solutions, which should be applied with damp towels or by brushing the surfaces, but never by fumigations or spray.

The WHO does not recommend the fumigation of interior spaces with solutions of chlorine and other chemicals due to its adverse effects on the health of exposed individuals, although its corrosive effect on metals with the consequent deterioration of equipment and furniture should also be mentioned. The fumigation of outdoor spaces (eg streets, sidewalks, squares) is not recommended as a preventive measure for COVID-19 since the solutions used are inactivated by dirt and the impossibility of removing organic matter by manual cleaning, open spaces are not a reservoir of infection for COVID-19 [30].

In health institutions, fumigation with hydrogen peroxide, peracetic acid, and ultraviolet light lamps have been used for terminal disinfection of patient rooms, which does not replace the need for manual cleaning and disinfection of surfaces [30,31]. If we consider the environmental survival of coronaviruses, the effectiveness of surface disinfection (performed by rubbing or scrubbing with selected solutions), and the cost of fumigation or ultraviolet radiation technologies, most probably the cost outweighs the benefits in terms of prevention.

Figure 2. Key issues in Influenza viruses and beta coronoviruses transmission.

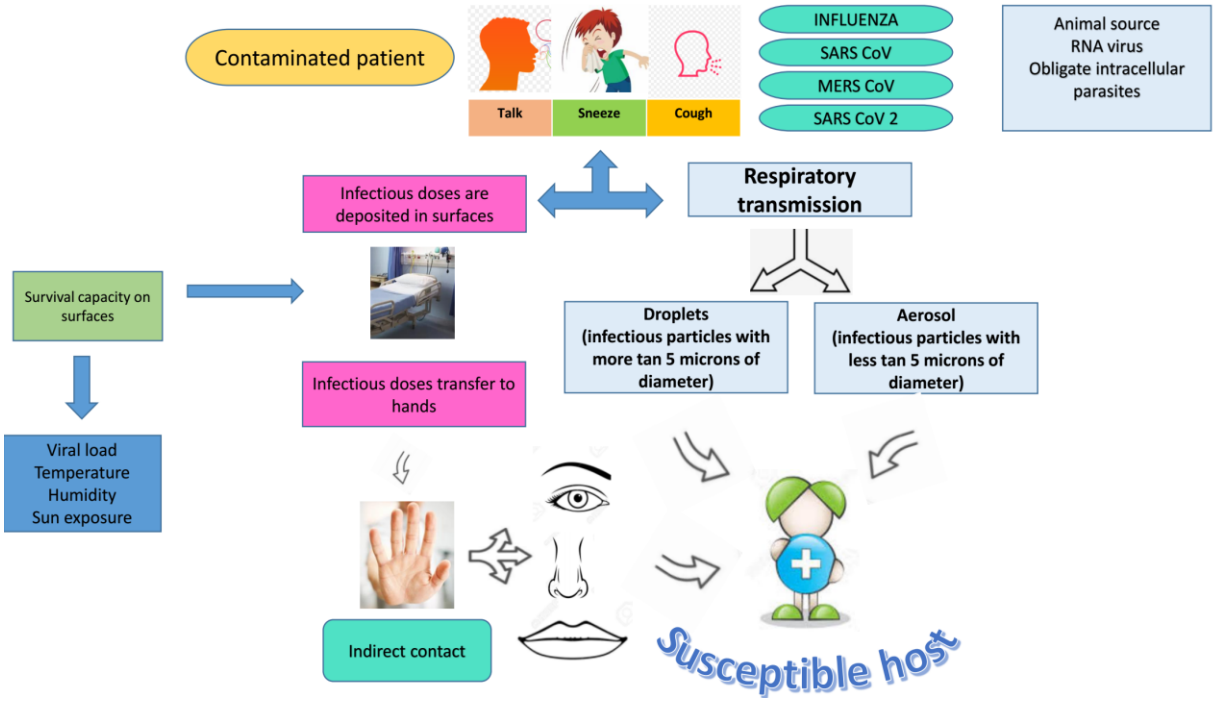


Figure 3. Transmission risk in community and healthcare environment.

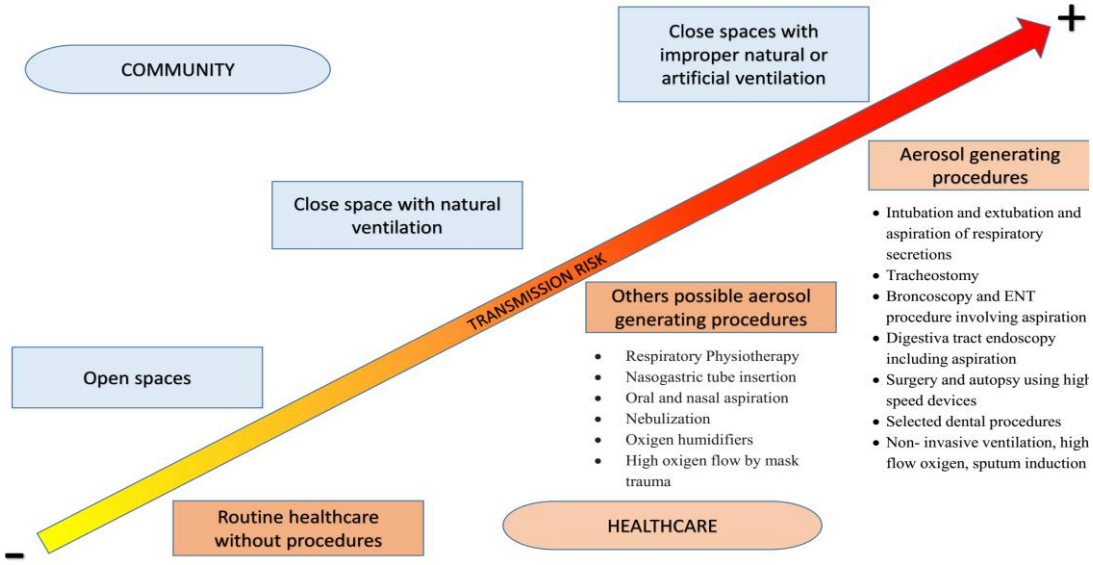


Table 1. Prevention measure of COVID-19 according to mechanism and environment for transmission.

Transmission mode		Riskof transmission	Environment *	Prevention measures according to transmission environment					
				Respiratory protection	Hand higiene	Social distance	Barrier measure	Ventilation system	Cleaning and disinfection of surfaces
Contact	Contact with contaminated environmental surfaces	Low, Very Low	C		Hand hygiene either by hand rubs or hand washing	In open spaces and specially in close spaces in the community	Non required	Open and well ventilated spaces generate lower risk of transmission	Detergent and hypoclorite solution at low concentration for domestic use
			HC			In selected place in healthcare failities (eg. Patient waiting áreas, meeting and food áreas for staff)	Required	Proper air changing and filtration	Based in local recommendation. The use of ethylic alcohol, peracetid acid, hydrogen peroxide and sodium hypochlorite is recommended
Droplets	Infectious particles higher than 5 microns transported usually less tan one meter from the source	High	C	Clothes mask or medical mask					
			HC	Medical mask or N95 respirator					
Airborne	Infectiousparticles lower than 5 microns transported usually long distances or keep suspended in the air for minutes or hours	Very high	C						
			HC	N95 respirators					

* C- community, HC- healthcare failities

Conclusion

Scientific evidence in relation to the transmission of COVID-19 assigns it the highest risk to the aerosol-generating procedures and by droplets in closed environments with poor ventilation, and the lowest risk of transmission by direct contact with contaminated surfaces. Prevention practices must be in correspondence with the evidence about the transmission of COVID-19, which will facilitate the rational use of available resources.

Conflict of interest

The authors declare that they have no conflict of interest.

Authorship contribution

HGG: research design, writing, revision and approval of the final text of the article.

RBA: drafting, review and approval of the final text of the article.

The authors participated in the discussion of the results and we have read, reviewed and approved the final text of the article**.**

Financial disclosure: None to declare

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