Transmission of SARS-CoV-2

COVID-19 is becoming more and more fatal as the day is passing by and the virus is becoming more and more powerful and very deadly to control it in a proper way. Scientists around the world are studying in different aspects to know the possible way of transmission of the virus in human body. The overarching aim of the global strategic preparedness and response plan for COVID-19 is to control COVID-19 by suppressing transmission of the virus and preventing associated illness and death. Current evidence suggests that SARS-CoV-2, the virus that causes COVID-19, is predominantly spread from person to person. Understanding how, when and in what types of setting SARS-CoV-2 spread is critical to develop effective public health and infection prevention and control measures to break chain.

Contact and droplet transmission

Transmission of SARS-CoV-2 can occur through direct, indirect or close contact with infected people through infected secrections such as saliva and respiratory secretions or their respiratory droplets, which are expelled when an infected person, coughs, sneezes, talks or sings. Respiratory droplets are >5-10 μm in diameter whereas droplets ≤5 μm in diameter are referred to as droplet nuclei or aerosols. Respiratory droplets transmission can occur when a person is in close contact with an infected person who has respiratory symptoms (eg. Coughing or sneezing) or who is talking or singing; in these circumstances, respiratory droplets that include virus can reach the mouth, nose or eyes of a susceptible person and can result in infection. Indirect contact transmission involving contact of a susceptible host with a contaminated object or surface (fomite transmission) may also be possible.

Airborne transmission

Airborne transmission is defined as the spread of an infectious agent caused by the dissemination of droplet nuclei (aerosols) that remain infectious when suspended in air over long distances and time. Airborne transmission of SARS-CoV-2 can occur during medical procedures that generate aerosols ("aerosol generating procedure"). WHO, together with the scientific community, has been actively discussing and evaluating whether SARS-CoV-2 may also spread through aerosols in the absence of aerosol generating procedures, particularly in indoor settings with poor ventilations.

The physics of exhaled air and flow physics have generated hypothesis about possible mechanisms of SARS-CoV-2 transmission through aerosols. These theories suggest that

1) a number of respiratory droplets generate microscopic aerosols by evaporating, and
2) normal breathing and talking results in exhaled aerosols.

Thus, a susceptible person could inhale aerosols, and could become infected if the aerosols contain the virus in sufficient quantity to cause infection within recipient. However, the proportion of exhaled droplet nuclei or of respiratory droplets that evaporate to generate aerosols, and the infectious dose of viable SARS-CoV-2 required to cause infection in another person are not known, but it has been studied for other respiratory viruses.

One experimental study quantified the amount of droplets of various sizes that remain airborne during normal speech. However, the authors acknowledge that this relies on the independent action hypothesis, which has not been validated for humans and SARS-CoV-2. Another recent experimental model found that healthy individuals can produce aerosols through coughing and talking, and another model suggested high variability between individuals in terms of particle emission rates during speech, with increased rates correlated with increased amplitude of vocalization. To date, transmission of SARS-CoV-2 by this type of aerosol route has not been demonstrated; much more research is needed given the possible implications of such route of transmission.

Experimental studies have generated aerosols of infectious samples using high powered jet nebulizers under controlled laboratory conditions. These studies found SARS-CoV-2 virus RNA in air samples within aerosols for up to 3 hours in one study and 16 hours in another, which also found viable replication-competent induced aerosols that do not reflect normal human cough conditions.

Some studies conducted in health care settings where symptomatic COVID-19 patient's are cared for, but where aerosol generating procedures were not performed, reported the presence of SARS-CoV-2 RNA air samples, while other similar investigations in both health care and non health care settings found no presence of SARS-CoV- RNA; no studies have found viable virus in air samples. Within samples where SARS-CoV-2 RNA was found, the quantity of RNA detected was in extremely low numbers in large volumes of air and one study that found SARS-CoV-2 RNA in air samples reported inability to identify viable virus. The detection of RNA using reverse transcription polymerase chain reaction based assays is not necessarily indicative of replication and infection competent virus that could be transmissible and capable of causing infection.

Recent clinical reports of health workers exposed to COVID-19 index cases, not in the presence of aerosol generating procedures, found no nosocomial transmission when contact and droplet precautions were appropriately used, including the wearing of medical masks as a component of the personal protective equipment. These observations suggest that aerosol transmission did not occur in this context. Further studies are needed to determine whether it is possible to detect viable SARS-CoV-2 in air samples from settings where no procedures that generate aerosols are performed and what role aerosols might play in transmission.

Outside of medical facilities, some outbreak reports related to indoor crowded spaces have suggested the possibility of aerosol transmission, combined with droplet transmission, for example, during choir practice, in restaurants or in fitness classes. In these events, short range aerosol transmission, particularly in specific indoor locations, such as crowded and inadequately ventilated spaces over a prolonged period of time with infected persons cannot be ruled out. However, the detailed investigations of these clusters suggest that droplet and fomite transmission could also explain human to human transmission within these clusters. Further, the close contact environment of these clusters may have facilitated transmission from a small number of cases to many other people, especially if hand hygiene was not performed and masks were not used when physical distancing was not maintained.

Is it likely that the SARS0-CoV-2 virus spreads by air? Its predecessor, SARS-CoV-1, did spread in the air. This was reported in several studies and retrospectively explained the pathway of transmission in Hong Kong's Prince of Wales Hospital (Li.et al.2005; Xiao at al.2017;Yu et al. 2005), as well as in health care facility in Toronto, Canada (Booth et al.2005), and in aircraft (Olsen et al. 2003). These studies concluded that airborne transmission was the main transmission route in the indoor cases studied. Other examples of airborne transmission of viral infections include the spread of Norwalk-like –virus between school children (Marks et al. 2003), and the transmission of influenza A/H5N1 virus ferrets (Herfst et. al. 2012). A World Health Organization review of the evidence stated that viral infectious diseases can be transmitted across distances relevant to indoor environment be aerosols, and can result in large clusters of infection in short period. Considering the many similarities between the two SARS viruses and the evidence on virus transport in general, it is highly likely that the SARS-CoV-2 virus also spread by air (Fineberg 2020). Therefore, all possible precautions against airborne transmission in indoor scenarios should be taken. Precautions include increased ventilation rate, using natural ventilation, avoiding air recirculation, avoiding staying in another person's direct air flow, and minimizing the number of people sharing the same environment. Of significance is maximizing natural ventilation in buildings that are, or can be naturally ventilation and ensuring that the ventilation rate is sufficiently high. These precautions focus on indoor environment of public places, where the risk of infection is greatest, due to the possible buildup of the airborne virus- carrying droplets, the virus likely higher stability in indoor air, and a larger density of people. Also, personal protective equipment, in particular masks and respirators should be recommended, to be used in public places where density of people is high and ventilation potentially inadequate, as they can protect against infecting others and being infected.

Fomite transmission

Respiratory secretions or droplets expelled by infected individuals can contaminate surfaces and objects, creating fomite (contaminated surface). Viable SARS-CoV-2 virus and or RNA detected by RT-PCR can be found on those surfaces for periods ranging from hours to days, depending on the ambient environment (including temperature and humidity) and the type of surface, in particular at high concentration in health care facilities where COVID-19 patients were being treated. Therefore, transmission may also occur indirectly through touching surfaces in the immediate environment or objects contaminated with virus from an infected person (eg. stethoscope or thermometer), followed by touching the mouth, nose or eyes.

Despite consistent evidence as to SARS-CoV-2 contamination of surfaces and the survival of the virus on certain surfaces, there are no specific reports which have directly demonstrated fomite transmission. People who come into contact with potentially infectious surfaces often also have close contact with the infectious person, make the distinction between respiratory droplet and fomite transmission difficult to discern. However, fomite transmission is considered a likely mode of transmission for SARS-CoV-2, given consistent findings about environmental contamination in the vicinity of infected cases and the fact that other corona viruses and respiratory viruses can transmit this way.

SARS-CoV-2 RNA has also been detected in other biological samples, including the urine and faces of some patients. One study found viable SARS-CoV-2 in the urine of one patient. Three studies have cultured SARS-CoV-2 from stool specimens. Some studies have reported detection SARS-CoV-2 RNA, in either plasma or serum, and the virus can replicate in blood cells. However, the role of blood borne transmission remains uncertain; and low viral titres in plasma and serum suggest that the risk of transmission through this route may be low. Currently, there is no evidence for intrauterine transmission of SARS-CoV-2 from infected pregnant women to their fetuses, although data remain limited. WHO has recently published a scientific brief on breast feeding and COVID-19. This brief explains that viral RNA fragments have been found by RTPCR testing in a few breast milk samples of mothers infected with SARS-CoV-2, but studies investigating whether the virus could be isolated, have found no viable virus. Transmission of SARS-CoV-2 from mother to child would necessitate replicative and infectious virus in breast milk being able to reach target sites in the infant and also to overcome infant defense systems. WHO recommends that mother with suspected or confirmed COVID-19 should be encouraged to initiate or continue to breast feed.

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Note

Informations were collected from

1. **Modes of transmission of virus causing COVID-19- World Health Organization, www.who.int> docs.**
2. **Airborne transmission of SARS-CoV-2: The world should face the reality/www.researchgare.net.**

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