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The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE)

President Shin-ichi Tanabe

Architectural Institute of Japan (AIJ)

President Izuru Takewaki

Role of ventilation in the control of the COVID-19 infection:
Emergency presidential discourse

At the Ministry of Health, Labour and Welfare's Expert Meeting on Novel Coronavirus Infectious Disease Control on March 9, 2020, "A View on Novel Coronavirus Infectious Disease Control" was announced [1]. Subsequently, on March 18, the Prime Minister's Office, together with the Ministry of Health, Labour and Welfare, published a leaflet titled "Let's Avoid These Three Conditions When We Go Out!" [2], according to which to be avoided are closed spaces with poor ventilation, crowded places, and close contact. Inquiries about ventilation have been received from members of the Architectural Institute of Japan and the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, both of which specialize in indoor environments.

Regarding the effects of ventilation on the novel coronavirus (COVID-19), Nishiura et al. analyzed the number of secondary infections produced by one infected person, identifying a characteristically high number of secondary infections in enclosed environments, where ventilation is considered inadequate [3]. The Ministry of Health, Labour and Welfare has quoted this result in a Q & A for the general public [4].

Open-window ventilation is easy to understand, but most modern buildings use air conditioning and mechanical ventilation systems. In this context, the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan and the Architectural Institute of Japan are committed to disseminating accurate knowledge and facilitating adequate ventilation.

1. Government Alert

On March 9, 2020, the Ministry of Health, Labour and Welfare's Expert Group on Countermeasures for Novel Coronavirus Infectious Diseases published "Positions for Countermeasures for Novel Coronavirus Infections" [1]. This document covers three ways to reduce the risk of transmission in everyday situations.

1. Enforce ventilation: In a room with windows, if possible, open the windows on opposite or different

sides simultaneously to encourage ventilation. However, there is no established evidence of how much ventilation is adequate.

2. Decrease the density of people: In case of crowds, reduce the density of people by securing the space of the venue and increasing the distance between people by 1-2 meters.

3. Avoid short-range conversations, vocalization, and chanting: Avoid places where people are in close proximity to you. If you need to talk at a close distance, wear a mask to prevent the transmission of droplets.

To put it plainly, at present, there is no information on how to perform ventilation. Figure 1 is from a flyer published by the government.

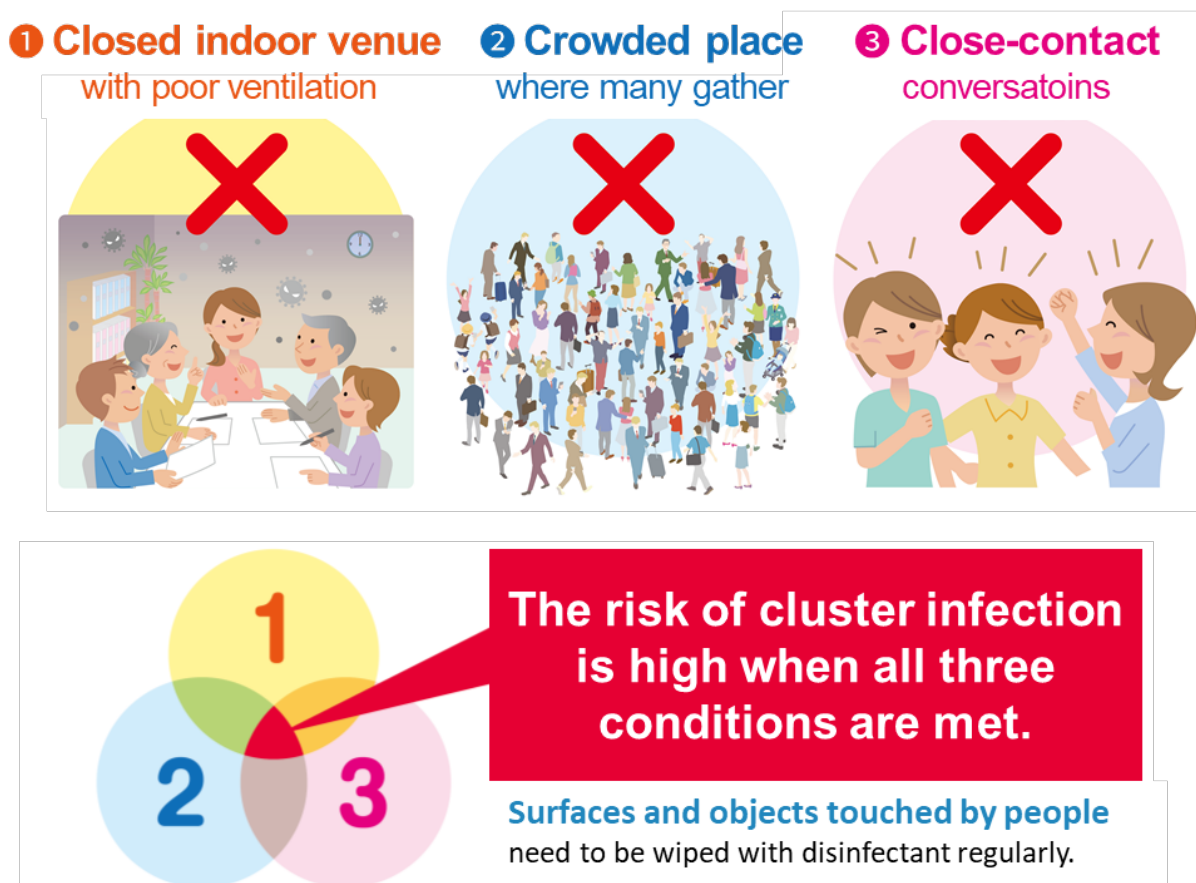


Figure 1. Make sure that the three conditions do not overlap at events and gatherings (quoted and translated from the Prime Minister’s Office and Ministry of Health, Labour and Welfare flyer) [2]

2. Modes of Transmission

There are three possible modes of transmission (Figure 2): droplet infection, contact infection, and airborne

infection. Droplets evaporate into droplet nuclei, which cause airborne infections such as tuberculosis and measles. In the case of influenza, it is said that very small droplet nuclei have very low infectivity, so it is important to prevent droplet infection and contact infection, which are the main routes of infection. Studies on the distance traveled by cough droplets report that risk of droplet infection can be reduced by maintaining a distance of 1-2 meters [5].

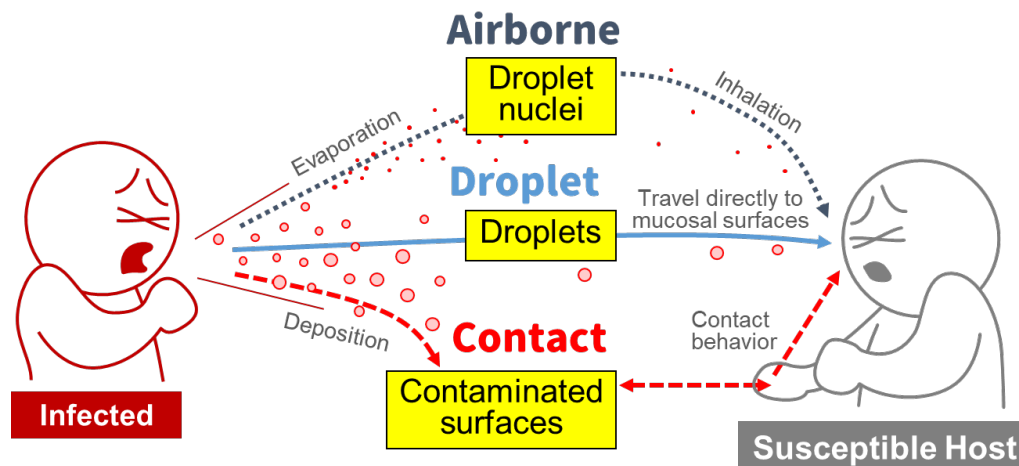


Figure 2. Modes of transmission: droplet infection, contact infection, and airborne infection

3. Latest Knowledge

The Ministry of Health, Labour and Welfare has conducted the following Q & A regarding the novel coronavirus (for the general public) [4].

Question 5: Is the novel coronavirus transmitted by airborne transmission?

Judging from domestic infection status, it is considered that airborne infection has not occurred. However, under certain circumstances, such as when talking to many people at a short distance in an enclosed space, there is a risk of spreading the infection even without coughing or sneezing.

The World Health Organization also states that the main modes of transmission are droplet and contact transmission [6]. Key messages and actions for controlling new types of coronavirus infections in schools [7] indicate that teachers and managers can increase ventilation by opening windows and using available air conditioning systems if outdoor air conditions are favorable.

Aerosols of 5 μm or higher are called droplets. Those below this level are called droplet nuclei. As droplets do not fly far, the greater the distance, the lower the risk of droplet infection. Aerosols are defined differently depending on the field, but the Japan Association of Aerosol and Technology defines a mixture of small liquid or solid particles suspended in a gas, together with the gas, as aerosol [8]. The particle size ranges from about 0.001 μm to 100 μm . However, as per the latest knowledge, droplets and droplet nuclei of about 5 μm float

in the air for a long period of time. Ventilation is effective in reducing the infection risk posed by these aerosols.

On March 17, 2020, the US National Institute of Allergy and Infectious Diseases, a subsidiary of the US National Institutes of Health, published research on aerosolization of a novel coronavirus [9]. Unlike large droplets, small droplet and droplet nuclei will float in a limited space for a prolonged time, and will survive in the air for at least three hours after the new coronavirus has been aerosolized.

4. How to Ventilate

The term “air change per hour” is often misunderstood. There is a misconception that two air changes per hour refers to opening windows twice an hour when in fact, air change per hour is the amount of outside air entering the room per hour (cubic meters) divided by the room volume (cubic meters). Air change per hour indicates the speed at which the air in the room is replaced. In other words, the higher the ventilation rate, the more the indoor air can be diluted with fresh outside air and replaced. A more detailed explanation is provided.

Generally, there are two major types of ventilation: natural ventilation with windows open and mechanical ventilation with fans. In buildings and vehicles with windows, it is effective to open the windows and take in outside air. For automobiles, it is effective to set the ventilation mode to take in outside air instead of allowing the air inside to recirculate. For mechanical ventilation to be effective, it is necessary to check that the air supply opening is not closed even if the ventilation fan is operated, and that it is not blocked by objects.

In rooms where it is not possible to open windows, mechanical ventilation is an alternative. In office buildings, the indoor air environment is maintained through the use of Heating, Ventilation, and Air Conditioning (HVAC) system. Usually, it is operated to satisfy the required ventilation rate in consideration of energy saving. If a large amount of outside air is taken in, the cooling and heating efficiency will worsen, but it is possible to take measures such as increasing the amount of outside air intake as long as it does not hinder workplace operations.

In addition, ordinary home and packaged air conditioners only circulate indoor air; they do not provide fresh air. In rooms with only air conditioners, opening the windows and using the ventilation system is recommended. The effect of the operation of indoor recirculating unit on infection risk mitigation cannot be expected.

It is not known whether general air purifiers are sufficiently effective at protecting people all over a room from the novel coronavirus because the amount of air passing through is smaller than the volume of ventilated air. Thus, when using air purifiers, it is necessary to ensure that people are in close proximity to them. The

guidelines published by the Federation of European Heating, Ventilation and Air Conditioning Associations [10] suggest that the air purifiers should be used in conjunction with regular ventilation, not just air purifiers, as different air purifiers have different filter performance and airflow. We will provide information on the usage and effects of air purifiers.

5. Conclusions

While this document presents an overview of ventilation methods, the most important measures against novel coronaviruses are social distancing and hand hygiene to avoid droplet and contact infection. Ventilation is effective in removing small sized droplets and droplet nuclei, which might cause high number of secondary infections in closed environments, but it should be reminded that ventilation alone cannot eliminate the risk of infection completely.

Further academic information will be provided by the Air Quality Steering Committee of the Environmental Engineering Committee (Chair: Prof. Ryozo Ooka, University of Tokyo) of the Architectural Institute of Japan and by the Ventilation Equipment Committee (Chair: Prof. Toshio Yamanaka, Osaka University) of the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan.

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Note: Most of references are written in Japanese.