Guidebook for

How to Prevent

SARS-CoV-2, influenza, colds, etc.

Respiratory Infections

New Coronavirus Newsletters
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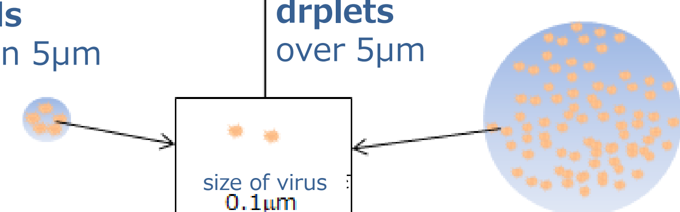
Respiratory infections

Disease transmitted by breathing.
Aerosols exhaled with breathing are generated by expiratory airflow from the layered liquid that covers the epithelial cells of the respiratory tract (RTLF; respiratory tract lining fluid).
The aerosol of a person suffering from a respiratory infection contains pathogens of the infection (bacteria, viruses).
Inhaling airborne aerosols released by the breathing of an infected person results in infection.
Respiratory infections include the new coronavirus SARS-CoV-2, influenza, colds, chickenpox, measles, pneumonia, and tuberculosis.

Droplet and aerosol

	Airborne infection	Droplet infection
Infectious particles	aerosols	droplets
What it comes from?	**exhaled breath, talk, song,** and cough and sneeze of infected person	**exhaled breath, talk, song,** and cough and sneeze of infected person
Particle size (diameter)	**aerosols** less than 5µm	**drplets** over 5µm
Characteristics	Lightweight, so it floats through the air with infectivity. ☞ **Airbourne infection**	Heavy, so it drops soon. Distance: exhaled droplets within 1 m. Coughing and sneezing within 1.8 m ☞ **Droplets/contact infection**



＊µm=1/1000 of a meter

On the occasion of the 15th edition of the revision

Since the publication of the guidebook for “How to prevent the New Coronavirus (SARS-CoV-2) Infection, 1st edition” in August of 2020, “awareness and caution of airborne infection of SARS-CoV-2“ has been main theme for avoiding infection to propose the specific methods to prevent infection.

In the meantime, with the accumulation of scientific evidence, the WHO, CDC, and the Ministry of Health, Labor and Welfare have officially recognized the ”airborne transmission” of SARS-CoV-2, but as an infection prevention measure, the emphasis on droplet and contact infection rather than airborne infection remains the mainstream, and the infection control measures remain completely inadequate to the present.

In pursuing the mechanism of airborne infection, it became clear that airborne infection is the main route not only for SARS-CoV-2 but also for respiratory infections including influenza and colds. Therefore, since this guidebook can be applied to all respiratory infections, the title has been changed to “Guidebook for How to Prevent Respiratory Infections” 15th edition.

The most effective way to prevent airborne infections is ventilation, in which aerosols containing viruses are discharged to the outside of the room. Insufficient ventilation dramatically increase the risk of airborne infection. Inadequate ventilation can be seen with a CO_2 monitor, so a CO_2 monitor is indispensable for preventing infection. The 15th edition of this guidebook has been revamped to provide more space for airborne infections, ventilation, and CO2 monitoring, and to minimize measures against droplet and contact infections.

Airborne infection control measures cannot be done well by individuals alone. In the course of a person‘s social life, if there is a place with poor ventilation somewhere indoors, there is always a risk of infection there. And then a group infection occurs. That's the current state of the world. The whole society needs to be equipped with a fresh air environment with no lack of ventilation.

Fresh air quality not only eliminates infectious diseases and stops the outbreak of pandemics, but also brings about a healthy and comfortable life with a non-polluting air environment. If we all work together based on current science and technology, we can make this dream a reality.

This guidebook has been restructured so that the latest knowledge and specific methods can be linked to the documents of PointPath-Land. We will also introduce the development of a breakthrough application CAP-AI that can calculate the risk of infection and indoor air quality.

The 15th edition of this guidebook is expected to be widely used as the definitive guide to infection prevention.

April 15, 2024, Hiroshi Kase

First edition: Introduction

August 1, 2020

This guidebook provides basic ideas, methods, and tips for preventing infection with the new coronavirus SARS-CoV-2 based on scientific evidence.
The spread of COVID-19 around the world is not stopping easily.
Why is the infection not subsiding?
The answer is that droplet infection and contact infection are the gold standard for infection. As long as we continue to cling to this idea, the infection will not stop.
How can the infection be contained?
We've put together the answers in this guidebook.
"The most contagious and important thing to watch out for is aerosol airborne transmission, which is not recognized." This is what causes the infection to spread. It is no exaggeration to say that unless we respond based on the importance of airborne infections, we will not be able to take any measures.
In order to prevent infection, it is important to wear a mask in the first place. However, most people appears to wear masks without knowing the real reason why wearing a mask can prevent infection. I think most people wear masks to prevent (vaguely) droplet transmission. However, droplets such as coughing and sneezing fly and hit the face directly, which is not common in daily life. In addition, droplet and contact infection are something that can be seen and noticed, so both you and those around you can be aware and vigilant to avoid them. The real purpose of wearing a mask is to prevent airborne transmission.
In addition, by considering droplet infection and contact infection to be the main transmission route of SARS-CoV-2, "excessive protection" is taken, which is detrimental to social activities. Excessive cleaning and disinfection, excessive physical distancing, excessive hand washing and disinfection, no contact, etc. Excessive restrictions have been placed on their lives and social activities, and many people have entered "nesting" or "secluded life".
SARS-CoV-2 is a very cunning and clever virus. In order to fight, you must first know your hostiles well and defeat them by attacking them by means that will take you above them. SARS-CoV-2 is a virus that hides in aerosols, floats in the air, and invades and attacks humans unnoticed while you breathe. Knowing this, it would be obvious how to prevent infection.
In the "Guidebook for Preventing Infection with SARS-CoV-2", I wrote specifically about how to do it. As long as knowing the right way and tips, anyone can live and act autonomously and freely.
I hope that our loved ones will be able to use this guidebook and share it with many people so that they will not be infected or infected.

On the occasion of the Revised 8th Edition

The guidebook for preventing infection was published in August 2020 for a limited number of people, mainly Dear You, members of the "New Coronavirus Newsletter". Fortunately, it was well received, and we were able to use it to prevent infection.

In opening "PointPath-Land" this time, we have made it available to a wider range of people and updated the latest scientific knowledge and information.

As in the previous edition, the main theme of "Awareness and Caution of Airborne Infections" was "How to Prevent Infection," and specific infection prevention methods were proposed according to the situation, location, and conditions.

Vaccination has begun, while increasing the infectivity of mutant strains and evading the immune response have become important issues. The revised 8th edition does not specifically touch on them, but there is no change in the way of thinking and methods of infection prevention.

I hope that this guidebook will be help to many people in preventing infection.

April 1, 2021. Hiroshi Kase

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Transmission with respiratory infections
Pay attention to airborne infections!

1）3 routes of infection of respiratory infections

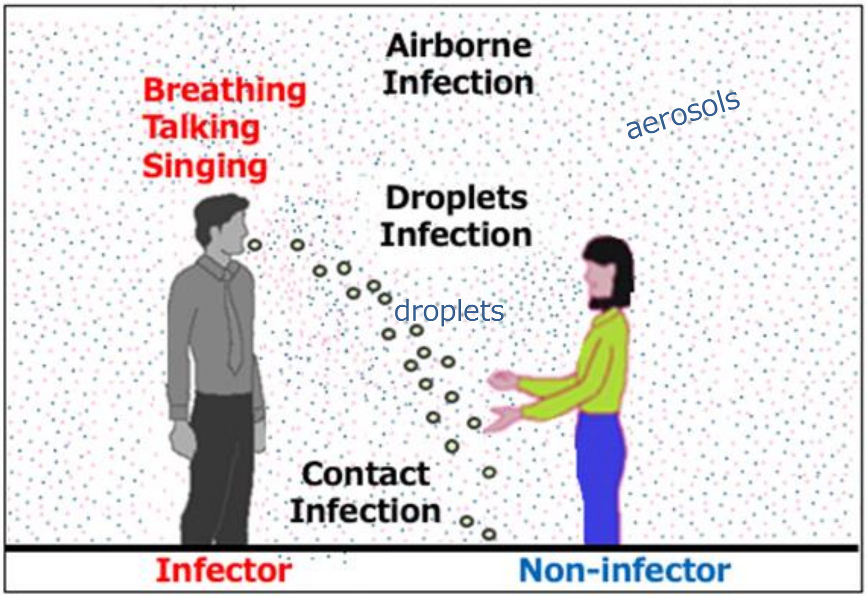


Fig. 1 Three routes of infection of respiratory infections

There are **3 routes** of transmission of respiratory infections.

Droplet infection
Infection by droplets emitted by coughing, sneezing, singing, screaming, talking and breathing
Contact infection
Infection by surface contact such as hand-to-hand, hand-to-face, hand-to-object, etc.
Airborne infections
Infection by aerosols that are released with breathing, talking, singing, etc. and are suspended in the air

If all three routes are blocked, you will not be infected.

2）Droplets and aerosols

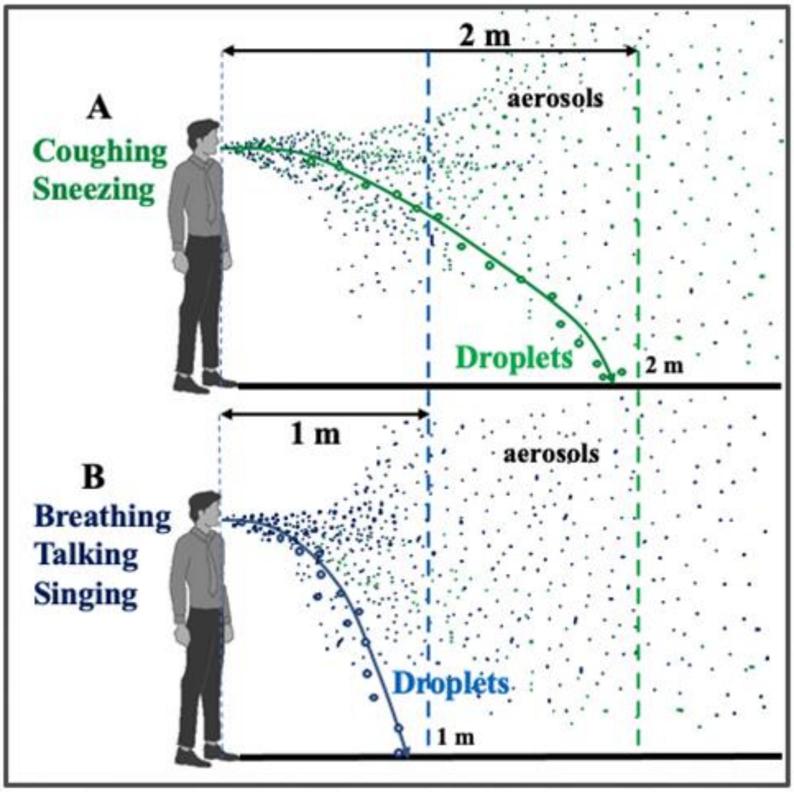


Fig. 2 Droplets and aerosols

Droplets

A. Coughing and sneezing droplets fly out of the mouth at speed of 10 m/sec and 20~60 m/sec, respectively, and fall quickly.
Droplets that pop out when sneezing can reach up to 1.8 m.

B. The expiratory velocity is 1 m/sec for normal breathing and 5 m/sec for talking.
Droplets expelled by breathing talking and singing, etc. fall within 1 m.

Aerosols

A. Fly out with coughing, sneezing, suspended in the air for a long time.

B. Aerosols are released from exhalation through breathing, talking, singing, etc., and floats in the air for a long time. Aerosol concentration of the exhaled air are released in one direction up to about 50 cm from the exhaled source, from where it diffuses and floats.

3) Infection with respiratory infections starts in the mucous membranes of the nose and mouth

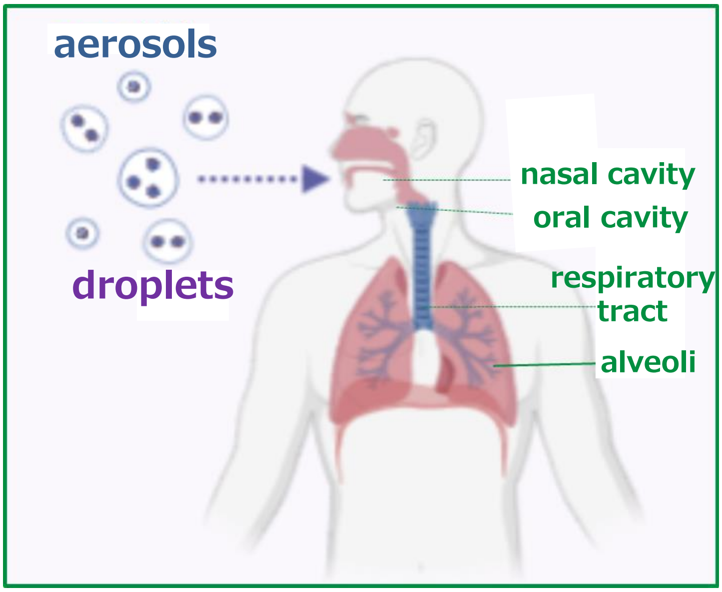


Fig. 3 Routes to infection

Pathogens (viruses, bacteria) enter through the nose or mouth and adhere to the nasal cavity, oral cavity, respiratory tract, and alveoli, causing infection.

This applies to both droplet, contact, and airborne transmissions.

The virus does not infect the face, hands, skin, etc. It is only after the virus adheres to the mucosal cells of the nasal cavity and oral cavity at the back of the nose that it becomes infected.

Droplet infection and contact infection can be prevented by washing your hands and face when you notice droplet adhering to your face, hands, skin, etc.

In airborne infection, aerosols containing pathogens are inhaled through the nose (or mouth) by breathing, which adheres to the mucosal cells of the nasal cavity, oral cavity, respiratory tract, bronchi and alveoli and becomes infected. This means that you are constantly at risk of infection through your breathing.

4) Mechanism of airborne transmission

A person cannot live without breathing.
Breathing inhales oxygen (O_2) from the air and exhales carbon dioxide (CO_2), but it also exhales aerosols and droplets produced by exhalation*[1,2]. The aerosol exhaled with breathing is produced from a layered liquid that covers the epithelial cells of the respiratory tract (RTLF; Respiratory tract lining fluid) by the flow of exhaled air*[1].
The aerosol of a person suffering from a respiratory infection contains pathogens of the infection (bacteria, viruses).

In an enclosed room, aerosols expelled by breathing by everyone present are suspended in the air and mixed. Over time, the overall number increases. The occupant inhales the mixed aerosol into the lungs through the mouth and nose by rebreathing. If anyone is infected, everyone will inhale an aerosol containing the virus. Then, by breathing, each person expels a newly produced aerosol from the exhaled air.

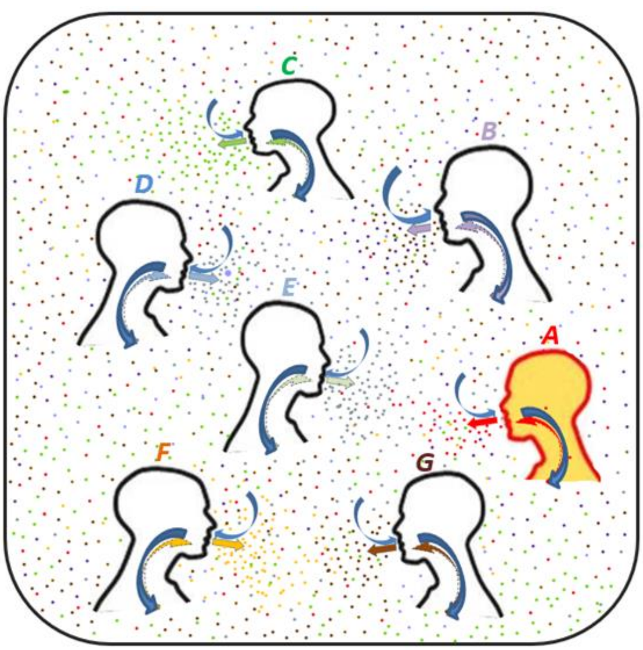


Fig. 4 Circulation of aerosols produced by breathing by rebreathing

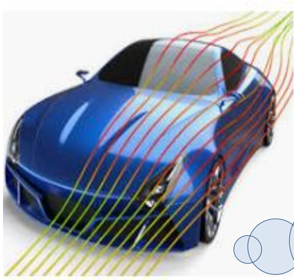
1) Seven people from A~G are in a sealed room. Each person breathes in a different rhythm and volume, expelling aerosols with exhalation. Aerosols are produced from each person's respiratory tract lining fluid (RTLF), and each person's aerosol has different properties. Each aerosol is color-coded as A: red, B: light purple, C: green, D: blue, E: pale blue, F: orange, and G: purple. Since A is an infected person, it emits an aerosol (red) containing the virus.
2) The aerosol emitted from each person is suspended in the air and diffused, and the whole is mixed.
3) Each person breathes the mixed aerosol again and inhales it through the mouth or nose into the lungs. Everyone inhales the aerosol (red) containing the virus, and the risk of infection is high.
4) Each person expels a new aerosol from their exhaled breath.

1. Bake, B., Exhaled particles and small air ways, Respiratory Res. 20:8 (2019)
2. Tellier R., et al., Recognition of aerosol transmission of infectious agents: a commentary, BMC infect. Dis. 19, 101 (2019)

Column1

Aerosols rarely stick to objects.

・You don't need to put on your clothes or take a shower after going out for a walk or shopping.
・It can be said that there are almost no viruses on the surface of mail, courier services, etc.



It's the same as when a car is driving slowly, a small insect doesn't hit the windshield. Insects are swept away by the air flow that runs along the car. In the same way, airborne virus particles do not adhere to hair or clothes because they flow with the air flow (air current) generated by human movement.

Tera Parker-Pope, "Is the Virus on My Clothes? My Shoes? My Hair? My Newspaper?" The New York Times April 17, 2020.

How to prevent respiratory infections

5) Prevent airborne transmission routes

Invisible microscopic water droplets called "aerosols" float in the air and spread.
It spreads far and wide on the flow of air.

Aerosols are "released" one after another by breathing and talking and accumulate in the room (Fig. 5).

The aerosols exhaled by an infected person with CO_2 contain pathogens such as viruses and bacteria.
Even after a few hours, the virus in the aerosol becomes infected and multiplies when it enters the human body again.
People in the same room rebreathe the shared air, and if they inhale the aerosol of an infected person floating in the air, the probability of infecting the virus increases.

Aerosols are promptly removed by ventilation

Ventilation is carried out by opening windows and doors or using ventilation devices.
Ventilation allows fresh outdoor air to enter the house and air contaminated with indoor aerosols to the outdoors (Figure 5-B).

Aerosols are invisible, so even if they accumulate, you won't notice them at all.
You don't know if the ventilation is sufficient or insufficient.
If there is an infected person there, everyone who is there is at high risk of being infected without realizing it.

Aerosols spread over long distances, so places with a high risk of infection
It can spread to hallways and remote rooms.
Even after the infected person leaves the room, the risk of becoming infected with accumulated aerosols remains.

5-1 Ventilation

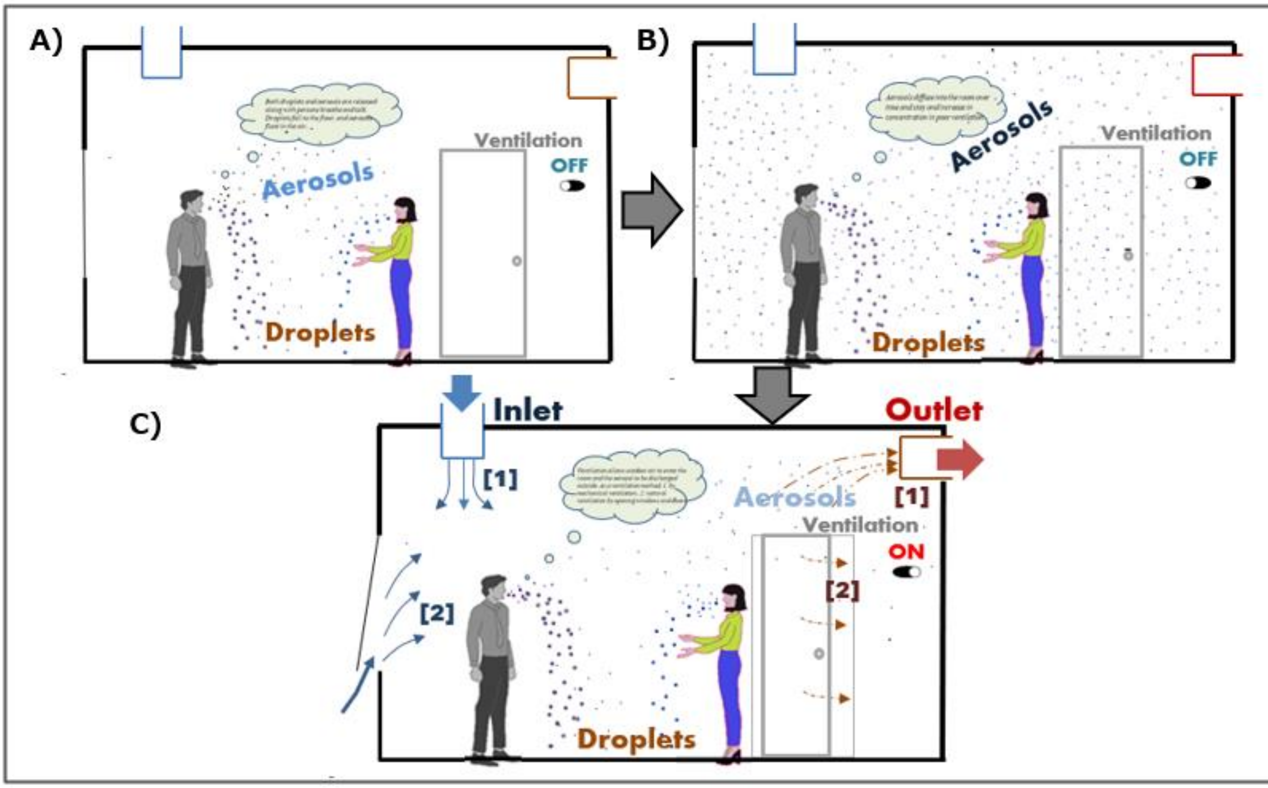


Fig. 5 Removal of aerosols generated with breathing and talking by ventilation

A) Two people are having a conversation in a room of a certain size. As you breathe and speak, droplets (purple) and aerosols (pink) are released from both sides. Droplets fall to the floor at a rapid rate, and aerosols are released one after another and float in the air. People indoors inhale airborne aerosols by sharing and breathing.

B) Aerosols diffuse into the room and stay in the room if ventilation is poor (ventilation OFF). Over time, the amount of aerosol in the room increases more and more. When there is one infected person, the aerosol they emit contains the virus, so the risk of infection in the room increases, and the probability of infection in an uninfected person increases.

C) Ventilation allows outdoor air to enter the room and aerosols are quickly discharged to the outside. Ventilation methods include ❶ supply of outdoor air by mechanical ventilation (ventilation ON) and exhaust of indoor air ❷ natural ventilation by opening windows and doors.

Airborne infections are scary because they lack ventilation without you noticing them

If there is a way to notice a lack of ventilation, the risk of airborne transmission can be reduced.

If you don't have that method, you don't know when you'll get infected without even realizing it.

This is where carbon dioxide concentration measuring devices (CO_2 monitors) come into play

5-2 CO_2 monitor

Good ventilation can be determined by looking at the CO_2 monitor (Figure 2-5). Why? The breath exhaled by a person contains carbon dioxide (CO_2). Its concentration is about 3% of exhaled air when doing light work. If there are people in a poorly ventilated room, the concentration of CO_2 will rise quickly. If ventilation is performed, CO_2 is discharged to the outside, and the concentration of CO_2 decreases. Therefore, if you know the concentration of CO_2, you can know whether ventilation is good or bad.

What is the concentration of CO_2 to say that ventilation is sufficient or insufficient? The "CO_2 concentration boundary" is 1,000 ppm (0.1%). For CO_2 monitors, ppm is used. In Figure 2-5, the CO_2 monitor is displayed as 0689. This means that the CO_2 concentration is 689 ppm.

The concentration of CO_2 in the atmosphere is around 420 ppm. The closer the CO_2 is below 1,000 ppm and closer to 420 ppm, the better the ventilation, and the higher the number exceeds 1,000 ppm to 1,500 ppm and 2,000 ppm, the worse the ventilation is and the worse it is to be insufficient.

If the CO_2 monitor display exceeds 1,000 ppm, it is judged that ventilation is insufficient, and ventilation action is taken.

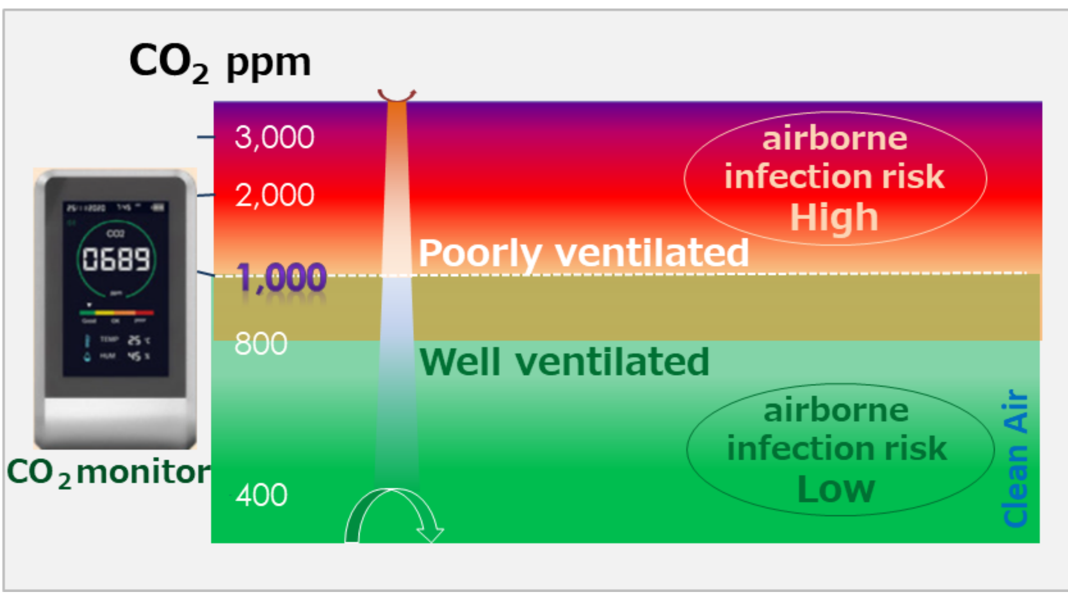


Fig. 6 CO_2 monitor and ventilation

If the CO_2 is less than 1,000 ppm, ventilation is sufficient.
The air in the room is fresh.
The risk of airborne transmission is low.
If CO_2 exceeds 1,000 ppm, ventilation is insufficient.
The risk of airborne transmission is high.

5-3 CO_2 Monitor Settings

In order to truly reduce the risk of airborne infection, it is necessary to take the following steps: (1) select an accurate CO_2 monitor, (2) install it in an appropriate location, and (3) visualize and record the CO_2 concentration in real time, and implement and manage ventilation measures so that there is no lack of ventilation. It will be explained in the following order.

1. Selecting an Accurate CO_2 Monitor
Various products are available on the market, but each country has its own guidelines for selecting equipment, but in Japan, the guidelines of the Ministry of Economy, Trade and Industry[*1] are helpful. The specifications of the model use an optical method (a detection method that uses a specific wavelength of light absorbed by CO_2 molecules) such as NDIR (Non-Dispersive InfraRed) and photoacoustic, and it is recommended that a correction function be attached to the measuring device.

2. Installation site setting[*2]
The CO_2 monitor is compact, handy, and can easily measure CO_2 concentration.
It can be installed anywhere indoors, and the CO_2 concentration can be checked in real time at any time.

In addition to real-time confirmation, the CO_2 monitor can be used for the following important assessments:
Even in buildings designed to ensure adequate ventilation, the efficiency of ventilation decreases when people and objects become obstructions. It is necessary to consider the position of people and objects and arrange them so that the air circulates appropriately, and CO_2 monitors are used well for such evaluations.
The location of the CO_2 monitor can be near the center of the room or at the edge, if it is avoided on the side of the door or window, and the height can be convenient. Generally, the number of installations is only one per room, but especially in large rooms, it is better to measure the CO_2 concentration in several places in the room in advance, and if there is a big difference, select the area where air storage is most likely to occur in the room so that there is no lack of ventilation and place it there[*2].
A system has also been developed that can connect CO_2 monitors with IoT and link them with smartphones for monitoring. It is a system that can be used for the assessment and maintenance of infection risk and air quality, as well as management and community activities. If such a system becomes widespread and established, it will be possible to monitor CO_2 concentrations with a smartphone at work, when going shopping, or when going on a business trip or travel, so it will be possible to practice an infection-free life using the monitor wherever you go.

*1.Guidelines for Carbon Dioxide Concentration Measuring Instruments: Ministry of Economy, Trade and Industry, Industrial Gas Detectors Association, November 1, 2021
*2. Practice! Guidebook to ventilation measures: production; Visualization of ventilation through community participation ~ improvement project, supervised by Yo Ishigaki and Shinji Yokogawa; Yoshito Niki ; https://dimensions-japan.org/share/kanki2.pdf

6) Prevent droplet transmission routes

Droplets are large droplets, so they fall down within almost one second. (Fig. 2) Droplets from coughing and sneezing can fly up to 2 meters, and droplets such as breath exhaled (vigorous exhalation), conversation, loud voice, and singing during training can fly up to about 1 meter.

Aerosols spread in all directions, while droplets fly only in the frontal direction (Figure 2). Therefore, while the risk of airborne infection by aerosols lasts for a long time over a wide area, droplet infection occurs sporadic within 1 second of facing the face. It's also within the range of 1 meter in front of the basic one-on-one face.

To block the route of droplet transmission, you can either block droplets or use social distancing to keep your distance from others.

Mask

The mask blocks droplets and allow little to pass through. Whether it is a non-woven mask or a cotton mask, droplets hardly pass through. If you wear a mask, droplets will hardly fly, and you will not be able to catch the droplets that fly and put them inside. If you wear a mask, droplet infection can be prevented.

Face shields, acrylic sheets and partitions can block droplets and prevents droplet infection.

Social distancing

Even if you don't wear a mask, droplet infection can be prevented by keeping a distance. This is social distancing.

Social distancing is 1 meter. If you keep a distance of 1 meter from people, droplet infection can be prevented even without a mask. In addition, even if the distance between people is within 1 m, if you do not face them head-on, droplet infection can be avoided sufficiently.

The social distance is 2 meters in the medical field or when meeting with a symptomatic virus infected person. It's a distance to avoid coughing and sneezing.

"Summary of methods for blocking droplet infection routes"

(1) Wear a mask. If you wear a mask, you can prevent droplet infection without keeping a distance from others. Partitions such as face shields and acrylic sheets are also effective ways to block droplets.

(2) Keep a distance of 1 meter from others. If you keep a distance of 1 m, droplet infection can be prevented even without a mask. Even within 1 m, droplets can be avoided if you do not face them in front of your face. (In medical settings, the distance is 2m)

7) Blocking the route of contact infection

Contact infection is caused by droplets of infected people.

Aerosols rarely reach people or objects, so they are not a source of contact infection. ☞ (Column 2).

For example, if a person infected with respiratory infection virus sneezes or coughs and splashes droplets on a doorknob, and another person touches the doorknob with his or her hand and then touches the nostrils, mouth, or eyes with the hand that touched the doorknob, there is a risk of contact infection.
However, such situations and opportunities are unlikely to be encountered.

In fact, "the risk of contact infection is low"*[1].

Make it a habit to wash your hands when you return from the outside, before eating, or after using the bathroom. The habit of washing and cleaning hands is not only to prevent contact transmission of the respiratory infection virus, but also to be a public health habit that everyone wants to acquire.

Since the new coronavirus, there have been more opportunities to disinfect. Wherever you go in town, disinfectant spray are increasingly available and for many people, disinfecting has become the norm.

Let’s disinfect if we think it's necessary and on demand.
That is sufficient to prevent contact infection.

*[1] Lewis, D., COVID-19 rarely spreads through surfaces. So why are we still deep cleaning? Nature News Feature 590, 26-28 (2021)

Influenza, new corona, colds, etc.
How to prevent respiratory infection

Summery

Viruses are powerless outside the human body.
If you don't put it in your body, you won't get infected and there's nothing to be afraid of.

In order to avoid infection with the virus, it is important to be aware of and clearly distinguish between airborne infection and droplet/contact infection.

First and foremost, it is essential to prevent airborne infections.
To do this, it is necessary to improve ventilation at all times.
Since it is easy to lack ventilation, when the CO_2 concentration exceeds 1,000 ppm on the CO_2 monitor, increase ventilation to keep the indoor air fresh (CO_2 concentration ≦ 1,000 ppm).
In this way, the risk of airborne transmission can be kept low.

To prevent droplet infection, wear a mask or keep a distance of at least 1 m from others.
You can also choose to avoid facing each other in front of your face within a distance of 1 m.
(However, in medical settings and face-to-face contact with symptomatic infected people, the distance is 2 m.)

To prevent contact infection, make a habit of washing your hands.

Column2

Group infection occur through the air

If there is even one person infected with a reparatory infection virus in a room with insufficient ventilation, aerosols containing the virus that are excreted with the breathing of the infected person will continue to spread and remain in the room. Everyone present shares an aerosol containing the virus, and when they rebreathe (Fig. 4), they all inhale it into their bodies, resulting in a group infection.

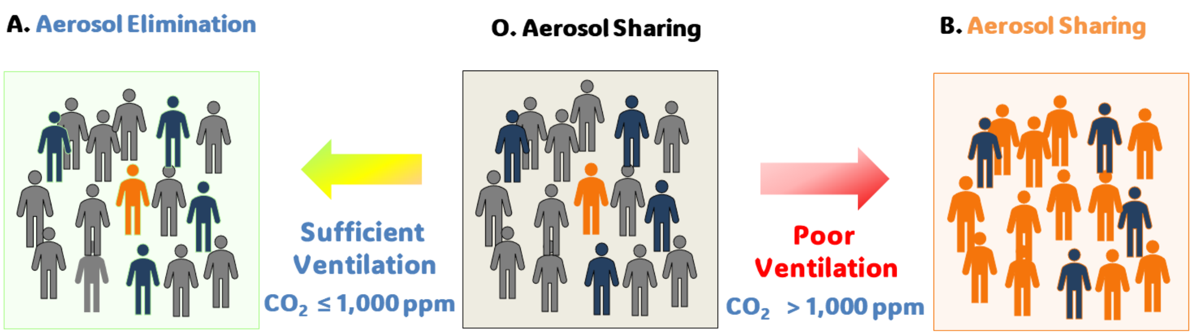


Fig. 7 Group infection

If there is an infected person in the same room

A. If the CO_2 concentration is always kept below 1,000 ppm and there is no lack of ventilation, aerosols are emitted, and group infections are rare.

B. When there is a lack of ventilation with a CO_2 concentration of more than 1,000 ppm, the aerosol containing the virus is shared by everyone, and the probability of group infection is high.
Orange people are infected, gray and blue people are not infected
People in blue are those who have immunity to the virus.

Airborne transmission by aerosols can infect from a single infected person to several to hundreds of people at a time. If there is even one person infected with a respiratory infection virus indoors with insufficient ventilation, aerosols containing the virus will continuously spread and stagnate indoors. The probability of infection increases for all those who are present.

Methods of ventilation

The key to ventilation is to maintain an indoor CO_2 concentration of 1,000 ppm or less so that there is no lack of ventilation. Therefore, it is necessary to install a CO_2 monitor in the room.

The mechanism of ventilation is to replace the dirty air in the room with fresh outside air. There are two ways to do this: natural ventilation and mechanical ventilation.

How to do natural ventilation immediately

Aerosols generated by breathing, talking, singing, etc. are eliminated by effective natural ventilation.

Open up the room and let the air out

- Open two or more places in the room (e.g., doors and windows).
- If only one part of the room can be opened, create a flow to exhaust the air with a fan or circulator. The fan can be directed to the outside of the door, and the circulator can efficiently exhaust air by sending air from the door to the side of the room.
- If the CO_2 concentration exceeds 1,000 ppm, the occupant should leave the room for about 5 minutes and enter the room after confirming that it has fallen below 1,000 ppm.

If the room is not open at all times

- When the CO_2 concentration exceeds 1,000 ppm, open multiple doors for a few minutes and exhaust air with a fan or blower to return the CO_2 concentration to 1,000 ppm or less.

Note that home air conditioners only circulate air and do not ventilate. (It is effective to open the room and circulate the air with an air conditioner.)

Methods of mechanical ventilation

Mechanical ventilation is a method of ventilation with the power of a machine such as a ventilation fan or blower.
In Japan, in response to the trend toward high heat insulation and airtightness of houses and measures against sick houses, **24-hour mechanical ventilation was made mandatory** in the revised Building Standards Law in 2003.
For example, in the case of a house, it is necessary to have mechanical ventilation equipment **(24-hour ventilation system) with a ventilation frequency of 0.5 times / 1 hour or more.**

There are three types of supply air (inlet) and exhaust (outlet), each of which is a combination of using or not using a machine. In housing, the first and third classes are mainly adopted.
Class 1 Mechanical Ventilation: Both air supply and exhaust air are carried out by machine.
Class 2 Mechanical Ventilation: The air supply is mechanical, and the exhaust is carried out by natural exhaust. Due to the forced air supply, the air pressure in the room is higher than outside, and exhaust air is naturally stimulated.
Class 3 Mechanical Ventilation: The air supply is naturally supplied, and the exhaust air is carried out by machine. Due to forced exhaust, the air pressure in the room is lower than outside, and the air supply is naturally promoted.

In order to obtain more comfort in an energy-saving house with high heat insulation and high airtightness, the use of a heat exchange ventilation system of first-class mechanical ventilation is effective.
During air conditioning, a general ventilation fan takes in cold outside air in winter and hot outside air in summer, so the heat in the room that has been warmed (cooled) is taken away, and the room becomes cold (hot). Since the heat exchange ventilation device takes in outside air close to the room temperature, it reduces the load on the air conditioner and saves energy, and the temperature unevenness in the room is suppressed, so comfort is not impaired.
HVAC (heating, ventilation, and air condition), a system that controls temperature, humidity, and air quality, along with ventilation, regulates comfort (temperature and humidity), energy efficiency, and air quality.
In order to end infectious diseases, it is necessary to create an indoor air environment with ventilation over a wide area, and mechanical ventilation plays a leading role in this. In addition to **successfully achieving air quality with an indoor CO_2 concentration of 1,000 ppm or less**, comfort by ensuring temperature and humidity that are not affected by ventilation, as well as energy efficiency are the challenges.
HVAC is the optimal system to solve this problem.

Column3

Ventilation and CO_2 monitoring

Indoor transmission through aerosols is very risky when indoor ventilation is not good. Therefore, the installation of CO_2 sensors to monitor indoor air quality in areas where people gather is very effective in preventing infection.
This is especially effective in places where groups or large groups spend a lot of time, such as schools, conference rooms, restaurants, eateries, karaoke, theaters, movie theaters, hotels, and other places where clusters are likely to form.

When CO_2 reaches 800 ppm, yellow/orange lights up, and at 1,000 ppm, it lights up red or an alarm to prompt ventilation or reduce the number of people.

There is also a web-based sensor system that notifies building managers of the need to open windows and ventilate and responds.

＊REHVA COVID-19 guidance document, August 3, 2020

CO_2 monitors

The benefits of masks to avoid infection

During respiratory infections, masks are very effective in preventing droplet transmission. Droplets can be prevented by more than 80% with cotton masks and by more than 90% with non-woven masks[1]. If both people face each other wear masks, the prevention effect will be even higher, and the risk of droplet infection will be almost eliminated. Masks made of cotton or non-woven fabrics are highly effective in preventing infection. The droplet prevention effect of N95 masks and surgical masks is even higher, and they prevent droplets by nearly 95-100%, so they are used in medical settings and other places where the risk of droplet infection is high.

What about aerosols?

There is also a report that cotton masks prevent aerosols by about 80% and non-woven masks by about 90%, and there are reports that cotton and non-woven masks have a 20-90% prevention effect[2]. On the other hand, if the mask is worn without gaps, aerosols are prevented by more than 90%. To prevent airborne infection, the risk of infection is reduced if the mask is tightly attached so that there are no gaps[1, 3].

However, in real life, the prevention of droplet infection by masks and the prevention of airborne infection are completely different.

The effect of wearing a mask on droplet infection is almost unchanged even if various conditions change. In the case of droplets, the blocking effect of droplets flying in the direction of the front of the mask wearer is directly linked to the infection prevention effect, so the filtering effect of droplets by the fibers of the mask is directly linked to the effect of wearing the mask[4].

The blocking effect of the mask on aerosols is not much different from droplets. This is because the fibers of the mask do not allow fine particles such as aerosols to pass through[5]. However, unlike droplets, aerosols float in the air through a gap between the mask and the face. Moreover, aerosols are expelled with exhaled breath along with breathing, and are inhaled by inhalation, so if you do not leave a gap even temporarily, you will inhale the aerosol.

When people coexist in the same room, they rebreathe and inhale the aerosols they exhale with their breathing. If you take off your mask when eating or sleeping, the aerosol will be inhaled. Eating while wearing a mask or eating silently is of little use in preventing airborne infections.

If you continue to wear airtight masks with no gaps, the risk of airborne transmission is lower, but it is not practical to do so in everyday life, and it is unlikely to be a normal daily routine. However, these risks and concerns can be eliminated by improving ventilation and eliminating lack of ventilation. This is because if there is no lack of ventilation, there is no need to wear a mask to prevent airborne infection. In real life, wearing a mask has the effect of preventing infection, but it is not too big because the main effect of masks is to prevent droplets, and it is not realistic to prevent airborne infection.

It is extremely important to position masks in infection control that they are worn to prevent droplets and not to prevent aerosols.

Once the infection subsides, it will no longer be necessary to wear a mask as a countermeasure against infection. On the other hand, it is necessary not to cut corners on ventilation even after the infection has subsided. This is necessary not only to sustain the end of the infection, but also to maintain good indoor air quality.

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4. Wang C-S, Face Masks and Prevention of Respiratory Viral Infections: An Overview, 2022 Asian Aerosol Conference, (AAC 2022) (II), Aerosol and Air Quality Research, 23 (1) 220343, https://aaqr.org
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Column 4

CAP-AI

An app that calculates ventilation volume, CO_2 concentration, and infection risk

CAP-AI is an app that calculates and provides the degree of pollution of indoor air and the likelihood of infection of people in the room. The app is applicable to respiratory infections (new coronavirus, influenza, colds, pneumonia, tuberculosis, measles, etc.).

Key functions of CAP-AI: Calculate the risk of infection and the degree of indoor air pollution based on the CO_2 concentration, number of infected people, number of uninfected people, average weight, room size, and occupancy time in a specific room.

Predictive model used by CAP-AI: Infection risk assessment and indoor air pollution level are calculated based on the MK-model (MK-AQIP model)*1.
Applications of CAP-AI: ❶ Assess the risk of infection indoors and provide data on which to take measures to prevent infection ❷ Provide actionable recommendations to optimize the indoor air environment cycle.

CAP-AI offers three types of question-and-answer apps:
CAP-AI-CK The risk of infection can be determined from CO_2 concentration
CAP-AI-VK Ventilation volume indicates CO_2 concentration and risk of infection
CAP-AI-SN The degree of air pollution can be determined from the ventilation volume

*1**MK-Model** (Mikawa-Kase AQIP Model): A prediction model newly developed by Mikawa and Kase to predict the risk of infection. It is a model that predicts the risk of infection based on the viral distribution of aerosols contained in the exhaled breath of an infected person.

CAP-AI can be downloaded free of charge from the QR code of PointPath-Land (https://pointpath.jp/).

Controlling group infection

Ending Pandemics

Stop the group infection

Without anyone noticing, there will be a lack of ventilation, and without their knowledge, a group infection will occur, which will occur many times here and there, and the number of infected people will increase rapidly and will not stop. This is the substance of the infection explosion*1.

The most effective way to eliminate unnoticed ventilation shortages is to monitor CO_2 concentrations in real time with a CO_2 monitor. If ventilation is maintained so that the CO_2 concentration is always below 1,000 ppm, there will be no lack of ventilation, and the probability of group infection will be less than 1%.（**CAP-AI app** http://pointpath.loopsnet.jp/cap-ai/ ）

Reduce the concentration of CO_2 in all indoor areas to 1,000 ppm or less at all times.

In this way, group infection does not occur by constantly providing good ventilation indoors. However, during a person's social life, if there is a place with poor ventilation somewhere indoors, there is always a risk of infection there. This means that there is a limit to the practice of infection prevention measures by individuals. If an environment is created in which all indoor spaces where people move are well always ventilated and filled with fresh air, group infections will disappear. In such an indoor environment, even if droplet or contact infection occurs, it will not be a group infection due to a limited number of people, and the infected people will disappear. In this way, **the epidemic of respiratory infections (colds, flu, new coronavirus, etc.) will end in areas where all indoor activities are filled with fresh air of CO_2 1,000 ppm or less.**

Enabling a world without a pandemic

Within that area, it will be possible to live without worrying about infection, no matter when or where you are. If such regional development is widely deployed and spread throughout the country, respiratory infections in that country will be eliminated and everyone in the country will be able to live without worrying about infection. And if we expand this kind of nation-building around the world, we will realize a truly pandemic-free world.

No More Pandemic!

Postscript

At the end of March, when the infection of the new coronavirus began to spread, I decided to deliver reliable scientific information to my friends and acquaintances (DearYou friends) and started sending out "New Coronavirus Newsletters" every day. Thanks to the support of everyone at DearYou, we have exceeded 150 issues. Then, I realized that the scientific information accumulated through communication was at the highest level in the world, and I was able to get a bird's-eye view of the global situation from the perspective of infection prevention.

On the other hand, more than 70% of the world's infections, including Japan, have re-spread, and the situation continues to be a trial and error to balance with the reopening of the economy. In this situation, I think that many people are confused about what to believe and how to act and are simply forced to refrain from doing so.

In the current situation, I thought that the most important thing was to go back to the starting point of protecting yourself and the people around you, rebuild your feelings from "not getting infected" and "not infect," and reflect it in all your actions and lives.

To that end, as the culmination of the 130th issue of the newsletter (August 8), we have published the "Guidebook for Preventing Infection with the Novel Coronavirus SARS-CoV-2" with a strong desire to become a bible for "not getting infected" and "not infect“. Fortunately, we were able to get a good reception, and thanks to the word of mouth of DearYou, the circle of people who read this guidebook has expanded to several companies, clinics, universities, high schools, sports clubs, etc.

The newly published "Guidebook for Preventing Infection with the Novel Coronavirus SARS-CoV-2 Latest Edition" has been significantly revised from the previous edition with the aim of making it more practical and easier to use for a wide range of people. We hope that this booklet will be used by as many people as possible and help form a new social style in which "no one is infected."

September 8, 2020
Hiroshi Kase

Biography of Hiroshi Kase
Born in 1942. Graduated from the Department of Agricultural Chemistry, Faculty of Agriculture, University of Tokyo. Doctor of Agricultural Sciences.
After joining Kyowa Hakko Kogyo Co., Ltd. (now Kyowa Kirin), he has been involved in pharmaceutical research and development for many years, developing global projects in Japan, Europe, and the United States. After retirement, he has participated in the R&D and management of a bio-venture in pharmaceutical research and development, but is currently a member of PointPath.biz Inc. Over the past few years, I have deeply enjoyed science, especially in Nature Briefing, which I believe has led to the publication of the new coronavirus newsletter and this guidebook.