

Reducing transmission of respiratory illness in community spaces through improved indoor air quality

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The following is an edited summary of a conversation with <u>Dr. Jeffrey Siegel</u>, Professor of Civil Engineering at the University of Toronto. Dr. Siegel is an expert on indoor air quality and ventilation. The conversation took place in late December, 2020. Updates were made in consultation with Dr. Siegel and Dr. Amy (Tianyuan) Li in July, 2021 and March, 2022.

Respiratory illnesses like COVID-19 are spread in a few ways, including through the air. When people are together indoors, infections can spread more easily. But there are things you can do to improve indoor air quality and help reduce transmission. While this is particularly urgent during the COVID-19 pandemic, improvements to indoor air quality are important long-term investments at any time. For example, these improvements can help reduce the transmission of long-standing respiratory illnesses such as flu and tuberculosis.

Please note, the below focuses on airborne transmission, and does not address or replace other infection control measures such as masks, handwashing, and the disinfection of surfaces.

What processes are generally used to improve indoor air quality?

• Ventilation, which involves bringing outside air into a room. This can be done by opening windows and doors to let fresh air in. In addition, some heating, ventilation, and air-conditioning systems (also known as HVAC systems) bring fresh air into buildings. Exhaust fans that move stale air from the inside to the outside are also part of the ventilation system.

Ventilation <u>does not</u> mean moving the same air around in a room. For example, ceiling fans do not provide ventilation. If a room feels stuffy or there are a lot of odours, this may be an indication that it is not well-ventilated.

• **Filtration**, which involves passing indoor air through a high-quality filter. This can be done using portable air filters. Some HVAC systems can also be equipped with high-quality filters.



What can I do to reduce airborne transmission in indoor spaces?

Easy things you can do right away do make some improvements in indoor air quality*

- Run bathroom fans that exhaust to the outside continuously when building is occupied. Run kitchen fans that exhaust to the outside when the kitchen is in use and for some time afterward.
- Where possible, open windows and doors.
- Use high-quality portable air filters.
- Consult a professional to see if low-cost improvements can be made in your heat, ventilation, and air conditioning system (also known as HVAC). For example, it may be possible to increase the ratio of outdoor air coming in through your HVAC system. Your HVAC system may also accommodate a higher-quality filter, or you may be able to improve the seal on the filter you do have.

* For details about what to consider when taking the above steps, please review the rest of this document.

When it comes to reducing transmission through improvements to indoor air quality, the goal is to reduce the amount of air that is "re-breathed" in a space. This can mean running 100 percent outdoor air through HVAC systems. Where this is not possible, re-circulated air should be run through a high-quality filter in the HVAC system. It's also important to make sure that HVAC systems provide ventilation and filtration at times when heating/cooling are not needed.

UV disinfection technologies—under the right conditions, and when carefully and professionally installed—can also help limit the recirculation of air that may contain the virus. Portable air filters can help too. So can open windows and doors.

When it comes to air quality, each space is different, and will require different solutions. Ideally, in settings where people gather outside of their homes, the HVAC system should have six equivalent air changes per hour. This means that that the combination of ventilation and filtration measures will provide six room volumes of air every hour that are relatively free of respiratory (and other) particles.

For more detail on optimizing HVAC systems during the pandemic, see the resources section of this document for: "Corona Virus Response Resources" from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, "COVID-19: Heating, Ventilation and Air Conditioning (HVAC) Systems in Buildings" from Public Health Ontario and "COVID-19: Guidance on indoor ventilation during the pandemic" from the Public Health Agency of Canada. Your best bet will always be to consult an HVAC expert to assess your current situation, and implement improvements.

You can use a variety of methods in combination to increase the air changes per hour in your space and improve air quality. And even if you can't get up to six air changes per hour right away, any improvement will help.



Short-term improvements

- If resources are available, work with a professional to **upgrade ventilation**. This will improve indoor air quality and reduce airborne transmission. This doesn't always mean a complete overhaul or replacement of HVAC systems. It can include consulting with an HVAC professional to see if you can circulate more or 100 percent outside air through your HVAC system, and if your HVAC system can accommodate a higher-quality filter or needs an improved seal around the filter.
- Bring in **high-quality portable air filters**, and position them strategically in your space. Portable air filters are particularly important if there is no central forced-air system with a well-installed and maintained high-quality filter as part of your building's HVAC system. For more on the choice and use of portable air filters, see "Use of Portable Air Cleaners and Transmission of COVID-19" from Public Health Ontario in the resources.

Here are some things to consider when using portable air filters:

- Choose portable air filters based on the room size and the clean air delivery rate of the unit. Large rooms may require multiple units.
- If people are sleeping together in a space, place portable air filters between beds.
- If your portable air filter exhausts from the bottom (as opposed to the top), ensure it is elevated so the unit does not disturb particles that may have been deposited on the floor, and so clean air reaches people while they sleep.
- Turn portable air filters up to maximum levels during higher-risk activities. For example, when people take their masks off to eat.
- Change filters as often as indicated, and take care when doing so. Use a mask and gloves, and change outdoors where possible. Immediately place the filter in a plastic bag and seal bag.
- As per Public Health Ontario guidance, "Directing airflow from a portable unit such that the air does not directly blow from one individual to another will help reduce the potential spread of respiratory droplets." (See resource on portable air filtration below.)
- Do not use portable air filters in bathrooms. Bathrooms are full of smooth surfaces such as toilets and tile. Particulate matter doesn't adhere well to these surfaces. As a result, there is a greater chance that portable air filters will disturb these particles and send them back into the air.
- **Fans that exhaust air** to the outside also contribute to air quality improvement. Run bathroom fans that exhaust to the outside continuously when the building is occupied. Run kitchen fans that exhaust to the outside whenever the kitchen is in use and for some time afterward.
- **Open doors and windows**. This may not always be feasible, but letting in air from the outside can improve ventilation.
- Install upper-room ultraviolet (UV) air disinfection. These units are installed in the ceiling, and help to neutralize viruses and bacteria that circulate through them. It is important that they are properly installed by professionals, as UV light can be harmful to people, and they will only be



safe and effective when there is appropriate air circulation, an adequate dose of UV delivered to the microorganisms, and sufficient assurance that UV illumination is contained to the part of the room near the ceiling.

- Keep people away from some types of airflow. For example, take care with placement and use of portable fans, air-conditioning units, ceiling fans, and portable air filters and avoid creating direct airflow between people. For more information about this, see related resources at the end of this document from Public Health Ontario and Toronto Public Health.
- Air out rooms between uses. For example, if a group of people is using a dining or meeting room, clear the air before the next group comes in. If you know the room's air exchange rate, make sure the air changes over three times before letting people back in. If you don't know the room's air exchange rate, air the room out for at least two hours.
- Avoid the use of unproven air cleaning technologies. These include many devices that use ionization, plasma, photocatalytic oxidation, hydroxyl radical and other similar approaches. Many of these air cleaners are not effective and some can emit harmful by-products.

Longer-term improvements

Work with an HVAC professional to equip your building with a <u>well- and regularly-maintained</u> HVAC system that has the capacity to change the air in each room at least six times an hour and use a filter with a high MERV rating. High quality HVAC systems can be supplemented with high-powered fans in bathrooms and kitchens that vent to the outside; portable filtration units; and professionally installed UV disinfection technology.

In all cases it's important to use professional, licensed contractors to select, install and maintain HVAC systems, exhaust fans and UV disinfection units. Choose professionals that have specialized knowledge of technologies such as UV disinfection. UV disinfection can be very helpful but has to be done well.

What can I do to reduce airborne transmission in bathrooms?

Bathrooms are small, so it's easier for a higher concentration of virus to build up in the air. There are many ways to help reduce transmission in bathrooms:

- Make sure bathroom fans exhaust to the outdoors. If they don't, work with an HVAC professional to install a new fan. Run bathroom fans continuously when the building is occupied.
- If possible, ensure only one person uses the bathroom at once, even in multi-person bathrooms.
- Leave the bathroom empty for as long as possible between uses.
- If possible, leave windows open.
- Leaving the toilet seat down while flushing may help reduce the dispersion of particles.



- In rare cases, virus particles may be able to travel through connected drain pipes from a bathroom on one floor to a bathroom on another due to dried-out drain traps. Regularly running water in showers, bathtubs and sinks, and adding water to floor drains to make sure they are not dried out, can help prevent particles from escaping from the drain pipes.
- As described above, portable air filtration units <u>are not appropriate</u> for bathrooms.

As noted earlier, these recommendations are only related to airborne transmission and do not address or replace other infection control measures such as masks, handwashing and the disinfection of surfaces between uses.

How will I know when I have created a space that is safe?

During a pandemic, no indoor space where people gather will be 100 percent safe. In addition, calculating risk is difficult, as each situation is different. The good news: we know that **places that are proactive see fewer infections**.

To get a sense of your ventilation situation right now, you can try to calculate the "air changes per hour" in a particular room. To reduce airborne transmission, you are looking to achieve at least six changes per hour. This will likely require some new measures such as those suggested here—most buildings currently have air change rates that are far below this benchmark. Remember—in some spaces many of these measures will be achievable in the short term, and taken together could bring you to six air exchanges per hour. And even if you can't get there right away, any improvement will help.

To figure out your "air changes per hour" (ACH), you will likely need an HVAC expert. It's easy, however, to calculate the contributions that high-quality portable air filters make to ACH. Most will list the room size they can serve (typically based on an assumption of eight-foot high ceilings and four ACH).

Or you can calculate yourself, using the Clean Air Delivery Rate (CADR). If the manufacturer expresses the CADR in cubic feet per minute, you can use the following equation: ACH = CADR*60/Room volume. The room volume is also expressed in cubic feet. If the manufacturer expresses the CADR in cubic metres per hour, then you can use this equation: ACH = CADR/Room volume, with the room volume in cubic metres.

Some spaces may also choose to use portable carbon dioxide (CO₂) meters, which offer a rough indication of how well-ventilated a space is or isn't. While CO₂ metres aren't a perfect indication of the risk of COVID-19 or other respiratory illnesses in a given space, they can be a helpful tool. See "Can CO2 sensors be used to assess COVID-19 transmission risk?" from the National Collaborating Centre for Environmental Health in the resources section for more information.

General characteristics of a safer space during a respiratory pandemic

While there will always be risk to gathering indoors during a pandemic, there are many steps you can take to improve the safety of your space. Here are the characteristics of spaces that have been optimized to reduce airborne transmission of COVID-19:

• Space has appropriate processes in place to improve indoor air quality.



- Very low occupancy level—a small fraction of allowed occupancy, ensuring a small number of people in a large space.
- People wear comfortable, clean and well-fitted masks.
- People maintain physical distance from each other.
- In shared living settings, individuals, couples or families have their own rooms.
- If appropriate and feasible, time spent together in indoor space is limited.
- Where possible, spaces are aired out after use.
- Activities such as singing, loud speaking, exercise—anything that requires people to project their voices or breathe heavily—take place outside whenever possible

Additional resources

FAQs and fact sheets

- American Society of Heating, Refrigerating and Air-Conditioning Engineers, Epidemic Task Force. (Jan 6, 2021). "Core Recommendations for Reducing Airborne Infectious Aerosol Exposure." Available at: https://www.ashrae.org/file%20library/technical%20resources/covid-19/corerecommendations-for-reducing-airborne-infectious-aerosol-exposure.pdf
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- National Collaborating Centre for Environmental Health. (January 15, 2021). "Can CO2 sensors be used to assess COVID-19 transmission risk?" Available at: <u>https://ncceh.ca/content/blog/canco2-sensors-be-used-assess-covid-19-transmission-risk</u>



Reports

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- Public Health Agency of Canada. (Jan. 11, 2020). ""COVID-19: Guidance on indoor ventilation during the pandemic." Available at: <u>https://www.canada.ca/en/public-</u> <u>health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/guide-indoor-ventilation-covid-19-pandemic.html</u>