

VENTILATION AND FILTRATION FOR INDOOR PUBLIC

GATHERING SPACES: A REVIEW

October 29, 2020

Tom Dunlop and Bob Schultz

One scientifically identified method for prevention of transmission of COVID is properly designed, installed and maintained ventilation and/or filtration of air in indoor spaces. The more enclosed a space becomes; the more likely viral load will increase due to activities of people within that space. This is especially true if air exchange is below the minimum necessary to effectively clean the air with a frequency that will assist in removal of contaminants in the space.

Most highly recommended is encouraging people to gather outside as natural mixing of moving air and physical spacing of people provides greater diffusion and movement of viral matter than being in a room. Ultraviolet (UV) light from the sun also helps disinfect outdoor surfaces.

Control of viruses cannot be achieved singularly by ventilation and filtration, but rather they are tools that can complement other strategies such as social distancing and limiting interactions, hand washing, hand sanitizing, wearing face masks, limiting exposure through quarantine or isolation and medical monitoring and intervention.

The likely methods of transmission of COV-SARS-2 include fomites, droplets and airborne (aerosol). Fomites (contact transmission) relates to objects that may be contaminated with infectious material which is then later transferred to another person through touch or ingestion. The primary strategy for addressing fomites is a regime of cleaning, sanitizing, and disinfecting as defined in previously issues guidance for restaurants and other commercial spaces. Avoiding hand shaking, hugging, or other contact also reduces the risk of this form of transmission.

Viral laden droplets are larger particles expelled by a person. Due to their size, they tend to fall to the earth within six feet of the ill person. The primary strategies for addressing droplets are distancing, masks, and cleaning/sanitizing/disinfecting. In a restaurant, where a mask is not worn, settling droplets are primarily addressed through disinfection and occupancy capacity restrictions. Fewer people, spaced apart and regular disinfection of shared spaces increase safety.

Airborne transmission involves tiny particles of viral material that are small and light enough to linger in the air and thus be shared through normal breathing. It is unclear how much of the material is needed to infect a person but there are several well-known instances of large outbreaks that can be tied to this form of transmission.

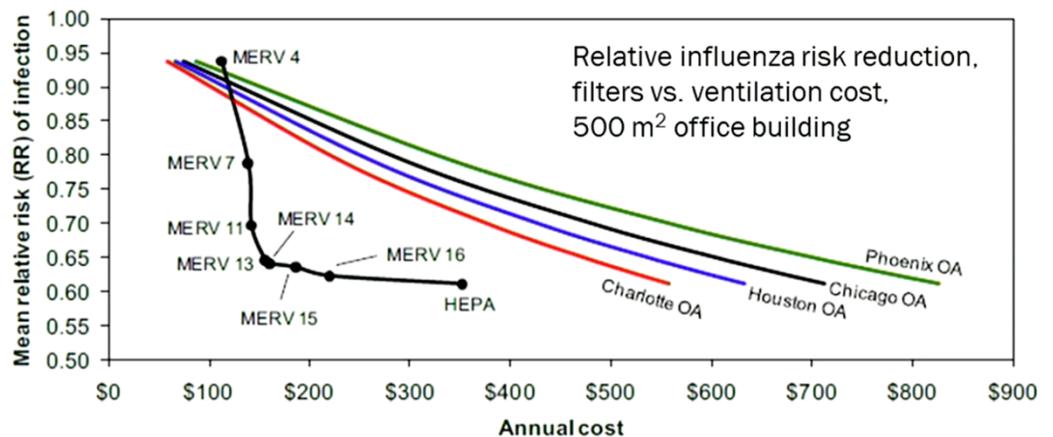
This is a less likely means of transmission that may be tied to an infected individual’s ability to transmit viral material that has a “super” spread aspect that we do not yet understand. The virus clearly does not transmit in the manner of highly airborne diseases such as tuberculosis, measles, or chicken pox and thus is a less likely means of transmission. The primary strategies for addressing aerosol transmission include ventilation/filtration, masks, capacity restrictions and distancing.

Indoor restaurant dining is an area of particular concern due to the inability to wear masks, lack of distance among tablemates from different households, haphazard air currents due to movement of people, and loud talking leading to projection of viral material. Concern for workers is a central issue in this setting as they interact with many groups over the course of a work shift.

The following recommendations are for Heating, Ventilation and Air Conditioning (HVAC) actions related to reducing the risk of airborne and droplet transmission;

- 1.) Have an existing HVAC system optimized for COVID to address need for optimal ventilation (fresh air) and filtration (air cleaning)
 - a. Check up by technicians to adjust the system with updated goals and clean the system
 - b. Determine highest MERV rating filter the system is designed to handle and install carefully to prevent leakage. MERV 13A or more is recommended. This is the best “bang for the buck” in reducing risk in a building with HVAC. If practical, purchase extras for scheduled replacements over winter (Filtration)

Filtration is a lower energy way to reduce aerosol/airborne infection risk than more ventilation



c. If the system cannot accept MERV 13A filters without creating pressure drops, then assess fresh air exchange rate settings and increase fresh air exchange rate as system allows. Increased airflow dilutes the threat of viral load. (Ventilation)

Ventilation with Outdoor Air

- Dilutes contaminants, increases exposure time required for exposure to an infectious dose
- Effective, but energy intensive, even with energy recovery
- Minimum required (e.g., ASHRAE 62.1) is a good baseline
- 7-10 L/s-pers \approx 15-20 cfm/pers

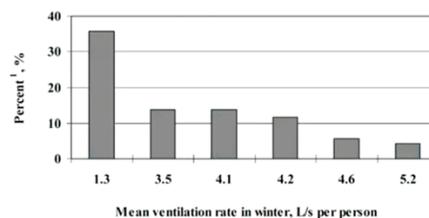


Figure 4. Associations between common cold infection rates and mean ventilation rate in winter in buildings constructed after year 1993. ¹ Proportion of occupants with ≥ 6 common colds in the previous 12 months.

Sun, et al. (2011)

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217956/>

d. If controls allow, set for two hours or three air exchanges before and after occupancy. Set system for low exchange and reduced heat when unoccupied to save energy. Example, restaurant is occupied from 5 pm to midnight. High exchange 3-5 pm and midnight to 2 am. Opening windows, when appropriate, can play lower energy role in introducing fresh air. (Ventilation)

e. Run restroom ventilation systems two hours before building occupancy. Consider setting them to run during building occupancy hours. (Ventilation)

f. Office or other work areas that may not be part of the HVAC system could benefit from fresh air (could be as simple as using a window and door) for increased ventilation and/or a portable (High Efficiency Particulate Air Filter) HEPA air purifier that is sized for the space for filtration. Small air exchange units are also available for installation by HVAC contractors to expel old air and import fresh air. (Ventilation and Filtration)

g. Small offices without ventilation with employees performing tasks that involve frequent talking would be a concern, especially for vulnerable individuals that should be addressed by increasing ventilation and purification or relocating the work area. (Ventilation and Filtration)

h. Prevent workers from gathering outside in areas where the HVAC system exhausts (ex. smoking area) (Ventilation). Also, locate clean air intake registers away from external causes of pollution (ex. Smoking areas, and building exhaust vents)

- i. Have a qualified technician examine heat recovery units, if any, to understand whether exhaust and fresh air are combined. If combined, determine whether that feature can be disabled and seek advice from operator on whether to disable. (Ventilation)
- 2.) All adjustments should be made by a technician who understands the mechanical limits of the system and ask them to identify adjustments that can be made by staff once winter occupancy occurs and use of the system increases.
- 3.) There are many old repurposed or emerging technologies on the market claiming to clean indoor air of particulates, viruses, mold and other contaminants. These are sold as Needlepoint Bipolar Ionization (NPBI), Ultraviolet (UV), Far-UV-C, dry hydrogen peroxide ionization, tube ionization, ozone generators, electronic air filters, vaporized hydrogen peroxide, and others appear on the market every month.

While marketing claims encourage purchase of these products based on study results, it is very important to look for 3rd party, independent, peer reviewed confirmation of claims being made in setting similar to the intended use and for COV-SARS-2 or similar viruses. Three agencies to look towards for confirmation of claims are the Centers for Disease Control and Prevention (CDC), Colorado Dept. of Public Health and Environment (CDPHE) and the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). At the time this is written, these are not part of strategies endorsed by the agencies listed above. They are also intended to address the least likely means of transmission.

- 4.) While there is proven disinfection from certain bands of UVC light in certain situations, that may not translate into a practical application for a restaurant or similar commercial space. There is a proven history of using UVC light on HVAC internal equipment for helping to keep the equipment clean.

There are also dangers to some UVC lights and there is little evidence of meaningful disinfection of air passing by the light in ductwork. Robot UVC lights or using Far UVC lighting as part of a lighting plan are areas of interest that are in current use for some settings, however, there are high costs and a lack practical experience in the types of settings discussed here.

Resources:

<https://www.ashrae.org/technical-resources/building-readiness#ecip>

<https://www.ashrae.org/technical-resources/filtration-disinfection>

<https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html>