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Living with Covid the focus of expertise has shifted from epidemiology to airconditioning and ventilation

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We now know that COVID-19 is primarily an airborne disease, so why aren't we seeing teams of airconditioning technicians decked out in PPE like we did cleaners in the early days? We provide an outline of what works, and what doesn't, in improving building ventilation and reducing the risk of virus transmission.

According to CDC (Centre for Disease Control and Prevention) based on available epidemiological data and studies of environmental transmissibility factors, surface transmission is not the main route by which SARS-CoV-2 spreads, and the risk is considered to be low.

Findings of studies suggest that the risk of SARS-CoV-2 infection via the fomite transmission route is generally less than 1 in 10,000, which means that each contact with a contaminated surface has less than a 1 in 10,000 chance of causing an infection. Concentrations of infectious SARS-CoV- 2 on outdoor surfaces could be expected to be even lower than indoor surfaces because of air dilution and movement, as well as harsher environmental conditions, such as sunlight.

Yet we see on the news vigorous cleaning regimes at work. This is often referred to as "theatre" in indoor air quality professional circles. **How come we don't see workers involved with air conditioning and ventilation in PPE checking building systems in schools, hospitals, and other buildings?**

The principal mode by which people are infected with SARS-CoV-2 is through exposure to respiratory droplets carrying infectious virus, the CDC stated in June this year.. Compared to fomite transmission there is a higher risk with direct contact, droplet transmission, or airborne transmission. Studies have shown when a person with suspected or confirmed COVID-19 has been indoors, virus can remain suspended in the air for minutes to hours. The length of time virus remains suspended and is infectious depends on numerous factors, including viral load in respiratory droplets or in small particles, disturbance of air and surfaces, ventilation, temperature, and humidity. Wearing masks consistently and correctly can substantially reduce the amount of virus indoors, including the amount of virus that lands on surfaces.

This leads to the role of experts who understand indoor air quality, air conditioning and ventilation.

Guidelines from the CDC suggest consulting experienced heating, ventilation, and air conditioning (HVAC) professionals with regards to implementation of strategies and improvements that can increase the delivery of clean air and dilute potential contaminants. **Building systems that provided healthy, code-compliant indoor air quality prior to the pandemic can be improved for pandemic occupancy often using less costly interventions.**

CDC lists ventilation improvements that can help reduce the concentration of virus particles in the air. **Interventions can reduce the risk of exposure to the virus and reduce the spread of disease, but they will not eliminate risk completely. However not addressing ventilation should not be an option.**

While the list of tools can be universally applied across indoor environments, applying them to various building types, occupancies, and activities under environmental and seasonal changes can be challenging. There is a need to identify which tools are appropriate for each building throughout the year. In addition to buildings, vehicles – including public transportation such as buses, subways, trains, planes, school buses, carpools, and rideshares – are also areas where ventilation improvements can be applied to reduce the spread of the virus and lower the risk of exposure.

Tools to Improve Ventilation

Many of the interventions, listed below, are based on the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Guidance for Building Operations during the COVID-19 pandemic. These have been known before (as per previous publications) but are finally now being acknowledged more widely.

The following tools identify ways to improve ventilation:

- Increase the introduction of outdoor air:
    - Open windows and doors, when weather conditions allow, to increase outdoor airflow. Do not open windows and doors if doing so poses a safety or health risk (e.g., risk of falling, triggering asthma symptoms) to occupants in the building. Even a slightly open window can introduce

beneficial outdoor air.
    - Open outdoor air dampers beyond minimum settings to reduce or eliminate HVAC air recirculation. In mild weather, this will not affect thermal comfort or humidity. However, this may be difficult to do in cold, hot, or humid weather, and may require consultation with an experienced HVAC professional.
- Use fans to increase the effectiveness of open windows.

- Rebalance or adjust HVAC systems to increase total airflow to occupied spaces where possible.
- Turn off any demand-controlled ventilation (DCV) controls that reduce fresh air supply based on occupancy or temperature during occupied hours. In homes and buildings where the HVAC fan operation can be controlled at the thermostat, set the fan to the "on" position instead of "auto," which will operate the fan continuously, even when heating or air-conditioning is not required.
- Improve central air filtration: Increase air filtration to as high as possible without significantly reducing design airflow.
- ASHRAE has similar guidance; however, they recommend a minimum filtration efficiency target of MERV 13, provided there are no substantial negative impacts on the HVAC system performance and occupant comfort. A MERV 13 filter is at least 50 per cent efficient at capturing particles in the 0.3 ?m to 1.0 ?m size range and 85 per cent efficient capturing particles in the 1 ?m to 3 ?m size range.
- Filter efficiency is especially helpful when enhanced outdoor air delivery options are limited.
- Make sure air filters are properly sized and within their recommended service life.
- Inspect filter housing and racks to minimize air that flows around, instead of through, the filter
- Ensure restroom exhaust fans are functional and operating at full capacity when the building is occupied.
- Inspect and maintain exhaust ventilation systems in areas such as kitchens, cooking areas, etc.

- Use portable high-efficiency particulate air (HEPA) fan/filtration systems to enhance air cleaning (especially in higher risk areas such as a nurse's office or areas frequently inhabited by people with a higher likelihood of having COVID-19 and/or an increased risk of getting COVID-19).
- Generate clean-to-less-clean air movement by evaluating and repositioning as necessary, the supply louvers, exhaust air grilles, and/or damper settings. This recommendation is easier to accomplish when the supply and exhaust points are located in a ceiling grid system.

Carbon Dioxide (CO_2) Monitoring

Under the pandemic response, a pragmatic application of portable CO_2 measurement tools is a cost-effective approach to monitoring building ventilation. The CO_2 meter can be purchased for under $300 and its measurements can be collected andlogged near the breathing zones of occupied areas of each room. Under this approach, the HVAC outdoor air dampers could be set to introduce more outdoor air than code requires (as recommended by CDC and ASHRAE). One potential target benchmark for good ventilation is CO_2 readings below 800 parts per million (ppm). If the benchmark readings are above this level, re-evaluate the ability to increase outdoor air delivery. If unable to get below 800 ppm, increased reliance on enhanced air filtration (including portable HEPA air cleaners) will be necessary. Note however that CO_2 concentration is not an indication of presence or, if present, concentration levels of COVID- 19.

Temperature and Humidity

Both temperature and humidity can influence the transmission of infectious diseases, including COVID-19, but that influence has practical limitations. Research on the impact of temperature has shown that SARS-CoV-2, the virus that causes COVID-19, is sensitive to elevated temperatures, with over 99.99 per cent inactivation in only a few minutes at 70 degrees C (158 degrees Fahrenheit). So, elevated temperatures offer the potential for decontamination of SARS- CoV-2 virus in the air or on surfaces, but the use of increased temperature solely for decontamination is not realistic for occupied spaces. Another important consideration is that when the temperature in a space is elevated, the corresponding relative humidity level decreases.

Current evidence is not persuasive that humidity significantly reduces transmission of SARS-CoV-2 beyond the level resulting from good ventilation and filtration. Some research studies have shown that the survival of viruses, including human coronaviruses, may be reduced when the relative humidity is in the 40–60 per cent range. However, the reductions are modest and there are outliers to these findings. Consequently, neither ASHRAE nor CDC recommends introducing humidification for the sole purpose of limiting transmission of COVID-19. While not affecting transmission, there are peer-reviewed studies that suggest preventing excessive dryness in the air could help maintain the effectiveness of the human body's immune system. Low moisture content in the air also means the air is less dense and can travel further.

Ultraviolet Disinfection.

Use ultraviolet germicidal irradiation (UVGI) as a supplemental treatment to inactivate SARS-CoV-2 when options for increasing room ventilation and filtration are limited. It can be used to provide air cleaning within occupied spaces, and in-duct UVGI systems can help enhance air cleaning inside central ventilation systems. HVAC air disinfection UVGI systems generally require more powerful UV lamps or a greater number of lamps, or both, to provide the necessary UVGI required to inactivate pathogens in a short period of time. Air disinfection systems are often placed downstream of the HVAC coils. This location keeps the coil, drain pan, and wetted surfaces free of microbial growth and also disinfects the moving air.

Far-UV (or Far-UVC)

Far-UV is one of many emerging technologies that have become popular during the COVID-19 pandemic. While standard UVGI fixtures emit UV energy at a wavelength around 254 nanometers (nm), far-UV devices use different lamps to emit UV energy at a wavelength around 222 nm. Aside from the wavelength, a major difference between the two technologies is that standard UVGI systems are specifically designed to avoid exposing people to the UV energy, while many far-UV devices are marketed as safe for exposing people and their direct environment to UV energy. A review of peer-reviewed literature indicates that far-UV wavelengths has the potential to inactivate microorganisms, including human coronaviruses, when appropriate UV doses are applied. Like with most technologies, it should be adopted on a case by case basis.

Detection of COVID-19 in the Air

There is increased funding being made available to research detection of COVID-19 in the air. Examples include “Scout”, “Bio-cloud”’ and “AerosolSense” to name a few. If the virus can be detected in sewer systems, why not in the air? Will our governments look at funding such technologies in Australia?

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