WATER QUALITY & HEALTH COUNCIL
PERSPECTIVES

Airborne Coronavirus: What We Know Can Help Prevent Illness

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In a nutshell…

This article reports on a recent virtual workshop on the airborne transmission of coronavirus (SARS-CoV-2). Based on the state of knowledge of this mode of virus transmission, experts outlined recommendations for modifying human behavior and indoor spaces to help avoid coronavirus infection.

Coronavirus (SARS-CoV-2) is unleashed into the air in a respiratory cloud when an infected person breathes, talks, laughs, sings, coughs, or sneezes. The louder and more forceful these activities, the greater the potential for discharging a larger number of coronavirus-laden particles in that cloud. That is just one of the interesting findings revealed, with vivid images (see at right), by researchers during last week's two-day virtual workshop, "Airborne Transmission of SARS-CoV-2." Hosted by the National Academies of Sciences, Engineering, and Medicine, the event drew approximately 3,000 simultaneous viewers from around the world. The point of the workshop was clear: As the global community awaits effective pharmaceutical interventions for coronavirus, a concurrent effort to understand the virus' airborne transmission can help reduce infections by informing human behavior and the design of indoor spaces, especially indoor air ventilation. This report on the workshop includes some findings that may not yet have been published.

Still image from a "shadowgraph" video of the respiratory exhalations of two people in normal conversation. From a publication by Tang et al. 2011 and available on YouTube

Plume Scale vs Room Scale

When a person breathes, talks, laughs, sings, coughs, or sneezes, respiratory particles of a wide range of sizes are released into the air. One can think of these particles as tiny packets of mostly liquid (saliva and mucous), which can potentially include viruses. The largest of these particles, sometimes characterized as respiratory "droplets," exit as a plume and trace downward curved, "ballistic" paths that travel laterally a meter or two through the air in response to gravity, before settling on tables, floors, or other surfaces, including people. Aerosols, on the other hand, are very small particles that can waft through the air, staying suspended for hours and covering greater distances (up to many meters) than their heavier counterparts. Aerosols may be critically important in spreading coronavirus[1]. The smallest of these aerosols can travel the farthest, commonly **beyond** the six feet of "social distance" recommendation of the current pandemic, and fill a room. Acrylic barriers and plastic face shields, meant to help prevent contact with respiratory particles may be most effective in limiting contact with heavier droplet particles, but may be ineffective in preventing our exposure to aerosols.

An Artificial Distinction

In considering respiratory particles, the scientists gathered at the workshop agreed that the widely used dividing line of five microns[2] (diameter) for separating aerosol particles from larger droplets is artificial and without scientific support. In reality, we emit a continuum of particle sizes from large droplets to single digit micron diameter sizes. There is evidence that respiratory particles up to about 20 microns in diameter can be aerosolized, remaining in the air for up to one minute or longer.

Importantly, room ventilation, from an open window to a rapid air handling system, helps reduce exposure to virus-laden aerosols. The higher the rate of delivery of fresh air, the better. Additionally, filtering air can supplement ventilation and further reduce exposure to the virus.[3] The experts note, however, controlling coronavirus emission at the source, aptly defined as "source control," is more effective than controlling the environment. If a room cannot be properly ventilated, for example, it should not be crowded with people. But how is crowding defined? Crowding in a room depends not only on ventilation, but also filtration, and social distancing.

The virus survives best in the dark and in cool and dry environments. Sunlight, warmth, and humidity help destroy it, according to workshop participant Dr. Emmie deWit of the National Institute of Allergy and Infectious Diseases. The diameter of the virus-laden particles appears to affect infectivity; smaller particles can go more deeply into the lungs, possibly resulting in more severe infections. That said, asymptomatic and presymptomatic people (people infected but without symptoms and people infected but not yet showing symptoms, respectively) are known to spread the virus, which is evidence that aerosols produced during normal breathing and talking carry the virus. Widespread viral infection in hospitals also supports aerosol transmission.

Layering Coronavirus Protections

A major conclusion of the workshop was that for optimum protection, we need to *layer* science-based recommendations for preventing coronavirus infection. A layered approach combines human behaviors with modifications of the built environment and can reduce the risk of infection by a factor of between two and five. These recommendations include:

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[1] See, for example, Morawska, L. and Cao, J. (2020). Airborne transmission of SARS-CoV-2: The world should face the reality, *Environ. Int.*, 139: 105730. Online, available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151430/

[2] One micron is one-millionth of a meter and 0.00004 inch. For perspective, the diameter of human hair ranges from 17 to 181 microns.

[3] See, for example, Morawska, L. et al. (2020). How can airborne transmission of COVID-19 indoors be minimized? *Environ. Int*., 142: 105832. Online, available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7250761/

- Wear face masks in public, whether indoor or outdoor. Face masks limit the transfer of virus *from* the wearer by approximately 50-90%. They also limit the transfer of viruses *to* the wearer by approximately 25-90%. Additionally, they reduce ballistic delivery (e.g., by sneezing or coughing) of the respiratory plume.
- Ventilate based on room occupancy (e.g., six liters of air per second per person) and filter indoor air to reduce aerosol virus transmission. Opening windows helps reduce the density of respiratory particles aloft.
- Limit the number of people in a public indoor environment consistent with the air ventilation rate while encouraging occupants to wear masks and socially distance.
- When face-to-face contacts are necessary, try to conduct as many as possible outdoors.
- Clean and disinfect floors, surfaces, and clothing where larger respiratory particles (droplets) settle. As these infectious particles may be disturbed if resuspended, personal protective equipment and appropriate protocols are needed for workers. Disinfectants known to destroy the coronavirus can be found on the U.S. Environmental Protection Agency's List N. Regular household chlorine bleach can also be used.
- Practice good hand hygiene, washing hands frequently and thoroughly.

A "Wicked Problem"

The virus that has circulated the globe and continues to impact our lives remains the subject of intense study. The workshop participants identified many areas of future research, including:

- How humans generate infectious aerosols and how those aerosols change over the course of an illness,
- The characteristics of a virus "super-spreader,"
- The effects of age, sex, and health status on disease severity,
- Designing the optimum face covering.

The virus and its control were described repeatedly as a "wicked problem," spanning both the physical and social sciences. After all, up to 45% of transmission may be by people who have no symptoms and therefore no awareness of their potential to spread illness simply through breathing and talking! All told, the workshop sharpened the focus on what we know and what we have yet to tackle to better prevent coronavirus infection.

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