

THE *LANCET* COVID-19 COMMISSION  
TASK FORCE ON SAFE WORK,  
SAFE SCHOOL, AND SAFE TRAVEL

**Building-related risk  
factors are a critical,  
but missing, component  
of SARS-CoV-2 outbreak  
investigations**

MARCH 2021



The *Lancet* COVID-19 Commission

Task Force on Safe Work, Safe School, and Safe Travel



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COVID-19 COMMISSION

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For more information about the *Lancet* COVID-19 Commission, please visit [www.covid19commission.org](http://www.covid19commission.org).

The following report has been posted online by the Commission Secretariat, and has not been peer-reviewed or published in *The Lancet*, nor in any other journal. This reports intends to bring together expert views on key topics as the COVID-19 pandemic unfolds.

SARS-CoV-2 is a virus that can spread through the air in small droplets called respiratory aerosols.<sup>1,2</sup> The concentration of virus-laden respiratory aerosols is greatest close to an infectious person. Respiratory aerosols can also accumulate indoors in rooms with low ventilation or poor filtration, making transmission beyond two meters (six feet) an important and relevant exposure pathway in these circumstances.

Despite this knowledge, investigations of COVID-19 case clusters repeatedly fail to assess the role of building ventilation systems in disease transmission. Here, we provide three examples of cluster investigations – two recent reports from the U.S. Centers for Disease Control and Prevention (CDC) and one report from an investigation of a hospital outbreak earlier in the pandemic – to illustrate the shortcomings and potential implications of failing to collect this information.

1. [A CDC Morbidity and Mortality Weekly Report \(MMWR\) from February 24, 2021, reported on a case cluster where 55 of 81 people attending an exercise class later tested positive.](#)<sup>3</sup> The investigation included thorough contact tracing and collection of demographic data and laboratory SARS-CoV-2 test results. With regard to the infection control measures that were in place, the report noted that six foot distancing was maintained but most attendees did not wear masks. No formal evaluation of the ventilation or filtration was performed, despite the recognition that, “inadequate air circulation might have exacerbated transmission in the building, which was not originally designed for exercise classes.” The primary recommendation presented in the Summary and Implications section was to reinforce the importance of mask wearing. They went on to recommend that facilities enforce six foot distancing and “improve ventilation”. While improving ventilation is mentioned, without knowing specific information on the ventilation rate or system (e.g., mechanical or natural ventilation, air circulation) in the facility during the outbreak or what filters were in place, there is no way to formally evaluate the extent
2. [A CDC MMWR from February 22, 2021, reported on a cluster of 45 cases in a school district in Georgia.](#)<sup>4</sup> The investigation included extensive contact tracing, as expected, but only reported on three aspects of infection control procedures – plastic dividers were placed on desks, students sat less than one meter (three feet) apart, and while mask use was required, there was inadequate compliance. No formal assessments of the schools’ ventilation and filtration systems were made. Additionally, no information was provided about building layouts and setups, even though this information could be informative for interpreting the case data – for example, including basic information on whether the classrooms had windows that were open or closed. The Discussion section concludes by appropriately highlighting the importance of mask wearing and distancing, but does not mention ventilation or filtration.
3. [Between early March and late April 2020, 39 patients and 80 staff at Netcare St. Augustine Hospital contracted COVID-19, resulting in 15 patient deaths.](#) The ensuing investigation concluded that droplet and fomite transmission were the most likely culprits.<sup>5</sup> This conclusion was predictable; in the section of the report on ‘likely modes of transmission’, the authors stated that existing evidence shows that only two modes of transmission are possible – droplet and fomite. However, the figures presented in the investigation showed that there were several instances where an infector in the intensive care unit, confined to a bed, infected other patients in the room at distances well beyond two meters. Within-room aerosol transmission beyond two meters was not only plausible, but likely, and, at a minimum, warranted investigation. The investigators do mention airborne transmission, but only narrowly: “Aerosol transmission may be

possible in specific circumstances and settings in which aerosol-generating procedures (AGPs) are performed (e.g., endotracheal intubation and manual vent before intubation).” However, aerosol emissions do not occur only during AGPs. In fact, aerosol emission rates from regular breathing exceed emission rates from aerosol-generating procedures.<sup>6</sup> The authors conclude, without formal investigation, that: “There is no evidence to suggest aerosol transmission contributed to the outbreak at St. Augustine’s Hospital.” In a subsequent news article about the investigation, the lead investigator stated, “We think in the main it’s likely to have been from [staff] hands and shared patient care items like thermometers, blood pressure cuffs, and stethoscopes.”<sup>7</sup> These conclusions have important implications for the hospital’s infection control strategy. Additionally, without a formal evaluation of the hospital’s ventilation and filtration strategy, there is no way to know how much within-room aerosol transmission beyond two meters contributed to the outbreak. As a result, this hospital may be devoting limited resources to address a minor mode of transmission (fomite) over a more likely mode (airborne).

The CDC and the infectious disease community should more closely align with building scientists and mechanical engineers for all future outbreak investigations of respiratory pathogens. Future investigations of COVID-19 outbreaks must not dismiss the potential for airborne transmission, and must include a thorough evaluation of the ventilation and filtration control strategies in place. This includes basic information on the type of ventilation system (e.g., mechanical or natural ventilation), whether the ventilation system was operating at the time of presumed disease transmission and at what level, the total volumetric outdoor air flow rate, the percent of outdoor air versus recirculated, the level of filtration (e.g., MERV 8 or MERV 13), location of supply and exhaust diffusers, presence or absence of operable windows, and/or use of portable air cleaning devices. In addition to evaluating building system performance, forensic investigations should also track key health performance indicators of indoor

air quality where possible, such as using real-time monitors to measure carbon dioxide as a proxy for ventilation.

A famous maxim in the business world is that we can’t manage what we don’t measure. The same applies for the medical and scientific fields. For an infectious disease that spreads through the air, a cluster investigation that does not include an assessment of the design, operation, and objective performance of the building’s ventilation system is incomplete. We are failing to collect valuable information on these outbreaks, and therefore are missing an opportunity to fully understand disease transmission dynamics – an understanding which can help inform decisions regarding the most effective risk reduction interventions in offices, schools, healthcare, manufacturing, and more.

#### Endnotes

- 1 Allen JG, Marr LC. Recognizing and controlling airborne transmission of SARS-CoV-2 in indoor environments. *Indoor Air* 2020; 30(4): 557-8.
- 2 Morawksa L, Milton DK. It is time to address airborne transmission of coronavirus disease 2019 (COVID-19). *Clinical Infectious Diseases* 2020; 71(9): 2311-3.
- 3 Lendacki FR, Teran RA, Gretsck S, Fricchione MJ, Kerins JL. COVID-19 Outbreak Among Attendees of an Exercise Facility — Chicago, Illinois, August–September 2020. *MMWR Morbidity and Mortality Weekly Report* 24 February 2021; 70(9): 321-5.
- 4 Gold JAW, Gettings JR, Kimball A, et al. Clusters of SARS-CoV-2 Infection Among Elementary School Educators and Students in One School District—Georgia, December 2020–January 2021. *MMWR Morbidity and Mortality Weekly Report* 22 February 2021; 70(8).
- 5 Lessells R, Moosa Y, de Oliveira T. Report into a nosocomial outbreak of coronavirus disease 2019 (Covid-19) at Netcare St. Augustine’s Hospital, 15 May 2020.
- 6 Wilson NM, Marks GB, Eckhardt A, et al. The effect of respiratory activity, ventilatory therapy and facemasks on total aerosol emissions. *medRxiv* 2021.
- 7 Nordling L. Study tells ‘remarkable story’ about COVID-19’s deadly rampage through a South African hospital. *Science*. 25 May 2020.