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February 2022

Schoolroom COVID-19 Safety Monitoring and Securing Wholesome Ambient Air

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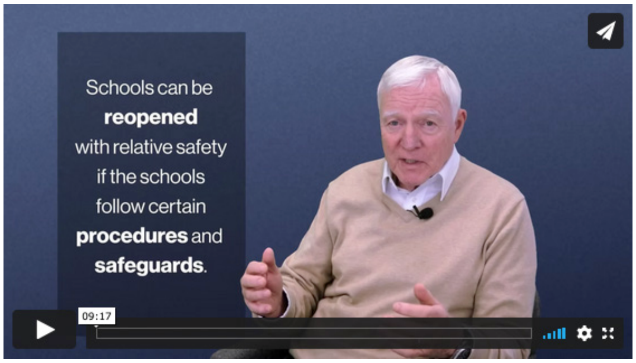
School Administrators (see page 4)

Although the interaction and safeguards relative the SARS-Co-V2 virus and school facilities has been erratic and evolving, we now have insight into both the degrading impact of shutting down school buildings and patterns for assuring safer schoolrooms.

In conjunction with other COVID-19 safeguards we need to review our approach for managing school facilities. Facility hygiene in general, but especially monitoring ambient air in individual schoolrooms requires a virus sensitive approach.

The Singular Objective

The objective for COVID-19 facilities control is to support our natural immune systems. That is the identical goal of vaccinations, masking, isolation/quarantine, and other personal protection practices.



We are gifted with remarkable protection through our internal immune system (see our attached paper *The Immune System and Schools Addressing COVID-19*).

Even as people have adjusted their lifestyles to support personal and community health, school facility management also must adjust its operations. Since the source of contamination is from **within** the schoolroom, the rooms must be addressed individually.

Changing Focus

When we first realized we were facing a virus-based pandemic in 2019 there was confusion and differing information from respected public and private sources. Initially there was a focus on compulsive hand washing, sanitizing applications and then what was termed, “repetitive deep cleaning” of surfaces in schools.

The CDC estimated that up to $13 billion ($260 per student nationally) was spent on laboriously wiping and re-wiping surfaces in schools. This absorbed significant staff time, including the valuable time of educators. The Johns Hopkins School of Public Health reported that nearly 75% of surveyed American teachers indicated they were spending professional time repetitively wiping down classroom surfaces.

Presently the clear consensus among public health researchers is that, while general surface area hygiene may be helpful, resources spent repetitively deep cleaning is of minimal value. We now understand that the SARS-Co-V2 virus infection is almost exclusively spread through inhalation of exhaled breath containing bronchial fluid embedded with the virus from infected, often asymptomatic, individuals in close proximity over an extended period of time.

Limiting the burdens of excessively inhaling another's exhalations, must be the focus of revised COVID-19 school facility management.

As you exhale, your breath emits a huge number of microscopic "bubbles." These thin membraned sacks of bronchial fluids are pushed into the atmosphere. Each bronchial fluid bubble is embedded with thousands of particles and chemicals including proteins, peptides, RNA, DNA, traces of hormones, and, if a person is infected, tiny SARS-Co-V2 viruses.

If you exhale in a cold area you observe a white mist of warm moisture particles, visible only for a moment, until their temperature equalizes with the surrounding air. Due to their small size the cloud of exhaled breath containing sacks of bronchial fluid tends to float erratically until they burst or gravity pulls the microscopic sacks of bronchial fluid to the ground.

If one is outside, the suspended bronchial fluid is quickly diluted and the virus constituents are destroyed. Transmission through inhaling the exhaled breath of someone infected is possible but unlikely when a person is out-of-doors.

The primary objective of COVID-19 new era school facility management is to monitor and, if necessary, respond to contaminated ambient air in schoolrooms as identified through testing rooms.

Schoolroom Ventilation and Circulation

Shortly after the May 2020 murder of George Floyd in Minneapolis a large tightly packed crowd of protesters marched in downtown Minneapolis for several hours, typically without masking. There was concern by the Minnesota Department of Health that many would be contaminated by SARS-Co-V2 virus. Although there were almost certainly asymptomatic individuals in the group, after extensive outreach and testing, no significant contamination was identified. Almost simultaneously a nearby hospital that had institutionalized distancing, masking, and intense deep cleaning experienced a "super spreader" event with tragic consequences.

This was one of many examples identifying ambient air as the primary vector of exposure. The hospital had extensive filtering within their air handling system (a 13 MERVE rating) which filtered incoming air but in doing so as a consequence of aggressive filtering possibly limited the volume of air exchange. The focus on building wide air exchange may have made things worse and it is unlikely that it had any significant value since the contamination was from person to person within a hospital room.

The outdoor event not only had sunlight with UV radiation degrading the virus embedded in exhaled bronchial fluid but more importantly there was almost instant dilution in the outdoor ambient air. This event corresponded to the Washington state Skagit choir super spreader experience, in which 58 of 62 choir members contracted COVID-19 after a prolonged choir practice in a poorly ventilated room. Indoor air contamination represents the most significant COVID-19 risk.

On May 7th 2021 the Centers for Disease Control and Prevention formerly published that aerosol transmission of SARS-CoV-2 was absolutely the primary cause of COVID-19 disease. Later that month the Johns Hopkins Bloomberg School of Public Health published that, "… improvements in ventilation in K12 schools can decrease the risk of SARS-Co-V2 spread."

The main school facility management objective, we now understand, is to limit prolonged indoor air inhalation of the exhalations of others in the same room. This may be accomplished by limiting occupancy and/or increasing the amount of fresh air introduced into rooms and assuring responsible circulation once the air is introduced. This should now become the primary objective of school maintenance relative to the prevention of COVID-19.

The COVID-19 impact in Korea occurred somewhat prior to the disease being introduced into the United States and Canada. The Korean government responded quickly to COVID-19 by promoting deep cleaning surfaces and installing plastic dividers around individual students. The objective was to reduce touching contact under the assumption that touching was a primary route of exposure. The unfortunate consequence was that the barriers prohibited fresh air circulation and promoted the spread of exhaled bronchial fluid and consequently COVID-19.

The objective of virus sensitive school facility maintenance is to support proper ventilation and assure appropriate circulation individually in each schoolroom.

This is a significant challenge for many school districts. In June of 2020 the Government Accountability Office (GAO) completed an in-depth survey of American schools finding that 41% needed to update or replace the ventilation systems. The increase in pre COVID-19 virus-based influenza among schools with inferior ventilation/circulation systems was well documented.*

The wholesomeness of the ambient air with individual schoolrooms is of primary concern. Air exchange includes ventilation, volumes of air turnover, type of filtering, and the patterns of circulation.

Schoolroom Safety Through Differential Carbon Dioxide (dCO2)

Obviously, it makes sense for a school district to review the characteristics of each building's overall HVAC systems, but there also must be a schoolroom by schoolroom assessment of risk based on the probability of contamination. The most responsible pattern for securing this profile of safety is to calibrate the potential for airborne exposure through measuring the carbon dioxide (CO_2) thresholds in each room, in comparison to the CO_2 threshold outside the building. This process is identified as the Differential Carbon Dioxide rating or dCO_2. This numerical, individual schoolrooms rating will provide critical information for the facility management.

The necessary testing protocol involves inexpensive equipment however, the sampling and interpretation of the readings must follow established guidelines. This process is illustrated in attached videos. It essentially involves measuring the carbon dioxide burdens outside the school building and then comparing the readings to CO_2 burdens inside each room or section of a room if circulation is an issue. Although there are several other elements that need to be taken into consideration, the difference between these two numbers directly corresponds to the probability of one individual inhaling the bronchial fluids of another person's exhalations. The dCO_2 reading provides an indication of the risk of contracting COVID-19 in the room.

*Indoor Air. 2017; 27(6):1039-1051.

FOR SCHOOL ADMINISTRATORS

Support for Schoolroom Differential CO2 Testing (dCO2)

The dCO2 process is inexpensive to implement and maintain. If you wish support for working with dCO2, please contact us at **admin@envrc.org**.

1. **Equipment**
   Obtain a responsible CO2/humidity monitor. The costs tend to be around $350 +/- and a single unit can be repeatedly used to support a number of rooms. Test results are instantaneous.
2. **Background CO2**
   Following protocols draw a CO2 reading outside the building.
3. **Schoolroom CO2**
   At specific times relative to room occupancy take several spaced CO2 readings within a room.
4. **Schoolroom Specifics**
   Identify characteristics within the room which might influence sharing breathing zones.
5. **Calculate Room and Building dCO2**
   Compare readings within the building. Room safety and problematic building areas will be identified.

Standardized readings within the room indicate proper circulation and a single reading can be taken in the future.

You will rapidly have indications of risk among rooms which can be utilized to profile sections of the building, and the entire building.

Although the dCO2 process has been successfully used in Europe no regulatory agency has established a threshold of safety for schoolroom dCO2. What a school can presently develop is a rank order of relative safety as relates to exposure. If there is a room or section of rooms where the dCO2 is substantially higher than another area or room, building facility managers can prioritize areas or rooms for review and response.

We have been involved in conducting an analysis of 1888 schoolrooms within 48 school buildings and have general benchmarks to help identify relative schoolroom risk allowing facility managers to prioritize areas of concern. As we continue to test schools and individual schoolrooms the confidence level in identifying problem areas become progressively more specific. The state of California is also in the process of establishing schoolroom CO2 thresholds.

Among the 48 buildings we found the outside ambient air to have a CO2 range of 315 parts per million (ppm) to 481 ppm. These figures were calibrated against CO2 burdens inside classrooms. The dCO2 the findings ranged from only a little over 0, meaning the air inside the classroom was close to outside ambient air, to a little over 250 with the mean average around 100. It made sense for us to identify about 20% of the rooms which had dCO2 readings above 150 which were then prioritized for monitoring. This also means that we could provide positive comments relative to the probable safety of around 80% of the rooms. Facility managers were able to typically adjust ventilation and circulation systems and/or make responsive recommendations regarding reduced room occupancy. For some of the rooms with extremely high readings the placement of a $500 portable high efficiency silent particulate freestanding air purification system within in the room would adjust the risk ratios.

Considering that the contamination sources are generated within the room by occupants, adjustments within the air handling system have limited value beyond increasing air exchange rates with careful considerations for circulation. The use of ionization or UV radiation systems within the air handling structure would be unlikely to have significant impact on room generated viruses.

Comment and Conclusion

Concerns regarding school ventilation and circulation have been a documented public health concern for decades. The high probability of virus exposure relating to influenza was identified by public health researchers in the 1990s as being exacerbated by inadequate schoolroom ventilation and circulation. Now, with the COVID-19 pandemic, documenting safe ambient air within individual schoolrooms becomes fundamental to schoolroom safety.

Eventually there will be regulation and likely standards for schoolroom dCO2 thresholds enforced by public agencies. Some states have such regulations being developed. Presently, for responsible school leaders, securing schoolroom specific data to promote schoolroom safety should be established as soon as possible.

A readable description of school air quality and COVID-19 has been created by the Johns Hopkins Bloomberg School of Public Health:

Olsiewski PJ, Bruns R, Gronvall GK,et al. School Ventilation: A Vital Tool to Reduce COVID-19 Spread. Baltimore, MD: Johns Hopkins Center for Health Security; 2021.

A review of guidelines of health and social related considerations for school reopening has been produced by the Academies of Science, Engineering, and Medicine:

Consensus Study Report from the National Academies Press. 2020; doi:17226/25858.

