Dry Hydrogen Peroxide: A Novel Solution for Providing the Best Environment for K-12 Private and Public Schools

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The spread of infection within schools has a broad-reaching impact on students, teachers, and the community at large. Children suffering from infections, be it the common cold or “stomach bug,” not to mention asthma and allergy symptoms resulting from exposure to molds or poor indoor air quality, often miss critical days of learning. These school absences are not only risk factors for low achievement and school drop-out,[1] but can be a real burden to families and caregivers who must also miss work to care for the sick children. Similarly, when teachers miss work because of infection—which, according to some research, happens even more often than children’s absences, there is a very real cost in terms of time, money, and student learning.[2]

Studies show that reducing the number of “bugs” or microbes (e.g. bacteria, viruses, and molds) living in an environment, lessens the risk of infections and can reduce troublesome allergic symptoms.[3-4] And while attempts have been made to reduce these numbers through improved manual cleaning and disinfection initiatives, research conducted in the healthcare setting shows that they can be costly and just do not get the job done well.[3]

An innovative technology has emerged to support and enhance environmental cleaning and disinfection efforts in schools. Synexis®’ dry hydrogen peroxide (DHP™) technology is a microbial reduction system that provides a continuous and effective mechanism for reducing microbes and disease-carrying pests in the air and on surfaces.[5-6] DHP™ has a 14-year history of effectively reducing environmental microbes in a wide range of settings from farms to food processing facilities, and it is now being used in a number of large healthcare systems and educational facilities across the country.

This technology, which invisibly delivers a gas composed of dry hydrogen peroxide molecules generated from a room’s ambient humidity and oxygen, is fully automated so there is no need to train staff and no impact on school operation. Further, it provides continued microbial reduction, regardless of whether students and staff are in classrooms. This is in stark contrast to other “no-touch” methods, which can only be used for disinfection when buildings are vacant.

From the Centers for Disease Control and Prevention (CDC) to the American Academy of Pediatrics and any of a number of government, accrediting, and professional organizations, the consensus is clear: reducing environmental pathogens—or microbes that cause infection—is an important step towards reducing infection transmission.[7-8] And, in turn, a reduction in these illnesses can potentially reduce school absenteeism, leading to better outcomes for students and society at large.

Introduction

Missed school, or school absenteeism, due to illness is a real problem, and the numbers are staggering. According to pre-pandemic data from the Healthy Schools, Healthy People program, a collaboration between the CDC and the American Cleaning Institute, more than two-thirds of school-aged children in the United States (32 million) miss school each year owing to infection or injury, while nearly 22 million school days are lost annually to the common cold alone.[2] Diarrheal illness is responsible for roughly 25 missed school days per 100 Americans each year and seasonal influenza is notorious for impacting school absenteeism.

Allergic disease, ranging from "hay-fever" symptoms to allergic asthma, is another major culprit for missed school days. Given that 1 in 13 children suffer from asthma, it is little surprise that, according to the Environmental Protection Agency (EPA), asthma is the leading cause of school absenteeism due to chronic disease.[9]

The challenge lies in the setting. Schools are often "tight quarters," bringing students and staff into close contact with one another and allowing ample opportunity for the spread of infection. The CDC has issued guidance for schools designed to help reduce this risk, including recommendations on routine environmental cleaning and disinfection. The EPA provides further guidance on maintaining a healthy physical environment in schools, including "practicing effective cleaning and maintenance, preventing mold and moisture, reducing chemical and contaminant exposures, ensuring good ventilation, and preventing pests and reducing pesticide exposure." Yet many interventions designed to address environmental hazards, such as electrostatic spraying or UV-C irradiation, can only be used when classrooms and other spaces are empty, and therefore can't address the ongoing contamination (e.g. sneezing onto shared surfaces or coughing in confined spaces) that inevitably occurs when children are present. Environmental solutions that can provide continuous reduction of pathogens, pests, and odors when students and staff are present offer an opportunity to enhance a school's environmental cleaning and disinfection efforts.

Environmental Hazards in the School Setting

To best understand how environmental hazards such as infectious microbes, allergy-inducing molds, or toxic chemicals in the school setting can be addressed, it is helpful to understand what they are and how they can potentially impact school communities.

Bugs in Schools: common culprits for illness in the classroom

The most obvious hazards for illness in schools are microbes which are likely to cause human disease and infection (also known as pathogens), particularly in those with chronic illness or immune system problems. Microbes such as bacteria, viruses, and fungi (including molds) can pose potential risks to students and staff alike as well as the overall educational environment. An often-overlooked fact is that many of these pathogens can survive for hours to weeks in the environment if conditions are right. Examples of common school pathogens include:

Bacteria: Methicillin-resistant *Staphylococcus aureus*, or MRSA, is perhaps one of the most well-known bacteria associated with transmission in school settings. Most often, MRSA can cause skin infections, some of which can be difficult to treat. According to the CDC, MRSA can survive for hours to weeks on surfaces ranging from towels to gym equipment, allowing for spread when students or staff come into contact with these items. And contamination with MRSA can be widespread.

In one study, Montgomery et al. detected MRSA on nearly half (46%) of the 90 surfaces tested in athletic facilities among ten different schools.[10]

Molds: Molds are a type of fungus that can contaminate facilities through inadequate maintenance and housekeeping, water spills, inadequate humidity control, or condensation. They can also be brought into the building by occupants or contaminated air. Molds are notorious for causing allergies and, in some cases, infection. People sensitive to molds can experience symptoms ranging from nasal and sinus irritation/congestion to dry hacking cough and skin rashes, while those with severe allergies to molds may suffer from more serious reactions such as wheezing or shortness of breath. Molds can also trigger asthma attacks and studies have shown that schools with mold problems are much more likely to have higher school absenteeism.[11]

Viruses: Viruses responsible for respiratory and gastrointestinal (GI) infections are commonly spread throughout schools. Rhinoviruses and human parainfluenza viruses are examples of viruses responsible for the "common cold" and can be spread through the air via larger respiratory droplets or smaller aerosols released when a person coughs, sneezes, or breathes. Droplets can also fall to surfaces where the virus can survive and then be spread to another individual who touches the surface and then touches their eyes, nose, or mouth. This surface contact can also lead to spread of GI viruses such as norovirus or rotavirus, both of which can "live" on surfaces for extended periods of time.

One of the most problematic viruses in schools is the flu, which infects approximately 20-30 percent of children each year. Not only can the flu virus "live" on surfaces for up to 2 days, but it can also circulate in the air in doses large enough to cause infection. In a recent study, Coleman and Sigler identified infectious doses of airborne influenza A virus in multiple locations throughout an elementary school up to four hours after students had left campus, demonstrating that the risk of airborne spread is not limited to when students are present.[12]

The most infamous virus today is SARS-CoV-2, the virus which causes COVID-19. SARS-CoV-2 has had devastating financial, operational, psychological, and public health impacts that will continue to be felt for years to come. Because it is so highly contagious and so widespread throughout communities, schools must now carefully consider and implement a comprehensive approach to maintaining a clean environment. COVID-19 can be spread via environmental surfaces, human hands, respiratory droplets, and airborne aerosols, and outbreaks have been observed in school settings when air circulation/purification is not optimized and when mitigation strategies (e.g. masks, social distancing) are not used.

Importantly, many of these pathogens, including SARS-CoV-2, can be transmitted by students and staff with or without visible symptoms (i.e. those either asymptomatically or pre-symptomatically infected), which can create a truly invisible risk to schools and their communities.

Toxic Chemicals: Volatile Organic Compounds

Volatile organic compounds, or VOCs, are another environmental hazard that can be found lurking in schools. VOCs are a large group of chemicals that are widely present in the indoor environment, including in school settings. They can be found in literally thousands of products including the paint on ceilings and walls, craft or hobby supplies, furniture, cleaning products, and school printers/copy machines, among others. When they are inside a building, the chemicals are released as a gas into the indoor air we breathe. Importantly, they may or may not be able to be smelled, and smelling is not a good indicator of health risk.

And, according to the EPA, the health risks associated with some VOCs are significant. They warn that these can include eye, nose and throat irritation, headaches, loss of coordination, nausea, damage to liver, kidney and the central nervous system. Additionally, some organics can cause cancer in animals, and some are suspected or known to cause cancer in humans.[13] Further, the EPA cautions that while people are using VOCs, they can expose themselves and others to very high pollutant levels, and elevated concentrations can remain in the air long after the activity (e.g. painting) is completed. Accordingly, the EPA advises minimizing the presence of VOCs in the environment, especially for young children and people with asthma, to decrease these potential impacts.

DHP: A Different Approach

The Synexis® DHP™ technology continuously uses dry hydrogen peroxide (DHP™) to reduce levels of harmful bacteria and viruses, fungi, and mold in occupied spaces. The system is also highly effective in eradicating insects; it has been proven in studies to kill bed bugs, lice, fleas, and cockroaches, another potential source of germs and infection. Finally, it is an effective strategy for reducing exposure to VOCs.

So how does it work? The system produces a dry gas, rather than an aqueous vapor, by catalytically converting ambient humidity and oxygen into Dry Hydrogen Peroxide. Whether through a unit installed in an HVAC system or a standalone unit, the DHP gas diffuses invisibly and continuously through the air.

Microbes require water to survive and have electrostatically charged points on their cell surfaces that are designed to attract water molecules. Because DHP™ (H_20_2) molecules are very similar to water (H_20) molecules, they are attracted to these charged points, attacking the microbes, disrupting their cell membranes, and incapacitating them.

In essence, DHP™ cleans every part of the room that air touches – including hard and soft surfaces, floors, walls, windows, doors, and ceilings. And because DHP™ units run continuously, there is less chance for cross-contamination and re-contamination of surfaces.

DHP and SARS-CoV-19

On October 5, 2020, the CDC updated their guidelines to acknowledge the likelihood for airborne spread of SARS-CoV-2, meaning that small virus-containing droplets or particles lingering in the air can infect people who are further than 6 feet away from the person who is infected or after that person has left the space. This position was supported by the investigation of COVID-19 cases spreading between people with no direct or indirect contact, suggesting that airborne transmission was the most likely route.[14] In March of 2021, the CDC went one step further in publishing updated ventilation recommendations designed to help improve air flow and to generate clean-to-less-clean air flow within buildings—all with the goal of reducing the concentration of viral particles indoors.

In an effort to similarly reduce the concentration of SARS-CoV-2 viral particles on surfaces, the CDC has also issued guidance on environmental cleaning and disinfection across a spectrum of settings, ranging from healthcare facilities to schools. This guidance includes use of disinfectants that meet the EPA's criteria for use against SARS-CoV-2.

The EPA states that products approved to make claims against the enveloped virus SARS-CoV-2 must have demonstrated efficacy against harder-to-kill viruses.[15] Specifically, "If an antimicrobial product can kill a small, non-enveloped virus, it should be able to kill any large, non-enveloped virus or any enveloped virus. Similarly, a product that can kill a large, non-enveloped virus should be able to kill any enveloped virus."

DHP has not only demonstrated a reduction of viral load of small, non-enveloped viruses in a number of studies, but also in reducing viral load of a gammacoronavirus, another member of the Coronavirus family. These results show that DHP could be an effective weapon in the battle against the COVID-19 pandemic.

Conclusion

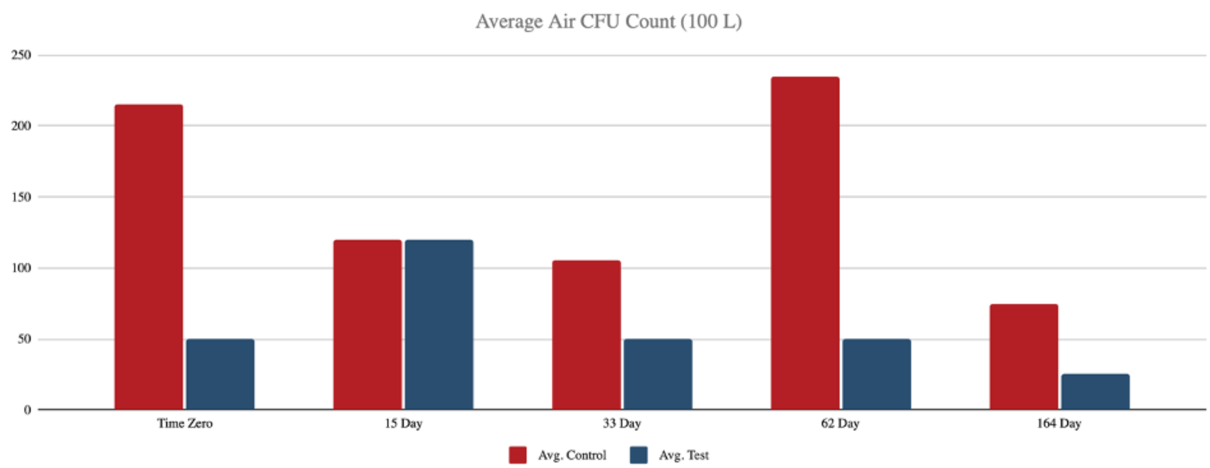
Unlike any of the other available "no-touch" technologies available today, the Synexis® DHP™ system offers a game-changing capability for the ongoing mitigation of microbial threats – even in occupied spaces and hard-to-reach areas throughout a school campus. Operating invisibly around the clock, this innovative, patented technology produces a gas that drastically reduces microbial bioburden without adding to the workload of an already over-taxed cleaning staff.

Other technologies focus on treating either just the air or just surfaces. Synexis® offers this well-established compound in a different vehicle – a near ideal gas that, by continuously diffusing throughout all areas of a treated space, can achieve microbial reduction both in air and on surfaces.

From preschool playrooms to high school labs, where students go, so do viruses and bacteria. And a classroom that's "just been cleaned" is no match for the hotbed of microbes being shared continuously. But DHP is.

Case Study: Bright Horizons Child Care

In 2018, Synexis® DHP™ technology was installed in a Bright Horizons Child Care facility in New York state to augment their manual cleaning and disinfection efforts. The winter months are historically challenging for childcare centers as respiratory viruses ranging from the flu to Respiratory Syncytial Virus (RSV) commonly spread between children, and the winter of 2018 was no exception in this facility's county. However, with deployment of DHP,™ this facility experienced only a single case of the flu (no spread to other students or staff) which was in stark contrast to the other Bright Horizons facilities in the surrounding area. Additionally, they had only three students diagnosed with RSV throughout the winter, again with no documented spread between students.



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