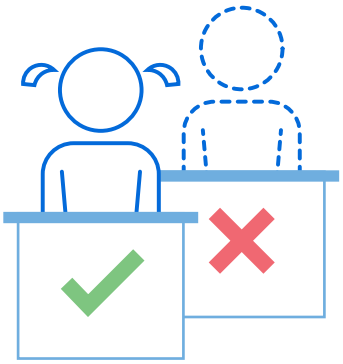
WELLAIR

Cleaner and Safer Learning Environments

It's that important

Clean indoor air ranks as a critical safeguard for preventing illness and absenteeism

Long before SARS-CoV-2, the virus that causes COVID-19, began rampaging the globe, before "hybrid" and "quarantine" entered the educational lexicon, schools faced vexing attendance challenges. Prior to COVID-19, some 16% of U.S. students — 25% to 50% in some cities — missed at least 10% of the school year. Already, the U.S. Department of Education had declared chronic absenteeism a "hidden educational crisis."



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The Crisis is No Longer Hidden

In the pandemic's wake, students in many districts have vanished by the thousands or surfaced sporadically. Absenteeism has reached unprecedented levels and spanned all demographics, putting so much at risk: academic achievement, social skills, graduation rates, employment prospects, lifetime wages. School funding, tied to enrollment and attendance, hangs in the balance, too.

Nationwide, schools are working mightily to bring kids back to class and keep them there. It's a complex enterprise, and obstacles abound — poverty, unstable housing, mental-health struggles, concern about COVID-19 transmission. At the same time, one of the most important strategies for bolstering attendance is also among the most achievable: keeping indoor air clean.

As we now know, SARS-CoV-2 is chiefly spread through the air. "There's an overwhelming amount of evidence — airborne transmission is in fact predominant," says Kim Prather, Ph.D., an atmospheric chemist at the University of California, San Diego.

> ***"We know coronavirus aerosols can hover for hours, travel well beyond 6 feet, and accumulate in a room "just like cigarette smoke,""*** as Prather says.

We know, too, that the virus will not disappear soon, if ever. "COVID-19 may well become seasonal, and we will have to live with it as we do with influenza," an international team of aerosol scientists cautioned in the *British Medical Journal*. Given this reality, the scientists urged schools and workplaces to provide safer indoor environments — not just to protect the unvaccinated and those for whom vaccines fail but also to rein in new SARS-CoV-2 variants and airborne pathogens yet to emerge.

Schools Can Make Us Sick or Keep Us Healthy

"Improving indoor ventilation and air quality," the BMJ team concluded, "will help all of us to *stay safe, now and in the future*."

These same measures also will defend against the germs school buildings have always harbored — influenza, norovirus, cold viruses, strep-causing bacteria — plus the mold, dust, soot, pollen, and chemical contaminants known to exacerbate asthma and allergies. Before Covid, asthma alone accounted for 13.8 million missed school days annually; now, after extended home confinements, students may find their asthma worsened.

> ***For all these reasons, schools must deploy "every control feasible" to keep air clean, from improving ventilation and filtration to adding portable air cleaners, according to a report from the Harvard School of Public Health, written to help schools minimize illness risk. "Schools can make us sick or keep us healthy,"*** the report states.

This has always been true. Even before COVID emerged, the Environmental Protection Agency described air quality in many schools as a "serious health threat." Harvard stated, in its pre-pandemic "Schools for Health" report, an estimated 46% of U.S. public schools, about 60,000 school buildings, faced air-quality challenges, presenting districts with a "prime opportunity to intervene and protect the health of children."

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Cleaning indoor air reduces the risk of infection and illness and instills confidence among parents; confidence begets enrollment and attendance. Air cleared of contaminants may even foster sharper thinking and reading and math achievement, research findings particularly relevant in this crucial catch-up period.

"Better air quality conditions are linked with improved test scores and school attendance," says Sefi Roth, Ph.D., an environmental economist at the London School of Economics.

Students Need School; Schools Need Students

In 2009, on a scorching, windy day, bushfires ripped through a swath of rural Australia, killing 173 residents, burning 2,000 homes, and damaging over 70 schools and childcare centers. Entire townships were destroyed, and displaced students lost months, or more, of schooling. Four years later, the children most affected by Black Saturday, as the disaster is

known, were, on average, still struggling to catch up in math and reading.

Though SARS-CoV-2 is new to the world, educational emergencies are not. From London during the Blitz to New Orleans after Hurricane Katrina, myriad disasters have profoundly disrupted learning.

Some students rebound quickly, others gradually. Still others, an estimated 15% to 30%, struggle with ongoing anxiety, depression, fatigue, and concentration difficulties. Overall, children who've experienced disaster have lower school attendance and more trouble learning than other children, potentially with lasting consequences.

"Their future academic trajectories and life opportunities may be compromised," reported Australian researchers who tracked the Black Saturday aftermath.

In the United States, chronically absent elementary students are less likely than their peers to read proficiently by 3rd grade; in turn, they're four times less likely to graduate high school. Students chronically absent between 8th and 12th grades are over seven times more likely than their peers to drop out.

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All that was known before Covid struck, but now, we've entered uncharted territory. Attendance has dropped in all regions and demographics. In one Mississippi district, it took just three months before 11% of students had met the threshold for chronic absenteeism — and this was a district whose pre-pandemic attendance exceeded 95%.

"What makes the pandemic different is how long it has been going on and how many people are affected," says Betty Lai, Ph.D., a Boston College psychologist who studies how disasters impact students. Now more than ever, students need to attend class. Schools need students just as badly, given that funding depends largely on enrollment and attendance. Some fear a funding "death spiral" if both metrics don't rebound.

A number of states have cut schools a break, temporarily untethering the budget from the number of students who show up. Others have taken a harder line. All schools feel pressure to fill more desks.

> ***"Historically, even a 1% loss in enrollment is financially destabilizing for districts,"*** reports Marguerite Roza, Ph.D., a Georgetown University expert on education finance policy. Even as the pandemic recedes, many districts face drops of 3%, 4%, even 5%.

Mystery Solved: Coronavirus Aerosols Are Infectious

In 1981, seven children contracted measles during a visit to a Georgia pediatrician. Three of them had never crossed paths with the boy identified as the outbreak's source. One arrived at the doctor a full hour after the infected boy had left.

At the time, health experts believed measles was transmitted through large respiratory droplets, the gobs generated by sneezes and phlegmy coughs, and only via close contact. Scientists deemed the Georgia outbreak an outlier, concluding that for measles, "airborne spread is unusual."

Early in the COVID pandemic, authorities made the same erroneous assumption about SARS-CoV-2, declaring aerosol transmission "probably very rare." That position has since crumbled. At first, the evidence was circumstantial: Cruise passengers and choir singers contracted COVID-19 by the hundreds, even though they had not ventured near, or touched the same surfaces as, the origin patients.

Then, direct proof emerged: At several hospitals, scientists plucked coronavirus RNA from the air at a distance from COVID patients — in hallways, above toilets, in rooms where healthcare workers removed their gear. The plot thickened: Were the captured particles actually viable or just harmless fragments of genetic material? The floating particles indeed proved infectious: At a Florida hospital, scientists pulled live coronavirus from the air, 16 feet from a Covid patient, and then cultured the virus in a lab dish.

"If this isn't a smoking gun, then I don't know what is," asserted Linsey Marr, Ph.D., a Virginia Tech aerosol scientist. Case closed. Today, a database that tracks super-spreader events has grown to include over 1,500 such outbreaks worldwide. "Every single one is explained by airborne spread," says Trisha Greenhalgh, M.D., an Oxford University physician. "None is explained without airborne spread."

Influenza, Norovirus and the Common Cold: "These viruses will come back"

Among airborne pathogens, SARS-CoV-2 is the most threatening — to both health and attendance — in school buildings today. But it's not the only germ of concern. Others will resurface as the pandemic fades.

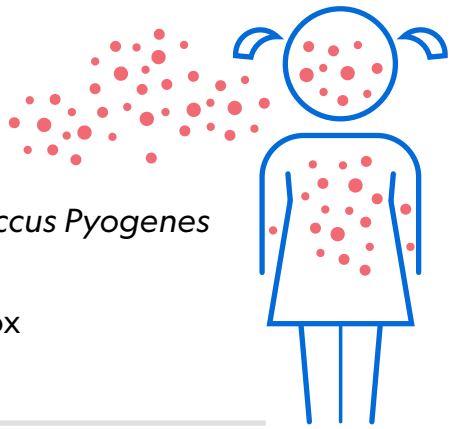
Until Covid struck, "influenza" was the word that most provoked dread among school principals each winter. Like SARS-CoV-2, the flu can spread via aerosol and before symptoms appear, so students who feel fine can trigger an outbreak. During severe flu seasons, absenteeism has exceeded 25% at some schools, prompting entire districts to shut down. "Flu is a major contributor to absenteeism," says Wisconsin epidemiologist Huong McLean, Ph.D., author

of a CDC-funded study on school absences and influenza. Likewise, norovirus, known as the "winter vomiting virus," commonly wreaks havoc at schools. When norovirus struck one Utah school district, 15% percent of students at three elementary schools called in sick. In a Northern California district, the virus sickened nearly 1,000 students and staff at 32 schools. A single vomiting episode can release 13,000 norovirus particles into the air; swallowing just 10 particles can trigger infection.

Then there's *Streptococcus pyogenes*, a bacteria responsible for strep throat. Highly contagious and commonly spread via aerosol, it's been dubbed "an occupational disease of schoolchildren."

Airborne illnesses in schools:

- COVID-19
- Influenza
- Norovirus
- *Streptococcus Pyogenes*
- Measles
- Chickenpox
- Mumps



These airborne illnesses, along with the common cold, are the most prevalent in school settings. However, as Harvard's COVID-era report notes, chickenpox, measles, and mumps also have spread at schools.

"Outbreaks have occurred even in populations of school children with high vaccination rates," the report observes, pressing the case for air cleaning. In 2019, the year COVID emerged, over 1,200 measles cases were reported in the United States. In one Washington district, an outbreak kept 800 exposed children out of school for weeks.

During the pandemic, school mask policies have greatly suppressed the spread of viral and bacterial infections. But when the masks come off, transmission will rebound. It's already happening in the southern hemisphere. With its strict shutdown measures, Australia crushed COVID-19 and, as a bonus, pushed influenza to historically low levels. But when restrictions were lifted, flu cases among young children increased sixfold.

> ***"Eventually these viruses will come back,"*** says Ellen Foxman, M.D., Ph.D., an immunobiologist at Yale University. ***"They always find a way."***

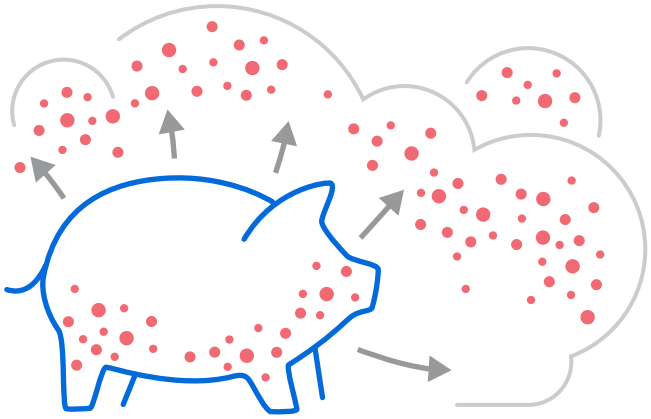
At school, viruses have plenty of opportunity. Particles expelled by infected students or staff — when they cough, talk, or merely breathe — can be inhaled by others or land on desks, books, toys, drinking fountains, and door handles. Though SARS-CoV-2 isn't readily spread via contaminated surfaces, plenty of other pathogens are, including influenza, strep, pink eye, and the common cold.

"Kids have runny noses and wipe their nose and touch their face and their friends and every object around them," notes Werner Bischoff, M.D., Ph.D., an infectious disease expert at Wake Forest University School of Medicine.

Norovirus particles launched by vomit are particularly infectious on surfaces. They're also impervious to common disinfectants and require special cleaning protocols. "Norovirus can hang around for weeks, so anyone who touches that table and then puts

their hand to their mouth could be at risk," says microbiologist Lee-Ann Jaykus, Ph.D., of North Carolina State University. Not only can airborne particles lead to disease transmission via surfaces, but the opposite scenario also can occur: Surface contamination can precipitate aerosol spread.

Aerosols can settle to the ground, where they are resuspended into air just by us walking around," says Virginia Tech's Linsey Marr. "This causes a secondary opportunity for transmission. We call this the Pig-Pen effect."



Pig-Pen Effect

Marr is referring to Pig-Pen, the Peanuts character, an amiable boy known for the cloud of dirt and dust that follows him everywhere. "I'm a dust magnet!" Pig-Pen declared in the famous comic strip.

In truth, we're all dust magnets, and this fact likely plays a role in the spread of illness, at school and elsewhere. All manner of activity can discharge settled pathogens. Crumpling a dry, flu-contaminated tissue releases up to 900 aerosols per second. Crawling across a carpet can shake loose thousands of particles in just 1 minute.

Mopping a vinyl floor, the kind typically found in school cafeterias, unleashes aerosols, too. After cleaning a norovirus-contaminated floor, Brazilian scientists captured over 600 viral particles from the air. "Norovirus can be aerosolized by floor cleaning," the scientists concluded, "and its particles may be inhaled and then swallowed." But it's not just viruses that can be aerosolized and inhaled. It's pollutants, too.

More Students with Asthma: "A long-term legacy of this pandemic"

In an early Peanuts strip, Pig-Pen is described as the only person who could manage to get dirty while walking in a snowstorm. He just can't shake off the dust. Of course, none of us can, and for students with asthma and allergies, that's a serious concern, especially in the age of COVID.

Classrooms, cafeterias, libraries, and gyms, even when cleaned to high standards, are reservoirs for a range of biological and chemical contaminants. Some are emitted within the building, by moldy ceiling tiles, cockroach dander, cleaning solvents, off-gassing carpets, science-lab chemicals, and vaping devices. Other allergens — ragweed pollen, exhaust from idling school buses — waft inside through windows, doors, and air intakes.

> ***"Even the best school has its work cut out in keeping floors and counters free of all that gets into***

school buildings from the foot traffic alone," says Mary Ellen Conley, R.N., a veteran school nurse in Abington, Massachusetts, and board member of the Asthma and Allergy Foundation of America.

In the United States, a lot of students — 10% overall, 20% in some communities — have asthma, and students with asthma miss a lot of school. In fact, before the Covid school shutdowns, asthma accounted for about one-third of all school days missed by K-12 students. On top of that, allergy symptoms — dizziness, nausea, runny nose, watery eyes, skin rash — kept 10,000 children home on any given school day.

For many children with asthma, doctors say, the pandemic has made matters worse. Stuck at home for months on end, some had greater exposure to tobacco smoke and residue, mold, mice droppings, dust mites, or other allergens. Some kids missed out on doctor's appointments, so their asthma may not be well managed.

"Ensuring that those with asthma return to school safely will require diligence and ongoing monitoring," American and Canadian scientists cautioned in The Lancet.

That's not all: In the years to come, schools should expect to enroll even more students with asthma and allergies, "an unfortunate and under-appreciated long-term legacy of this pandemic," says Byram Bridle, Ph.D., a viral immunologist at Canada's University of Guelph.

The pandemic's babies spent unprecedented amounts of time in sanitized environments, apart from kids with runny noses, away from the sandbox and the mud, increasing their risk for developing hypersensitivities. "The immune systems of children," Bridle says, "are not designed to develop in isolation from the microbial world."

Over the course of a K-12 education, a child will spend over 15,000 hours at school. Unless schools rectify their air-quality issues, students with asthma and allergies will spend that time in buildings apt to exacerbate, rather than alleviate, their symptoms.

Mold, Pollution, and Test Scores

These days, we associate school closures with COVID-19, but in the years leading up to the pandemic, plenty of schools shut down because of a different airborne menace: mold.

In 2018, a half dozen New Jersey districts delayed the start of school after a hot, humid summer transformed school campuses into "a Petri dish of mold." A Pennsylvania school shuttered despite a thorough summer cleaning, after mold triggered allergy symptoms in returning students and teachers. In Connecticut, mold infestation caused by poor gutter drainage and condensation on the pipes forced a school to close for the entire spring.

Airborne mold spores not only can intensify shortness of breath in children diagnosed with the asthma but also can promote development of asthma and wheezing in previously healthy kids.

The fungus can grow on damp wood, paper, carpet, even dirty glass panes. As the planet heats up, setting off more severe weather, mold will more frequently infiltrate campuses. Snow build-up on school roofs often leads to ice dams; when the ice melts, water drips into buildings. As hurricane flooding recedes, mold and bacteria sprout from the sludge.

Portable classrooms, used by 36% of U.S. school districts, are particularly susceptible to mold growth. So are windowless rooms, a relic of the 1973 energy crisis that has proven problematic in the Covid era. Though old, rundown buildings tend to invite excess moisture, newer buildings are not impervious. When physicians sampled the air in 180 classrooms at 12 Boston schools, mold was detected in every room. "School age did not correlate with total mold," the doctors reported. Poor ventilation and plumbing problems were among the culprits.

At mold-infested schools, fuzzy, slimy fungal patches are often visible, but invisible allergens, too, infiltrate school campuses. Cleaning chemicals, adhesives, carpet backing, particle board, dry-erase markers, copier ink, newly painted surfaces — all can emit toxic VOCs (volatile organic compounds).

In some regions, classroom concentrations of particulate matter — an inhalable fusion of dust, pollen, mold spores, and chemicals — exceed levels of outdoor pollutants. What this suggests: contaminants generated within a school, by mold, VOCs, and human activity, are combining with particles that waft in from outside, such as auto emissions and pollen.

Breathing this mixture is bad news for students. In general, studies suggest three ways contaminated air may hamper learning: by compromising brain development, by triggering illnesses that depress attendance, and by disrupting students' attention.

It Doesn't Take Extreme or Extended Pollution Exposure to Harm Students

A student sitting for an exam in a room with typical pollution levels will "suffer a substantial reduction in test scores" compared with the scores that same student likely would achieve in a room with clean air, says Sefi Roth, Ph.D., of the London School of Economics.

That's what Roth found after tracking 2,400 university students who took 11,000 exams at multiple locations over multiple days. Poor air quality — as measured right inside the room, not miles away — compromised test results, even when pollution levels fell well below EPA standards.

The effect of contaminated indoor on test scores, Roth says, is "very large." What's more, poor test performance, like poor attendance, can plague students for years.

In an Israeli study, students who took college-admission tests on high-pollution days earned lower scores, on average, than peers who took the same test on days when the air was clean. The disparity proved to be a big deal: A decade later, the students who'd taken the high-stakes test amid poor air quality had completed less college and were earning less than their classmates.

It's evident that contaminated air can harm students' health, depress attendance, hamper learning, and compromise test performance. Intriguingly, research suggests cleaning the air may do the reverse.

Cleaner Air, Sharper Thinking

In 2015, a leaky pipe at an underground natural gas facility released massive amounts of methane into a Los Angeles suburb. The gas leak, the worst in U.S. history, lasted four months and caused 15,000 residents, stricken by nausea, headaches, and nosebleeds, to relocate. It also gave a New York University economist a chance to study the effect of purified air on student academic performance.

Following the accident, the gas company installed air purifiers in every K-12 classroom, office, and common area within 5 miles of the leak. Months of breathing purified air seems to have provided an unexpected benefit to students: a boost in math and reading scores. At the schools within the 5-mile zone, year-over-year scores improved significantly more than at comparable schools just outside the zone.

"The results, from a total of 28 schools, provide clear and convincing evidence" that clean and disinfected air raised test scores, according to the study's author, Michael Gilraine, Ph.D. of New York University. ***"You can get a lot just from being able to think clearly while you take a test,"*** says Gilraine. Day-to-day learning might have improved for the same reason, he says. When schools deliberately clean the air, studies suggest, students perform better.

After the state of Georgia retrofitted 2,600 diesel-spewing school buses, English scores improved to a "meaningful" extent among students who rode the clean buses in comparison with students whose schools did not upgrade their fleet. In a Texas school district, test scores rose after 66 schools renovated buildings — removing mold, repairing roofs, improving ventilation — for the purpose of improving indoor air quality. Mold remediation alone improved the odds a student would pass a reading test by 4%.

A few years back, Harvard's Healthy Buildings program conducted a more direct and elaborate test of clean indoor air on cognitive performance — learning, thinking, reasoning, and so on. Twenty-four professionals, such as architects and engineers, spent six workdays in an office where VOCs and ventilation levels were tightly controlled and systematically altered. At various times, the volunteers were challenged with simulated scenarios, such as managing a crisis as an emergency coordinator.

On average, cognitive scores were 101% higher on the days the volunteers inhaled the cleanest air, compared with the days air quality matched that of a typical office. The authors suggested schools heed the results.

Joseph Allen, Ph.D., the study's lead author, predicts the Covid pandemic will turn clean indoor air — critical for health, a boost to brainpower — into a commodity that businesses will leverage "as recruitment tools and sources of competitive advantage." To be sure, schools can do the same.

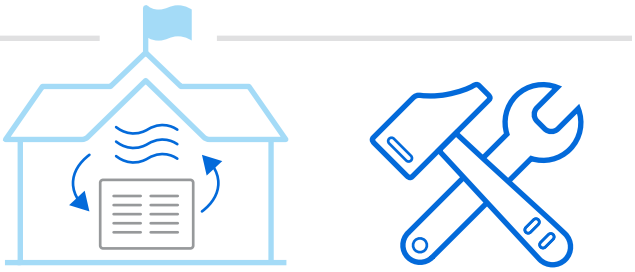
The Pandemic Will Fade, But the Need for Clean Air Won't

At the height of the tuberculosis epidemic, in the 1920s, 150 American cities offered open-air classrooms to children who'd been exposed to TB or were recovering from the disease. Students learned on rooftops, in abandoned ferries, in the park. Period photos show students wrapped in blankets, their feet resting on heated soap stones.

At the time, TB, a lung-attacking bacterial infection, was the leading cause of death in the United States. Scientists hadn't yet proven TB was transmitted via aerosol (or developed the antibiotics that cure the disease), but to many doctors and educators, it was obvious that fresh, clean air would stop the spread. A century later, fresh, clean and disinfected air is still what schools need.

Of course, we can't educate the nation's 56 million students outdoors. Functional windows can help, but the same windows that usher in cleansing breezes also bring pollen, noise, exhaust, frigid air, humidity, and oppressive heat. **Today, delivering clean air to school rooms requires multiple solutions: ventilation, filtration, and air purification and disinfection.**

Yet, as the pandemic has laid bare, our K-12 campuses fall short on all fronts. Some 36,000 schools in the US need repair or replacement of HVAC systems. Even upgrades often fail to produce clean air. In a study of 94 California classrooms that received HVAC retrofits, only about 15% met the state's ventilation standard.



36,000 schools need repair or replacement of HVAC systems

Schools have great incentive to do better, for their students and their budgets. In another California study, researchers found that exceeding the state's ventilation standard could "substantially decrease illness absence," fetching the district an additional $33 million in attendance-linked funding.

But HVAC replacements are expensive and time-consuming, building renovations even more so. For these reasons, many schools are turning to a cost-effective, powerful defense against both pathogens and pollutants: air purification and disinfection technology by WellAir.

WellAir Solutions for Schools

Schools throughout the United States are deploying WellAir's medical-grade portable disinfection devices in their classrooms, offices, cafeterias and gyms. These devices reduce harmful airborne microorganisms using a powerful but safe nanotechnology called NanoStrike™. NanoStrike can inactivate pathogens, like viruses, bacteria and mold, on contact, providing no ability for it to self-heal and reinfect. Quiet and unobtrusive, the devices are simple to deploy and have a very low total cost of ownership.

Reducing live SARS-CoV-2 virus* by 99.99% the virus causing COVID-19

VIRUSES
- SARS-CoV-2
- Influenza A
- Phi X 174
- Norovirus[1]
- Measles[2]

BACTERIA
- MRSA
- *Bacillus subtillis*
- *Staphylococcus epidermidis*
- Tuberculosis[3]
- *Escherichia coli*
- *C. difficile*
- *Bacillus Globigii* endospores

MOLD SPORES
- *Aspergillus niger*

1. Tested on MS2 Bacteriophage, a surrogate for Norovirus.
2. Tested on Human parainfluenza type 3 (HPIV3), a surrogate for Measles.
3. Tested on *Mycobacterium smegmatis*, a surrogate for *Mycobacterium tuberculosis*.

* Utilizing NanoStrike™ Technology, WellAir portable devices can help to remove airborne viruses like SARS-CoV-2 which travel in tiny aggregated droplets that can linger for hours before they settle on surfaces.

WellAir's portable recirculating air cleaning systems, the Defend 400 and the Defend 1050, are cleared by the FDA as Class II Medical Devices for use in healthcare settings such as operating rooms, intensive care units, emergency rooms, waiting and treatment areas, and other critical environments. Schools now are looking to devices such as these to keep their environments clean and safe.

Defend 1050 *Defend 400*

Protect 900

WellAir's HVAC solutions are ideal for larger spaces and whole-building deployment. The entire air purification portfolio has been UL 2998 validated for zero ozone and works well against reducing airborne pollutants and particulate matter. WellAir's surface disinfection solution is one of the only portable handheld UVC solutions to disinfect harmful bacteria and viruses in as little as one second.

AutoClean 1500 *PA 600*

All of the WellAir technologies have been proven, in numerous independent tests, to radically reduce and inactivate airborne viruses, bacteria, fungi and particulate matter and are safe for use around students and staff.

NuvaWave UVC Handheld

From Crises Comes Change

For years prior to the pandemic, virologists warned of a looming global catastrophe. But life is busy; day-to-day problems trump theoretical ones. When disaster struck, even hospitals and governments were caught flat-footed. No wonder that schools were, too.

What's important now is acting on what we've learned.

"Crises force us into changes we might not have made otherwise," says Douglas N. Harris, an economist at Tulane University, who studied the educational fallout from Hurricane Katrina.

"Before the pandemic, nearly 50% of America's students attended schools that lacked a plan for indoor air quality management. That is no longer the case. COVID-19 has forced a new definition of "school safety." Now, we're all acutely aware of the airborne threats, viral and otherwise, hovering within school buildings."

Historically, K-12 schools have played a pivotal role in community healing from disaster. When adequately prepared, schools can — and do — buffer the damage, says University of Colorado sociologist Jennifer Tobin, Ph.D., an expert on educational emergencies.

"You can't always plan for a catastrophe," Tobin says, "but we have to plan for recovery." In the pandemic era, recovery must include a plan to clean and disinfect school air.