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Airborne Transmission of COVID-19

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The evidence supporting aerosol transmission for Covid-19 is actually stronger than it is for measles.

In 1981, seven American children contracted measles during a visit to the same doctor's office.

Three of the children had never crossed paths with the 12-year-old source patient. One child arrived at the office an hour after the infected boy had left.

The outbreak caused a stir. At the time, public-health authorities believed measles was transmitted via large respiratory droplets, the kind generated by phlegmy coughs, and required contact within about 1 meter of an infected person.

So ingrained was this belief that a major medical journal, Pediatrics, deemed the outbreak an outlier, concluding that for measles, "airborne spread is unusual."

Of course, today we know the opposite is true. Microscopic measles particles can remain airborne and infectious for up to 2 hours and can drift far and wide. In one case, an infected athlete transmitted the disease to spectators 100 feet (30.5 meters) away. The notion that measles is primarily contracted through contact with large droplets, rather than via tiny, inhaled aerosols, has been thoroughly debunked.

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One year into the Covid-19 pandemic, that same theory has been debunked with respect to SARS-CoV-2 transmission, though infection-control measures have lagged behind the science.

In one regard, the evidence supporting aerosol transmission for Covid-19 is actually stronger than it is for measles: Viable SARS-CoV-2 has been captured via air sampling, a feat that has yet to be achieved with the measles virus.

In fact, only one study, published in 2016, long after experts declared measles airborne, has captured measles RNA in the air — a study its authors called "the first study to directly detect evidence of airborne transmission of measles." Yet in that study, testing in cell cultures failed to detect viable measles virus.

By contrast, at least six air-sampling studies have isolated SARS-CoV-2 RNA. And one, conducted at the University of Florida, proved SARS-CoV-2 viral particles — captured as far as 4.8 meters from a Covid-19 patient — were viable.

"If this isn't a smoking gun, then I don't know what is," asserts Linsey Marr, Ph.D., a Virginia Tech aerosol scientist who was not involved the study.

Marr calls the results "unambiguous evidence that there is infectious virus in aerosols."

The Florida study, piled atop volumes of other evidence pointing to aerosol transmission, has intensified calls for more robust infection control indoors — in hospitals, nursing homes, dental practices, and retail establishments.

With ultra-contagious SARS-CoV-2 variants now surging globally, the stakes could not be higher.

While physical distancing and masks remain important, "We should be looking at the extra precautions we can add to stem the spread of this disease", argues Justin Morganstern, MD, a Canadian emergency physician in an evidence review.

Foremost among these precautions should be air filtration and dis-infection, say experts, including Kevin Fennelly, M.D., of the U.S. National Institutes of Health.

At hospitals and nursing homes, infection-control protocols are based on "old data and inferences," Fennelly asserts in The Lancet Respiratory Medicine.

Droplet transmission is not driving the pandemic, he argues, and precautions should be updated to "account for the predominance of small particles within infectious aerosols."

> "It is very clear that aerosols play a considerable role in the transmission of Covid-19 and that we are unlikely to prevail against this pandemic unless we acknowledge that fact."
>
> – Justin Morganstern, *MD*

Coronavirus in the Air

Asymptomatic carriers can spread Covid-19 in huge numbers, without sneezing or coughing.

At the pandemic's outset, health authorities made the same assumption about SARS-CoV-2 that they'd made, erroneously, about measles in the 1980s and tuberculosis in the 1950s: that aerosol transmission, if it happened at all, was "probably very rare."

But that assumption soon began to wither. Quickly, it became clear that asymptomatic carriers were spreading Covid-19 in huge numbers, without sneezing or coughing.

What's more, scientists identified outbreaks — on cruise ships and bus rides, at choir practices and ski resorts, in call centers, restaurants, and shopping malls — that could not be explained by surface or droplet transmission.

Strengthening the case for aerosol spread, scientists captured SARS-CoV-2 genetic material on surfaces that patients could not possibly have touched, such as air outlet vents and air-handling grates.

Even more compelling, coronavirus particles were captured in the air — above flushing toilets, in hospital nurses' stations and changing rooms, in hallways outside patient rooms, and inside patient rooms beyond 6 feet from the patients.

Still, questions persisted: Was the RNA viable? Could the captured particles actually invade a cell, replicate, and trigger infection? Or were they inert, harmless fragments of genetic material?

The answer was elusive because aerosols, microscopic and fragile, are easily damaged by the air-sampling process.

But the University of Florida team used new, more sophisticated technology, preserving SARS-CoV-2 RNA captured in the air 15 feet from a Covid-19 patient. The genome sequence of the collected virus matched the sequence isolated from the patient.

The study, says lead researcher John Lednicky, Ph.D, proved "conclusively" that viable SARS-CoV-2 particles, small enough to be inhaled, can linger in the air and pose a risk to those in the vicinity.

The study squelched doubt that Covid-19 can spread — and readily — via aerosols.

Infectious Aerosols: Small but Potent

What makes aerosols so dangerous is that, once inhaled, they can penetrate deeper into the lungs.

Many Covid-19 precautions — plexiglass dividers, desks spaced 6 feet apart, reduced restaurant occupancy — are premised on the notion that large droplets, generated by sneezes and coughs, pose the greatest danger to vulnerable people.

In reality, the most dangerous droplets are the invisible ones, particularly those in the range of 2 µm to 3 µm. Not only can aerosols hover for hours and travel across rooms, but they also carry more infectious virus than large droplets.

"Humans produce infectious aerosols in a wide range of particle sizes, but pathogens predominate in small particles," explains Kevin Fennelly of the NIH.

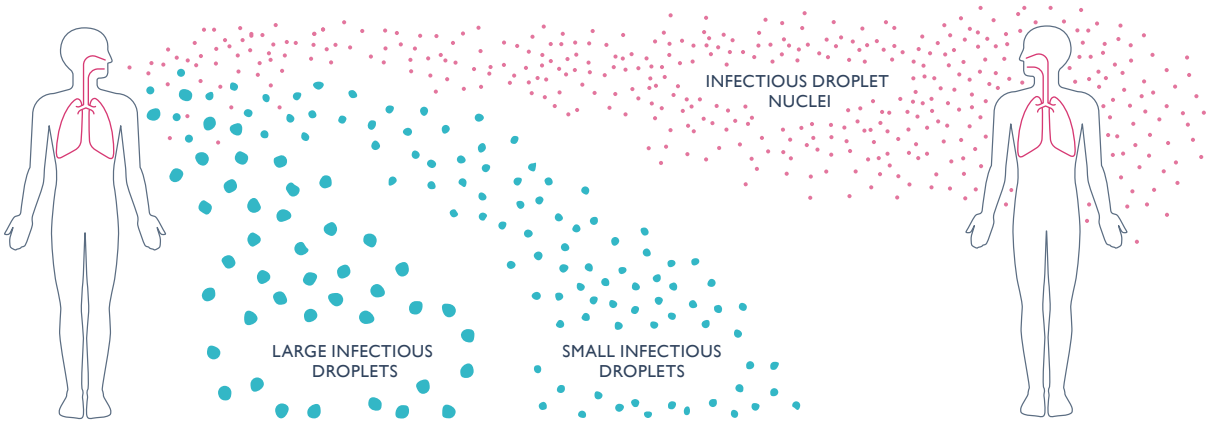
This is true for influenza, SARS-CoV-2, and other respiratory viruses, says William Lindsley, Ph.D., a biochemical engineer with the U.S. Centers for Disease Control and Prevention. "You see a lot more virus in small aerosols," Lindsley told a panel at an international conference on the aerosol transmission of Covid-19.

This is because of where aerosols originate: in the lungs. Research shows the viral load of SARS CoV-2 is higher in the lungs compared to the upper respiratory tract.

What makes aerosols so dangerous is that, once inhaled, they can penetrate deeper into the lungs. For a patient to develop severe Covid-19 symptoms, such as pneumonia or acute respiratory distress syndrome, the virus must reach the lower airways, and only small aerosols can travel that far.

"We know that if the virus makes it down deeper into the respiratory system, fewer viruses are required to initiate infection, and this can also affect the severity of disease," Marr reported at the international Covid-19 conference.

To those still skeptical that aerosol transmission is driving Covid-19 spread, NIH's Fennelly responds: "There is no evidence to support the concept that most respiratory infections are associated with primarily large droplet transmission. In fact, small particle aerosols are the rule, rather than the exception, contrary to current guidelines."



Metres	Up to 1 m	Up to 1.5 m	1.5 – 48 m
	20 micron took **4 min** to fall to the floor (bacteria)	10 micron took **17 min** to fall to the floor (spores)	1-3 micron remained suspended **indefinitely** (viruses)

J.W. Tang, Y. Li, I. Eames, P. K. S. Chan, G. L. Ridgway, Factors involved in the aerosol transmission of infection and control of ventilation in healthcare premises. Department of Microbiology, The Chinese University of Hong Kong, Prince of Wales Hospital. Hong Kong; Department of Mechanical Engineering, The University of Hong Kong, Pokfulam, Hong Kong; Department of Mechanical Engineering, University College London, London UK School of Public Health

Protected by NanoStrike™ technology

NanoStrike Technology: Fighting Aerosol Spread of Viruses

The 6-foot/2-metre rule does not stop aerosols from floating across a room.

How can guidelines be updated to reflect the reality of aerosol transmission? Healthcare facilities cannot simply rely on personal protective gear, hand hygiene, and cleaning protocols. And distancing protocols, whether implemented in nursing homes, offices, or pubs, are of limited use indoors; the 6-foot/2-metre rule does not stop aerosols from floating across a room.

With SARS-CoV-2 hovering, undetectable, what all indoor environments need is high-powered air dis-infection, such as Novaerus' NanoStrike technology.

NanoStrike technology obliterates pathogens at the molecular level, instantly rendering them inactive. The technology has been used in over 65 countries to help combat Covid-19, particularly in hospital operating rooms, intensive care units, emergency rooms, waiting rooms, and surgical theatres.

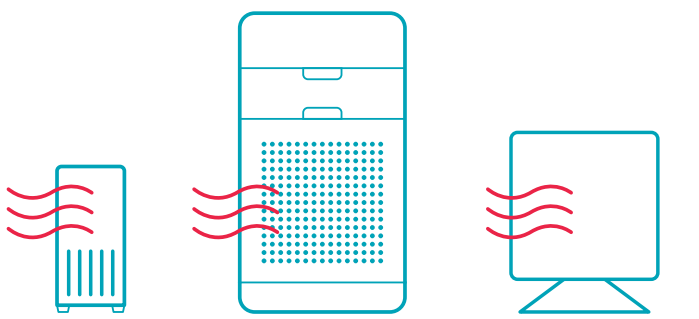
The Novaerus Defend 1050, cleared by the U.S. Food and Drug Administration as a 510(k) Class II medical device, has been proven in independent laboratory testing to filter out and inactivate a wide range of airborne viruses and bacteria.

Within 30 minutes, the Defend 1050 has demonstrated a 99.99% reduction of the live SARS-CoV-2, the virus causing COVID-19. The device has shown similar efficacy with other airborne pathogens, including influenza, Clostridium difficile, Aspergillus, and surrogates for Measles virus, Tuberculosis and Methicillin-Resistant Staphylococcus Aureus (MRSA).

Upon obliterating pathogens, the Defend 1050, a portable, free-standing system, releases clean air back into the room. Unlike other technologies, which can pose risks to humans, Novaerus devices are safe for 24/7 use among the most vulnerable patients.

Though NanoStrike technology was designed for use in medical settings, Novaerus' sleek, compact devices have also been installed in retail, hospitality, and office settings, from wine-tasting rooms to hotel lobbies, offering medical-grade protection to customers and staff alike.

Novaerus' Compact Devices



Protect 200 Defend 1050 Protect 800/900

From Measles to Covid-19

With regard to Covid-19, building operators must make sure the precautions keep up with the science.

In 1982, one year after those seven American children contracted measles during a visit to the pediatrician, a similar outbreak occurred in another American pediatrics practice.

This time, three children contracted measles despite arriving at the doctor's office more than an hour after the source patient had left the building. And this time, instead of dismissing the incident as an outlier, scientists conceded that the conventional wisdom about measles likely had been wrong.

"Airborne transmission may occur more often than previously suspected," a team of public-health physicians wrote in the Journal of the American Medical Association.

With regard to Covid-19, scientists have come to that conclusion more quickly. Now, building operators must make sure the precautions keep up with the science.

Learn more about Novaerus portable air dis-infection solutions at **www.novaerus.com**.