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Ventilating complaints about air standards

By Clare Watson / 30 July 2021

It's an airborne-spread virus. Credit: Borchee/Getty

The world has finally accepted that the COVID-19 virus is spread on the air, and mainly indoors. So why haven't ventilation standards been updated for buildings?

Australia is in the grips of another COVID-19 outbreak. This time, the highly transmissible Delta variant of SARS-CoV-2 has plunged many into lockdown and put the nation on high alert.

Epidemiologists say the Delta variant, which has spread to 104 countries and counting, may be about 90% more infectious than the original – Alpha – strain of SARS-CoV-2. But one thing remains the in Brisbane, says the latest outbreak has once again exposed the gaps in our hotel quarantine system and highlighted flaws in building design and ventilation systems – which should flush out contaminated air, without affecting other occupants, if designed correctly and operating well.

"Well over a year into the pandemic, there hasn't seen any progress whatsoever [in Australia] to tackle this," Morawska says. "No one mentions the word ventilation."

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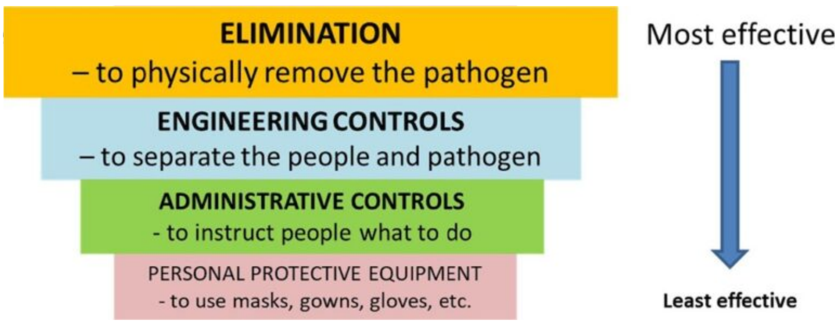
Morawska is not alone in her frustration. Architects and building engineers are also calling for stronger recognition of respiratory viruses that spread via aerosols and improvements to ventilation in public spaces.

"We knew in July last year that SARS-CoV-2 was airborne," says architect Geoff Hanmer, an adjunct professor of architecture at the University of Adelaide. "And yet it's taken ISIAQ [the International Society of Indoor Air Quality and Climate] and the World Health Organization almost a year to admit that that's the case."

These experts' exasperation is exacerbated because the engineering solutions to rid indoor spaces of airborne pathogens already exist – they just need to be installed or upgraded.

What needs to be done?

There are three key ingredients in the cocktail that is infection risk, Morawska explains. The first is the concentration of airborne particles that are emitted when an infected person talks, sings, coughs or sneezes. Second, a lack of ventilation, which lets aerosols linger in the air. And thirdly, some exposure time for people to inhale the virus-laden particles.



Traditional infection control pyramid adapted from the US Centers for Disease Control. Credit: Morawska et al/CDC/Environment International

Changing how buildings operate can address two out of those three factors. Improved ventilation increases airflow, diluting airborne particles; incorporating high-grade filtration systems can remove microscopic contaminants from the air.

However, the current standards for ventilating indoor public spaces (excluding hospitals) are not designed for infection control.

"Very few countries have any regulations about indoor air quality. Infection transmission – which occurs mainly in indoor public spaces – is not specifically mentioned in any national regulations,"

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Hanmer says revising construction codes to improve ventilation standards to control for airborne infections would be a good start.

inadequate or poor ventilation, particularly in colder months.

"But the problem is that new buildings are only a very small fraction of the total population of buildings," he says.

Public buildings from hospitals to schools and aged care facilities are "naturally" ventilated, meaning they rely on open windows to let fresh air in. They often have inadequate or poor ventilation, particularly in colder months.

Many commercial buildings, such as shopping centres, hotels and universities, are also poorly ventilated, Hanmer says, because the performance of their mechanical ventilation systems – which pump in fresh air to replace stale indoor air – is too often substandard.

"It's a bit of a lottery at the moment – certainly we need to get to a state where we've got better data and better regulation on air quality, generally," says Hanmer, who recently surveyed the air quality in a number of public buildings.

"Clearly, the application of [national construction] codes in mechanically ventilated buildings hasn't been as good as it should be."

How can it be done?

Increasing ventilation rates to create greater airflow through rooms and buildings is one way to minimise infection risk indoors.

In 2009, WHO compiled 65 studies showing that poor ventilation is "associated with increased infection rates or outbreaks of airborne diseases", concluding that "higher ventilation rates could decrease the risk of infection".

But hard evidence linking improved ventilation with reduced infection rates directly is scarce. A 2019 study from the Taiwan Centres of Disease Control is a rare example. It found that increasing ventilation in stuffy university buildings controlled an outbreak of tuberculosis, an airborne bacterial disease. The outbreak, which lasted three years and involved 27 active cases and 1,665 contacts, was snuffed out after ventilation specialists reconfigured the building's ventilation systems to improve airflow.

Fast forward to 2021, and both the WHO and US Centres for Disease Control and Prevention (CDC) now recommend that the total indoor air volume in healthcare facilities should be replaced with fresh outdoor air a minimum of 6 to 12 times per hour to prevent the spread of COVID-19.

Epidemiologist Mary-Louise McLaws, of UNSW Sydney, says this is the gold standard for ventilation for "hot zones" in hospitals – equivalent to 80 litres of air per second per person – and that these ventilation rates can be hard to achieve. In other settings, such as confined spaces and offices, airflow rates of 3 litres of air per second per person are needed, McLaws says.

magic number because it depends on how the building is used.

This includes the number of people in each room ("The more sources, the higher the [required] ventilation rate," she says) and their usual activities such as exercising, singing or talking loudly, all of which expel large amounts of viral particles.

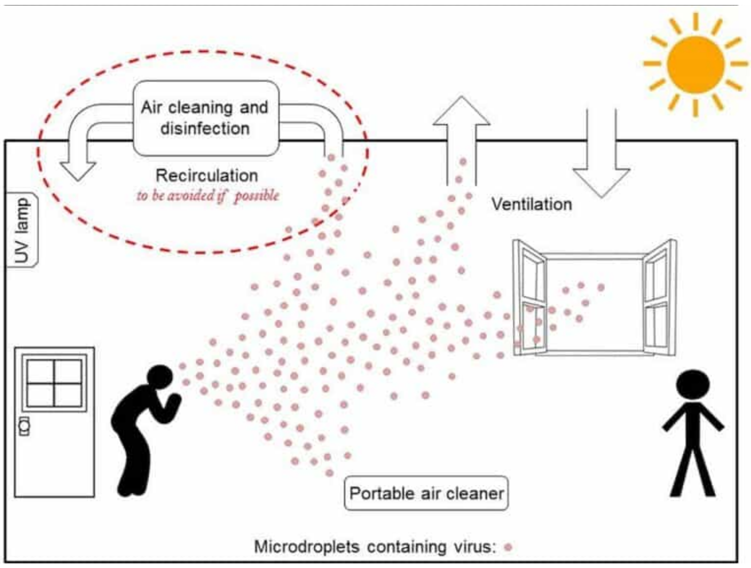
Portable air purifiers may help. Credit: Onurdongel/Getty

Occupancy, though, can vary from one hour to the next, so ventilation systems need to be flexible. But ramping up ventilation is not just a matter of a simple flick of a switch; airflow direction and distribution are also important.

Adding pathogen-proof filters to existing ventilation systems is not always possible either, if the airflow is too weak. Engineers also need to design ventilation systems with energy conservation in mind, Morawska says.

"It's not just about increasing ventilation rates," she says. We need smarter systems that remove the virus or any other contaminants but do not increase energy use."

"We need to make sure that naturally ventilated buildings with high use have some fallback ventilation," he says.



Engineering level controls to reduce the environmental risks for airborne transmission. Credit: Morawska et al/Environment International

Demand-controlled systems could be used in schools to increase ventilation during predictably busy periods and dial airflow down when rooms are not in use. Another option is installing ventilation systems that detect rising levels of CO_2 levels and kick in when air quality deteriorates, says Hanmer.

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A fallback ventilated system comes into operation when the detected levels of CO_2 in the air rise above about 800 parts per million, so it could reliably improve air quality, Hanmer says. Aged-care facilities would be the "absolute first priority" and schools a close second.

important.

installed to filter air in crowded public spaces such as supermarket checkouts. These systems could be deployed quickly to reduce infection risk, provided they are the right size for the space.

Researchers are also designing smart systems that can detect mobile phone signals or use cameras (with image-processing algorithms) to determine when an indoor space gets too crowded and needs more ventilation, adjusting flow rates accordingly.

What would it cost?

Few economic analyses have been done to estimate the cost of improving ventilation because no one has been asking the question, says Morawska. However, available estimates suggest that necessary investments in building systems may be less than 1% of the construction cost of a typical building for new builds.

Hanmer estimates it would cost a few thousand dollars per room to install fallback ventilation systems in aged-care facilities. "I don't think that's an unreasonable burden given the seriousness of the disease," he says. "And it's whole lot less than a lockdown in a major capital city."

But on top of the price tag for installations and upgrades, Zhai says that building engineers also have to consider the energy costs of running souped-up ventilation systems. Installing high-grade filters capable of trapping and removing microscopic airborne particles means greater fan power is needed to push the air through the filter – and that uses more energy, he says.

Around 40% of the total electricity used in buildings already goes into powering ventilation fans and it would take tremendous amounts of energy to increase airflow rates to recommended levels, Zhai says: "To double the flow rate, you basically need eight times the energy use.

"It can work for most emergency situations. You can supply a lot of air for a short period of time, to reduce infection risk. But for regular times, it's not economically wise to do that."

Morawska says, however, that the cost of improving ventilation system would be far less than the billions of dollars spent each year on influenza and other respiratory diseases. It could also help curb the costs of COVID-19, which currently has a global financial toll to the tune of $1 trillion each month.

But if countries continue to dismiss the airborne transmission of COVID-19 and other infectious diseases, as they have done for decades, then we will suffer the cost of this denial, Morawska says.

> **"It has the advantage," Hanmer adds, "of improving people's health above and beyond catching infectious disease like COVID-19, tuberculosis or measles, all of which are airborne. Studies in Europe have shown that improving air quality in aged care facilities has a positive effect on health."**

"Unless we start putting steps in place now to fix things on the longer term, once the pandemic passes –

What other options are there?

In other environments, where it is difficult to improve ventilation, ultraviolet lights could help disinfect contaminated air as they have used before to control outbreaks of other infectious diseases, such as tuberculosis in the 1980s.

Some modelling studies suggest that inactivating airborne pathogens using UV light may reduce infection risk about the same as doubling the ventilation rate.

SARS-CoV-2 is extremely sensitive to UV-C light and UV-C lights could be installed in the ducts of ventilation systems, however, according to the WHO, evidence remains limited for the effectiveness of this control strategy.

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Morawska says, however, that the cost of improving ventilation system would be far less than the yearly medical costs of influenza and other respiratory infections, which are staggering: over $50 billion in the US alone and $140 million in Australia each year – not accounting for lost productivity, work absenteeism, or COVID-19 itself.

"We can't say how much this cost would decrease if there was good ventilation because we don't how many cases are because of the lack of ventilation," says Morawska. But as she and her collaborators wrote in the journal Science, "the existing evidence suggests that controlling airborne infections can cost

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