

Australia must act to prevent airborne transmission of SARS-CoV-2

Overlooking the potential for airborne transmission of SARS-CoV-2 leaves Australia vulnerable to outbreaks

“Those who cannot remember the past are condemned to repeat it”

George Santayana, *The Life of Reason*, 1905

In late 2002 in southern China, a previously unknown coronavirus crossed the species barrier to humans, igniting the severe acute respiratory syndrome (SARS) pandemic that would claim over 900 lives before it was finally contained. When SARS reached Canada, health care workers were among its most frequent victims. In the epidemic's aftermath, an independent inquiry highlighted failures in infection control, particularly with regard to the risk of airborne transmission, and recommended the precautionary principle underpin the development of future policies and practices.¹

Today, the world is faced with a second, unprecedented pandemic. Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has overwhelmed nations across the world, resulting in an inability to deliver normal standards of health care. Elective surgeries have been cancelled, field hospitals established, and more grimly, care has sometimes been rationed to those most likely to survive. Additionally, nosocomial infection has been frequent in some regions, for both health care workers and patients.

Since the earliest days of the pandemic, respiratory droplets and fomites were assumed to be the major transmission routes, with airborne transmission only accepted within the limited confines of certain “aerosol generating procedures”.² In fact, this is a misnomer, because volitional coughing produces more aerosols than both invasive and non-invasive respiratory therapies.^{3,4} The experience of SARS and Middle East respiratory syndrome (MERS) should also have alerted us to the likelihood that SARS-CoV-2 could also be transmitted via the airborne route. It did alert some. China, South Korea and Vietnam adopted airborne precautions in early 2020.

SARS-CoV-2 is more readily aerosolised than SARS and MERS, and can retain infectivity for at least 16 hours in the air under laboratory conditions.⁵ Speech is sufficient to produce aerosols which can remain suspended for tens of minutes.⁶ Importantly, SARS-CoV-2 RNA is readily detected in breath samples,⁷ and the virus has been cultured from air samples collected at a distance of up to 4.8 m from COVID-19 patients, in the absence of aerosol generating procedures.⁸ SARS-CoV-2 RNA has been detected at even greater distances in ventilation systems.⁹ This evidence, which is more comprehensive than that available for other accepted airborne pathogens, clearly demonstrates the

potential for airborne transmission. This is borne out by numerous documented examples.

One of the most compelling was an outbreak in an apartment complex in South Korea, in which only residents living in apartments connected by a common ventilation shaft were infected. All seven affected apartments (out of a total of 200) were located along the vertical line of the shaft, suggesting a stack effect carried virus-laden aerosols into residents' bathrooms.¹⁰ A similar outbreak occurred in an apartment building in China, in which the virus appeared to spread from residents on the 15th floor to those in vertically aligned flats on the 25th and 27th floors, by means of dried-out floor or bath drains.¹¹ An environmental sample in an unoccupied flat on the 16th floor was also positive. Faecal aerosols produced by toilet flushing were thought to be responsible,¹¹ reminiscent of the Amoy Gardens SARS outbreak in Hong Kong in 2003. There have also been several documented outbreaks in health care settings which were not only highly suggestive of airborne transmission but also demonstrated that physical distancing and the use of surgical masks is not always sufficient to prevent infection.¹²⁻¹⁵ In contrast, a study of health care workers from Finland found that none of those using FFP2/3 respirators became infected.¹⁵

Similar outbreaks, some of which may have been aided by the dehumidifying effect of air conditioning (which might desiccate respiratory droplets), have been reported globally, with indoor transmission being the common factor. Indoor transmission appears many times more likely than outdoor transmission,¹⁶ and outbreak settings have included restaurants,¹⁷ public transport,¹⁸ abattoirs,¹⁹ cruise ships,²⁰ aeroplanes,²¹ nursing homes,²² places of worship²³ and choir groups.²⁴ Notably, in one bus cluster, one of the secondary cases boarded the bus 30 minutes after the index case had left.¹⁸ Such superspreading events will continue to fuel the pandemic if measures to prevent airborne transmission are not implemented.

Countries which acknowledged the danger of airborne transmission have not only been able to control COVID-19 in the community, but where cases have occurred, they have been able to safeguard health care workers from getting infected. Countries which have not, including Australia, the United Kingdom, the United States and many European nations, have not only seen widespread community transmission but staggering numbers of health care worker infections. In Melbourne, 4170 clinical and non-clinical health care workers were infected with SARS-CoV-2, most of them in the workplace.²⁵

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Despite this evidence of occupationally acquired infection among health care workers, infection prevention and control guidelines — including those published as recently as May 2021 — continue to specify only droplet and contact precautions for the majority of known and suspected COVID-19 patients.²⁶ It has seemed at times as if any reason, other than airborne transmission, is being sought to explain occupationally acquired health care worker infections. Health care workers have been accused of “doing the wrong thing in the tearoom”, “mostly getting it outside work”, “not doffing correctly”, “car pooling” and “having unauthorised dinner parties”.

Outbreaks are also occurring in hotel quarantine with increasing frequency. From November 2020 to mid-January 2021, an estimated 1 in 200 hotel quarantine cases led to infections outside the system.²⁷ Genomic sequencing revealed multiple guests occupying one floor of a Brisbane hotel contracted the disease from another person in quarantine.²⁸ A similar outbreak occurred in Sydney.²⁹ Recent infections in hotel quarantine staff have triggered intensified public health measures in Melbourne, and lockdowns in Adelaide, Brisbane and Perth. Brisbane went into a second lockdown this year after health care worker infections led to a resumption in community transmission.³⁰ A report into the hotel quarantine breach in Perth concluded the staff member was likely infected via the airborne route.³¹ A probable case of airborne transmission in New Zealand’s hotel quarantine system has also since been reported.³²

The occurrence of airborne transmission of SARS-CoV-2 has far-reaching implications, particularly for the ventilation of indoor spaces including public buildings and public transport, infection control in health care, and provision of personal protective equipment. Australia is in an enviable position, having essentially achieved elimination of COVID-19. However, the country will remain vulnerable until the vaccination program is complete. We should not jeopardise our prosperity by risking future, preventable outbreaks, with the attendant health, social and economic costs that invariably follow. Recently, a group of health care workers and scientists wrote an open letter to the Australian Health Protection Principal Committee and other groups tasked with disease control, in addition to the Prime Minister, state and territory leaders, and Chief Health Officers of Australia, calling for national action on aerosol transmission.³³ The letter is supported by over 350 national and international signatories, and makes several specific recommendations which are summarised in [Box 1](#).

Despite clear evidence of the airborne route, progress continues to be dogged by debate around the specifics of aerosol transmission. A recent review dismantled the myths preventing recognition of airborne transmission of SARS-CoV-2.³⁴ It noted there is no clear dichotomy between respiratory droplets and aerosols, and that particles produced by breathing, talking, coughing and sneezing span a continuum of sizes from < 1 µm to > 100 µm.

Summary of recommendations to prevent airborne transmission of SARS-CoV-2: key areas for action*

- Reinforce the border through improved ventilation in quarantine facilities, vaccination of workers and the use of airborne personal protective equipment
- Replace high rise quarantine facilities with accommodation modelled on the Howard Springs facility, in which residents are separated by open air
- Update all COVID-19 guidance to emphasise the risk of aerosol transmission of SARS-CoV-2
- Mandate and fund ventilation assessments and upgrades of essential public institutions, such as hospitals, schools, aged care facilities and prisons
- Promote strategies to reduce transmission risk through clear public health messaging and education
- Ensure the availability of fit-tested P2/FFP2/N95 respirators for anyone in contact with a potential COVID-19 patient
- Replace the harmful concept of “aerosol generating procedures” as the sole risk for airborne spread with the knowledge that airborne transmission is likely the norm in all situations, given SARS-CoV-2-containing aerosols are readily produced by breathing
- Fast track research into indoor air quality, including the study of carbon dioxide monitoring as a surrogate measure of indoor air quality and airborne pathogen risk
- Include recommendations on the usage of indoor air cleaners such as appropriately sized portable air filtration (high efficiency particulate air) units or simple, practical and low cost homemade devices using MERV-11/13 filters and box fans
- Develop clear national ventilation standards for indoor environments
- Broaden the diversity of people advising on infection control, by including experts from: aerosol science; engineering; heating, ventilation and air conditioning; occupational hygiene; occupational health and safety; and organisational psychology

MERV = minimum efficiency reporting value. * Recommendations adapted from Berger et al (open letter to the Australian Health Protection Principal Committee and national and state and territory leaders).³³ ♦

Respiratory droplets (defined by the World Health Organization as being > 5–10 µm in size²) do not always fall within 1–2 m of their source, as is often claimed, and are affected by ambient airflow. While short range transmission may be more common, this does not rule out the airborne route, because aerosols are more concentrated at their source. Finally, the review noted that the lower basic reproduction number (the number of secondary cases an infection is expected to give rise to; R_0) of SARS-CoV-2 compared with measles is not evidence for droplet-only spread. R_0 has no relation to the mechanism of transmission, and there are airborne pathogens with a lower R_0 than SARS-CoV-2, such as tuberculosis.³⁴ Interestingly, measles was once thought to be transmitted via large respiratory droplets, requiring close contact with an infected person.³⁵ This view was revised following a number of “unusual” outbreaks in paediatric practice that could only be explained by airborne transmission.^{35,36}

In summary, there is clear and compelling evidence for airborne transmission of SARS-CoV-2. The evidence is sufficiently strong to warrant the immediate strengthening of Australia’s infection prevention and control guidelines. We must apply the precautionary principle, and urgently improve biosecurity measures at ports, airports and quarantine facilities in particular, lest outbreaks continue to spill

over into the community. The emergence of more transmissible variants heightens this urgency. Health care workers must also be afforded the highest level of protection, commensurate with their high risk of exposure, and to comply with workplace health and safety laws, which require the adoption of every reasonably practicable method to prevent worker harm. Australia must learn from history, not repeat the mistakes of the past.

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