Australian Nursing & Midwifery Federation

ANMF EVIDENCE BRIEF

COVID-19: MODES OF TRANSMISSION AND INFECTION

Author: Dr Micah DJ Peters **Date:** July 9 2020

Question: What is the best available evidence regarding known modes of transmission and infection in the context of COVID-19?

***ALERT* Evidence regarding COVID-19 is continually evolving. This Evidence Brief will be updated regularly to reflect new emerging evidence but may not always include the very latest evidence in real-time.**

Key messages:

- COVID-19 appears to be readily transmitted via saliva and mucus droplets (e.g. from coughing and sneezing) and environmental surface contamination.
- Asymptomatic people may be infectious, so regular and proper hand washing, coughing and sneezing etiquette, and maintaining appropriate physical distance is vital.
- COVID-19 may be transmissible via small, airborne aerosolised particles in certain conditions. Aerosol generating procedures, and uncovered coughs/sneezes, and respiratory sample collection can disperse these smaller droplets into the air several metres.
- Crowded, poorly ventilated, indoor environments and contexts where saliva/mucus may be more readily aerosolised may increase exposure to smaller aerosolised droplets.
- Aerosolised droplets may remain in the air for several hours, however, viability/infectiousness of the virus in aerosolised droplets is uncertain.
- Virus particles may remain on some surfaces for up to 72 hours (on plastic), however viability/ infectiousness of the virus is uncertain.
- Correct and consistent hygiene and infection control methods, organisational and point of care risk assessment, engineering and system controls, administrative controls, and patient accommodation must be implemented in tandem with correct use of appropriate personal protective equipment (PPE).
- Personal protective equipment precautions for droplet and environmental surface contamination should be observed in the context of caring for people with suspected or confirmed COVID-19.
- Personal protective equipment precautions for airborne transmission should be observed in high-risk areas e.g. (ICU, COVID-19 wards) where aerosol generating procedures take place including collection of respiratory samples including for asymptomatic patients (bronchoalveolar lavage and induced sputum) and in contexts where small aerosolised particles may pose a potential infection risk (e.g. poorly ventilated, crowded areas) and when in frequent close contact with patients with suspected or confirmed COVID-19.

Summary

Background: COVID-19 (from 'severe acute respiratory syndrome coronavirus 2' (or 'SARS-CoV-2') is a newly discovered (novel) coronavirus first identified in Wuhan, Hubei province, China in 2019 as the cause of a cluster of pneumonia cases.[1] Coronaviruses are similar to a number of human and animal pathogens including some of those which cause the common cold as well as more serious illnesses including severe acute respiratory syndrome (SARS/ SARS-CoV-1) and Middle East respiratory syndrome (MERS). Since discovery, COVID-19 has spread to many countries and was declared a global emergency by the World Health Organization (WHO) on 30 January 2020,[2] and a pandemic on March 11.[3] Risk of exposure to COVID-19 and potential infection occurs through close contact with infected people and/or objects, droplet transmission (>5-10μm), and contact with surfaces contaminated by COVID-19 infected droplets. There is ongoing investigation and debate regarding the degree of risk posed by small <5μm droplets (aerosols) which travel through the air differently from larger respiratory droplets with a growing number of experts calling for clearer acknowledgement of the risks posed by aerosols.[4]

COVID-19 transmission: droplets, surfaces, and aerosols

Based on currently available evidence, COVID-19 is transmitted when the virus enters the body via the mucosae (mouth and nose) or conjunctiva (eyes) which can occur through;[5]

- direct person-to-person contact,
- respiratory droplets >5-10μm in diameter (e.g. from coughing and sneezing), and;
- indirect contact from touching infected environmental surfaces/formites and transferring viral particles to the mucosae or conjunctiva.

There is ongoing inquiry regarding the potential for smaller viral particles/aerosols (<5μm) to remain in the air and upon different environmental surfaces. Specific evidence for COVID-19 transmission is emerging, particularly around the potential for 'airborne' transmission.[6] It is important to recognise that both large and smaller droplets travel through the air and may be considered 'airborne', however smaller droplets behave differently to larger droplets as they are lighter, more buoyant, and evaporate more quickly. The science regarding the airborne transmission of disease is itself complex and equivocal. Questions remain regarding virology (i.e. what amount of a virus is enough to cause an infection?) and biophysics (i.e. how do particles move in the air under different conditions?).[7] The SARS-CoV-2 may be found in small, aerosolised particles,[8] but extent to which these smaller particles pose an infection risk or how they move in the air under different conditions is currently unconfirmed.[7] Some authors have indicated that combined with previous and developing understandings regarding the behaviour of aerosolised particles from coughs, sneezes and aerosol generating procedures, as well as evidence concerning other respiratory viruses (e.g. SARS-CoV-1), the emerging evidence regarding the potential for COVID-19 to be a transmission risk via aerosols suggests that additional precautions beyond usual droplet and contact contamination should be considered in some contexts such as crowded, poorly ventilated, and indoor environments.[6,9-13]

While respiratory symptoms increase the risk of transmitting the virus via saliva and mucus expressed by coughing and sneezing – particularly when proper cough/sneeze etiquette, hand hygiene and surface cleaning/decontamination is not followed – people not displaying respiratory symptoms may also be infectious.[14] This highlights the importance of engaging in frequent and proper hand washing, coughing and sneezing etiquette, and maintaining appropriate physical distance regardless of whether or not one feels unwell. Because so little is known regarding the infectious potential and behaviour of aerosolised droplets, the level of infection risk that actions such as singing and as speaking, which can generate smaller particles, pose is still uncertain.[7,15] It is important to understand, that droplets and aerosols should be understood as existing on a continuum (i.e. larger expired particles versus smaller expired particles); droplets of varying size are expired by coughs, sneezes, and even talking and these droplets behave

differently in different environments (i.e. inside versus outside).[16] Uncovered, droplets and aerosols from coughs, sneezes, and talking can travel and/or remain in the air for up to several metres, which is why cough/sneeze etiquette and careful adherence to protective measures and infection control is vital. Evidence regarding the potential risks for aerosol transmission and contamination is emerging and currently inconclusive, however some authors do suggest that PPE precautions and guidance regarding transmission of COVID-19 could be revised to account for potential airborne risks.[9,10,17]

COVID-19 is transmitted by droplets from coughs and sneezes and exposure to droplet-contaminated surfaces

One study found that like SARS CoV-1, when aerosolised COVID-19 can remain in the air for up to three hours.[18] The same study found that COVID-19 can also remain on surfaces while gradually degrading for up to 72 hours on plastic, 48 hours on stainless steel, 24 hours on cardboard, and four hours on copper.[18] In another study, researchers studied aerosolised SARS-CoV-2 viral particles under laboratory conditions and determined that the virus retained infectivity and virion integrity for up to 16 hours in respirable-sized aerosols.[19]

Another ongoing study has found that COVID-19 ribonucleic acid (RNA) particles were captured by air samplers placed in negative pressure isolation rooms and in hallways outside of these rooms, however the researchers have not yet determined whether viral activity was present due to such low particle concentrations.[20]

A laboratory study found that exhaled breath condensate may contain SARS-CoV-2 particles which can be detected in the air and on surfaces.[16] These authors argue that their results imply that airborne transmission of SARS-CoV-2 may play a major role in COVID-19 spread.

Based on emerging evidence from small laboratory studies, the outside surface of surgical and cotton masks may harbor COVID-19 particles when coughed into by an infected person. A recent small laboratory study with four participants with confirmed COVID-19 infection found that neither surgical nor cotton masks effectively filtered COVID-19 particles if the patients coughed into the masks.[21] The authors noted that contamination of the outer surface of the masks was greater than the inner surface, highlighting the importance of hand hygiene, correct mask removal and disposal. Together with the assumption that the virus particles of COVID-19 and SARS/ SARS-CoV-1 are similarly sized, this could indicate that both surgical and cotton masks may be ineffective in preventing the dissemination of COVID-19 from the coughs of patients with COVID-19 to the environment and external mask surface.[21] Another laboratory study found a detectable level of infectious virus (~0·1% of the original inoculum) could still be present on the outer layer of a surgical mask seven days after inoculation at a temperature of 22°C and a relative humidity of around 65%.[22]

Small (<5µm) droplets may pose an infection risk particularly in crowded, poorly ventilated, indoor environments but the level of risk is unknown

Based on emerging evidence and assessment of known modes of contact and transmission,[23] COVID-19 could be transmitted via 'airborne' molecules (i.e. transmissible via droplet nuclei <5µm in diameter that can remain in the air for up to three hours and travel >1m).

A study in China found that droplet transmission was the most likely cause of infection of a cluster of cases that dined at an airconditioned restaurant at tables adjacent to a confirmed case.[24] The authors suggest that turbulent air caused by air-conditioning most likely led to droplet transmission between tables as the direction of airflow appeared to be related to infection with other diners and staff who were not 'down-stream' unaffected.[24]

A study conducted in intensive care units (ICU) and general wards (GW) in Wuhan tested air and surface samples (e.g. floors, computer mice, rubbish bins, doorknobs, and bedrails) for the presence of COVID-19 virus particles.[8] It is important to note that the study was unable to determine whether samples contained viable/infectious particles or not. The investigators found that more samples from the ICU compared to the GW tested positive the presence of the virus. One hundred percent of floor samples from the pharmacy tested positive as well as half of the samples taken from the soles of ICU staff shoes. These findings indicate that COVID-19 may be spread between floor surfaces. Objects such as computer mice, rubbish bins, handrails, and doorknobs also tested positive for the presence of COVID-19, confirming that virus particles may be transferred between surfaces via direct contact. Air samples tested positive for the presence of COVID-19 particles with the most positive results obtained from samples taken from air closest to the patient with fewer positive samples obtained further away. Based on the findings of aerosol distribution, results indicate that COVID-19 virus particles may travel up to around four metres, however viability and infectious potential of the sampled particles could not be determined.[8]

Small COVID-19 virus particles may be dispersed into the air by uncovered coughs and sneezes and aerosol generating procedures in clinical practice and testing, may travel several metres, remain in the air, and be deposited on surfaces

While the degree of risk posed by aerosol particles is not known, engineering controls in built environments have been proposed to reduce the risk of potential aerosol transmission.[25] Limiting crowds, avoiding air recirculation, and effective ventilation may be improved further by particle filtration and air disinfection and have been suggested as worthwhile approaches to combine with including isolation, quarantine, distancing and hand hygiene.[4,25] Outdoor environments may be less risky than indoor due to the degrading effects of ultraviolet light (UV) on viral particles.[26]

Aerosol generating procedures

Various clinical procedures can generate aerosolised particles which may lead to risk of infection.[5] Different jurisdictions around the world have varying guidance regarding what is classed as an aerosol generating procedure. In Australia, in the context of COVID-19, aerosol generating procedures are defined as:[27]

- Tracheal intubation
- Non-invasive ventilation
- Tracheotomy
- Cardiopulmonary resuscitation
- Manual ventilation before intubation
- Bronchoscopy

Further, the Australian guidance cautions against the use of nebulisers and alternative means of delivering medication should be used (such as a spacer).[27] Collection of respiratory specimens may also result in aerosol production including bronchoalveolar lavage and induced sputum for any patient (including asymptomatic) and any respiratory sample collection procedure with fever, breathlessness and/or severe cough.[27] The Australian Government Department of Health recommends that health and aged care staff use P2/N95 respirators in the context of both aerosol generating procedures and if in frequent close contact with patients with suspected or confirmed COVID-19.[28]

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