



COVID-19: PERSONAL PROTECTIVE EQUIPMENT

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Question: What is the best available evidence regarding personal protective (PPE) equipment 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:

- Correct size, fit, use, and disposal of PPE is essential to safe, effective, and sustainable infection prevention and control activities in the context of responding to COVID-19.
- Personal protective equipment in the context of COVID-19 includes; gloves, medical/surgical/procedure masks, goggles or face shields, gowns, respirators (P2/N95 minimum), and fluid resistant aprons.
- Health and aged care staff and others in contact or close proximity to people with suspected or confirmed COVID-19 infection must receive appropriate PPE, clear and understandable information on PPE use, removal, and disposal, and associated resources, information, and services to maintain safe, effective infection control.
- Correct and consistently applied 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 for PPE to be effective.
- Personal protective equipment precautions for droplet and environmental surface contamination, including floors and objects staff and patients may touch 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 when providing frequent and/or close-contact care for people with suspected or confirmed COVID-19.
- Health and aged care staff not involved in direct patient contact (e.g. preliminary screening, triage) should wear masks and other designated PPE as appropriate for duty but maintain spatial distance of at least two metres from patients and use physical barriers (e.g. transparent Perspex, glass) where possible.

- Health and aged care workers should be aware that, uncovered, coughing and sneezing, and in some instances, speaking can generate small droplets and aerosols that may travel several metres, remain airborne, and collect on surfaces. While the infection risk, particularly of smaller aerosolised particles, is as yet not well understood, this highlights the importance of careful risk assessment and infection control measures for airborne transmission risk particularly in crowded, poorly ventilated, indoor environments.
- Members of the general public with respiratory symptoms and those caring for people with suspected or confirmed COVID-19 should wear medical masks and adhere to proper cough/sneeze etiquette and hand hygiene practices.
- Community members who are asymptomatic and do not have suspected or confirmed COVID-19 or are not at assessed risk of carrying the virus should not wear PPE.

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 The most at-risk individuals of infection are those in close contact with patients with COVID-19 which includes health and aged care workers. The WHO recommends rational use of personal protective equipment (PPE) and urges precautions for droplet and contact transmission in the setting of caring for people with COVID-19 and airborne precautions in settings when aerosols may be generated.⁴ In response to emerging evidence and advice, the WHO is currently reviewing its position regarding the degree of infection risk that smaller airborne particles (droplets <5µm) pose, which has implications for the types of PPE that should be used in different scenarios. The Australian Government Department of Health recommends that health and aged care staff use P2/N95 respirators instead of masks in the context of both aerosol generating procedures and if in frequent close contact with patients with suspected or confirmed COVID-19.⁵

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;⁴

- direct person-to-person contact,
- respiratory droplets >5-10 µm 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 the 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}

For further summarised information regarding the transmission of COVID-19 please see the [ANMF Evidence Brief: COVID-19 Modes of Transmission and Infection](#)

Various clinical procedures can generate aerosolised particles which may lead to risk of infection.⁴ Generally, these procedures are conducted in intensive care units, COVID-19 dedicated wards, and in isolation rooms which could be understood as high-risk environments. Exposure to aerosolised particles may include both those directly undertaking aerosol generating procedures, as well as those in the same areas where such procedures occur.⁸ 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:¹⁴

- 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).¹⁴ 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.^{8,14}

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 prolonged periods up to several metres under certain conditions, such as in indoor environments with poor ventilation.^{8,17} This 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.^{9,10,18}

Personal Protective Equipment:

Healthcare staff must have both access to appropriate PPE and receive information and training regarding how to correctly put on (don), take off (doff), and dispose of PPE.^{19,20} Correct size, fit, use, and disposal of PPE is essential to safe, effective infection prevention and control activities in the context of responding to COVID-19.²¹ Many jurisdictions globally are facing ongoing limitations in terms of access to suitable types and sizes of PPE, so correct, rational use is vital.²¹ Where stocks and supplies allow however, health and aged care workers should have ready access to adequate PPE to protect themselves and others from potential transmission and infection in the context of providing care for people with suspected or confirmed COVID-19 based upon carefully assessed local risks.

The WHO highlights that PPE is only effective when adopted within the setting of a range of infection control measures including:²¹

- Administrative controls and measures that ensure resources, access, testing, policies, placement of patients, triage, adequate staff-to-patient ratios, and training.
- Environmental and engineering controls that aim to reduce pathogen spread and contamination of surfaces and objects through ensuring adequate space and human distance, ventilation, and isolation rooms for patients with suspected or confirmed infection.

The WHO recommends rational use of PPE and urges precautions for droplet and contact transmission in the setting of caring for people with COVID-19 and airborne precautions in settings when aerosols may be generated.⁴ Recommendations are however not completely consistent across all jurisdictions, with the US Centers for Diseases Control and Prevention (CDC) and the European Centre for Disease Prevention and Control, recommending airborne precautions for any situation involving the care of COVID-19 patients, and consider the use of medical masks as an acceptable option in case of shortages of respirators (N95, FFP2 or FFP3).²²⁻²⁴ Correct size and fit of respirators is critical as the incorrect size or poor-fit renders the mask ineffective.²⁵

As noted, guidance for the selection and use of PPE varies somewhat by jurisdiction, but is summarised here.^{21,23} In the context of COVID-19 PPE includes:

- single-use surgical masks
- single-use, powder-free, non-sterile gloves
- single-use fluid-resistant, long-sleeved, cuffed isolation gowns*
- single-use or reusable eye protection (goggles or glasses with side shields, plastic visors/face shields)
- single-use, fit-checked respirators (P2 or N95 minimum)**

Coveralls, such as that used in the context of infections that are transmitted via bodily fluids (e.g. Ebola) are not required for managing COVID-19 infection.

The WHO has highlighted that the increasing number of COVID-19 cases, misinformation, panic buying, and stock-piling has disrupted supply of many PPE items including medical masks and respirators with further shortages expected to impact upon gowns and goggles.²¹ Widespread crisis-point shortages such as those occurring in the United States have not occurred as yet in Australia, and due to the initial success of infection control and containment strategies, jurisdictions have largely been able to prepare for further outbreaks in most areas.

* Plastic aprons may be worn with a non-fluid resistant gown if suitable fluid-resistant gowns are unavailable.

** A single respirator may be used for up to four hours without being removed while caring for multiple patients with the same diagnosis.

Three key actions are required to ensure optimal access to PPE considering current global shortages:²¹

- i. Minimisation of PPE use
- ii. Appropriate use of PPE
- iii. Coordination of PPE supply chain

Evidence reviewed by the Oxford COVID-19 Evidence Service found no direct evidence one way or the other indicating that standard surgical masks are as effective as respirator masks (N95, P2, or P3) in the context of COVID-19 based on evidence from other respiratory illnesses, highlighting that this is an under researched area.²⁶

Minimisation of PPE use: The use of PPE can be minimised among healthcare staff while ensuring protection for staff and others. Interventions include:

1. Use of telemedicine to screen and evaluate suspected cases of COVID-19.
2. Use of physical barriers between patients and staff (i.e. plastic and glass windows).
3. Minimise contact and proximity between healthcare staff and patients via activity bundling and avoidance of unnecessary indirect care.
4. Prohibit or otherwise restrict visitors time in areas where patients with confirmed or suspected COVID-19 are being isolated.
5. Ensure healthcare staff and visitors correctly don, doff, and dispose of appropriate PPE.
6. Ensure healthcare staff and visitors correctly perform hand hygiene.

Appropriate use of PPE: Incorrect or overuse of PPE impact supply and use should be based on risk of exposure including type of activity and transmission dynamics. Interventions include:

1. Health and aged care staff working in areas where suspected/confirmed COVID-19 cases are, but who do not provide direct patient care or work in high-risk environments (e.g. where aerosol generating procedures (e.g. intubation, ventilation, resuscitation) take place/crowded, poorly ventilated, indoor environments) should use:
 - Gowns, gloves, medical masks, eye protection (goggles or face shields).[#]
2. Health and aged care staff involved in close (within two meters), frequent, direct care, in high-risk environments, or the same areas as aerosol-generating procedures occur with people with suspected or confirmed COVID-19 should use:
 - Respirators (N95 or P2 standard or equivalent), eye protection, gloves, and fluid-resistant gowns or aprons (in the absence of suitable fluid-resistant gowns).^{##}
3. Healthcare staff *not* involved in direct patient contact (e.g. preliminary screening, triage) and not working in high-risk environments with people with suspected or confirmed COVID-19 should not use PPE but maintain:
 - Spatial distance of at least two metres.^{^26, ^27}

Goggles or glasses may be worn under face shields to offer additional protection.

Emerging evidence suggests that aerosolised particles may travel for up to four metres, as such, PPE for aerosol generating procedures should be worn when working in proximity to and in areas where aerosol generating procedures occur and in high-risk environments where people with suspected or confirmed COVID-19 may be in crowded, poorly ventilated, indoor environments.

^ More recent guidance has recommended that staff wear masks and maintain spatial distance of greater than one metre when not engaged in direct patient care (e.g. cleaning equipment or room).

^^ More recent guidelines in light of emerging evidence has recommended two metres.

4. Healthcare staff involved in direct patient care of people *without* suspected or confirmed COVID-19 should use PPE according to standard precautions and risk assessment.
5. Healthcare staff in administrative areas away from people with suspected or confirmed COVID-19 should not wear PPE unless otherwise indicated.
6. Laboratory staff manipulating respiratory samples should wear:
 - Gowns, gloves, eye protection (where splash risks exist).
7. Members of the general public with respiratory symptoms and those caring for people with suspected or confirmed COVID-19 should wear:
 - Medical masks.
8. Asymptomatic people should *not* wear medical masks unless in close contact with or caring for people with suspected or confirmed COVID-19.

Coordination of PPE supply chain: Global and national supply of PPE should be coordinated and managed. Interventions include:

1. Use PPE use forecasts based on rational quantification models to ensure rationalisation of supply.
2. Monitor and control PPE requests from countries and large responders.[†]
3. Promote centralised request management approaches to minimise duplication and ensure strict adherence to stock management rule to limit wastage, overstock, and stock ruptures.
4. Monitor end-to-end distribution.
5. Monitor and control distribution of PPE from medical facilities stores.

Correct use of PPE: Correct size, fit, and use (donning, doffing, disposal) of all PPE must occur for effective and efficient use.^{19,20} Users of PPE including healthcare and auxiliary staff and members of the public including patients must be provided with clear, understandable, and consistent information and training on correct use. Correct PPE use must also occur together with proper hand hygiene and personal infection control measures.

Due to ongoing and intensifying shortages, special crisis-capacity strategies and considerations are being recommended by the CDC regarding PPE.²⁸ In the United States, guidance has included mention of the use of homemade masks for healthcare professional use in crisis circumstances, but highlights that homemade masks are not substitutable for PPE.²⁹ The CDC notes that the effectiveness of crisis strategies is uncertain and could pose transmission risks between healthcare staff and patients and that standard PPE practices must be reinstated as soon as PPE supplies return. Current crisis capacity strategies stipulated by the CDC include:²⁸

- Consider using intact PPE that is beyond the manufacturer-designated shelf life for patient care activities.
- Carefully prioritise PPE use for selected care activities, including;
 - o reserving sterile gowns and gloves for urgent sterile patient procedures (e.g. surgery), and;
 - o reserving respirators for aerosol-generating procedures and patient care with airborne transmitted disease risks, like tuberculosis, measles, and varicella.

[†] Masks are not necessary for handling cargo from affected countries. Gloves are only required in the context of mechanical hazards (e.g. rough surfaces). No additional PPE is required for disinfecting pallets or supplies.

- Carefully consider if alternative approaches will reduce the risk of HCP exposure and are safe for patient care if no commercial PPE is available.

Further, in some US settings where PPE shortages are dire, there are investigations examining whether recycling normally non-reusable masks and respirators can be safe and effective in crisis scenarios.²⁸⁻³⁰ Based on emerging evidence regarding the length of time that the COVID-19 virus has been observed to remain on surfaces, the CDC has described a process to conserve respirator use.³⁰ The CDC notes that where supplies are further constrained, in crisis scenarios decontamination of non-reusable respirators may be necessary. It is highlighted that there are currently no manufacturer-authorized approaches to the decontamination of non-reusable respirators for reuse and that decontamination does not render a respirator 'sterile'. Further, decontamination can reduce goodness of fit, filtration efficiency, and breathability due to changes to the filtering material, straps, nose bridge material, or strap attachments.³⁰ These all need to be checked before use and if integrity or fit has been compromised, the respirator should not be used. Evidence regarding decontamination of used respirators for reuse has existed prior to COVID-19 but is still emerging and overall, indicates that evidence is limited.³¹

Jurisdictional evolution of PPE advice

In light of increasing rates of community transmission, community outbreaks, difficulty assessing infection risk prior to engaging new patients, and heightened risk to health and aged care staff, some jurisdictions have updated their guidance for the use of PPE in the context of COVID-19.^{5,32,33}

Some newer guidance recommends that respirators be worn when undertaking aerosol generating procedures as well as in 'higher risk' areas and contexts where aerosol generating procedures are regularly performed (e.g. intensive care and high-dependency, emergency departments, and resuscitation areas etc) or when providing close, frequent care for people with suspected or confirmed COVID-19 particularly in crowded indoor contexts with poor ventilation.^{5,33} This is consistent with emerging evidence that indicates that aerosolised particles may travel up to around four metres and may remain in the air for prolonged periods.⁸ 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.³⁴ 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.^{34,35}

The UK NHS refer to a rapid review conducted by the UK Health and Safety Executive that concluded that FFP2 respirators offer protection against COVID-19 and can be used during high risk procedures (i.e. aerosol generating), if FFP3 respirators are not available.³²

The WHO has recommended full-arm gowns when seeing any suspected or confirmed case of COVID-19.²¹ The UK guidance also recommends full-arm gowns in high-risk procedures and aprons for other procedures, noting that this is consistent with the UK 'bare below the elbow' policy aimed at reducing healthcare associated infections and effective hand hygiene.³²

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