Guidelines for Personal Protective Equipment

A rapid review commissioned by RACS

5 May 2020

Royal Australasian College of Surgeons

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1	5 May 2020	Original version

Recommendations

The extent of COVID-19 community spread is yet to be determined, and as such the recommendations offered in this report may be updated to reflect changes in practice as related to COVID-19 prevalence in the community over time.

The recommendations regarding appropriate PPE use are based on the available current literature:

1. Implement mandatory PPE donning and doffing training for all surgical staff

2. Implement mandatory infectious disease control training for all surgical staff

3. Consider contingency plans to extend the use of PPE specifically P2/N95 respirators

4. Patients with acute respiratory symptoms and/or suspected or proven COVID-19 to wear a surgical mask when transported to and from the operating theatre

5. PPE Composition:

    - **Non-Aerosol Generating Procedures (non-AGPs)**

    1. Surgical mask
    2. Disposable gown
    3. Double gloves
    4. Eye protection (safety glasses, goggles or full face shield)
    5. Head covering
    6. Shoe covering
    7. Perform hand hygiene

    - **Aerosol Generating Procedures (AGPs)** *disposable apron is a suggested additional PPE item*

    1. Surgical P2/N95 respirator
    2. Disposable gown
    3. Apron
    4. Double gloves
    5. Eye protection (safety glasses, goggles or full face shield)
    6. Head covering
    7. Shoe covering
    8. Perform hand hygiene

It is acknowledged that the decision for PPE use is situation and jurisdiction dependent; guidance provided below may be adapted by individual surgical teams.

- **Emergency surgery** (performed within 24 hours of presentation) where the patient is unconscious and unable to provide medical history and/or recent travel history; patient is conscious but the COVID-19 status and patient history are unknown; patient has no obvious symptoms (e.g., dry cough, fever, sore throat):
    - Decision**:** Surgical team to don appropriate level of PPE that is dependent on whether Aerosol Generating Procedures (AGPs) are performed. The rationale is to treat the patient as suspected COVID-19 positive until diagnostic tests indicate otherwise

- **Category 1 surgery** (surgery performed within 1 month of presentation)
    - Decision**:**
        - If patient is COVID-19 positive, surgical team to don appropriate level of PPE that is dependent on whether Aerosol Generating Procedures (AGPs) are performed
        - If patient is not COVID-19 positive, surgical team to don attire as stipulated by their surgical unit e.g., surgical mask, eye protection (shield or goggle protection), disposable gown, gloves

Executive summary

Although the pathogenic nature of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) is yet to be fully elucidated health authorities in Australia and New Zealand have been afforded the rare opportunity to learn from the Northern Hemisphere experience as how best to maintain a healthy surgical and ancillary workforce during this pandemic. SARS-CoV-2 causes the disease COVID-19 that was first identified in Wuhan, China in late 2019.

Given that SARS-CoV-2 transmission occurs via droplets, aerosols and fomite contact, surgical teams exposed to asymptomatic COVID-19 positive patients are at greater risk during aerosol generating procedures (AGPs).

This has brought into focus the use of Personal Protective Equipment (PPE) as the last line of defence for surgical staff.

This guideline reinforces what is considered the minimum threshold for PPE use by healthcare workers (HCWs) in the treatment of COVID-19 patients.

These consist of P2/N95 filtering facepiece respirators (FFRs), eye protection, disposable gloves, gowns, aprons, head and foot covering as reported in the current peer-reviewed literature and guidance from the World Health Organization (WHO).

Formal training on donning and doffing PPE procedures, comprehensive infectious disease control education and good hand hygiene are equally important aspects for the prevention of SARS-CoV-2 infection in surgical staff.

Where possible, patients with acute respiratory symptoms and/or suspected or proven COVID-19 are to wear a surgical mask during transfer to and from theatre.

Healthcare administrators are also encouraged to have contingency plans for extending the use of P2/N95 FFRs should PPE supply chains be interrupted.

Introduction

SARS-CoV-2 is a single stranded RNA spheroid shaped virus ranging from 40-140 nm in diameter, which is closely related to the Severe Acute Respiratory Syndrome Coronavirus-1 (SARS-CoV-1) virus. The mechanism of human infection begins with airborne viral particles binding to the angiotensin-converting enzyme 2 (ACE 2) protein that is expressed on the surface of lung alveolar epithelial cells.[1] ACE 2 protein is widely distributed and is also present in a variety of human organs: oral and nasal mucosa, nasopharynx, lung, stomach, small intestine, colon, skin, lymph nodes, thymus, bone marrow, spleen, liver, kidney, and brain.[2]

Droplet, aerosol exposure and fomite contact are the main modes of transmission of SARS-CoV-2[3] and depending on the initial inoculum shed can remain viable and infectious in aerosols for hours, and depending on surface type for up to days.[4]

The highest priority for Australian State and Federal, and New Zealand health authorities must be that of preserving workforce capacity and capability by mitigating the risk of infection to healthcare workers (HCWs), specifically surgeons, anaesthetists and the theatre team.

This document provides guidelines regarding the most appropriate use of Personal Protective Equipment (PPE) taking into consideration: i) the supply of and access to PPE and ii) the COVID-19 status of the patient.

Personal Protective Equipment (PPE)

PPE consists of disposable gowns, aprons, gloves, face shields, goggles, outer foot covering, head covering, surgical masks, filtering facepiece respirators (P2/N95) and PAPR (Powered Air Purifying Respirators). The properties and utility of surgical masks and filtering facepiece respirators (P2/N95) will be the focus of this guideline document.

Surgical Mask

Surgical masks are loose fitting, single-use items that cover the nose and mouth (Table 1). They are used as part of standard precautions to keep splashes or sprays from reaching the mouth and nose of the person wearing them. They also provide some protection from respiratory secretions and are worn when caring for patients who are on droplet precautions. Surgical masks can be placed on coughing patients to limit potential dissemination of infectious respiratory secretions from the patient to others - *NHMRC, Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019)*[5]

Table 1. Surgical Masks - Level Barrier Protection

Characteristics	Level 1 Barrier	Level 2 Barrier	Level 3 Barrier	Test Method
Application	For procedures where the wearer is not at risk of blood or bodily substance splash or to protect staff and/or the patient from droplet exposure to microorganisms (e.g., patient with upper respiratory tract infection)	For procedures where the wearer is at risk of moderate exposure to blood and body substances (e.g., surgery, dentistry, general patient care areas; to protect staff and/or the patient from droplet exposure)	For procedures such as major trauma first aid or in any area where the health worker is at risk of substantial exposure to blood or bodily substance splash (e.g., orthopaedic, ENT, cardiovascular procedures)	N/A
Bacterial Filtration Efficiency (BFE)%	≥ 95%	≥ 98%	≥ 98%	ASTM F2101-14 or EN 14683:2014
Differential pressure (ΔP), mm H_2O/cm^2	< 4.0	< 5.0	< 5.0	EN 14683:2014
Resistance to penetration by synthetic blood (fluid resistance) minimum pressure in mmHg for pass result	80 mmHg	120 mmHg	160 mmHg	ASTM F1862 / F1862M-13 or ISO 22609

Source: *AS 4381: 2015 Standards Australia: Single-use face masks for use in health care*[6]

P2 and N95 filtering facepiece respirators

P2 and N95 respirators are disposable filtering facepiece respirators worn to protect both the patient and HCW from airborne microorganisms, bodily fluids and particulate matter (Table 2).

While the terms 'P2 respirator' and 'N95 respirator' are often used interchangeably in the healthcare setting, they are required to meet different standards. In Australia, the requirements for P2 respirators are stated in Standard AS/NZS 1716: 2012. The United States (US) National Institute of Occupational Safety and Health (NIOSH) specifies N95 respirator requirements. – NHMRC Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019)[5]

Table 2. Properties of P2 and N95 respirators

Properties	P2 Respirators	N95 Respirators
Characteristics	• Raised dome or duckbill • 4-5 layers (outer polypropylene, central layers electret [charged polypropylene]) • Filtration through mechanical impaction and electrostatic capture • Designed to provide a good facial fit to minimize aerosol contamination of the mucous membranes of the nose and mouth P2 particulate filtering respirators/masks must have a filter efficiency of at least 94% when tested with sodium chloride aerosol at a flow rate of 95 L/min. Under the European Standard (EN) system, aerosol testing is similar to Standard AS/NZS 1716:2012 but have additional filter efficiency testing with paraffin oil aerosol that must also meet the minimum 94% filter efficiency to be classified as P2. The particle size of this aerosol has a mass median diameter of 0.3 to 0.6 microns with a range of particles in the 0.02 to 2 micron size range.	• Raised dome or duckbill • 4-5 layers (outer polypropylene, central layers electret [charged polypropylene]) • Filtration through mechanical impaction and electrostatic capture • Designed to provide a good facial fit to minimize aerosol contamination of the mucous membranes of the nose and mouth NIOSH classified N95 particulate filtering respirators/masks must have a filter efficiency of at least 95% when tested with sodium chloride aerosol at a flow rate of 85 L/min. N95 respirator masks can only be used for oil free aerosols. The particle size of this aerosol is ~0.3 micron.
Sealing	• Ties at crown and bottom of head, pliable metal nose bridge • Fit testing and fit checking recommended	• Ties at crown and bottom of head, pliable metal nose bridge • Fit testing and fit checking recommended
Standards	Standard AS/NZS 1715: 2009 Standard AS/NZS 1716: 2012	Set by the US NIOSH classification (NIOSH Guidelines – Procedure No. TEB-APR-STP-0059)

Intended use	• Routine care of patients on airborne precautions • High-risk procedures such as bronchoscopy when the patient's infectious status is unknown • Procedures that involve aerosolisation of particles that may contain specific known pathogens (AGPs)	• Routine care of patients on airborne precautions • High-risk procedures such as bronchoscopy when the patient's infectious status is unknown • Procedures that involve aerosolisation of particles that may contain specific known pathogens (AGPs)
Notes	Care must be taken if placing respirators on patients and must suit clinical need (i.e., if the patient has chronic obstructive airways disease, or is in respiratory distress, the respirator will exacerbate symptoms).	Care must be taken if placing respirators on patients and must suit clinical need (i.e., if the patient has chronic obstructive airways disease, or is in respiratory distress, the respirator will exacerbate symptoms).

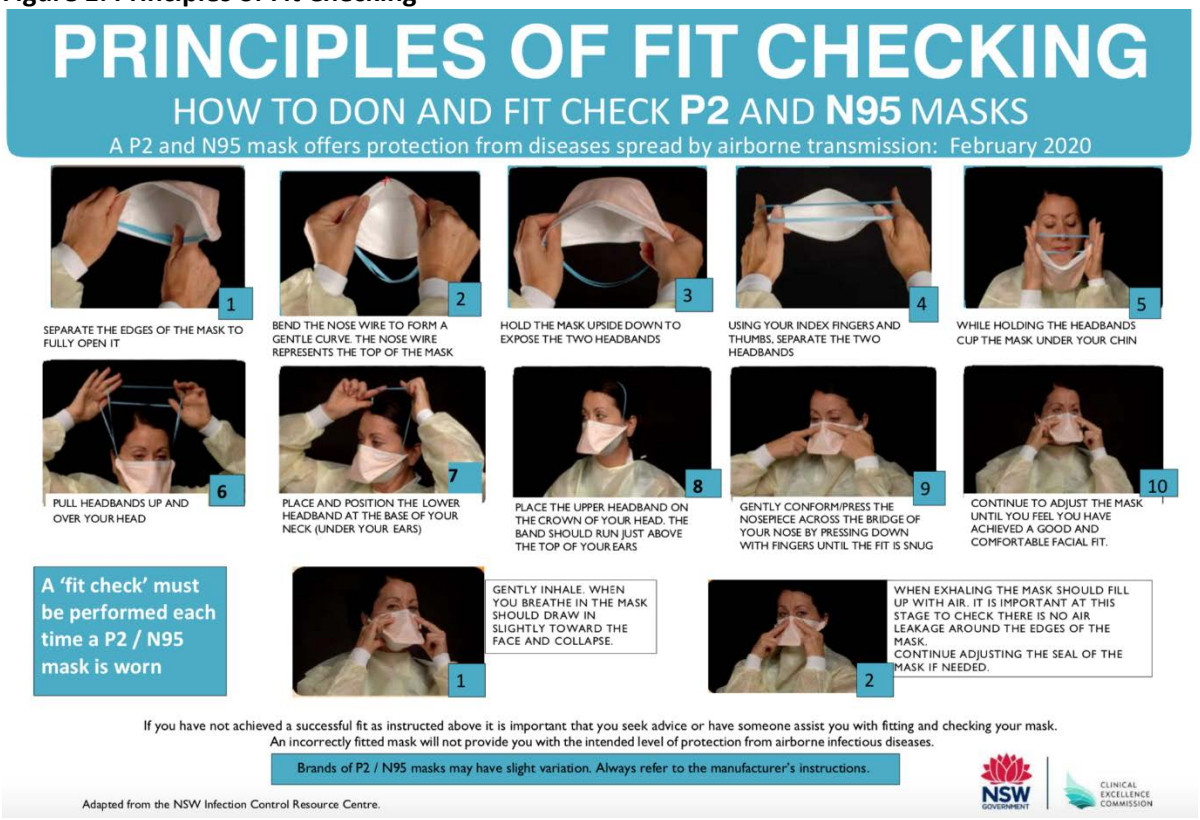
Source: Table 13 - NHMRC, Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019)[5]

Fit testing

Fit testing is essential to ensure the expected level of protection (i.e., concentration of airborne contaminants inside the respirator is less than or equal to 10% of ambient levels).[7] The highest level of protection is provided by passing a fit-test with a N95 respirator model that has good-fitting characteristics; Figure 1.[8]

As most particle penetration occurs through face-seal leakage, which varies with breathing flow rate and particle size[9], manufacturers recommend the removal of facial hair for optimum sealing of a P2/N95 respirator around the wearer's face.

Figure 1. Principles of Fit Checking



Source: *Principles of fit checking: how to don and fit check P2 and N95 masks, adapted from the NSW Infection Control Resource Centre*

Importance of infectious disease education for HCW, including good hand hygiene

Good hand hygiene practice through the increased frequency of use of alcohol-based hand sanitisers (min 70% ethanol or isopropanol) is an economical and efficient method for reducing the risk of SARS-CoV-2 infection amongst HCWs.

A lesson learnt from the SARS outbreak was that inadequate (< 2 h) training on infection control procedures and inconsistent use of PPE were high risk factors for HCWs[10], as were HCWs being unsure of proper PPE donning and doffing procedures. Also, fatigue was a cited as a significant factor in poor decision making and breaches of PPE protocols.[11]

PPE donning and doffing training

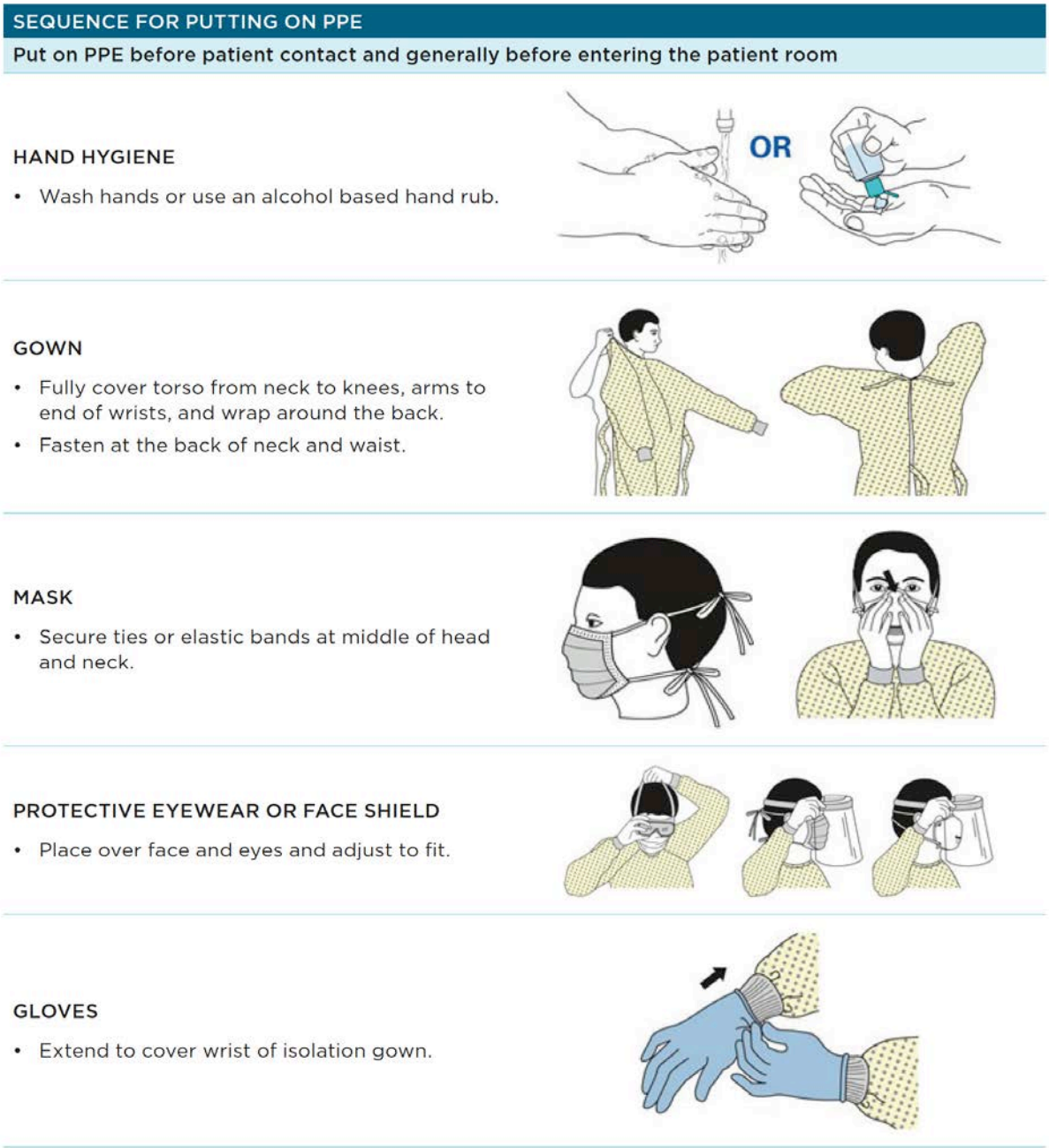
It is imperative that formal training be provided to HCWs on donning and doffing PPE, given that improper doffing increases the risk of nosocomial SARS-CoV-2 spread.[12]

It should not be assumed that all HCWs have had adequate training in donning and doffing procedures.

Individual surgical units are strongly encouraged to:

- implement training programs for staff regardless of seniority or length of service
- use a buddy system where one person ("buddy") observes and gives step by step verbal instructions to the partner who follows as instructed
- fix laminated posters onto walls in ante rooms and/or theatre staff change rooms that demonstrate stepwise donning and doffing procedures (Figures 2a and b)
    - If possible, staff to doff in an ante room, practise hand hygiene before departing ante room
    - Staff to shower before resuming other duties[13]

Figure 2a. Donning PPE Prior to non-sterile Patient Encounters



Source: - *NHMRC, Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019)*[5]

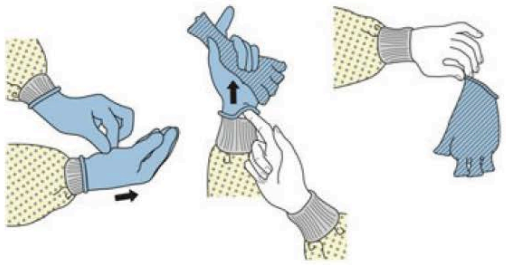
Figure 2b. Doffing PPE After non-sterile Patient Encounters

SEQUENCE FOR REMOVING PPE

Remove PPE at doorway or in anteroom

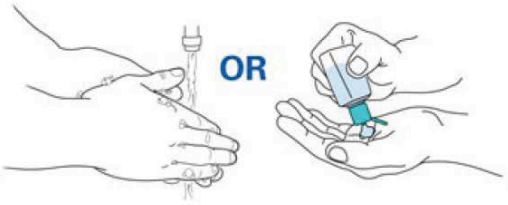
GLOVES

- Outside of gloves is contaminated!
- Grasp outside of glove with opposite gloved hand; peel off.
- Hold removed glove in gloved hand.
- Slide fingers of ungloved hand under remaining glove at wrist.
- Peel glove off over first glove.
- Discard gloves in waste container.



HAND HYGIENE

- Wash hands or use an alcohol based hand rub.



PROTECTIVE EYEWEAR OR FACE SHIELD

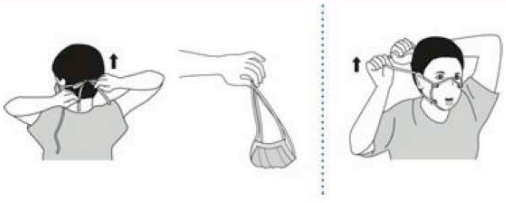
- Outside of eye protection or face shield is contaminated!
- To remove, handle by head band or ear pieces.
- Place in designated receptacle for reprocessing or in waste container.

GOWN

- Gown front and sleeves are contaminated!
- Unfasten ties.
- Pull away from neck and shoulders, touching inside of gown only.
- Turn gown inside out.
- Fold or roll into a bundle and discard.

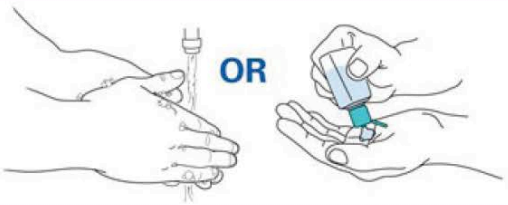
MASK

- Front of mask is contaminated—DO NOT TOUCH!
- Grasp bottom, then top ties or elastics and remove.
- Discard in waste container.



HAND HYGIENE

- Wash hands or use an alcohol based hand rub immediately after removing all PPE.



Source: - *NHMRC, Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019)*[5]

As reported by Wong et al (2020) another measure to minimise SARS-CoV-2 infection employed in Singapore was to have the patient wear a surgical face mask whilst being transported to and from the operating theatre along a designated route with minimal contact with other HCWs.[14]

Patient status and PPE

The World Health Organization (WHO) has provided interim guidance which was issued against a backdrop of acute global PPE shortages: *Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages, Interim guidance, 6 April 2020* (Appendix 1). The guidance regarding the types of PPE to be worn when treating COVID-19 positive patients in AGP and non-AGP environments is in concordance with the Australian and New Zealand College of Anaesthetists (ANZCA) recently released *Statement on personal protection equipment during the SARS-CoV-pandemic, 9* April 2020 (Appendix 2).

HCWs with firsthand experience treating COVID-19 patients such as those in Italy[15] advised that PPE should include: helmets, covers or hoods, FFP3 or FFP2/N95 masks, goggles or face shields (if no helmets), hazmat suits or long sleeved fluid-resistant gowns, double gloves (possibly different colours), and overshoes. (*National Institute for Occupational Safety and Health (NIOSH)-approved FFRs require a minimum of 95 and 99.97% efficiencies for N95 and P100 FFR respectively. European Norms (EN)-certified 'Conformite European' (CE)-marked FFRs require 94 and 99% for class P2 (FFP2) and class P3 (FFP3) respectively*).

It is recommended that individual healthcare centres refer to advice issued by the Australian Government Department of Health: *Interim advice on non-inpatient care of persons with suspected or confirmed Coronavirus disease (COVID19), including use of personal protective equipment (PPE)* to define "low risk, suspected and confirmed COVID-19" status of patients.
New Zealand healthcare centres should refer to the Ministry of Health, NZ for guidance: *Case definition of COVID-19 infection 8 April 2020.*

Aerosol Generating Procedures (AGPs)

A major risk to HCWs is the exposure to viral particles during AGPs. The Australian and New Zealand College of Anaesthetists (ANZCA) recently released *Statement on personal protection equipment during the SARS-CoV-pandemic, 9* April 2020 (Appendix 2) indicated there is broad consensus that the following are classified as AGPs.

a. Bag and mask ventilation

b. Tracheal intubation

c. Tracheal extubation

d. Ventilation via supraglottic airways (including insertion and removal)

e. Non-invasive ventilation including Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP) therapies

f. High flow nasal oxygen therapy

g. Use of nebulisers

h. Cardiopulmonary Resuscitation (CPR)

i. Anaesthesia procedures for women in late first stage labour and second or third stage labour and especially those who are distressed. Secretions from the respiratory tract and faeces are the principle risk to staff and others.

j. Anaesthesia procedures for highly symptomatic patients who are considered high risk for aerosol generation (e.g., coughing or other signs of respiratory distress)

High risk Procedural/Surgical AGPs

k. High Risk Procedural AGPs - Diagnostic and therapeutic instrumentation of the airway including bronchoscopy and tracheostomy

l. High Risk Surgical AGPs - Any surgical procedure involving the upper respiratory tract, such as ear, nose and throat, facio-maxillary or anterior pituitary surgical, procedures, where aerosolisation of tissue is likely; for example, the use of pulsed lavage, the use of high-speed drills and laser techniques. *The risk of transmission from non-respiratory tract blood aerosol, digestive tract aerosol, pulsed lavage and laser work is currently not accurately known but is thought to be lower.*

In addition to the above listed procedures, further examples are provided by the Department of Health *Guidance on the use of personal protective equipment (PPE) in hospitals during the COVID-19 outbreak (version 4):*

i) Intentional or inadvertent disconnection/reconnection of closed ventilator circuit
ii) Intercostal catheter insertion for relief of pneumothorax
iii) Thoracic surgery that involves entering the lung
iv) Collection of induced sputum

Special attention is drawn to the high risk (k) procedural and (l) surgical AGPs, with respect to the final ANZCA statement regarding "*The transmission risk from non-respiratory tract blood aerosol etc*". We provide here more relevant information relating to SARS-CoV-2 presence in various bodily fluids.

Evidence of SARS-CoV-2 in bodily fluids

Although rapid, Reverse Transcription-Polymerase Chain Reaction (RT-PCR) is an imperfect COVID-19 diagnostic test.[16] A review by Lippi et al (2020) found that due to patients being tested whilst in the early stages of disease progression and therefore carrying low viral loads, the RT-PCR test can report up to 30% false negative results. Other attributable factors include poor pre-analytical handling of patient samples and compromised quality of reagents and primers.[16]

- The highest SARS-CoV-2 RNA positive rates were detected in bronchoalveolar lavage fluid, then sputum, nasal swabs, fibrobronchoscope brush biopsy, pharyngeal swabs, faeces and blood but not urine samples of 205 patients screened by RT-PCR.[17] Four of the SARS-CoV-2 positive faecal specimens were cultured and viable viral particles detected by scanning electron microscopy (SEM).

- Detection of SARS-CoV-2 RNA in sputum from convalescing patients that tested negative in their throat and anal swabs[18]; further confirming that SARS-CoV-2 virions attach to alveolar epithelium in the lower lungs.

- Lacrimal secretions from another cohort of COVID-19 patients screened by RT-PCR and viral isolation (inoculation of lacrimal sample into Vero-E6 cells and examined for signs of cytopathic effect) returned negative results at the time their nasopharyngeal swab tested positive for COVID-19.[19] *However*, a **SARS-CoV-2 infected patient with conjunctivitis** tested positive for SARS-CoV-2 RNA in tear and conjunctival secretions.[20]

Aerosolisation of infectious viruses by excimer laser

For context, SARS-CoV-2 virions are elliptical/spheroid particles with a diameter of 40-140 nm.

- *Live virus production following excimer laser*
  Excimer laser photoablation of the A549 adenocarcinoma cell line infected with Herpes Simplex Virus (155–240 nm diameter) and adenovirus (90-100 nm diameter) produced live virus that was detected in sentinel dishes of uninoculated A549 monolayer placed at adjacent sites.[21]

- *Smaller viruses can survive excimer laser ablation*
  The captured phototherapeutic ablation plumes from fibroblasts previously inoculated with oral polio virus (30 nm diameter) caused a cytopathic effect when seeded on untreated human embryonic lung fibroblasts.[22] The authors suggested that laser plumes generated during corneal photorefractive keratectomy were to be treated as biohazardous material. They advised wearing surgical masks that filter out small particles and evacuating the laser plume where possible.

- *Generation of 0.13-0.42 µm diameter respirable particles during ablation*
  Excimer laser plume of eye-bank corneas set for phototherapeutic ablation produced respirable particles.[23] The authors commented that particles of 5.0 µm or larger are generally deposited on mucosa of nasopharynx, trachea and bronchial bifurcation whereas particles smaller than 2.0 µm lodged in the respiratory bronchioles and alveoli.

Conserving and extending P2/N95 respirator use

The critical worldwide shortage of P2/N95 respirators is posing a challenge to health department administrators as how best to manage current stocks in hospitals.

Strategies for conserving and extending P2/N95 respirator use may include:

1. mandating the use of full face shields over the P2/N95 respirator to reduce the contamination of the outer respirator surface. The protection from droplets and aerosols afforded by the face shield allows extended use of the respirator.[24]
2. covering respirators with surgical masks or similar disposable covers over the top of respirators can potentially extend the life of the respirator without significant adverse effects. A study trialling 30 NIOSH-approved N95 FFR models, with and without a surgical mask cover, found that at the lower levels of energy expenditure, placement of a surgical mask cover over the FFR produced clinically small changes in inhaled breathing gases and pressure and minimal effect on physical work performance.[25]
3. disinfection of P2/N95 respirators by Ultraviolet Germicidal Irradiation (UVGI). MS2 coliphage (single stranded RNA virus of 27 nm diameter) viral droplets aerosolised onto N95 FFRs (model N1105; Willson, Santa Ana, CA) then subjected to UV irradiation resulted in approximately 3-log reduction in the level of MS2 virus at a dose of 4.32 J/cm^2 (3 h of contact time with a UV intensity of 0.4 mW/cm^2).
   At higher doses of ≥7.20 J/cm^2; UV intensity, 0.4 mW/cm^2 and contact times ≥5 h, all MS2 was inactivated.[26] The UV doses used are significantly higher than that required to inactivate single-stranded RNA viruses, such as SARS-CoV-2 which are generally inactivated by UVGI exposure of 2-5 mJ/cm^2 .[27]

Conclusions

Correct use of PPE, infectious disease control training and good hand hygiene are fundamental to reducing the risk of HCWs contracting COVID-19.

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Appendix 1

World Health Organisation

Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages

Interim guidance 6 April 2020

Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages

Interim guidance

6 April 2020

World Health Organization

Background

This document summarizes WHO's recommendations for the rational use of personal protective equipment (PPE) in health care and home care settings, as well as during the handling of cargo; it also assesses the current disruption of the global supply chain and considerations for decision making during severe shortages of PPE.

This document does not include recommendations for members of the general community. See here: for more information about WHO advice of use of masks in the general community.

In this context, PPE includes gloves, medical/surgical face masks - hereafter referred as "medical masks", goggles, face shield, and gowns, as well as items for specific procedures-filtering facepiece respirators (i.e. N95 or FFP2 or FFP3 standard or equivalent) - hereafter referred to as "respirators" - and aprons. This document is intended for those involved in distributing and managing PPE, as well as public health authorities and individuals in health care and home care settings involved in decisions about PPE use and prioritization; it provides information about when PPE use is most appropriate, including in the context of cargo handling.

This document has been updated to address key considerations for decision making processes during severe shortages of PPE.

Preventive measures for COVID-19 disease

Based on current evidence, the COVID-19 virus is transmitted between people through close contact and droplets. Airborne transmission may occur during aerosol-generating procedures and support treatments (e.g. tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy)[1]; thus, WHO recommends airborne precautions for these procedures.

For all, the most effective preventive measures include:

- maintaining physical distance (a minimum of 1 metre) from other individuals;
- performing hand hygiene frequently with an alcohol-based hand rub if available and if your hands are not visibly dirty or with soap and water if hands are dirty;
- avoiding touching your eyes, nose, and mouth;
- practicing respiratory hygiene by coughing or sneezing into a bent elbow or tissue and then immediately disposing of the tissue;
- wearing a medical mask if you have respiratory symptoms and performing hand hygiene after disposing of the mask;
- routine cleaning and disinfection of environmental and other frequently touched surfaces.

In health care settings, the main infection prevention and control (IPC) strategies to prevent or limit COVID-19 transmission include the following:[2]

1. ensuring triage, early recognition, and source control (isolating suspected and confirmed COVID-19 patients);
2. applying standard precautions[3] for all patients and including diligent hand hygiene;
3. implementing empiric additional precautions (droplet and contact and, wherever applicable for aerosol-generating procedures and support treatments, airborne precautions) for suspected and confirmed cases of COVID-19;
4. implementing administrative controls;
5. using environmental and engineering controls.[4]

Standard precautions are meant to reduce the risk of transmission of bloodborne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control precautions to be used, as a minimum, in the care of all patients.

Additional transmission-based precautions are required by health care workers to protect themselves and prevent transmission in the health care setting. Contact and droplets precautions should be implemented by health workers caring for patients with COVID-19 at all times. Airborne precautions should be applied for aerosol-generating procedures and support treatments.

Although use of PPE is the most visible control used to prevent the spread of infection, it is only one of the IPC measures and should not be relied on as a primary prevention strategy. In the absence of effective administrative and engineering controls, PPE has limited benefit, as described in WHO's Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care. These controls are summarized here.

- **Administrative controls** include ensuring resources for infection prevention and control (IPC measures, such as appropriate infrastructure, the development of clear IPC policies, facilitated access to laboratory testing, appropriate triage and placement of patients, including separate waiting areas/rooms dedicated to patients with respiratory symptoms, and adequate staff-to-patient ratios, and training of staff. In the case of COVID-19, consideration should be given, wherever possible, to establish differentiated care pathways that minimize mixing of known or suspected COVID-19 patients with other patients (e.g. through separate health facilities, wards, waiting, and triage areas).
- **Environmental and engineering controls** aim at reducing the spread of pathogens and the contamination of surfaces and inanimate objects. They include providing adequate space to allow social distance of at least 1 m to be maintained between patients and health care workers and ensuring the availability of well-ventilated isolation rooms for patients with suspected or confirmed COVID-19, as well as adequate environmental cleaning and disinfection.[4]

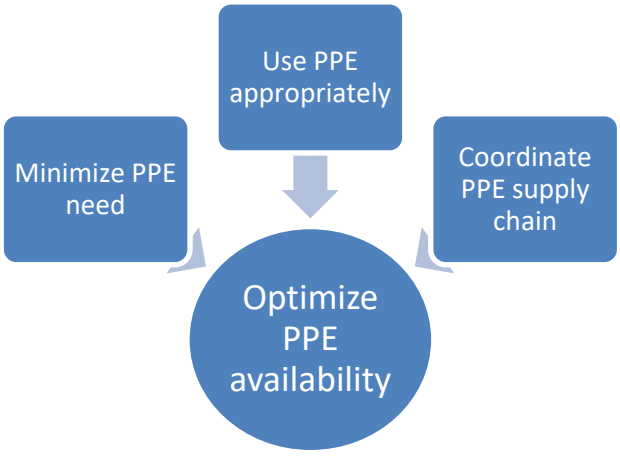
Coveralls, double gloves, or head covers (hood) that cover the head and neck used in the context of filovirus disease outbreaks (e.g. Ebola virus) are not required when managing COVID-19 patients.

Recommendations for optimizing the availability of PPE

The protection of our frontline health workers is paramount and PPE, including medical masks, respirators, gloves, gowns, and eye protection, must be prioritized for health care workers and others caring for COVID-19 patients.

In view of the global PPE shortage, strategies that can facilitate optimal PPE availability include minimizing the need for PPE in health care settings, ensuring rational and appropriate use of PPE, and coordinating PPE supply chain management mechanisms (Figure 1).

Figure 1. Strategies to optimize the availability of personal protective equipment (PPE)



1. Minimize the need for PPE in health care settings

The following interventions can minimize the use and need for PPE while ensuring that the protection health care workers and others from exposure to the COVID-19 virus in health care settings is not compromised.

- Wherever feasible, use telemedicine and telephone hotlines to initially evaluate suspected cases of COVID-19[5], thus minimizing the need for these persons to go to health care facilities for evaluation.
- Use physical barriers to reduce exposure to the COVID-19 virus, such as glass or plastic windows. This approach can be implemented in areas of the health care setting where patients will first present, such as triage and screening areas, the registration desk at the emergency department, or at the pharmacy window where medication is collected.
- Postpone elective, non-urgent procedure, and hospitalizations, reduce frequency of visits for chronic patients, apply telemedicine and telephone solutions where possible so that health care workers, wards, and PPE can be redistributed to services in which COVID-19 patients receive care.
- Cohort confirmed COVID-19 patients without co-infection with other transmissible microorganisms in the same room in order to streamline the workflow and facilitate extended use of PPE (see below).
- Designate dedicated health care workers/teams only for COVID-19 patient care so that they can use PPE for longer periods of time (extended use of PPE), if necessary (see considerations section below for details).
- Restrict the number of health care workers from entering the rooms of COVID-19 patients if they are not involved in providing direct care. Streamline the workflow and reduce to a safe level care that requires face-to-face interaction between health worker and patient. To do so, consider bundling activities to minimize the number of times a room is entered (e.g. check vital signs during medication administration or have food delivered by health care workers while they are performing other care) and plan which activities will be performed at the bedside.
- Consider using specific PPE only if in direct close contact with the patient or when touching the environment (e.g. wearing a medical mask and face shield, not using gloves or gown over the scrub suit, if entering the patient's room only to ask questions or make visual checks).
- Visitors should not be allowed to visit confirmed or probable COVID-19 patients, but if strictly necessary, restrict the number of visitors and the time allowed; provide clear instructions about what PPE is required to be used during the visit, about how to put on and remove PPE, and perform hand hygiene to ensure that visitors avoid exposure.

2. Ensure rational and appropriate use of PPE

PPE should be used in combination with administrative and engineering controls. The indications for PPE should be

based on the setting, target audience, risk of exposure (e.g. type of activity) and the transmission dynamics of the pathogen (e.g. contact, droplet, or aerosol). The overuse or misuse of PPE will have a further impact on supply shortages. Observing the following recommendations will ensure rational use of PPE:

- The type of PPE used when caring for COVID-19 patients will vary according to the setting, type of personnel, and activity (Table 1).
- Health care workers involved in the direct care of patients should use PPE according to indications (Table 1).
- Specifically, for aerosol-generating procedures and support treatments (tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, and bronchoscopy)[1] health care workers should use respirators, eye protection, gloves and gowns; aprons should also be used if gowns are not fluid-resistant.[4]
- Among the general public, persons with symptoms suggestive of COVID-19 or those caring for COVID-19 patients at home should receive medical masks and instructions on their use. For additional information, see Home care for patients with COVID-19 presenting with mild symptoms and management of their contacts.[6]
- For additional information, see Advice on the use of masks in the community, during home care, and in health care settings in the context of COVID-19.[7]

3. Coordinate PPE supply chain management mechanisms.

The management of PPE should be coordinated through essential national and international supply chain management mechanisms that include but are not restricted to:

- Using PPE forecasts based on rational quantification models to ensure the rationalization of requested supplies;
- Monitoring and controlling PPE requests from countries and large responders;
- Promoting a centralized request management approach to avoid duplication of stock and ensuring strict adherence to essential stock management rules to limit wastage, overstock, and stock ruptures;
- Monitoring the end-to-end distribution of PPE;
- Monitoring and controlling the distribution of PPE from medical facilities stores.

Handling cargo from affected countries

An experimental study conducted in a laboratory evaluated the survival of the COVID-19 virus on different surfaces and reported that the virus can remain viable up to 72 hours on plastic and stainless steel, up to four hours on copper, and up to 24 hours on cardboard.[8] To date, there are no data to suggest that contact with goods or products shipped from countries affected by the COVID-19 outbreak have been the source of COVID-19 infection in humans. WHO will continue to closely monitor the evolution of the COVID-19 outbreak and will update recommendations as needed.

The rationalized use and distribution of PPE when handling cargo from and to countries affected by the COVID-19 outbreak includes the following recommendations:

- Wearing a mask of any type is not recommended when handling cargo from an affected country.
- Gloves are not required unless they are used for protection against mechanical hazards, such as when manipulating rough surfaces.
- Importantly, the use of gloves does not replace the need for appropriate hand hygiene, which should be performed frequently, as described above.
- When disinfecting supplies or pallets, no additional PPE is required beyond what is routinely recommended.
- Hand hygiene should be practiced

Table 1. Recommended PPE during the outbreak of COVID-19 outbreak, according to the setting, personnel, and type of activity[a]

Setting	Target personnel or patients	Activity	Type of PPE or procedure
Health care facilities			
Inpatient facilities			
Screening[i] Clinical triage for prioritization of care according to severity (e.g. Manchester classification) should be performed in separate area for individuals with symptoms and signs	Health care workers	Preliminary screening not involving direct contact[c].	• Maintain physical distance of at least 1 metre. • Ideally, build glass/plastic screens to create a barrier between health care workers and patients • No PPE required. • When physical distance is not feasible and yet no patient contact, use mask and eye protection.
	Patients with symptoms suggestive of COVID-19	Any	• Maintain physical distance of at least 1 metre. • Provide medical mask if tolerated by patient. • Immediately move the patient to an isolation room or separate area away from others; if this is not feasible, ensure spatial distance of at least 1 metre from other patients. • Perform hand hygiene and have the patient perform hand hygiene
	Patients without symptoms suggestive of COVID-19	Any	• No PPE required • Perform hand hygiene and have the patient perform hand hygiene
Patient room/ward	Health care workers	Providing direct care to COVID-19 patients, in the absence of aerosol-generating procedures	• Medical mask • Gown • Gloves • Eye protection (goggles or face shield) • Perform hand hygiene
	Health care workers	Providing direct care to COVID-19 patients in settings where aerosol-generating procedures are frequently in place[ii]	• Respirator N95 or FFP2 or FFP3 standard, or equivalent. • Gown • Gloves • Eye protection • Apron • Perform hand hygiene
	Cleaners	Entering the room of COVID-19 patients	• Medical mask • Gown • Heavy-duty gloves • Eye protection (if risk of splash from organic material or chemicals is anticipated) • Closed work shoes • Perform hand hygiene
	Visitors[b]	Entering the room of a COVID-19 patient	• Maintain physical distance of at least 1 metre • Medical mask • Gown • Gloves • Perform hand hygiene

[i] The screening procedure refers to prompt identification of patients with signs and symptoms of COVID-19.
[ii] AGP: tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy.

Areas of transit where patients are not allowed (e.g. cafeteria, corridors)	All staff, including health care workers.	Any activity that does not involve contact with COVID-19 patients	• Maintain physical distance of at least 1 metre • No PPE required • Perform hand hygiene
Laboratory	Lab technician	Manipulation of respiratory samples Specimen handling for molecular testing would require BSL-2 or equivalent facilities. Handling and processing of specimens from cases with suspected or confirmed COVID-19 infection that are intended for additional laboratory tests, such as haematology or blood gas analysis, should apply standard precautions[9]	• Maintain physical distance of at least 1 metre • Medical mask • Eye protection • Gown • Gloves • Perform hand hygiene
Administrative areas	All staff, including health care workers.	Administrative tasks that do not involve contact with COVID-19 patients.	• Maintain physical distance of at least 1 metre • No PPE required • Perform hand hygiene

Outpatient facilities			
Screening/triage	Health care workers	Preliminary screening not involving direct contact[c].	• Maintain physical distance of at least 1 metre. • Ideally, build a glass/plastic screen to create a barrier between health care workers and patients • No PPE required • When physical distance is not feasible and yet no patient contact, use mask and eye protection. • Perform hand hygiene
	Patients with symptoms suggestive of COVID-19	Any	• Maintain spatial distance of at least 1 metre. • Provide medical mask if tolerated. • Perform hand hygiene
	Patients without symptoms suggestive of COVID-19	Any	• No PPE required • Perform hand hygiene
Waiting room	Patients with symptoms suggestive of COVID-19	Any	• Provide medical mask if tolerated. • Immediately move the patient to an isolation room or separate area away from others; if this is not feasible, ensure spatial distance of at least 1 metre from other patients. • Have the patient perform hand hygiene
	Patients without respiratory symptoms	Any	• No PPE required • Have the patient perform hand hygiene
Consultation room	Health care workers	Physical examination of patient with symptoms suggestive of COVID-19	• Medical mask • Gown • Gloves • Eye protection • Perform hand hygiene
	Health care workers	Physical examination of patients without symptoms suggestive of COVID-19	• PPE according to standard precautions and risk assessment. • Perform hand hygiene
	Patients with symptoms suggestive of COVID-19	Any	• Provide medical mask if tolerated. • Hand hygiene and respiratory etiquette

	Patients without symptoms suggestive of COVID-19	Any	• No PPE required • Have the patient perform hand hygiene
	Cleaners	After and between consultations with patients with respiratory symptoms.	• Medical mask • Gown • Heavy-duty gloves • Eye protection (if risk of splash from organic material or chemicals). • Closed work shoes • Perform hand hygiene
Administrative areas	All staff, including health care workers	Administrative tasks	• Maintain physical distance of at least 1 metre between staff • No PPE required • Perform hand hygiene
Home care			
Home	Patients with symptoms suggestive of COVID-19	Any	• Maintain physical distance of at least 1 metre. • Provide medical mask if tolerated, except when sleeping. • Hand and respiratory hygiene
	Caregiver	Entering the patient's room, but not providing direct care or assistance	• Maintain physical distance of at least 1 metre • Medical mask • Perform hand hygiene
	Caregiver	Providing direct care or when handling stool, urine, or waste from COVID-19 patient being cared for at home	• Gloves • Medical mask • Apron (if risk of splash is anticipated) • Perform hand hygiene
	Health care workers	Providing direct care or assistance to a COVID-19 patient at home	• Medical mask • Gown • Gloves • Eye protection
Points of entry at airports, ports and ground crossing as applicable			
Administrative areas	All staff	Any	• No PPE required
Screening area	Staff	First screening (temperature measurement) not involving direct contact[c].	• Maintain physical distance of at least 1 metre. • Ideally, build a glass/plastic screen to create a barrier between health care workers and patients • No PPE required • When physical distance is not feasible, yet no patient contact, use mask and eye protection. • Perform hand hygiene
	Staff	Second screening (i.e. interviewing passengers with fever for clinical symptoms suggestive of COVID-19 disease and travel history)	• Maintain physical distance of at least 1 metre. • Medical mask • Gloves • Perform hand hygiene
	Cleaners	Cleaning the area where passengers with fever are being screened	• Medical mask • Gown • Heavy duty gloves • Eye protection (if risk of splash from organic material or chemicals). • Boots or closed work shoes • Perform hand hygiene
Temporary isolation area	Staff	Entering the isolation area, but not providing direct assistance	• Maintain physical distance of at least 1 metre. • Medical mask

			• Gloves
	Staff, health care workers	Assisting or caring for passenger being transported to a health care facility as a suspected COVID -19 cases	• Medical mask • Gown • Gloves • Eye protection • Perform hand hygiene
	Cleaners	Cleaning isolation area	• Maintain physical distance of at least 1 metre. • Medical mask • Gown • Heavy duty gloves • Eye protection (if risk of splash from organic material or chemicals). • Closed work shoes • Perform hand hygiene
Ambulance or transfer vehicle	Health care workers	Transporting suspected COVID-19 patients to the referral health care facility	• Medical mask • Gowns • Gloves • Eye protection • Perform hand hygiene
	Driver	Involved only in driving the patient with suspected COVID-19 disease and the driver's compartment is separated from the COVID-19 patient	• Maintain physical distance of at least 1 metre. • No PPE required • Perform hand hygiene
		Assisting with loading or unloading patient with suspected COVID-19	• Medical mask • Gowns • Gloves • Eye protection • Perform hand hygiene
		No direct contact with patient with suspected COVID-19, but no separation between driver's and patient's compartments	• Medical mask • Perform hand hygiene
	Patient with suspected COVID-19.	Transport to the referral health care facility.	• Medical mask if tolerated • Have the patient perform hand hygiene
	Cleaners	Cleaning after and between transport of patients with suspected COVID-19 to the referral health care facility.	• Medical mask • Gown • Heavy duty gloves • Eye protection (if risk of splash from organic material or chemicals). • Boots or closed work shoes • Perform hand hygiene

Special considerations for rapid-response teams assisting with public health investigations[d]			
Anywhere	Rapid-response team investigators	Remote interview of suspected or confirmed COVID-19 patients or their contacts.	• No PPE if done remotely (e.g. by telephone or video conference). • Remote interview is the preferred method.
		In-person interview of suspected or confirmed COVID-19 patients or contacts without direct contact	• Medical mask • Maintain physical distance of at least 1 metre. • The interview should be conducted outside the house or outdoors, and confirmed or suspected COVID-19 patients should wear a medical mask if tolerated. • Perform hand hygiene

[a] In addition to using the appropriate PPE, frequent hand hygiene and respiratory etiquette should always be performed. PPE should be discarded in an appropriate waste container after use according to local guidance, and hand hygiene should be performed before putting on and after taking off PPE.

[b] the number of visitors should be restricted. If visitors must enter a COVID-19 patient's room, they should be provided with clear instructions about how to put on and remove PPE and about performing hand hygiene before putting on and after removing PPE; this should be supervised by a health care worker.

[c] This category includes the use of no-touch thermometers, thermal imaging cameras, and limited observation and questioning, all while maintaining a spatial distance of at least 1 m.

[d] All rapid-response team members must be trained in performing hand hygiene and how to put on and remove PPE to avoid -self-contamination.

For PPE specifications, refer to WHO's disease commodity package.

Disruptions in the global supply chain of PPE

The current global stockpile of PPE is insufficient, particularly for medical masks and respirators, and the supply of gowns, goggles, and face shields is now insufficient to satisfy the global demand. Surging global demand—d riven not only by the number of COVID-19 cases but also by misinformation, panic buying, and stockpiling—has resulted in further shortages of PPE globally. The capacity to expand PPE production is limited, and the current demand for respirators and masks cannot be met, especially if widespread inappropriate use of PPE continues.

However, with manufacturing companies in some of the main exporting countries restarting their production, and an established global coordination mechanism that WHO anticipates will contribute to addressing the global shortage. Dedicated assistance and international solidarity mechanisms are required to meet the needs of the most vulnerable countries, which may face affordability issues in a context of rising prices determined by an unprecedented surge in demand, coupled with supply and distribution disruptions.

Members States and large responders can forecast their supply needs using the Essential Supplies forecasting tool.

Considerations for decision making processes during severe shortages of PPE

In the context of severe PPE shortages despite application of the above-mentioned strategies, it is crucial to ensure a "whole of society" response and to protect frontline health care workers. This includes advocating for the urgent increased production of PPE, including, if needed, through advance market commitments, public-sector mandated scale up of production by the private sector, pursuing donation options, international solidarity through financial support of PPE purchase and distribution for the needs of the most vulnerable countries, and engaging with the general public to prevent irrational use of PPE at community level, among other strategies.

Any alternative approach to find temporary solutions to mitigate critical shortages of PPE should be based on scientific evidence, the principles of safe care delivery and health care safety, workload minimization for health care workers, and avoiding a false sense of security.

Based on current evidence, in consultation with international experts and other agencies in the field of IPC, WHO carefully considered **last-resort temporary measures** in crisis situations to be adopted **only** where there might be serious shortages of PPE or in areas where PPE may not be available.

WHO stresses that these temporary measures should be avoided as much as possible when caring for severe or critically ill COVID-19 patients, and for patients with known co-infections of multi-drug resistant or other organisms transmitted by contact (e.g. Klebsiella pneumoniae) or droplets (e.g. influenza virus).

The following temporary measures could be considered independently or in combination, depending on the local situation:

1. PPE extended use (using for longer periods of time than normal according to standards);
2. Reprocessing followed by reuse (after cleaning or decontamination/sterilization) of either reusable or disposable PPE;
3. Considering alternative items compared with the standards recommended by WHO.

An additional consideration is the use of PPE beyond the manufacturer-designated shelf life or expiration date for a limited time. The items should be inspected before use to be sure they are in good condition with no degradation, tears, or wear that could affect performance. N95 respirators that are past their designated shelf life are no longer NIOSH-approved, as all manufacturer-designated conditions of use must be met to maintain the NIOSH approval. An expired respirator can still be effective at protecting health care provider if the straps are intact, there are no visible signs of damage, and they can be fit-tested. Health care providers should inspect the mask and perform a seal check before use.

The reuse of any item without a reprocessing/ decontamination process is considered inadequate and unsafe. The reprocessing should be performed by trained staff in the sterile services department of a health care facility or at bigger scale under controlled and standardized conditions. Many medical devices are designed to be reusable, hence their compatibility with decontamination methods; this is not the case for face shields, medical masks, and respirators. Normally, for any reprocessing methods, cleaning before disinfection and sterilization is required. This is a problem for masks and respirators because they cannot be cleaned without losing their proprieties.

Methods for reprocessing masks or respirators are not well established nor standardized, and therefore should be considered only when there is critical PPE shortage or lack of PPE. Issues to take into consideration when reprocessing include:

1. efficacy of the process to guarantee disinfection or sterilization
2. reprocessing method not resulting in residual toxicity for health care workers
3. maintenance of functional integrity and shape of item. Further, when considering reprocessing and reuse, manufacturers' instructions for reprocessing should be followed, if available. In addition, systems should be put in place to routinely inspect, repair (if applicable) and dispose of reused PPE when necessary (e.g. damaged, no longer suitable for reuse).

In the current exceptional crisis scenario of the COVID-19 pandemic, reprocessing of disposable PPE is an evolving area where research and development is ongoing and urgently needed. In this document, only methods that have been tested and either published in peer-reviewed journals or commissioned by the US Food and Drug Administration (FDA) are reported. However, WHO is aware of ongoing studies that are testing promising approaches (e.g. steam or heat sterilization of medical masks if performed in standardized conditions). As more evidence becomes available, WHO will update these considerations accordingly and hence this document should be considered interim guidance.

Alternative materials

As of the date of publication, the replacement of standard PPE with items produced with materials not having the necessary requirements (e.g. cotton cloth masks to replace medical masks or respirators) has not been proven to be effective and is discouraged (see below). If production of any PPE for use in health care settings is proposed locally in situations of shortage or stock out, a local authority should assess the proposed PPE according to specific minimum standards and technical specifications.

Each of these measures carries significant risks and limitations and thus should be considered only as **a last resort when all other strategies for rational and appropriate use and procurement of PPE (see Figure 1) have been exhausted.**

Summary of temporary measures in the context of severe PPE shortage

Table 2 summarizes temporary measures in the context of severe PPE shortage or stock-out. For each option, there is a description of how the measure should be used, what the limitations are, criteria for PPE removal and precautions, and feasibility. The latter mainly takes into consideration costs and local capacity (e.g. infrastructures, equipment, human resources) to undertake the measure in the safest and most standardized conditions possible, and it refers to feasibility for high-income countries (HIC) vs low and middle-income countries (LMIC).

Irrespective of the measure implemented, health care workers must have the required IPC education and training about the correct use of PPE and other IPC precautions, including demonstration of competency in appropriate procedures for putting on and removing PPE required for direct care of patients with COVID-19 and other tasks - see: WHO | How to put on and take off Personal Protective Equipment (PPE).

Table 2. Options for temporary measures due to the shortage of Personal Protective Equipment (PPE): extended use, reprocessing, or use of alternative PPE

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
Medical mask use by health workers	1) Extended use	The use without removing for up to 6h, when caring for a cohort of COVID-19 patients	Risks: • Extended use of medical mask may increase risk of contamination of the mask with COVID-19 virus and other pathogens • Wearing the mask for a prolonged period may increase the chance of the health care worker touching the mask or having inadvertent under-mask touches; if the mask is touched/adjusted, hand hygiene must be performed immediately • Damage to or reactions of face skin tissue may occur with prolonged use of medical masks • Filtration media of the medical mask may become clogged, thereby increasing breathing resistance and the risk of breathing unfiltered ambient air from the sides of the medical mask • Extended periods of time in active patient wards required for health care workers Removal criteria and precautions: • If the mask becomes wet, soiled, or damaged, or if it becomes difficult to breathe through • If the mask is exposed to splash of chemicals, infectious substances, or body fluids • If the mask is displaced from face for any reason. • If the front of the mask is touched to adjust it • Follow the safe procedure for removal and do not touch the front of the mask • The mask needs to be removed whenever providing care outside a designated cohort of COVID-19 patients • Follow the safe procedure for removal and do not touch the front of the mask • Use of the same medical mask by a health care worker between a patient with COVID-19 and a patient who does not have COVID-19 is not recommended owing to the risk of transmission to another patient who would be susceptible to COVID-19	Feasible in all countries Minimum requirements include definition of standard procedure, training and follow up to ensure good practices

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
	2) Reprocessing	No quality evidence is available to date on medical mask reprocessing and is not advised	NA	NA
	3) Alternative items in absence of medical masks	i) FFP1 respirator	Removal criteria and precautions: • If the mask becomes wet, soiled, or damaged, or if it becomes difficult to breathe through • If the mask is exposed to splash of chemicals, infectious substances, or body fluids • If the mask is displaced from face for any reason • If the front of the mask is touched to adjust it • The mask needs to be removed whenever providing care outside of designated cohort of COVID-19 patients • Follow the safe procedure for removal and do not touch the front of the mask	
		ii) Face shield with proper design to cover the sides of the face and below the chin To be used only in the critical emergency situation of lack of medical masks	Risks: Protective against direct direct exposure of mouth, nose and eyes to droplets; however depends on the design and on the positioning of HCW in relation to the patient Removal criteria: • If face shield is contaminated by splash of chemicals, infectious substances, or body fluids • If face shield obstructs health care worker safety or visibility of health care environment • Follow the safe procedure for removal and do not touch the front of the face shield	Feasible in HIC and LMIC Potential of local production Minimum requirements include definition of standard procedure, training, and follow up to ensure good practices
Respirators (FFP2, FFP3 or N95)	1) Extended use	The use without removing up to 6h, when caring for a cohort of COVID-19 patients.	Risks: • Extended use of respirators may increase risk of contamination with COVID-19 virus and other pathogens • The prolonged period may increase the chance of health care workers touching the respirator or having inadvertent under-respirator touches; if respirator masks are touched/adjusted, hand hygiene must be performed immediately	Feasible in HIC and LMIC Minimum requirements include definition of standard procedure, training and follow up to ensure good practices

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
			• Facial dermatitis, respirator-induced acne, respiratory fatigue, impaired work capacity, increased oxygen debt, early exhaustion at lighter workloads, elevated levels of CO_2, increased nasal resistance, and increased non-compliance with best practices while wearing a respirator (adjustments, mask or face touches, under-the-respirator touches, and eye touches), have been reported after prolonged use of respirators. • Extended use may clog the filtration media, leading to increased breathing resistance <u>Removal criteria and precautions:</u> • If respirator becomes wet, soiled, damaged, or difficult to breathe through. • If exposed to splash of chemicals, infectious substances, or body fluids • If displaced from the face for any reason. • If the front of the respirator is touched to adjust it • Follow the safe procedure for removal and do not touch the front of the respirator • Use of the same respirator by a health care worker between a patient with COVID-19 and a patient who does not have COVID-19 is not recommended owing to the risk of transmission to another patient who would be susceptible to COVID-19	
	2) Reprocessing (see Annex 1 for evidence)	Process to decontaminate a respirator using disinfection or sterilization methods. <u>Methods (not validated) for respirator reprocessing (see Annex 1):</u> • vapor of hydrogen peroxide • ethylene oxide • UV radiation lamp	<u>Limitations/ Risks:</u> • Reprocessing methods have not been validated by substantial research and there are currently no standardized methods or protocols for ensuring the effectiveness nor integrity of the respirators after reprocessing • Shelf-life of reprocessed respirators is unknown; however, degradation of the filtration media or elastic strap after one or more sterilization cycles affects the fit of a respirator to the face • Damage to the shape of respirators due to the reprocessing may affect fit and protection properties • Number of reprocessing cycles highly variable, depending on the reprocessing method used and the respirator brand/model <u>Disposal criteria and precautions:</u> • After a pre-defined number of reuses the respirator should be discarded in appropriate contained waste receptacle according to local guidance/policy	Feasible in HIC Potentially feasible in LMIC; Human resources, equipment installation, procurement of consumables, health care worker safety during the reprocessing should be considered. Minimum requirements include defining a standard operating procedure, training, and follow up to ensure good practices

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
			• When a respirator is removed from the face, it should be immediately placed in a designated container for reprocessing and labeled with the original wearer's name. • The respirator should be returned to original wearer after reprocessing cycle.	
Gowns used by health workers	1) Extended use	The use without removing, when providing care of a cohort of patients with COVID-19. Not applicable if the patient has multidrug resistant microorganisms or other type of disease requiring contact precautions. In such case, the gowns should be changed between patients	Risks • Extended use of gowns may increase risk of contamination with COVID-19 virus • The extended use of gowns may increase the risk of transmission of other pathogens between patients Removal criteria and precautions: • If gown becomes wet, soiled, or damaged • If gown is exposed to splash of chemicals, infectious substances, or body fluids • When providing care outside designated cohort of COVID-19 patients • Follow the safe procedure for removal of gowns to prevent contamination of environment • Use of the same gown by a health care worker between a patient with COVID-19 and a patient who does not have COVID-19 is not recommended due to the risk of transmission to another patient who would be susceptible to COVID-19	Feasible in HIC and LMIC Minimum requirements include definition of standard procedure, training, and follow up to ensure good practices
	2) Reprocessing	Process to decontaminate a cotton gown by washing and disinfection methods. Reprocessing can be done with cotton gowns. Wash and disinfect cotton gowns: washing by machine with warm water (60-90°C) and laundry detergent is recommended for reprocessing of the gown. If machine washing is not possible, linen can be soaked in hot water and soap in a large drum, using a stick to	Risk • In hot and humid weather, the cotton gown can lead to discomfort and sweating Removal criteria: • If gown becomes wet, soiled, or damaged	Feasible in HIC and LMIC Requires additional support staff, gown reprocessing inventory; laundry equipped with hot water or manual washing with water and soap, followed by soaking in disinfectant

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
		stir, avoiding splashing. Then soak linen in 0.05% chlorine for approximately 30 minutes. Finally, rinse with clean water and let it dry fully in the sunlight		
	3) Alternatives	i) Disposable laboratory coats Only for brief contact with the patients; should not be used for prolonged contact or when performing aerosol-generating procedures and support treatments	<u>Risks:</u> • Disposable laboratory coats are less durable than gowns, so there is a risk of damage during the patient care <u>Removal criteria and precautions:</u> • If disposable alternatives to gowns become wet, soiled, or damaged • If alternative to gown is exposed to splash of chemicals, infectious substances, or body fluids • Follow the safe procedure for removal of laboratory coat to prevent contamination of environment • Use of the same laboratory coat by a health care worker between a patient with COVID-19 and a patient who does not have COVID-19 is not recommended due to the risk of transmission to another patient who would be susceptible to COVID-19	Feasible in HIC and LMIC
		ii) Disposable impermeable plastic aprons Should be avoided when performing aerosol-generating procedures and support treatments	<u>Risks:</u> • Plastic aprons do not protect arms and the back of the torso, which can be exposed to splashes <u>Removal criteria and precautions:</u> • If disposable alternatives to gowns become wet, soiled, or damaged • If alternative to gown is exposed to splash of chemicals, infectious substances, or body fluids • Follow the safe procedure for removal of apron to prevent contamination of environment	Potentially feasible in HIC and LMIC Requires procurement of aprons with proper design for health care Potentially feasible in HIC and LMIC
		iii) Reusable (washable) patient gowns, reusable (washable) laboratory coats (see above recommendations for laundry of gowns)	<u>Risk</u> • Design and thickness may not be compatible with the full protection of the torso or arms <u>Removal criteria:</u>	Requires additional support staff, gown reprocessing inventory; laundry equipped with hot water or manual washing with water and soap, followed by soaking in disinfectant

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
			• If gown or coat becomes wet, soiled, or damaged	
Goggles or safety glasses used by health workers	1) Extended use	The use without removing during the shift period, when caring for a cohort of COVID-19 patients.	Risks: • Extended use of goggles may increase the discomfort and fatigue of health care workers • Skin tissue damage may occur to face with prolonged goggle use Removal criteria and precautions: • If goggles are contaminated by splash of chemicals, infectious substances, or body fluids • If goggles obstruct health care worker safety or svisibility of health care environment or become loose • Follow the safe procedure for removal of goggles to prevent contamination of eyes • Use of the same goggles by a health care worker between a patient with COVID-19 and a patient who does not have COVID-19 is not recommended due to the risk of transmission to another patient who would be susceptible to COVID-19	Feasible in both HIC and LMIC
	2) Reprocessing	Clean goggles with soap/detergent and water followed by disinfection using either sodium hypochlorite 0.1% (followed by rinsing with clean water) or 70% alcohol wipes Goggles may be cleaned immediately after removal and hand hygiene is performed OR placed in designated closed container for later cleaning and disinfection.	Risks: • Residual toxicity of sodium hypochlorite can occur if not thoroughly rinsed after disinfection. • Increases health care worker workload (limitation) Removal criteria: • If contaminated by splash of chemicals, infectious substances, or body fluids • If goggles obstruct health care worker safety or visibility of health care environment	Potentially feasible in HIC and LMIC Requires procurement of disinfectants and adequate clean space for the procedure

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
		Ensure cleaning of goggles takes place on a clean surface by disinfecting the surface before cleaning of goggles. Appropriate contact time with disinfectant (e.g. 10 minutes when using sodium hypochlorite 0.1%) should be adhered to before reuse of goggles. After cleaning and disinfection, they must be stored in a clean area to avoid recontamination		
	3) Alternative items	Safety glasses (e.g. trauma glasses) with extensions to cover the side of the eyes.	Removal criteria and precautions: • If contaminated by splash of chemicals, infectious substances, or body fluids • If goggles obstruct health care worker safety or visibility of health care environment	Feasible in HIC and LIMC Minimal requirements include definition of standard procedure, training and follow up to ensure good practices
Face shield * used by health workers	1) Extended use *Face shield must be designed to cover the side of the face and to below the chin	The use without removing during the shift period, when caring for a cohort of COVID-19 patients.	Risks: • Extended use of face shield may increase discomfort and fatigue • Skin tissue damage may occur to face with prolonged google use Removal criteria and precautions: • If contaminated by splash of chemicals, infectious substances, or body fluids • If face shield obstructs health care worker safety or visibility of healthcare environment • Follow the safe procedure for removal of goggles to prevent contamination of the face and eyes • Use of the same face shield by a health care worker between a patient with COVID-19 and a patient who does not have COVID-19 is not recommended due to the risk of transmission to another patient who would be susceptible to COVID-19	Feasible in both HIC and LMIC Minimal requirements include definition of standard procedure, training and follow up to ensure good practices

Type of PPE	Measure	Description	Limitations/risks/removal criteria	Feasibility considerations
	2) Reprocessing	Cleaning with soap/detergent and water and disinfection with 70% alcohol or sodium hypochlorite 0.1%; finally rinsing with clean water if sodium hypochlorite used after contact time of 10 min Face shield may be cleaned immediately after appropriate doffing and hand hygiene is performed OR placed in designated closed container for later cleaning and disinfection Ensure cleaning of face shield takes place on surface without contamination. Disinfection of surface for cleaning of face shield is advised. Appropriate contact time with disinfectant should be adhered to before reuse of face shield. After cleaning and disinfection, they must be stored in a clean area to avoid recontamination	Limitations/Risks: • Damage to plastic, resulting in reduced visibility and integrity • Residual toxicity of the sodium hypochlorite can occur if not thoroughly rinsed after disinfection. Removal criteria and precautions: • If contaminated by splash of chemicals, infectious substances, or body fluids • If face shield obstructs health care worker safety or visibility of healthcare environment • Follow the safe procedure for removal of goggles to prevent contamination of the face and eyes	Feasible in both HIC and LMIC Minimal requirements include definition of standard procedure, training and follow up to ensure good practices Human resource requirements, equipment installation, procurement of consumables, HCW safety during the chemical manipulation should be considered.
	3) Alternative	Local production of face shield	Limitations/Risks: • Suboptimal quality, including inadequate shape to ensure face protection Removal criteria: • If contaminated by splash of chemicals, infectious substances, or body fluids • If face shield obstructs health care worker safety or visibility of health care environment	Minimal requirements include definition of standard procedure, availability of material, human resource requirements, training, and follow up to ensure good practices

Options not recommended by WHO: What WHO does and does NOT recommend:

1. Gloves: gloves should be worn when providing direct care for a COVID 19 case and then removed, followed by hand hygiene between COVID-19 patients. Using the same gloves for a cohort of COVID-19 cases (extended use) must not be done. Changing gloves between dirty and clean tasks during care to a patient and when moving from a patient to another, accompanied by hand hygiene, is absolutely necessary. Double gloving is not recommended, except for surgical procedures that carry a high risk of rupture.

2. The reuse of masks, gowns, or eye protection without appropriate decontamination/sterilization is strongly discouraged. The removal, storage, re-donning, and reuse of the same, potentially contaminated PPE items without adequate reprocessing is one of the principal sources of risk to health care workers.

3. The use of cotton cloth masks as an alternative to medical masks or respirators is not considered appropriate for protection of health care workers.[10] Fabric thickness and weaving standards vary widely; hence, the barrier (filtration efficiency) against microorganisms passing through the fabric is unknown. In addition, cotton cloth masks are not fluid-resistant and thus may retain moisture, become contaminated, and act as a potential source of infection.[10] Although some studies have been carried out for cloth masks using synthetic, hydrophobic materials on the outer layer, there is no current evidence to show that these perform adequately as PPE for health settings.[11] As for other PPE items, if production of masks for use in health care settings is proposed locally in situations of shortage or stock out, a local authority should assess the proposed PPE according to specific minimum standards and technical specifications. As evidence becomes available WHO will update these considerations accordingly.

Annex 1: Studies on medical masks and respirators reprocessing methods

Table 1 presents a summary of studies on reprocessing options for respirators; only one study testing medical masks was found. This study, from 1978, used ethylene oxide sterilizer (EtO) with a single warm cycle (55°C and 725 mg l-1 100% EtO gas) with exposure for 1 hour followed by 4 hours of aeration time.[13] The study was however performed with restricted sampling of nonwoven masks, and it therefore not generalizable.

When considering whether to adopt described methods, the handling of masks and respirators for the decontamination procedure is a critical step; excessive manipulation must be avoided. In addition, systems should be in place to carefully inspect the items before every reprocessing cycle to check their integrity and shape maintenance; if damaged or not suitable for reuse, they should be immediately disposed of. The key aspects to be considered for considering a reprocessing method as acceptable are: 1) the efficacy of the method to disinfect/sterilize the equipment; 2) the preservation of the respirator's filtration; 3) the preservation of the respirator's shape and thus, of its fit; and 4) the safety for the person wearing the respirator (e.g. toxic effect after reprocessing).

Some methods should be avoided due to the damage to the mask, toxicity, or loss of filtration efficiency: washing, steam sterilization at 134°C, disinfection with bleach/sodium hypochlorite or alcohol, or microwave oven irradiation.[14] Microwave ovens have shown some biocidal effect when combined with moisture to combine radiation with steam heat; however, problems that require careful consideration include: i) a lack of substantial review of standard microwave oven radiation capacities with respirator disinfection, ii) an inability to ensure controls for uniform distribution of steam, and iii) concern that the metal noseband of respirators may combust.[15,16]Although gamma irradiation demonstrated experimental efficacy against emerging virus, this method was not evaluated specifically for masks or respirators .[17]

Both vapor of hydrogen peroxide [14,18,19] and ethylene oxide were favorable in some studies but limited by the models of respirators evaluated. The use of UV radiation can be a potential alternative; however, the low penetration power of UV light may not reach inner materials of respirator or penetrate through pleats or folds.[20] The parameters of disinfection by using UVC light is not yet fully standardized for the purpose of reprocessing masks and respirators; this requires a validation procedure to ensure that all surfaces inside and outside masks are reached by the UVC light with appropriate irradiation time.[20,21] Comparison among studies regarding methods is limited owing to different outcomes and evaluation methods. Further, the implications for practical considerations must include the feasibility of the control of all parameters of the methods.

Table 1. Studies on medical mask and respirators reprocessing methods

Method	Equipment Parameters	Medical/ Respirator - Test method/Outcome Evaluated	Author, year	Limitations/Considerations	Pertinent Study Conclusion
Hydrogen Peroxide Vaporized	STERRAD NX100 Express cycle - Vaporized hydrogen peroxide low pressure gas sterilization Chamber temperature <55 °C. Hydrogen Peroxide concentration 26.1mg/L. 6-minute sterilant exposure time. Total dose of 157 (mg/L x exposure time). 24 minutes	• FFP2 (3M) - Sodium chloride 'fit test' for total inward leakage used after each reprocessing cycle	RIVM, 2020 [19]	• Not to be used with any material containing celluloses. • Soiled respirators were not used in this study. • Shelf life of reprocessed respirators not determined.	Filtration efficacy for an unused respirator is retained after 2 sterilization cycles
Hydrogen Peroxide Vaporized	Room Bio-Decontamination Service (RBDS™, BIOQUELL UK Ltd, Andover, UK), Clarus® R hydrogen peroxide vapor generator utilizing 30% H2O2) +	• N95 (six models)	Bergman, et al, 2010[24]	• No observable physical changes	Control and decontamination treatment groups, had mean % penetration (P) <

	Clarus R20 aeration unit, The Clarus® R was placed in a room (64 m3). The hydrogen peroxide concentration, temperature, and relative humidity within the room monitored: Room concentration= 8 g/m3, 15-min dwell, 125-min total cycle time. Following exposure, the Clarus R20 aeration unit was run overnight inside the room to catalytically convert the hydrogen peroxide into oxygen and water vapor.	•Study evaluated physical appearance, odour, and laboratory filtration performance. • 8130 Automated fit test (NaCl aerosol) •Filter air flow resistance Control group: 4-hour 3x submersion in deionized water			4.01%, which is similar to penetration levels found in untreated
Hydrogen Peroxide Gas plasma	STERRAD 100S Gas Plasma Sterilizer 55 minutes standard cycle	• N95 and P100 - Automated Filter Tester used to measure initial filter aerosol penetration post-decontamination.	Viscusi et al, 2009 [14]	• Not to be used with any material containing celluloses. • Standardized sterilization cycle performed at commercial facility, not by primary researcher • If cotton is present in head straps or mask layers; they may absorb hydrogen peroxide and cause the STERRAD cycle to abort due to low hydrogen peroxide vapor concentration. • Soiled respirators were not used in this study	Did not significantly affect the aerosol penetration or filter airflow resistance.
Hydrogen Peroxide Vaporized	Bioquell Clarus C hydrogen peroxide vapor generator Generator was used in a closed chamber built for the experiment. Cycle: 10 min conditioning phase, 20 min gassing phase at 2 g/min, 150 min dwell phase at 0.5 g/min, 300 min aeration phase. Total cycle duration of 480 min (8 hr).	• N95 (3M) - Decontamination efficacy after inoculation of Geobacillus stearothermophilius droplets; 50 repeated aerosol inoculation/decontamination cycles	Batelle, 2016 [18]	• Some degradation in elastic respirator straps noted following 30 cycles	Study showed performance of N95 FFR (respirator) continued to exceed 95% efficiency after 50 repeated inoculation and decontamination cycles. Approach allowed >50 respirators to be decontaminated simultaneously

Hydrogen Peroxide gas plasma	3 cycles STERRAD® 100S H2O2 Gas Plasma Sterilizer (Advanced Sterilization Products, Irvine, CA) 59% Hydrogen Peroxide Cycle time ~55-min (short cycle); 45°C–50°C. Samples were packaged in Steris Vis-U-Tyvek®/polypropylene–polyethylene Heat Seal Sterilization pouches	• N95 (six models) •Study evaluated physical appearance, odour, and laboratory filtration performance. • 8130 Automated fit test (NaCl aerosol) •Filter air flow resistance Control group: 4-hour 3x submersion in deionized water	Bergman et al, 2010[24]	• Physical damage varied by treatment method. • No observable physical changes	After 3 cycles of treatments resulted in mean penetration levels > 5% for four of the six FFR models, which was bigger than other methods and the control group.
Ethylene Oxide	Steri-Vac 5XL sterilizer 55 °C 725 mg/L 100% ethylene oxide gas 1-hour exposure 4 hours aeration	• N95 and P100 - Automated Filter Tester (AFT) used to measure initial filter aerosol penetration post-decontamination.	Viscusi et al, 2009 [14]	• Standardized sterilization cycle performed at commercial facility, not by primary researcher • 5 hours processing cycle	Decontamination did not affect the filter Aerosol penetration, filter airflow resistance, or physical appearance of masks in this study.
Ethylene Oxide	Gas concentration of 800 mg/L 60 ° C Relative humidity 55% 4 hours sterilization, 1-hour aeration	• Medical mask (2 commercial nonwovens; 3 cotton gauze masks (3 layers); 1 gauze mask - % of Bacterial Efficiency Filtration was measured for aerosol of bacteria (Staphylococcus aureus and Serratia marcescens)	Furuhashi, 1978 [13]	• Standardized sterilization cycle performed at commercial facility, not by primary researcher • 5 hours processing cycle • Restricted sampling of nonwoven masks	Synthetic nonwoven masks had higher bacterial filtration efficiency than cotton or gauze masks There was no difference in the bacterial filtration efficiency after sterilization of nonwoven medical masks
Ethylene oxide	Amsco® Eagle® 3017 100% Ethylene oxide sterilizer/Aerator (STERIS Corp., Mentor, OH) 55°C; 1-hour exposure (736.4 mg/L) followed by 12-hour aeration. Samples were packaged in Steris Vis-U-Tyvek®/polypropylene-polyethylene	• N95 (six models) •Study evaluated physical appearance, odour, and laboratory filtration performance. • 8130 Automated fit test (NaCl aerosol)	Bergman, et al, 2010[24]	• No observable physical changes	Control and decontamination treatment groups, had mean % of penetration (P) < 4.01%, which is similar to penetration levels found in untreated

		•Filter air flow resistance Control group: 4-hour 3x submersion in deionized water			
Ultraviolet irradiation	SterilGARD III model SG403A A low-pressure mercury arc lamp (5.5 mg Hg; lamp type, TUV 36TS 4P SE; lamp voltage, 94 Volts; lamp wattage, 40 Watts; wavelength, 253.7 nm) 5-hour irradiation time Final doses: • Low 4.32-5.76 J/cm^2 • High: ≥7.20 J/cm^2	• N95 (Honeywell) - Respirator masks uniformly loaded with nebulized MS2 droplets generated with six-jet Collison nebulizer. Coupons were cut from respirator masks for viral detection.	Vo et al, 2009 [20]	• Author mentions potential limitation of pleats or folds in the respirator for UV light penetration • Efficacy demonstrated only for decontamination of single virus (MS2) in study	Low UV irradiation doses resulted in 3.00- to 3.16-log reductions Higher UV irradiation doses resulted in no detectable MS2 virus in this study.
Ultraviolet irradiation (UV)	Sterilgard III laminar flow cabinet (The Baker Company, Sanford, ME, USA) fitted with a 40-W UV-C light (average UV intensity experimentally measured to range from 0.18 to 0.20 mW cm2). Fifteen-minute exposure to each side (outer and inner) Final doses: 176–181 mJ/cm^2 exposure to each side of FFR.	• 9 FFR models Model 8130 Automated Filter Tester used to measure initial filter aerosol penetration post-decontamination, filter airflow resistance or physical appearance	Viscusi et al, 2009 [14]	• Limited by the available working surface area of a biosafety cabinet equipped with a UV-C source or other area being irradiated by a UV source.	the treatment did not affect the filter aerosol penetration, filter airflow resistance, or physical appearance of the FFRs.
Ultraviolet irradiation (UV)	15-W UV-C (254-nm wavelength) lamp Height of 25 cm above the cabinet's working surface Irradiance range: 1.6 to 2.2 mW/cm^2 (milliWatts per square centimeter) 15 min exposure on external panel of respirator Final dose: 1.8 J/cm^2	• N95 (3M) Quantitative real-time polymerase chain reaction (qRT-PCR) for decontamination efficiency of H5N1 virus NaCl penetration with 0.3µm particle size	Lore et al, 2012 [16]	• Study did not examine decontamination effect on the straps or nose clip of the two respirators	qRT-PCR indicated decontamination resulted in lower levels of detectable viral RNA compared with other two methods (microwave-generated steam and moist heat) Filtration efficiency was maintained with <5% penetration of NaCl
Ultraviolet irradiation (UV)	A 120-cm, 80-W UV-C (254 nm, (nanometer) lamp was adjusted to a height of 25 cm. The range of UV to which the FFR was exposed varied from 1.6 mW/cm^2 to 2.2 mW/cm^2 (Joules per square centimeter) Final dose: 1.8 J/cm^2(Joules per square centimeter) 15 Minutes	• N95 Laboratory applied H1N1 added to exterior surface of respirator. Circular coupons were cut from respirator and placed in medium to detect viable H1N1 in $TCID_{50}$ assay.	Heimbuch et al, 2011 [15]	• Two instances in which viable virus were recovered in study can possibly be attributed to mask shielding • Authors note that hundreds of FFR models exist but only 6 FFR were tested in study; other FFRs may perform differently • Efficacy demonstrated for decontamination of single virus (H1N1) in study	Average log reduction of 4.69, virus reduced to values below the detection limit with no obvious signs of deterioration or deformation.

Ultraviolet irradiation (UV)	FFRs were placed on a laboratory stand inside a Sterilgard III laminar flow cabinet, fitted with a 40 W UV-C bulb. Intensity 1.8 mW/cm^2 measured with a UVX Digital Radiometer with model UVX-25 sensor (254 nm filter). 15 min exposure to outer side of FFR Final dose; 1.6-2.0 mW/cm^2	• Surgical N95 (fluid resistance N95): 3M 1860, 3M 1870, KC PFR95- 270 (46767) • Respirator fit AND face seal leakage were measured with 10 participants using PORTACOUNT® Plus Model 8020A Respirator Fit Tester with an N95 Companion™ Model 8095 accessory	Bergman et al, 2011[25]	• Study use an abbreviated fit-test protocol, only three FFR models, and a small group (n = 10) of respirator test subjects per FFR model. • Subjects wore their FFRs for a shorter total test time of ~5 min (which includes the 3-min acclimatization period) using the modified protocol compared with the standard OSHA-accepted protocol (~12 min) •	Respirator fit was maintained throughout three decontamination cycles alternating with four donning/doffing cycles. Face seal leakage value was maintained at below 1%
Ultraviolet irradiation (UV)	Custom UV device made of polished aluminum measuring 40-in L × 16-in W × 13-in H with a tunnel extension measuring 18-in L × 8-in W × 6-in H. Eight 32-in 254-nm UV-C bulbs with an irradiance of 0.39 W/cm2 at 1 m to deliver a UV dose of 1 J/cm2 in ~1 minute. A sliding wire mesh rack was used to position the FFR during UV treatment. Air circulation system with high-airflow fans. Mean UV dose per FFR 1.1 ± 0.1 J/cm2, mean temperature 21°C ± 2°C, mean relative humidity 48% ± 6% within the UV device.	• N95 (3M, Alpha Protech, Gerson Kimberly-Clark Moldex, Precept Prestige Ameritech, Sperian, U.S. Safety) - Study artificially contaminated N95 with H1N1 influenza. Artificial saliva (mucin buffer) and artificial skin oil (sebum) were applied directly over influenza contamination. Coupons cut from mask for viral detection.	Mills, et al, 2018 [22]	• Study conducted at 100x theoretical highest real-world respirator viral contamination levels estimated in other studies.	Mean log reduction ranged from 1.25-4.64 log $TCID_{50}$ for sebum-soiled facepieces and 0.08-4.40 log $TCID_{50}$ for sebum-soiled straps.
Ultraviolet irradiation (UV)	Ultraviolet light with a primary wavelength of 254 nm (UV-C) Custom-made chamber of 91 cm × 31 cm × 64 cm high chamber. Two 15-Watt T-150 254 nm UV-C lamps in a reflective housing lined with black felt. UV doses from 120–950 J/cm^2 (coupons) and 590-2360 J/cm^2 (straps)	• Four models of N95 (3M, Gerson, Middleboro, Kimberley & Clark) - 37mm coupons were punched + 2 straps from each respirator Determination of filter penetration and flow resistance before and after exposure to UV	Lindsley, et al, 2015 [21]	• Study found dramatic differences in the bursting strength of the layered materials that make up the respirator • Study tested exterior of respirators, not interior but estimates this would require a high dose UV to penetrate to inside layers and would require testing the specific respirator used	UV exposure led to small increase in particle penetration (1.25%) at UV doses from 120–950 J/cm2 with little to no effect on flow resistance. Some degradation of the elastic straps used in different respirator designs when exposed to higher UV levels.

Ultraviolet irradiation (UV)	Mineralight® XX-20S 20-W UV bench lamp Average UV output of 4.2 ± 0.0 mW/cm2 Effective UVGI dose of 1 × 106 µJ/cm2 A laboratory-scale UVGI was built for the purpose	• N95 – 15 models (3M, Kimberley Clark, Moldex, Precept, Gerson, Sperian, US Safety, Alpha Protect, Prestige Ameritech) - Influenza; MERS-CoV, SARS-CoV-1. Presence of either artificial saliva or artificial skin oil 50% tissue culture infectious dose per mL (TCID50/mL)	Heimbuch, 2019 [23]	• Decontamination the presence of soiling agents on N95 can be effective but is dependent on the material being treated. • The shapes of respirators, their materials, and UV light arrangement can significantly affect decontamination efficacy	UV dose of 1 J/cm2 was found to be the minimum dose providing maximum disinfection Up to 20 cycles of UV treatment (approximately 1 J/cm2 per cycle) does not have a meaningfully significant effect on, fit, air flow resistance, or particle
Ultraviolet irradiation (UV)	UV Bench Lamp (UV-C, 254 nm, 40 W), Model XX-40S (UVP, LLC, Upland, CA). The UV intensity; mean of 27 measurements over the rectangular area used at the surface of the hood using a UVX Digital Radiometer with a model UVX-25 Sensor (254 nm filter) 45-min exposure at intensity 1.8 mW/cm2 (UVP, LLC, Upland, CA).	• N95 (six models) •Study evaluated physical appearance, odour, and laboratory filtration performance. • 8130 Automated fit test (NaCl aerosol) •Filter air flow resistance	Bergman et al, 2010[24]	• No observable physical changes	Control and decontamination treatment groups, had mean %P < 4.01%, which is similar to penetration levels found in untreated
Ultraviolet irradiation (UV)	Sterigard cabinet flow cabinet (The Baker Company, Sanford, Maine fitte with 40 W UV-C Bulb, intensity 1.8mW/cm2, 245nm Total exposure 30min (15 min each FFR side)	• FFR (6 model, 3M, Moldex, Kimberley Clark) - Phase 1: fit test to identify fit factor Phase 2: Physically examined for degradation and smell	Viscusi et al, 2011[26]	• Each FFR model is constructed uniquely, which may affect the impact that decontamination has on that model. • No physical damage • One subject reported strong odour • The MDFF were lower than the control depending on the model	No significant changes in fit, odour detection, comfort, or donning difficulty with each of the six models.

		Multidonning fit-test procedure – metal nose bridge was return to the original position – multidonning fit factor (MDFF) 10 subjects x 6 FFR models x 4 treatment Subjective questionnaires Standard visual analog scale			
Moist heat incubation	Caron model 6010 laboratory incubator (Marietta, OH) 30-min incubation at 60°C, 80% relative humidity Following the first incubation, the samples were removed from the incubator and air-dried overnight. Following the second and third incubations, samples were removed from the incubator and air-dried for 30 min with the aid of a fan.	• N95 (six models) •Study evaluated physical appearance, odour, and laboratory filtration performance. • 8130 Automated fit test (NaCl aerosol) •Filter air flow resistance Control group: 4-hour 3x submersion in deionized water	Bergman et al, 2010[24]	• Some samples to experience partial separation of the inner foam nose cushion from the FFR Possible sparking during microwave heating caused by the metallic FFR nose bands.	Control and decontamination treatment groups, had mean %P < 4.01%, which is similar to penetration levels found in untreated
Moist Heat Incubation	15 min incubation at 60 °C (upper temp. limit), 80% relative humidity in a Caron model 6010 laboratory incubator	• Surgical N95 (fluid resistance N95): 3M 1860, 3M 1870, KC PFR95- 270 (46767) • Respirator fit AND face seal leakage were measured with 10 participants using PORTACOUNT® Plus Model 8020A Respirator Fit Tester with an N95 Companion™ Model 8095 accessory	Bergman et al, 2011[25]	• Study utilized an abbreviated fit test protocol, only three FFR models and a small group (n = 10) of respirator test subjects per FFR model. • Subjects wore their FFRs for a shorter total test time of ~5 min (which includes the 3 min acclimatization period) using the modified protocol compared to the standard OSHA-accepted protocol (~12 min) • MHI decontamination cycle was shorter than previous study.	Slight separation of the inner foam nose cushion was not exacerbated with multiple MHI treatments compared to a single treatment. Respirator fit was maintained throughout three MHI decontamination cycles alternating with four donning/doffing cycles. Face seal leakage value was maintained at below 1%

Moist heat incubation	Caron Model 6010 laboratory incubator (Marietta, Ohio= 60°C, 30 min, 80% relative humidity.	• FFR (6 model, 3M, Moldex, Kimberley Clark) - Phase 1: fit test to identify fit factor Phase 2: Physically examined for degradation and smell Multidonning fit test procedure – metal nose bridge was return to the original position – multidonning fit factor (MDFF) 10 subjects x 6 FFR models x 4 treatment Subjective questionnaires Standard visual analog scale	Viscusi et al, 2011[26]	• Each FFR model is constructed uniquely, which may affect the impact that decontamination has on that model. • Any physical damage or strong odour • The MDFF were lower than the control depending on the mode	No significant changes in fit, odour detection, comfort, or donning difficulty with each of the six models.

TCID50 = 50% tissue culture infectious dose

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WHO continues to monitor the situation closely for any changes that may affect this interim guidance. Should any factors change, WHO will issue a further update. Otherwise, this interim guidance document will expire 2 years after the date of publication.

WHO reference number: WHO/2019-nCov/IPC_PPE_use/2020.3

Appendix 2

ANZCA statement on personal protection equipment during the SARS-CoV-2 pandemic

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ANZCA statement on personal protection equipment during the SARS-CoV-2 pandemic

This statement is intended to establish the standard, as defined by ANZCA, in relation to the indications for use of PPE by anaesthesia staff

We have prepared this statement based on the advice of Australian and New Zealand health authorities, including Australia's chief medical officers, the Australian Health Protection Principal Committee (AHPPC), and the Infection Control Expert Group

The character, magnitude and spread of SARS-CoV-2 varies greatly from location to location. Health services and hospitals are encouraged to seek advice from local specialist infectious diseases authorities, where they are available, if they wish to depart from the advice in this statement.

The College acknowledges that this statement will require updating as more information becomes available and is, to that extent, a living document.

1. Introduction and general recommendations

The recently discovered severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)[1] is highly infectious and can cause a range of symptoms from asymptomatic carriage to coronavirus disease (COVID-19). The epidemiology and pathophysiology of this disease is still emerging, but it is now declared as a global pandemic. Healthcare workers are at a greatly elevated risk of contracting SARS-CoV-2, and of developing COVID-19. The Australian and New Zealand College of Anaesthetists (ANZCA) acknowledges that there is significant and justified concern from anaesthetists, pain medicine specialists and indeed all clinicians across Australia and New Zealand regarding the appropriate use of personal protective equipment (PPE) during the current COVID-19 crisis.

These concerns principally relate to:

- The "*minimum threshold for PPE use*". In other words – what type of PPE do I need to employ, in what circumstances and for which patients?
- The *adequacy of the PPE supply chain* such that clinicians are confident to treat patients without worrying about compromising their own health and that of others.

Personal Protective Equipment (PPE) refers to any device, garment or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards. In the setting of healthcare, PPE refers to protective clothing, helmets, gloves, face shields, goggles, facemasks and/or respirators or other equipment designed to protect the wearer from injury or the spread of infection or illness. [2] The term "precautions" is generally used to indicate the measures (both behavioural and the PPE) required to protect the healthcare worker.

The College highly recommends that its members adhere to guidelines on PPE type (contact, droplet or airborne) rather than develop local or regional hybrid models of PPE. Adherence to PPE guidelines involves providing appropriate protection for the whole team, not only the anaesthesia personnel.

When used, PPE should be used carefully and consistently, particularly maintaining vigilance in avoiding unintended self-contamination while wearing PPE and strict adherence with donning and doffing procedures. Formal training is essential and should be part the operating room work schedule. Simulation of COVID case management is highly recommended.

N95/P2 masks require formal *fit – testing* to comply with the ISO standard for use. [3] While this may not be attainable or practical in all situations and organisations, the College recommends that the minimum standard should be *fit-checking* by a suitably trained person.

Teams should also factor in wait times for clearing of aerosols by the operating theatre ventilation systems – the recommendation is to wait for 3-5 room air changes after completing any AGP with the operating theatre doors closed. Aerosol clearing times should be agreed locally depending on the capacity of the facility ventilation system

Adequate supplies of PPE are necessary to ensure maintenance of adequate standards of personal protection for health care workers. The College is unequivocal; staff safety comes first. However, overseas experience shows that stocks are not infinite and consideration should be given to ensuring that the supply is utilised appropriately and judiciously.

The conduct of non-urgent elective surgery should cease immediately, in order to conserve valuable supplies of PPE. Please see the Royal Australasian College of Surgeons website for more information.[4]

The college is well aware that there is no consistent national or international guidance on exactly where the minimum threshold for PPE requirement sits at present. It is clear from feedback that guidance and local practice are highly variable and frequently changing throughout Australia and New Zealand.

We are working with other organisations and Societies to ensure that consensus on the use of PPE is reached, in order to mitigate the confusion among clinicians in this uncharted situation.

We appreciate geographic variation in the character and magnitude of the SARS-CoV-2 epidemic and strongly encourage health services or jurisdictions who wish to depart from the national epidemiological and risk assessment to consult their public health units.

As always, the most effective protection is frequent and effective hand hygiene and actively not touching the face or mucous membranes / conjunctiva.

The following sections refer to the stratification of patient risk, the proposed procedure and the hierarchy of PPE type that should be used.

2. Risk stratification

a. A key component of risk stratification to permit effective HCW protection includes the early identification of high-risk patients these being: symptomatic patients with COVID-19, and asymptomatic patients at high risk of developing COVID-19 due to epidemiological factors (including close contacts and those with recent international travel). These are defined in the *COVID-19 National Guidelines for Public Health Units* and jurisdictional guidelines[5] and and the New Zealand Ministry of Health guidelines[6]. It is acknowledged that the risk screening advice is changing in both countries and clinicians are advised to access the

latest information. There is an increasing prevalence of antigen testing in acute patients which may add a useful stratum of risk assessment but this is not universally available yet

b. Consultation with local infectious disease clinicians will guide risk stratification and management of patients whose risk of community acquired transmission is uncertain, for example symptomatic patients without confirmed infection or epidemiological risk factors and or patients who are classified as low-risk who live in geographic settings where apparent clusters of community acquired infection have been identified. It is acknowledged that access to specialist infectious diseases advice is limited in some areas (specifically some of our rural/regional communities). In these circumstances decisions need to be made utilising the most appropriate information available.

c. Healthcare workers clearly need to be protected from contracting SARS-CoV-2 and in turn avoid infecting vulnerable patients during the pre-symptomatic period.

3. Hierarchies of protective measures and PPE

PPE is one component of a hierarchy of protective measures (precautions) for healthcare workers. These differ from measures taken to protect the patient, which are governed by "Infection Control in Anaesthesia apply", PS28.The broad classification of these measures is specified as follows:

a. **Standard precautions** (rigorous hand hygiene, cough etiquette) are employed for the routine care of all patients. These are a basic standard when dealing with any patient with which the clinician may have contact.

b. **Contact precautions** comprise the use of gloves, a theatre scrub suit or protective gown and / or apron.

c. **Droplet precautions** surgical mask, eye shield or goggle protection, a long sleeve fluid impervious gown and gloves.

d. **Airborne precautions** N95 / P2 respirator, eye shield/goggle protection, long -sleeved fluid impervious gown, gloves +/- double gloves for primary airway proceduralist and team. Disposable headwear must be used and discarded safely after any case. Local guidelines on treatment of footwear should be followed, as these vary considerably. In certain very high-risk circumstances, the use of powered air purifying respirators (PAPRs) may also be recommended but it is acknowledged that supply may be severely limited.

This hierarchy is incremental and each precaution category comprise the measure in all of the previous categories. Hence, "Droplet" refers to the use of standard *and* contact *and* droplet precautions. Airborne refers to the use of standard *and* contact *and* droplet *and* airborne precautions. Droplet precautions are generally employed as the minimum measures and PPE for procedures undertaken in the course of anaesthesia and pain medicine where there is the likelihood for splashing, splattering or spraying of blood or body fluids.

4. Aerosol generating procedures (AGPs)

4.1 AGPs (See ** in Flow chart)

There is broad consensus that the following are classified as AGPs.

a. Bag and mask ventilation

b. Tracheal intubation

c. Tracheal extubation

d. Ventilation via supraglottic airways (including insertion and removal)

e. Non-invasive ventilation including CPAP and BiPAP

f. High flow nasal oxygen therapy

g. The use of nebulisers

h. Cardiopulmonary Resuscitation (CPR)

i. Anaesthesia procedures for women in late first stage labour and second or third stage labour and especially those who are distressed. Secretions from the respiratory tract and faeces are the principle risk to staff and others.

j. Anaesthesia procedures for highly symptomatic patients who are considered high risk for aerosol generation (eg coughing or other signs of respiratory distress)

4.2. High risk Procedural/Surgical AGPs (See * in Flow chart)**

k. High Risk Procedural AGPs - Diagnostic and therapeutic instrumentation of the airway including bronchoscopy and tracheostomy.

l. High Risk Surgical AGPs – any surgical procedure involving the upper respiratory tract, such as ear, nose and throat, facio-maxiliiary or anterior pituitary surgical ,procedures, where aerosolization of tissue is likely; for example, the use of pulsed lavage, the use of high-speed drills and laser techniques. The risk of transmission from non- respiratory tract blood aerosol, digestive tract aerosol, pulsed lavage and laser work is currently not accurately known but is thought to be lower.

5. Recommendations for protective measures and PPE according to SARS-CoV-2 risk status (See Flowchart)

5.1. Patients at low risk for SARS-CoV-2

Where, after risk assessment, patients are identified to not have any risk factors for SARS-CoV-2, it is safe and appropriate to follow the following precautions:

a. Scenarios not involving AGPs

Manage according to existing standards of infection control. Consultations may be undertaken using **standard precautions.** In many situations, including scenarios involving general anaesthesia and or invasive procedures **droplet precautions** are appropriate due to the risk of exposure to bodily fluids and secretions.

b. Scenarios involving AGPs**

Where AGPs are undertaken as defined in Section 4.1 (a-d), It is safe and appropriate to use **droplet precautions.**

5.2. Any patients for whom high risk procedural/surgical AGPs**** are undertaken

Where a high-risk procedural/ surgical AGP*** as defined in section 4.2 (k-l) is undertaken, particularly a procedure on or in the airway, **airborne precautions** should be used for all patients, regardless of SARS-Cov-2 status.

5.3. Patients with confirmed or suspected SARS-CoV-2

The following precautions apply where, after risk assessment, patients are identified as confirmed or suspected SARS-CoV-2:

a. Scenarios not involving AGPs

It is safe and appropriate to use **droplet precautions** for non-AGPs , with examples as follow:

- Regional anaesthesia and local infiltration
- Conscious sedation
- Vascular access (Peripheral intravenous, central venous catheter, arterial).
- During recovery from an AGP after an appropriate period of time has elapsed
- Consultations including pre-operative assessments, pain management consultations and other consultations when located less than 1.5 metres from the patient.

The generally accepted requirement to don airborne PPE within 20-30minutes of an AGP (according to local room ventilation conditions) applies to situations in which unintended conversion to general anaesthesia occurs. In anticipation of this, consideration should be given to using **airborne precautions** in preparation for time critical situations, such as emergency caesarean section, irrespective of the primary mode of anaesthesia.

b. Scenarios involving AGPs

It is safe and appropriate to use **airborne precautions**.

6. Training and preparation

It is well recognised that donning and in particular doffing of PPE carry risks of transmission of infection from patients to healthcare workers. It is essential that each and every one of us has received expert training on the use of PPE and the management of AGPs. This may take the form of watching videos and/or simulation training. There are a number of resource links for this on the college Library Guide pages here.

7. Wellbeing and Workforce

Please actively manage your own wellbeing and that of others. Buddy systems, mental health advice access and virtual social events, among other initiatives, may assist us in recognising signs of stress and supporting us to develop coping strategies. . There are a number of resource links for this on the college Library Guide pages here.

This is a stressful time for all and we need to stay well to able to lead our departments and hospitals through this crisis. Workforce constraints will undoubtedly limit the provision of services in places and it is vital that caseloads are reduced and managed and that staff have adequate time and facility to train for managing COVID-19 positive or suspect cases.

8. PPE Supplies

We are also aware that the PPE supply is challenging and may be variable in certain areas at times. National and regional bodies are trying to secure and enhance production and supply in both countries.

While the college cannot control that process, we categorically support the need for healthcare workers to be protected from the risk of transmission and are actively consulting with fellows and government to ensure that government strategies are informed by up to date information and in the best interests of our fellows across all regions and sectors. Provision of timely and accurate information about local patterns of disease will improve clinician / institution engagement and help to embed agreed PPE guidelines.

Further Resources

The College has created a COVD 19 section in Library Guides on the College website. This has a wide range of guidelines and advice documents, classified under tabbed categories for ease of searching. It includes advice and guidance on well-being, curated by the Welfare SIG and all of the resources on the site are curated actively to ensure they are up-to date.

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Disclaimer

The Australian and New Zealand College of Anaesthetists ("The College") has issued this statement as guidance for its members and also for the wider clinical community and this is based on the best evidence at the time of publication. The College accepts no liability for any harm or adverse outcomes resulting from actions taken on the basis of this statement.

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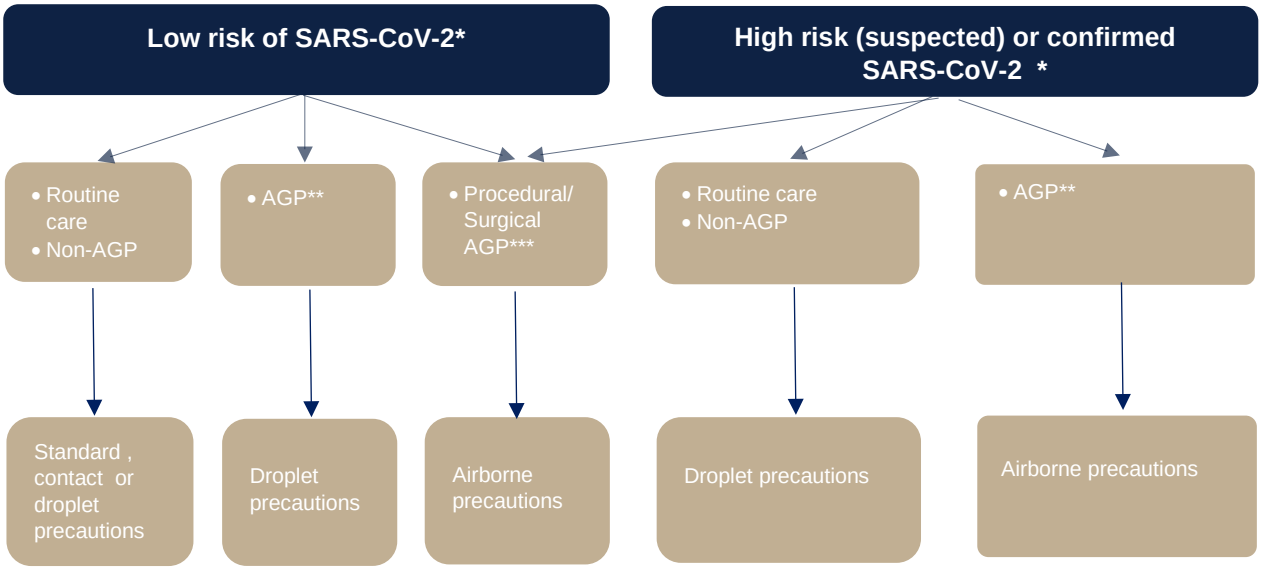
Recommendations for PPE according to SARS-CoV-2 risk status



The measures in this flow chart refer to protection of the anaesthetist. Protection of the patient during invasive anaesthesia procedures (such as central venous catheterisation, neuraxial anaesthesia etc.) are guided by **PS28** "Infection Control in Anaesthesia".

* Definition of 'Low risk of SARS-CoV-2' and 'Suspected/confirmed SARS-CoV-2' will depend on your location, and should be based on **national case definitions** and guided by local infectious diseases and public health advice

** AGPs: a. Bag and mask ventilation; b.Tracheal intubation; c. Tracheal extubation; d. Ventilation via supraglottic airways (including insertion and removal); e. Non-invasive ventilation including CPAP and BiPAP; f. High flow nasal oxygen therapy; g. the use of nebulisers; h. Cardiopulmonary Resuscitation (CPR);

i. Anaesthesia procedures for women in late first stage labour and second or third stage labour and especially those who are distressed. Secretions from the respiratory tract and faeces are the principle risk to staff and others.

j. Anaesthesia procedures for highly symptomatic patients who are considered high risk for aerosol generation (eg coughing or other signs of respiratory distress)

***High risk Procedural/Surgical AGPs: l. *High Risk Procedural AGPs* - Diagnostic and therapeutic instrumentation of the airway including bronchoscopy and tracheostomy; m. *High Risk Surgical AGPs*- any surgical procedure involving the upper respiratory tract, such as ear, nose and throat, facio-maxillary or anterior pituitary surgical ,procedures, where aerosolization of tissue is likely; for example, the use of pulsed lavage, the use of high-speed drills and laser techniques. The risk of transmission from non- respiratory tract blood aerosol, digestive tract aerosol, pulsed lavage and laser work is currently not accurately known but is thought to be lower.

Appendix 3

Department of Health

Australian Government

Guidance on the use of personal protective equipment (PPE) in hospitals during the COVID-19 outbreak (Version 4)

Guidance on the use of personal protective equipment (PPE) in hospitals during the COVID-19 outbreak

Background

This guidance was developed by the Infection Control Expert Group (ICEG) and endorsed by the Australian Health Protection Principal Committee (AHPPC) to provide guidance on the use of personal protective equipment (PPE) in hospital settings during the COVID-19 outbreak.

These recommendations are based on *current evidence, current status of COVID-19 in Australia*, risk assessment and expert advice. This guidance will be updated as new information becomes available.

This guidance is intended for health care workers in hospital settings including emergency department (ED), intensive care unit (ICU), operating suite, surgery, general medical and surgical wards and obstetrics.

For current case definitions and testing criteria see *Communicable Diseases Network Australia (CDNA) National Guidelines for Public Health Units*.

NOTE: For clinical care of, or procedures on, patients who are NOT suspected of having COVID-19, i.e. business as usual, the usual infection prevention and control precautions, including PPE if required, should be observed, according to clinical circumstances.

Additional COVID-19 specific precautions are not required.

CURRENT EVIDENCE

Evidence relating to transmission of COVID-19 in hospitals is of variable quality, sometimes contradictory and cannot, necessarily, be extrapolated to the Australian context. Many uncertainties remain. The following advice is based on the best available evidence and the current epidemiology of COVID-19 in Australia, where community transmission is minimal, except in limited geographic areas.

- **Asymptomatic COVID-19** is apparently not uncommon but its incidence and role in transmission are unknown
    - It can occur at all ages
    - Fairly high rates of asymptomatic infection have been reported in the context of outbreaks in closed settings (e.g. cruise ship, aged care facility) or high community prevalence (e.g. China, New York)
- **Presymptomatic transmission** is well documented but the duration of infectivity before onset of symptoms is uncertain
- Relationships between **viral RNA load, infectivity and the stage and severity** of disease are uncertain
    - The presence on viral RNA does not necessarily indicate viable/infectious virus
    - Viral RNA load is variably reported as higher in the early than later stages of disease or increasing with late clinical deterioration

- There is varying evidence and much debate about the degree, if any, of **airborne vs droplet transmission** of COVID-19 but the relevance to the type of respiratory protection required in different settings is uncertain
    - There is strong evidence that COVID-19, like most respiratory viral infections, is predominantly transmitted by droplets
    - Clinical and epidemiological evidence suggest that airborne transmission is rare, but some aerosol-generating procedures (AGPs) can increase the risk
    - Some fine particle (<5 micron) aerosols are produced by infected patients, but the quantity of virus in these particles is significantly less than that in large droplets
    - The transmission dynamics of COVID-19 differ from those of the few infectious diseases for which airborne transmission is recognised e.g. TB, measles and varicella

CURRENT STATUS OF COVID-19 IN AUSTRALIA

- By international standards, Australia has a high (and increasing) rate of testing and a low percentage of positive results (currently 1.6%)
- More than 60% of total cases in Australia have been acquired overseas
- The number of cases and deaths from COVID-19 in Australia are in marked contrast to that in many parts of Europe, the United Kingdom and North America
- Since the introduction of travel restrictions and social distancing measures the daily number of new infections in Australia has fallen dramatically
- Community transmission is modest and limited to a few localised sites
- The case fatality rate in Australia, overall, is <1% and the median age of death is 78.5 years
- Limited data are available about COVID-19 cases in healthcare workers. Of those for which information is available, a significant proportion were not occupationally-acquired

These data indicate that current containment measures in community and health care settings in Australia are effective if consistently observed.

General guidance on procedures performed on patients who are **NOT** suspected or confirmed cases of COVID-19

During the COVID-19 outbreak, PPE for the care of patients who are not suspected or confirmed cases of COVID-19 should be used in line with the *Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019)*[1].

AGPs performed on non-COVID-19 patients in operating theatre, emergency department, endoscopy suite etc.

Given the relatively low prevalence of COVID-19 in Australia, standard precautions, in addition to standard operating theatre attire or personal protective equipment appropriate for the procedure, are adequate for the performance of AGPs on patients who are not suspected or confirmed cases of COVID-19. A surgical mask, theatre gown, gloves, eye protection (and head covering only if required as regular theatre attire) should typically be worn. A P2 respirator is not necessary in this context.

See page 6 for a list of AGPs.

[1] https://www.nhmrc.gov.au/about-us/publications/australian-guidelines-prevention-and-control-infection-healthcare-2019#block-views-block-file-attachments-content-block-1

NOTE: For AGPs performed on patients who are NOT suspected or confirmed cases of COVID-19, P2 respirators are not necessary, i.e., a surgical mask is sufficient.

General guidance on procedures performed on patients who are suspected or confirmed cases of COVID-19

Management of hospital patients in whom COVID-19 is NOT suspected

PPE required for each patient encounter depends on the specific clinical circumstances, but similar principles apply to all.

Standard precautions are required for all patients regardless of known COVID-19 status. This includes hand hygiene (5 Moments) and risk assessment to determine the level of PPE required, if any.

Cough etiquette and respiratory hygiene must be observed at all times.

Physical distancing during the COVID-19 outbreak: stay at least 1.5 m away from other people including:

- patients, except when unavoidable, e.g. during physical examination/care AND
- members of the public, hospital visitors and other staff e.g. in wards, clinics and nonclinical areas e.g. during meetings, tea breaks etc.

Management of patients with acute respiratory symptoms and/or suspected or proven COVID19

- Patients with acute respiratory symptoms should be asked to wear a surgical mask upon presentation to hospital AND
- Placed in a single room with the door closed or in a physically separated closed area designated for suspected COVID-19 cases OR
- If an AGP is to be performed, the patient should be placed in a negative pressure room (or an isolation room with door closed if a negative pressure room is not available)

If transfer outside of the room is necessary, the patient should wear a surgical mask during transfer and follow respiratory hygiene and cough etiquette.

Environmental hygiene

- In addition to routine cleaning, frequently touched surfaces should be cleaned frequently or whenever visibly soiled, with detergent/disinfectant wipes or a detergent product, using disposable or laundry safe cloth

Advice on *Environmental cleaning and disinfection for health and residential care facilities* is available on the Department of Health website.

Transmission-based precautions

- **Contact and droplet precautions** should be used for the routine care of patients in quarantine/isolation or under investigation for COVID-19 or with confirmed COVID-19

    - The use of nebulisers should be avoided and alternative medication administration devices (e.g. spacers) used

- **Contact and airborne precautions** should be used when performing AGPs

NOTE: Previous advice to use airborne precautions for care of patients with severe coughing has been withdrawn because:

- **viral load does not necessarily correlate with clinical condition**
- **coughing generates droplets, predominantly**
- **surgical masks used by patient, if possible, and healthcare worker provide adequate protection.**

Contact and **droplet** precautions for use in routine care of patients with suspected or confirmed COVID-19

There is strong clinical and epidemiological evidence that the predominant mode of spread of COVID-19 is via **respiratory droplets** (produced during speaking, coughing, sneezing etc.):

- **Directly** during close face-to-face contact (within ~1.5 m) by exposure of the mucosae of mouth, nose or eyes OR
- **Indirectly** by touching surfaces or fomites contaminated by respiratory droplets and then touching the face

Use of personal protective equipment

The following PPE should be put on, in this order, before entering the patient's room:

- Long-sleeved fluid resistant gown
    - An apron is a suitable alternative in situations in which the risk of splash is low (e.g. specimens collection)
- Surgical mask (fluid resistant, level 2 or 3)
- Eye protection: face shield, wrap-around safety glasses or goggles
- Disposable non-sterile gloves when in contact with patient (use hand hygiene before donning and after removing gloves)

Use of boots or shoe covers is not recommended unless gross contamination is anticipated or required as standard attire in operating theatre or trauma room.

Long hair should be securely tied back.

A head covering is not required except as part of standard operating theatre attire or when performing a sterile/aseptic procedure (e.g. central line insertion).

Take care to avoid self-contamination, when removing PPE.

- Remove gloves without touching the outside of the glove and perform hand hygiene
- Remove gown, without touching the front of the gown, by folding it so that the external (exposed) side is inside; perform hand hygiene
- Remove eye protection and mask outside the patient's room. Do not touch the front of mask or eye covering; perform hand hygiene after each step

Unsoiled PPE can be discarded into general waste; if visibly soiled e.g. with blood or faeces, PPE should be disposed of as clinical/infectious waste. (**Note:** local jurisdictional regulations for waste disposal should be followed).

Only PPE marked as reusable should be reused after decontamination and reprocessing according to the manufacturer's instructions. All other PPE must be disposed of after use.

Contact and **airborne** precautions during aerosol-generating procedures in the care of patients with COVID-19

The only modification for **airborne precautions**, is the use of a **particle filter (P2/N95) respirator** or equivalent instead of a surgical mask.

Principles of use of P2/N95 respirators in care of patients with suspected or confirmed COVID-19

- P2/N95 respirators should be used only in the context of patient care using airborne precautions
- Health care professionals who use P2/N95 respirators should be trained in their correct use
- Unless used correctly, protection against airborne pathogen transmission will be compromised
- The minimum standard of use of a P2/N95 respirator is **careful fit-checking** with each use
    - An airtight protective seal is difficult to achieve for people with facial hair that underlies the mask at its edges
        - Facial hair which impedes achieving a seal should be removed or an alternative respirator protection, e.g. powered air-purifying respirator (PAPR) - considered (see below)
    - If available, a range of P2/N95 respirators may need to be fit-checked to find one that achieves a protective seal (i.e. passes fit-check)
        - If a suitable P2/N95 respirator cannot be found and alternative respirator - e.g. PAPR - should be considered
    - **Fit-testing** is recommended as the gold-standard (AS/NZS 1715:2009) for use of P2/N95 respirators, but it has not been widely applied in Australia
        - Despite increased awareness and demand, in the context of COVID-19, fit-testing of all healthcare professionals, who need to use P2/N95 respirators, will be difficult due to limited supplies and range of types/sizes available
        - **NOTE: Fit-testing does not guarantee that a respirator will not leak, particularly if a different type or size is used – this reinforces the need to fit-check with each use**

Transmission-based precautions, as outlined—including appropriate use of P2/N95 respirators—will provide high level protection of health care workers caring for patients with suspected or confirmed COVID-19.

Powered air-purifying respirators (PAPR)

- PAPRs are an alternative to P2/N95 respirators in selected circumstances:
  - A number of different types of relatively lightweight, comfortable PAPRs is available
  - PAPRs should only be used by healthcare professionals trained in their use, including safe removal with other PPE
  - PAPRs should be used according to the manufacturer's instructions
  - If a health care professional is required to remain in the patient's room continuously for a long period to perform multiple procedures e.g. more than one hour, the use of a PAPR may be considered for additional comfort and visibility
  - PAPRs designed for use in other settings outside of health care are not recommended
  - Manufacturer's instructions for reprocessing of reusable PAPR components and management of filters should strictly followed

Care is required with removal of a PAPR, which is associated with a risk of self-contamination.

Only PPE marked as reusable should be reused after decontamination and reprocessing according to the manufacturer's instructions. All other PPE must be disposed of after use.

Aerosol-generating procedures

AGPs during the care of patients with suspected or confirmed COVID-19 are associated with a risk of transmission. The following *examples* are illustrative of a range of AGPs.

Instrumentation or surgical procedures on the respiratory tract including:

- Insertion or removal of endotracheal tube
- Intentional or inadvertent disconnection/reconnection of closed ventilator circuit
- High frequency oscillatory ventilation (HFOV)
- Open oropharyngeal or tracheal suctioning
- Upper respiratory instrumentation or surgery
  - e.g. bronchoscopy, tracheotomy, ear nose throat surgery
- Surgical or post mortem procedures on respiratory tract involving high-speed devices
- Intercostal catheter insertion for relief of pneumothorax
- Thoracic surgery that involves entering the lung

Other procedures that can generate respiratory aerosols

- Manual or non-invasive ventilation (NIV);
  - Bi-level positive airway pressure ventilation (BiPAP)
  - Continuous positive airway pressure ventilation (CPAP)
- Collection of induced sputum
- High flow nasal oxygen (HFNO)
- Transoesophageal echocardiography

Cardiopulmonary resuscitation (CPR) is a special circumstance:

- Chest compression and defibrillation during resuscitation are not considered AGPs
- First responders can commence resuscitation without the need for airborne precautions while awaiting the arrival of clinicians to undertake airway manoeuvres

PPE in specific hospital settings

Intensive care unit (ICU)

- Contact and **droplet** precautions should be used for general care of COVID-19 patients in ICU e.g. a patient not requiring ventilation or AGPs
- Contact and **airborne** precautions should be used for care of COVID-19 patients in ICU requiring AGPs
    - The risk of aerosol transmission is reduced once the patient is intubated with a closed ventilator circuit
    - The use of P2/N95 respirators is recommended for AGPs, in the ICU. However, if a healthcare professional is required to remain in an ICU patient's room continuously for a long period (e.g. more than one hour) to perform multiple AGPs, the use of a PAPR may be considered, as an alternative, for greater comfort and visibility
    - ICU staff caring for patients with COVID-19 (or any other potentially serious infectious disease) should be trained in the correct use of PPE, including the use of P2/N95 respirators or PAPRs, preferably by an infection prevention and control professional or other suitably qualified personnel

Wards, including care of critically ill patients outside of the ICU setting

- Contact and **droplet** precautions should be used for care of COVID-19 patients in general wards
- Contact and **airborne** precautions should be used for care of COVID-19 patients in general wards, when performing an AGP
    - AGPs should be performed in a negative pressure room (or a standard isolation room with door closed)
    - the number of persons present in the room should be minimised

Emergency departments

- Contact and **droplet** precautions should be used for routine care of COVID-19 patients in the emergency department except when an AGP (including passage of an endotracheal tube) is required
- Contact and **airborne** precautions should be used for care of COVID-19 patients when performing an AGP
    - AGPs should be performed in a negative pressure room (or a standard isolation room with door closed)
    - the number of persons present in the room should be minimised

Operating suite

NOTE: For procedures performed on patients in an operating suite who are NOT suspected or confirmed cases of COVID-19, the usual surgical PPE for the clinical circumstances should be used, i.e., surgical mask, theatre cap, gown, gloves and eye protection.

The principles of routine infection prevention and control during elective surgery should be strictly adhered to, including avoidance of unnecessary entry and exit from the operating theatre during surgery.

The number of people in the theatre should be limited to those required for clinical or educational purposes.

- Surgical procedures for patients with suspected or confirmed COVID-19 should be performed only in an emergency

Separate guidelines are available for use of PPE by anaesthetic and surgical staff, caring patients with suspected or proven COVID-19 in the operating suite, during different types of surgery or procedures.

The same general principles apply as outlined above:

- Standard precautions apply to the care of all patients including use of PPE based on risk assessment
- **Contact** and **droplet** precautions for anaesthetic or surgical procedures not involving AGPs in patients with suspected/confirmed COVID-19
- Contact and **airborne** precautions for anaesthetic or surgical procedures involving AGPs with suspected/confirmed COVID-19

Labour ward

For care of a pregnant woman, with suspected or confirmed COVID-19, during labour:

- The woman should be asked to wear a surgical mask, if tolerated
- **Contact and droplet precautions** should be observed by labour ward staff, in addition to standard precautions
- The woman's partner **or** other support person (one only) may attend the delivery even if s/he is in quarantine, as a close contact. Precautions required to protect labour ward staff:
    - On entering the hospital, the partner/support person should: perform hand hygiene and put on surgical mask (to protect staff); in the labour ward put on a gown (to protect clothes from blood/liquor)
    - On leaving the labour ward, remove gown and perform hand hygiene; remove mask and perform hand hygiene when leaving premises

Where can I get more information?

For the latest advice, information and resources go to www.health.gov.au

Call the National Coronavirus Health Information Line on 1800 020 080. The line operates 24 hours a day, seven days a week. If you require translating or interpreting services, call 131 450.

The telephone number of your state or territory public health authority is available on the coronavirus page at www.health.gov.au/state-territory-contacts