Rational use of personal protective equipment for COVID-19 and considerations during severe shortages

Interim guidance

23 December 2020

World Health Organization

This fourth edition of the *Rational use of personal protective equipment for COVID-19 and considerations during severe shortages* interim guidance, which was last published on 6 April 2020, includes:

- Updated strategies for optimizing personal protective equipment (PPE) use by health workers caring for patients with suspected, probable, and confirmed COVID-19
- New options for gloves and respirators
- Updated advice regarding PPE reuse by health workers as a strategy that should be avoided
- Updated section describing PPE recommendations for health workers based on the transmission scenario, setting, and activity (Annex 1)
- Updated section describing PPE decontamination/ reprocessing considerations (Annex 2)

Key points

Recommendations:

- WHO recommends: contact and droplet precautions to be applied during care for patients with suspected, probable, and confirmed COVID-19. Additionally, airborne precautions are recommended to be applied during aerosol generating procedures.
- WHO does not recommend: PPE reuse (donning of a used PPE item without decontamination/ reprocessing), use of gloves in settings where they are not needed, wearing a medical mask over a respirator, or the use of non-medical masks as an alternative to medical masks or respirators.

Strategies during shortages:

- Where shortages in PPE supply are forecasted to impact the safety and sustainability of health care delivery, the use of PPE in health care settings where patients with COVID-19 are cared for must be optimized:
  - Optimize the use of PPE through care planning; bundling activities and using alternatives to face-to-face interactions where quality of care can be maintained.
  - Use PPE items according to the transmission risk; standard and transmission-based precautions should be accordingly applied when providing care to patients.
  - Expand PPE availability by evaluating PPE items tested to functionally equivalent international standards.

Temporary strategies during severe shortage:

- In situations where there is a severe PPE shortage or anticipated stockout and when strategies for optimizing available PPE use have been implemented, consider temporary stand-alone or combination measures to maximize the use of available supplies:
  - extended PPE use (using PPE items for longer than normal or for multiple patient encounters)
  - reprocessing PPE (using previously worn PPE after decontamination or reprocessing methods)
  - alternative PPE items (using non-standardized or repurposed products as PPE items).

Introduction

Ongoing worldwide efforts to increase the scale of manufacturing and distribution mechanisms in the global supply chain for PPE have improved since the onset of the COVID-19 public health emergency (1). However, global PPE shortages impacting health worker safety and the sustainability of essential health services remain (2-5).

This guidance is intended for public health authorities and organizations involved in decisions regarding PPE use and prioritization for health workers, such as Infection Prevention and Control and Occupational Health and Safety focal points, health care managers and individuals responsible for coordinating distribution and management of PPE.

The success of any modification to conventional PPE use strategies depends on the availability of adequate human resources (6), training (7-14), institutionally supported IPC and occupational health and safety measures (15-17) and consistent evaluation of the safety of a health service setting (18-20). Accompanying administrative and environmental/ engineering controls which reduce the risk of SARS-CoV-2 transmission in health settings, as well as setting-specific guidance are described in detail in other WHO technical resources.

This document includes operational advice for the use of PPE in the context of COVID-19 and is complimentary to other technical resources used for the selection and procurement of PPE items, including; WHO's *Technical specifications of personal protective equipment for COVID-19* (21), WHO's *COVID-19 Essential Supplies Forecasting Tool* (22), and for PPE items supplied through the UN COVID-19 Supply Chain System (CSCS) Supply Portal (23).

Methodology for developing this guidance

Recommendations included in this document are based on published WHO guidelines (24-26). Strategies and practical interim guidance included in this document have been developed through evaluation of emerging literature, country experiences, and expert opinions presented and discussed at the WHO ad hoc COVID-19 Infection Prevention and Control Guidance Development Group (COVID-19 IPC GDG), and the WHO Technical Advisory Group of Experts on PPE (see acknowledgement section).

During emergencies WHO publishes interim guidance, the development of which follows a transparent and robust process of evaluation of the available evidence on benefits and harms (specifically, outcomes of infection). This evidence is evaluated through expert consensus building through weekly consultations, and, when necessary, followed up by surveys. This process also considers potential resource implications, values and preferences, feasibility, equity, and ethics. Draft guidance documents are reviewed by the COVID-19 IPC GDG and an external panel of experts prior to publication.

Infection prevention and control practices

All health workers and caregivers must receive adequate training in infection prevention and control practices including risk assessment (7, 24), standard and transmission-based precautions (8-10, 25), WHO 5 Moments for Hand Hygiene (11, 26), donning and doffing of personal protective equipment (12) and waste management (13, 27) to ensure that PPE is utilized effectively where indicated and does not become a source of contamination to the wearer. Competencies among users of PPE in appropriate procedures for donning and doffing, and other occupational health and safety measures required when caring for patients with COVID-19 should be reviewed regularly (14).

The use of droplet and contact precautions (medical masks, gowns, gloves, eye protection) (24) are recommended for all health workers when caring for patients with suspected, probable, or confirmed COVID-19 (15). When performing aerosol generating procedures, WHO recommends airborne and contact precautions (15, 28). Universal masking and targeted continuous use of medical masks are recommended in specific transmission scenarios; WHO's current guidance is provided in *Mask use in the context of COVID-19* (29).

Where care is provided to patients isolated for suspected or confirmed infections, transmission-based precautions should be known to all health workers who will be providing care or interacting with the patient environment (25). Decision-making when planning which PPE items are worn in the patient environment must encompass appropriate risk assessment specific for tasks, their duration and the level of body fluid exposure that may be experienced (24, 25).

Appropriate storage of clean PPE and regular environmental cleaning of all areas in which PPE donning and doffing are performed is essential for effective use and reducing the risk of contaminating clean PPE and self-contamination during doffing procedures (30). PPE donning areas should be appropriately cleaned and have availability of hand hygiene supplies (34). Places where PPE is doffed should ideally be separate from donning areas, have hand hygiene accessibility and clearly posted instructions for disposal of PPE (19). Areas where PPE is doffed may become rapidly contaminated with SARS-CoV-2 (31) and should be prioritized for frequent cleaning and disinfection (32).

Hand hygiene should be performed prior to donning PPE and performed again whenever PPE is manipulated during care provision (36). Care should be taken so that proper PPE fit is achieved during the donning process for comfort and protection and to avoid manipulating PPE after donning. Gloves should be doffed and discarded in order to perform hand hygiene if worn during any of WHO's 5 moments for hand hygiene and replaced with new gloves if necessary to continue providing care (26).

Strategies during PPE shortages

PPE must be prioritized for health workers and caregivers at local, national, and international levels where shortages threaten health worker safety in the delivery of essential health services. In view of continued global PPE shortages, strategies that can facilitate optimizing PPE use in health care facilities include: minimizing the use and frequent changing of PPE, ensuring rational and appropriate use of PPE, and optimizing PPE supply chain management mechanisms to increase procurement options.

WHO strongly advises operational planning for strategies used during PPE shortages to be conducted well in advance of an anticipated impact to health care delivery. Health workers and patient advocacy groups should be provided opportunity to collaborate with decision makers when selecting strategies to be used locally (33, 34). Standard operating procedures are advised to incorporate inventory management and forecasting processes which define local/institutional escalation strategies to use during shortages, severe shortages, and stockouts.

Optimize PPE use

In areas experiencing PPE shortages, the following interventions introduced to a health setting (stand-alone or in combination), can optimize the availability of PPE for direct care of patients with COVID-19 while ensuring protection of health workers from exposure to SARS-CoV-2 (35).

- Wherever feasible and appropriate, consider alternatives to face-to-face outpatient visits using virtual consultations, such as through telemedicine, to provide clinical support without direct contact with the patient (36).
- Use physical barriers, including glass or plexiglass screens that extend above the head of all standing occupants when performing screening (37), observational windows or transparent curtains in critical care settings (38) and fluid-resistant privacy curtains separating patients on wards (39).
- Cohort patients with COVID-19 (who have no co-infection with other healthcare transmissible pathogens) in the same room and designate dedicated health workers/teams to care exclusively for these patients to streamline clinical workflow and facilitate extended use of PPE if needed (24).

- Restrict the number of health workers entering the rooms of patients with COVID-19 if they are not involved in providing essential care. For example, consider bundling care activities to minimize the number of times a room is entered by checking vital signs during medication administration or having food delivered by health workers while they are performing other care activities.
- Ensure health workers perform risk assessment for appropriate PPE selection according to whether physical distancing can be maintained or if there will be direct contact with the patient and their environment. For example, wearing a medical mask and not gloves, gowns, or eye protection when entering a patient's room briefly to ask a question or perform a visual check.
- In areas of known or suspected community or cluster SARS-CoV-2 transmission, traffic of visitors should be limited in inpatient health care settings, but when necessary, restrict the number of visitors and the time allowed. Provide clear instructions about what PPE is required during the visit, how to put on and remove PPE, enforce/audit the frequent performance of hand hygiene and consider escorting the visitor in and out of the health setting as appropriate.

Ensure rational and appropriate PPE use

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 airborne).

- The type of PPE required when caring for patients with suspected or confirmed COVID-19 will vary according to the transmission setting, type of personnel and the activity performed (see Annex I for an expanded list of PPE by activity and transmission scenario).
- The use of transmission-based precautions (contact/droplet/airborne) and their associated isolation measures should be applied appropriately when patients are infectious (30) and can be stopped when no longer necessary in the care of a patient (40).
- Coveralls, double layering of gloves or gowns, shoe protection or head covers (hoods) that cover the head and neck used in the context of filovirus disease outbreaks (e.g. Ebola virus) are not required when caring for patients with COVID-19.

Coordinate PPE supply chain management mechanisms

The management of PPE should be coordinated through essential national and international supply chain management mechanisms that include:

- monitoring the end-to-end distribution of PPE to anticipate shortages at the facility and supplier level
- using PPE forecasting tools based on rational quantification models to ensure the volume of requested PPE items is proportional to the demand and use in the facility (21, 41)
- monitoring and controlling a centralized PPE procurement channel for countries and response efforts
- procuring supplies which have manufacturer and associated certification body approvals to withstand reprocessing where feasible
- promoting a centralized request management approach to avoid duplication of stock and ensuring strict adherence to essential stock management rules to limit waste, overstock, and stock ruptures
- monitoring and controlling the distribution of PPE from medical facilities stores
- monitoring and controlling waste management streams and appropriate processes for discarding used PPE (27, 42).

Stringent regulatory standards for PPE specifications and testing criteria used in local procurement processes may restrict available supply options. Given the global nature of current shortages of PPE, WHO's Technical Advisory Group of Experts on Personal Protective Equipment have evaluated regional and international standard specifications to facilitate the procurement of PPE that meets functional and protective criteria for use when caring for patients with COVID-19. International standards which meet functional equivalency for each type of PPE item are included in WHO's *Technical specifications of personal protective equipment for COVID-19: interim guidance* (22). A summary list by type and standard is outlined in WHO's *COVID-19 Disease Commodity Package* (43). These documents do not supersede local standards and regulations for the manufacturing and technical evaluation of PPE but may be consulted for procurement options from available global supply networks.

Temporary strategies during severe PPE shortages

Based on current evidence, in consultation with international experts and other agencies in the field of IPC, WHO and partners have carefully considered **last-resort temporary measures** in crisis situations to be adopted **only** when there is an anticipated PPE shortage that will adversely affect health worker safety and care delivery or in areas where access to the global supply chain of PPE remains limited despite attempts to use exceptional procurement processes.

The following temporary measures could be considered as stand-alone, or in combination, depending on the local situation:

1) Extended use of PPE

Extended use of PPE implies the use of any PPE item for a longer period than normal according to standards for conventional use and manufacturer recommendations (44). WHO advises that if this strategy is used to wear the same PPE for multiple patient encounters, this should be limited to scenarios where health workers are providing continuous care or assessment to a cohort of patients with confirmed COVID-19 who are not additionally suspected or confirmed of other healthcare transmissible infections (45).

In all instances where the same item of PPE is used for care activities beyond a single patient encounter, there is risk that contamination of the PPE item may facilitate the spread of pathogens within the healthcare environment to health workers (46) and other patients (47). An extended use

strategy depends on health workers ensuring that their PPE is not manipulated during or between patient encounters and that any PPE item that has been used in the provision of care is discarded when doffed. Implementing a strategy for extended use of PPE requires staff training to avoid self-contamination during prolonged use (7,12).

An additional consideration is the use of PPE beyond the manufacturer-designated shelf life or expiration date. All items used in this way should be inspected before use to be sure they are in good condition with no degradation, tears, or wear that could affect performance. Respirators that are past their designated shelf life are not considered approved in accordance with their associated regional/international standards. However, an expired respirator may still be effective for protecting health workers if it has been appropriately stored to avoid the effects of moisture or contamination, the straps have remained intact, there are no visible signs of damage and a self-fit test/seal check can be performed successfully by the wearer before use (42).

2) Decontamination or reprocessing of PPE

Many PPE items, such as cotton gowns and eye protection devices designed to be worn multiple times–are compatible with standard decontamination methods. This is not the case for many single-use PPE items. In some cases, manufacturers have developed operational instructions for PPE designed to withstand decontamination or reprocessing cycles for multiple usages (48, 49) or exceptional temporary measure guidance on the decontamination or reprocessing of single-use personal protective equipment (50, 51). However, methods for reprocessing PPE used in the care of patients with infectious diseases are not well established or standardized (52), and therefore reprocessing of single-use PPE items should be considered an extraordinary measure to be considered only when there would otherwise be a shortage of available PPE to perform tasks safely in the health care setting.

Wherever decontamination or reprocessing of PPE is performed, the process must be performed by trained staff under controlled and standardized conditions. When considering decontamination or reprocessing of single-use PPE, manufacturers' instructions for reprocessing and local regulatory approval processes (including, where applicable, emergency use authorizations) should be followed. Systems should be put in place locally to routinely inspect, repair (if applicable) and dispose of PPE when it is damaged or no longer suitable for use (52).

One approach may be to develop and operationalize strategies for decontamination or reprocessing, inspection/testing, and adequate storage of reprocessed PPE ahead of an anticipated stockout. This will allow for the development of a standard operating procedure for reprocessing and emergency stockpile of reprocessed PPE to be available to health facilities if supply chain mechanisms are unable to replenish stock of PPE (53).

Decontamination or reprocessing of single-use PPE is an evolving area that is undergoing research and development, in which additional studies are urgently needed. Methods that can be considered are described in Annex 2 of this document; as more evidence becomes available, WHO will update these considerations accordingly.

3) Alternative PPE materials

Several alternative options for PPE have been proposed or implemented in the context of COVID-19 by repurposing items from healthcare and other industries to serve as a temporary replacement to PPE items in limited supply. If alternatives for any PPE item used in health care settings are proposed locally in situations of shortage or impending/immediate stockout, a local authority should assess any proposed alternative PPE item according to specific minimum standards and technical specifications.

Medical masks

The use of FFP1 respirators, which are mainly used in industrial settings, have been proposed as an alternative to medical masks. FFP1 respirators are designed with technical specifications that can be considered to provide comparable protection for health workers compared to medical masks. However, many FFP1 models use exhalation valves that bypass the filtration media to reduce resistance during exhalation and will therefore not ensure source control (54).

In the instance of a stockout of medical masks, face shields used without masks, or paired with non-medical fabric masks (non-medical fabric masks should be validated per essential parameters listed in the WHO interim guidance *Mask use in the context of COVID-19*) have been proposed as alternatives for medical masks (29). It should be noted, however, that both options are inferior to medical masks for protection against respiratory pathogens and should be considered a temporary last resort measure (see Table 1).

Gowns

Disposable or launderable aprons, lab coats, and patient gowns have been repurposed as alternatives to PPE gowns in the context of shortages. In some instances, these alternatives may not effectively shield health workers' torsos or arms from contaminants and may not be tested for adequate resistance to fluid penetration.

Eye protection

Safety glasses and alternative manufacturing processes for face shields (such as 3D printing and homemade designs) have been used as alternatives in the context of eye protection item shortages (55-57). These alternatives are in many cases untested for eye protection performance and standards (57). Homemade designs are unlikely to be evaluated for their ability to protect eyes from inadvertent splashes of fluids.

Respirators

Powered air purifying respirators (PAPR) and elastomeric respirators are considered multi-use devices validated by international standards and, in some instances, manufacturer recommendations for reprocessing (48, 49). Both have been used conventionally and in the context of respirator shortages in health settings (58, 59). The quality of filtration of many models of PAPR and elastomeric respirators is equivalent to or greater than that of FFP2/N95 respirators (60, 61), and some evidence states that they are less likely to cause dermatological or inhalation safety harms compared to FFP2/N95 respirators (61, 62). However, there are caveats to the successful adoption of these alternatives, including:

- the high initial cost of implementation (58, 59)
- feasibility to maintain and replace the filters (and batteries if applicable) when needed (58, 59)

- ability to perform manual reprocessing of small mechanisms within the device including the filters effectively (63, 64) and in a timely manner (65),
- storage of the units following reprocessing between uses (58, 59, 66),
- potential disruption to the line of sight and hearing in some models (58, 59, 66)
- inability of many models with unfiltered exhalation ports to ensure source control from the wearer (66).

Gloves

In the context of a shortage of gloves, the best strategy is to temporarily reduce the activities in which gloves are used (including, as applicable, within the bundle of PPE used for contact precautions while caring for patients with suspected, probable, or confirmed COVID-19) (67). Alcohol-based hand rub and hand washing with soap and water have been demonstrated to effectively decontaminate hands from SARS-CoV-2, but only when performed thoroughly with the recommended surface coverage friction, and time (73). Health workers with non-intact skin on their hands should not perform direct care on patients without gloves (68).

In instances of a shortage of gloves, available supplies of medical grade gloves should be rationed where possible for use in high-risk activities including:

- hazardous medication or chemical handling (e.g. chemotherapy administration, medical device reprocessing),
- surgical/oral health settings,
- procedures with high body fluid exposure risks
- cleaning of excrement or large spills of blood

Protective gloves that are used for safety in other industries, such as those for laboratories and for the handling of chemical hazards, have been proposed as alternatives in the context of prolonged shortages of available gloves in the PPE global supply chain (69). In some instances, there are internationally recognized standards associated with the manufacturing processes and integrity of gloves used in other industries. However, there are important precautions that should be considered if sourcing non-medical gloves, including:

- possible poor elasticity and tear strength
- possible lack of tactile sensitivity/dexterity
- not purpose-built to provide protection against hazards present in a health care environment (70).

Table 1. Options for temporary measures in the context of shortages of Personal Protective Equipment (PPE)

The table below summarizes temporary measures that can be used by health workers 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. 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 use and procurement of PPE have been exhausted.

WHO stresses that these temporary measures should be avoided as much as possible when caring for patients with severe COVID-19, patients who are critically ill, and for patients with known co-infections of multi-drug resistant organisms or other organisms requiring contact precautions (e.g. Clostridiodes difficile), droplet precautions (e.g. influenza virus), or airborne precautions (e.g. pulmonary tuberculosis).

Type of PPE	Measure	Description	Limitations/risks/removal criteria
Medical mask used by health workers	1) Extended use (for use with multiple patients)	Use without removing for up to 6 hours, when caring for a cohort of patients with COVID-19	Risks: • Extended use of a medical mask may increase risk of contamination of the mask with SARS-CoV-2 and other pathogens. • Wearing the mask for a prolonged period may increase the chance of the health care worker touching the mask or inadvertently touching underneath the mask. • Damage to or reactions of facial 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 are required for health workers. Removal criteria and precautions: • Follow safe procedures for removal and do not touch the front of the mask. • If the mask is touched/adjusted, hand hygiene must be performed immediately. • Masks must be changed if they become wet, soiled, or damaged; difficult to breathe through; exposed to a splash of chemicals, infectious substances, or body fluids; or if the have been removed for any reason, including when drinking fluids or eating meals. • A new medical mask should be worn when providing care outside of a designated cohort of patients with COVID-19. • 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.
	2) Reprocessing	No quality evidence is available to date on medical mask reprocessing, and it is not advised	NA
	3) Alternative items (in the absence of medical masks)	FFP1 Respirator without exhalation valve	Risks: • Damage to or reactions of facial skin tissue may occur with prolonged use of respirators. • If the respirator contains an unfiltered exhalation valve, it reduces the capacity of the respirator to ensure source control from a potentially infected wearer. Removal criteria and precautions: • If the respirator is touched/adjusted, hand hygiene must be performed immediately.

			• Respirators must be changed if they become wet, soiled, or damaged; difficult to breathe through; exposed to a splash of chemicals, infectious substances, or body fluids; or if they been removed for any reason, including when drinking fluids or eating meals. • Respirators need to be removed whenever providing care outside of a designated cohort of patients with COVID-19. • Follow the safe procedure for removal and do not touch the front of the respirator.
		Face shield alone (with proper design to cover the entire face, wrap around the sides of the face and extend below the chin) or paired with validated* non-medical mask *Per Essential parameters (minimum and preferred thresholds) for manufactured non-medical mask in WHO interim guidance *Mask use in the context of COVID-19* (29) **Temporary measure only in the critical emergency situation of a stockout of medical masks**	<u>Risks</u>: • The face shield is an incomplete physical barrier and does not provide the filtration layers of a mask. • Face shields are considered to provide a level of eye protection only and should not be considered as an equivalent to masks with respect to respiratory droplet protection and/or source control. • Reusable face shields carry risk of residual contamination and must be properly cleaned and stored after each use. • Caution should be taken to avoid injury when donning, wearing and doffing face shields. • Non-medical fabric masks are not regulated as protective masks or part of the PPE directive and should only be considered a source control measure. • Non-medical fabric masks vary in quality and filtration efficiency will degrade with subsequent laundering for reuse. <u>Removal criteria and precautions:</u> • Face shields should be removed if they are contaminated by a splash of chemicals, infectious substances, or body fluids; or if they obstruct visibility. • Follow the safe procedure for removal and do not touch the front of the face shield.
Respirator (FFP2, FFP3, N95, N99, N100 or equivalent) used by health workers	1) Extended use (for use with multiple patients)	Use without removal for up to 6 hours, when caring for a cohort of patients with COVID-19.	<u>Risks:</u> • Extended use of respirators may increase the risk of contamination with SARS-CoV-2 and other pathogens. because it may increase the chance of health workers touching the respirator or inadvertently touching under the respirator. • Extended use of respirators may clog the filtration media, leading to increased breathing resistance. • Damage to or reactions of facial skin tissue may occur with prolonged use of respirators. <u>Removal criteria and precautions:</u> • A respirator must be removed if it becomes wet, soiled, damaged, or difficult to breathe through or if it is exposed to a splash of chemicals, infectious substances or body fluids. • If respirators are touched or adjusted or removed from the face for any reason, hand hygiene must be performed immediately. • Follow the safe procedure for removal and do not touch the front of the respirator. • Use of the same respirator by a health worker when caring for patients with COVID-19 and patients not suspected of having COVID-19 is not recommended owing to the risk of transmission from exterior contamination of the respirator.
	2) Reprocessing	Process to decontaminate a respirator using disinfection or sterilization methods.	<u>Limitations/ Risks:</u> • There are currently no standardized decontamination and reprocessing methods or protocols for ensuring the effectiveness or integrity of the respirators.

	(see Annex 2 for evidence)	<u>Methods (not validated) for respirator reprocessing (see Annex 2):</u> per manufacturers instructions, where applicable: • vaporized hydrogen peroxide • ultraviolet germicidal irradiation • dry or moist heat • methylene blue dye + dry heat	• The 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 and may affect protection properties. • The number of reprocessing cycles which may be performed without degradation of protection is highly variable, depending on the reprocessing method used and the respirator brand/model. <u>Removal criteria and precautions:</u> • After a pre-defined number of reprocessing cycles, the respirator should be discarded in an appropriate waste receptacle according to local guidance/policy. • When a respirator is removed from the face, it should be placed immediately into a designated container for reprocessing and labeled with the original wearer's name. • Respirator should only be donned by a wearer a maximum of five times. • The respirator should be returned to the original wearer after a reprocessing cycle. • Health workers should always inspect the respirator and perform a seal-check before use.
	3) Alternatives	Powered air purifying respirators (PAPRs) or elastomeric respirators designed with the capability of being reprocessed without damaging the seal and effectiveness of filtration (58, 59)	<u>Limitations/Risks:</u> • Staff members may be unfamiliar with the use, operation and handling of PAPRs or elastomeric respirators and will need training to ensure safe operation and practices. • Most models do not ensure source control for wearer, as exhalation valves allow unfiltered exhaled air to escape into the environment. PAPRs and elastomeric respirators that facilitate both protection and source control through filtered inhalation and exhalation should be selected where available. • PAPRs with hood designs and/or with irregular placement of components or cords may interfere with health worker mobility and visibility. • The ability to hear may be reduced because of the blower noise and noise induced by the movement of a loose head covering, depending on the model used. • The ability to use a stethoscope may be limited. • Batteries and filters/cartridges must be recharged or replaced when indicated. • PAPRs and elastomeric respirators require a significant amount of storage space in between shifts. <u>Removal criteria and precautions:</u> • Discard filters when soiled, damaged or reducing air flow below manufacturer specified levels. • Battery capacity and cartridges should be checked before each use. • Reprocessing should be performed per the manufacturer's instructions, and the facility must train staff to maintain and properly disinfect and clean the PAPR. • Ideally, the PAPR or elastomeric respirator should be dedicated to a single wearer and returned to this wearer during their next clinical use after each reprocessing cycle.
Gown used by health workers	1) Extended use (for use on multiple patients)	The use <u>without removal</u>, when providing care of a cohort of patients with COVID-19.	<u>Risks</u> • Extended use of gowns may increase risk of self-contamination. • The extended use of gowns may increase the risk of transmission of other pathogens between patients.

		Not applicable if caring for a patient with a suspected or confirmed multidrug-resistant microorganism or another type of disease requiring contact precautions. In these cases, the gown should be changed between patients.	Removal criteria and precautions: • Gown should be removed if it becomes wet, soiled or damaged or is exposed to splash of chemicals, infectious substances or body fluids. • Gown should be removed when providing care outside a designated cohort of patients with COVID-19. • Follow the safe procedure for removal of gowns to prevent contamination of the environment.
	2) Reprocessing	i) Process to decontaminate a cotton gown by laundering or washing and disinfection methods. Methods for laundering (**see Annex II**): • Laundering in 60ºC water with detergent followed by hang drying • Manual washing in water and detergent, followed by soaking in disinfectant followed by hang drying	Risk • Damage to textile may occur, providing less fluid resistance and increased potential for self-contamination. Removal criteria: • Gowns should be discarded if they become wet, soiled, or damaged or are exposed to splash of chemicals, infectious substances or body fluids.
	3) Alternatives	i) Disposable laboratory coats Only for brief contact with patients; should not be used for prolonged contact or when performing AGPs and support treatments	Risks: • Disposable laboratory coats are less durable and can provide less torso coverage/fluid resistance than gowns. • There is risk of contamination to the health worker's scrubs and damage to the coat during patient care. Removal criteria and precautions: • A disposable laboratory coat should be removed if it becomes wet, soiled, or damaged or is exposed to splash of chemicals, infectious substances or body fluids. • Follow the safe procedure for removal of a disposable laboratory coat to prevent contamination of the environment.
		ii) Disposable impermeable plastic aprons Should be paired with lab coats or patient gowns when performing AGPs and support treatments	Risks: • Plastic aprons do not protect the arms and the back of the torso and provide less coverage than gowns. Removal criteria and precautions: • A plastic apron should be removed if it becomes wet, soiled, or damaged or is exposed to a splash of chemicals, infectious substances or body fluids. • Follow the safe procedure for removal of the apron to prevent contamination of the environment.

		iii) Reusable (washable) patient gowns, reusable (washable) laboratory coats Should be paired with aprons when performing AGPs and support treatments Methods for laundering (**see Annex II**): • Laundering in 60ºC water with detergent • Manual washing in water and detergent, followed by soaking in disinfectant	Risk • Design and thickness may not be compatible with providing coverage for the full protection of the torso or arms. Removal criteria: • An alternative gown should be removed if it becomes wet, soiled, or damaged or is exposed to splash of chemicals, infectious substances or body fluids. • Follow the safe procedure for removal of apron to prevent contamination of the environment. • Use of the same alternative gown by a health worker when caring for patients with COVID-19 and patients not suspected of having COVID-19 is not recommended owing to the risk of transmission from contamination on the alternative gown.
Goggles used by health workers	1) Extended use (for use on multiple patients)	The use without removal during the shift period, when caring for a cohort of patients with COVID-19.	Risks: • There is a risk of contaminating the exterior of the goggles. • Extended use of goggles may increase discomfort and fatigue due to abrasive straps and visual distortion. • Dermatological tissue damage may occur to the face with prolonged goggle use. Removal criteria and precautions: • Goggles should be removed if they are contaminated by a splash of chemicals, infectious substances or body fluids; or if they obstruct visibility or become loose. • Follow the safe procedure for removal of goggles to prevent contamination of eyes. • Use of the same googles by a health worker when caring for patients with COVID-19 and patients not suspected of having COVID-19 is not recommended owing to the risk of transmission from contamination of the goggles.
	2) Reprocessing	Clean goggles with soap/detergent and water followed by disinfection using either with sodium hypochlorite 0.1% (followed by rinsing with clean water) or 70% alcohol wipes – **see Annex II** for more information.	Risks: • Residual toxicity of sodium hypochlorite can cause eye irritation if not thoroughly rinsed after disinfection. • Reprocessing increases health care worker workload. Removal criteria: • Goggles should be removed if they are contaminated by a splash of chemicals, infectious substances or body fluids; or if they obstruct visibility or become loose.
	3) Alternatives	Safety glasses (e.g. trauma glasses) with extensions to cover the side of the eyes.	Removal criteria and precautions: • Safety glasses should be removed if they are contaminated by a splash of chemicals, infectious substances or body fluids; or if they obstruct visibility.
Face shield used by health workers	1) Extended use (for use on multiple patients)	The use without removal during the shift when caring for a cohort of patients with COVID-19.	Limitations/Risks: • There is risk of contaminating the exterior of the face shield. • Extended use of a face shield may increase discomfort and fatigue due to abrasive head strap and visual distortion. • Dermatological tissue damage may occur to the face with prolonged face shield use.

	Face shield must be designed to cover the sides of the face and to below the chin		Removal criteria and precautions: • Face shields should be removed if they are contaminated by a splash of chemicals, infectious substances or body fluids; or if they obstruct visibility. • Follow the safe procedure for removal of face shields to prevent contamination of the face and eyes. • Use of the same face shield by a health worker when caring for patients with COVID-19 and patients not suspected of having COVID-19 is not recommended owing to the risk of transmission from contamination of the face shield.
	2) Reprocessing	Clean face shield with soap/detergent and water followed by disinfection using either sodium hypochlorite 0.1% (followed by rinsing with clean water) or 70% alcohol wipes – **see Annex II** for more information.	Limitations/Risks: • Plastic may become damaged, resulting in reduced visibility and integrity. • Residual toxicity of the sodium hypochlorite can occur if face shield is not thoroughly rinsed after disinfection. Removal criteria and precautions: • Face shields should be removed if they are contaminated by a splash of chemicals, infectious substances or body fluids; or if they obstruct visibility. • Follow the safe procedure for removal of face shields to prevent contamination of the face and eyes.
	3) Alternative items	Local production of face shields (for example by 3D printing, binder sheets with headband, local plastics manufacturers)	Limitations/Risks: • Locally produced face shields are not validated by international standards for personal protective equipment as eye protection. • There is potential for suboptimal quality, including visibility, facial protection coverage, strap/band quality and shape to ensure eye protection. Removal criteria and precautions: • Face shields should be removed if they are contaminated by a splash of chemicals, infectious substances or body fluids; or if they obstruct visibility. • Follow the safe procedure for removal of face shields to prevent contamination of the face and eyes.
Gloves used by health workers	1) Extended use (for use on multiple patients)	No quality evidence is available on the extended use of gloves for multiple patients, and it is not advised.	N/A
	2) Reprocessing (during a single patient encounter)	The use of alcohol-based hand rub or a manufacturer approved disinfectant on medical gloves instead of removal and donning of new gloves when a moment for hand hygiene is performed during a single patient encounter (such as a bundled patient encounter with multiple care tasks) - **see** Options **NOT** advised by WHO below for more information.	Risks: • This practice should only be considered where a glove manufacturer has evaluated and approved the use of a disinfectant on non-sterile examination gloves. • Use of disinfectant may result in reduction of tensile strength of gloves and increased likelihood of permeability and leaks. • Certain materials (e.g. vinyl) may degrade with the use of alcohol-based hand rub or become sticky. • Microtears in material may result in increased risk of contamination by pathogens present in the care environment from the disinfected glove to the patient versus alcohol-based hand rub alone used during moments for hand hygiene. • Gloves should not be removed from the hands when performing disinfection of gloves as this practice risks further degradation of the tensile strength and likelihood of permeability. • Gloves with long cuffs, reaching well above the wrist may be safer to use when decontaminating gloved hands using a disinfectant solution.

		Temporary measure only in the emergency situation of a pending stockout of gloves	Removal criteria: • Gloves must be removed after a **single patient encounter** when exiting the care area or when providing care to another patient. • Gloves should be removed if they become visibly damaged, discolored, sticky or contaminated with body fluids. • Gloves must be discarded as waste immediately after removal
	3) Alternative items	i) In the absence of gloves, hand washing or alcohol-based hand rub alone as indicated for the WHO 5 moments for hand hygiene (36)	Risks: • Skin damage or other safety concerns may occur when exposed to chemical risks present in the healthcare environment and in the delivery of some medications (e.g. chemotherapy). • Hand hygiene must be performed thoroughly because viral, bacterial, and fungal pathogens; and particularly, spore-forming pathogens may reside on the hands of health workers whenever hands are not cleansed effectively. Use criteria: • Soap and water should be used instead of alcohol-based hand rub where hands are visibly soiled or when there is a risk of contamination with spore-forming pathogens. • Patient care without gloves should be avoided wherever possible for direct care activities with high risk of contamination with body fluids, contact with mucous membranes and non-intact skin, or with significant safety risks to exposed hands during procedures such as peripheral venous catheter insertion/removal, intubation, cleaning spills of body fluids, emptying emesis basins, chemotherapy administration, handling/cleaning used instruments, preparation of disinfectants, manipulation of hazardous chemicals or handling waste. • Direct care without the use of gloves should not be performed when health workers or caregivers have non-intact skin on their hands.
		ii) The use of non-medical industrial grade disposable gloves where indicated (e.g. contact precautions) for routine care tasks involving manipulation of the patient or patient environment **Temporary measure only in the emergency situation of a pending stockout of gloves**	Risks: • Non-medical gloves may not meet standards for safety and use in settings with biological contaminants, have poor elasticity and tear strength and may not allow for tactile sensitivity/dexterity. • Non-medical gloves may be sized inappropriately and increase the likelihood of microbial contamination. • Non-medical gloves should not be made of materials that can cause allergic reaction or be coated in powder that can cause airway inflammation if inhaled. • Ideally, gloves should be coated in polymer or chlorination. If not; the doffing process may be more difficult and the risk of contamination high. Removal criteria and precautions: • Gloves should be discarded and replaced whenever they have ripped or torn. • They are to be discarded to allow for hand hygiene to be performed when indicated according to WHO 5-moments for hand hygiene with a new pair of gloves donned afterward if continuing to provide care to a single patient. • Such gloves should not be used for direct care activities with contact to patient's mucous membranes or non-intact skin, or with significant safety risks to exposed hands during procedures such as. peripheral venous catheter insertion/removal, intubation, chemotherapy administration, handling/cleaning used instruments, preparation of disinfectants, manipulation of hazardous chemicals or handling waste.

Options NOT recommended by WHO

PPE reuse

The doffing of PPE, storage for a set time period, re-donning, and reuse of the same, potentially contaminated PPE item, in particular medical masks and respirators, without decontamination or reprocessing (71, 72), is not recommended by WHO. Other pathogens present in the healthcare environment with long inanimate surface survival may also contaminate PPE items during routine care (73). Further research is additionally needed to better understand the environmental conditions that may facilitate longer surface survival of SARS-CoV-2 and other healthcare transmissible pathogens on PPE used in patient care (31, 74-77), to minimize risk of self-contamination and to protect against inoculation of the mucosal surfaces of patients if reused (78-81).

Inappropriate glove use

The use of gloves for protection against SARS-CoV-2 in community settings where no care is provided to patients with suspected or confirmed COVID-19 should not be relied upon as a strategy to reduce transmission (82). WHO recommends that increasing hand hygiene availability in healthcare and community settings should be prioritized, as indicated in WHO's *Recommendations to Member States to improve hand hygiene practices to help prevent transmission of the COVID-19 virus* (83). Touching the mucous membranes of the face with contaminated hands, whether wearing gloves or not, may result in infection (84). Medical grade examination gloves used in the general community setting for purposes other than health care delivery is strongly discouraged by WHO while acute shortages in global supply and availability continue.

Using the same gloves for a cohort of patients with COVID-19 (extended use) is not recommended by WHO due to the potential for SARS-CoV-2 and other pathogens in the healthcare setting to be transmitted via the gloves and cause infection (26). Another consideration is the likelihood that the tensile strength and permeability of the gloves will break down with extended use.

Double gloving is not recommended as this practice does not provide any additional protective benefit against SARS-CoV-2. Double gloving is only known to have protection benefits during surgical procedures that carry a high risk of rupturing the gloves (26).

Gloves are worn in healthcare settings to reduce excess contamination of the hands (26). Changing gloves between tasks during care to a patient with a contact-transmissible infection, accompanied by hand hygiene, is a well-established best practice to mitigate contamination of the hands as a source of infection (25, 26). For the care of patients with confirmed or suspected COVID-19, if an optimal supply of gloves is available, they should be worn when providing direct physical care, aseptic procedures, when there is a risk of body fluid exposure, and when performing tasks involving prolonged interaction with the patient environment (e.g. cleaning and disinfection of surfaces). Gloves should be discarded, followed by hand hygiene during all moments for hand hygiene. It is worth noting that there is no direct evidence for increased protection against SARS-CoV-2 through glove use, compared to hand hygiene alone (82. 85, 86).

In the context of a glove shortage, it is preferable to temporarily reduce activities in which gloves are used, as previously described.

In the situation of a critical shortage of medical gloves, various strategies have been developed for the decontamination of gloved hands (e.g. decontaminating gloves without removal) to allow for the extended use of gloves on a cohort of patients. WHO has carefully evaluated various methods of disinfection of gloves as described in research studies (87-90), by manufacturers (91, 92), and in practical guidance by public health authorities and advisory agencies (93,94). Some results show promising resistance of single-use gloves to various disinfectants with high efficacy against microbial contaminants present in the healthcare facility, but altogether there are mixed results on the impact to tensile strength and permeability of gloves.

Given current evidence, WHO does not advise disinfection of gloved hands. However, if strictly necessary, the disinfection of a gloved hand through validated methods which have been supported by the glove manufacturer should only be performed during a moment for hand hygiene as part of the bundling of care tasks to be performed on a single patient (95). One reason for adopting this approach would be to avoid changing gloves in a patient's room or having to return to the donning area with potentially contaminated PPE. This approach should not be considered to extend the use of gloves when caring for multiple patients, even if all patients are cohorted in the same room (see Table 1).

Wearing a medical mask over a respirator

In light of safety concerns (96-98), WHO does not recommend the use of a medical mask in combination with a respirator to extend the use of a respirator, or to ensure source control when using a respirator with an unfiltered exhalation valve.

WHO advises the use of a face shield as a rational alternative when it is deemed locally necessary to add a protective layer to a respirator during extended use. In all instances, a used respirator should be handled as if it were contaminated since neither a medical mask nor a face shield will thoroughly shield the respirator from all contamination risks present in the healthcare environment (99). Respirators with exhalation valves that do not filter exhaled breath, and therefore do not ensure source control for a wearer potentially infected with SARS-CoV-2, are not advised and should be used only when no other options are available (29).

Non-medical masks as an alternative to medical masks or respirators

Non-medical masks are not considered appropriate for protection of health workers when working in patient care areas or caring for patients (29). Material thickness and weaving standards vary widely; hence, the barrier (filtration efficiency) against microorganisms passing through the fabric is unknown. In addition, non-medical masks are often designed with multiple layers of hydrophilic materials such

as cotton, and thus may retain moisture, become contaminated and act as a potential source of infection to a wearer (100, 101). Although current recommendations advise the use of synthetic, hydrophobic materials on the outer layer, the overall use of non-medical masks is for source control purposes. There is no current evidence to show that these masks perform adequately or consistently as PPE (29).

If production of non-medical fabric masks for use in health care settings is proposed, a local authority must assess them according to specific minimum standards and technical specifications (29).

References

1. Supply chain task force, notes for the record. Geneva: World Health Organization; 25 November 2020 (https://www.who.int/publications/m/item/supply-chain-task-force-notes-for-the-record-25-november-2020, accessed 15 December 2020)
2. Park, C.-Y., Kim, K., Roth, S., Beck, S., Kang, J.W, Tayag, M.C., et al. Global Shortage of Personal Protective Equipment amid COVID-19: Supply Chains, Bottlenecks, and Policy Implications. Asian Development Bank. (https://doi.org/10.22617/BRF200128-2, accessed 15 December 2020)
3. Cohen, J., Rodgers, Y. van der M., 2020. Contributing factors to personal protective equipment shortages during the COVID-19 pandemic. Prev Med 141, 106263. (https://doi.org/10.1016/j.ypmed.2020.106263, accessed 15 December 2020)
4. Rowan, N.J., Laffey, J.G., 2020. Challenges and solutions for addressing critical shortage of supply chain for personal and protective equipment (PPE) arising from Coronavirus disease (COVID19) pandemic – Case study from the Republic of Ireland. Science of The Total Environment 725, 138532. (https://doi.org/10.1016/j.scitotenv.2020.138532, accessed 15 December 2020)
5. Sharma, A., Gupta, P., Jha, R., 2020. COVID-19: Impact on Health Supply Chain and Lessons to Be Learnt. Journal of Health Management 22, 248–261. (https://doi.org/10.1177/0972063420935653, accessed 15 December 2020)
6. Health workforce policy and management in the context of the COVID-19 pandemic response. Geneva: World Health Organization; 3 December 2020 (https://apps.who.int/iris/handle/10665/337333, accessed 14 December 2020)
7. Infection Prevention and Control (IPC) for COVID-19 Virus (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-PPE-EN, accessed 29 November 2020)
8. Infection Prevention and Control (IPC) core competencies and multimodal strategies (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-PPE-EN, accessed 29 November 2020)
9. Standard Precautions: Injection safety and needle-stick injury management (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-IS-EN, accessed 29 November 2020)
10. Standard Precautions: Environmental cleaning and disinfection (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-EC-EN, accessed 29 November 2020)
11. Standard Precautions: Hand Hygiene (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-HH-en, accessed 29 November 2020)
12. COVID-19: How to put on and remove personal protective equipment (PPE). Geneva: World Health Organization; 2020 (https://openwho.org/courses/COVID-19-IPC-EN?locale=en, accessed 29 November 2020)
13. Standard Precautions: Waste management (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-EC-EN, accessed 29 November 2020)
14. Occupational health and safety for health workers in the context of COVID-19 (OpenWHO course). Geneva: World Health Organization; 2020 (https://openwho.org/courses/IPC-PPE-EN, accessed 29 November 2020)
15. Infection prevention and control during health care when coronavirus disease (COVID-19) is suspected or confirmed. Interim Guidance. Geneva: World Health Organization; 29 June 2020. (https://apps.who.int/iris/handle/10665/332879, accessed 29 November 2020)
16. Interim guidance note for hospitals: managing hospital services, maintaining essential routine health care and generating surge capacity. Manilla: World Health Organization, Western Pacific Regional Office; 6 April 2020 (https://apps.who.int/iris/handle/10665/332381, accessed 29 November 2020)
17. Administrative Controls to Guarantee Implementation of Infection Prevention and Control Measures in the Context of COVID-19. Washington; World Health Organization Regional Office for the Americas; 25 June 2020 (https://iris.paho.org/handle/10665.2/52389, accessed 29 November 2020)
18. Rapid hospital readiness checklist: a module from the suite of health service capacity assessments in the context of the COVID-19 pandemic: interim guidance. Geneva: World Health Organization; 25 November 2020 (https://apps.who.int/iris/handle/10665/337038, accessed 29 November 2020)
19. Infection prevention and control health-care facility response for COVID-19: a module from the suite of health service capacity assessments in the context of the COVID-19 pandemic: interim guidance. Geneva: World Health Organization; 20 October 2020 (https://apps.who.int/iris/handle/10665/336255, accessed 29 November 2020)
20. Ensuring a safe environment for patients and staff in COVID-19 health-care facilities: a module from the suite of health service capacity assessments in the context of the COVID-19 pandemic: interim guidance. Geneva: World Health Organization; 20 October 2020 (https://apps.who.int/iris/handle/10665/336257, accessed 29 November 2020)

21. COVID-19 essential supplies forecasting tool overview of the structure, methodology, and assumptions used: interim guidance. Geneva: World Health Organization; 25 August 2020 (https://apps.who.int/iris/handle/10665/333983, accessed 26 November 2020)
22. Technical specifications of personal protective equipment for COVID-19: interim guidance. Geneva: World Health Organization; 2020 (https://apps.who.int/iris/handle/10665/336622, accessed 22 November 2020).
23. COVID-19 Supply Chain System: Requesting and receiving supplies. Geneva: World Health Organization; 30 April 2020 (https://www.who.int/publications/i/item/emergency-global-supply-chain-system-(covid-19)-catalogue, accessed 26 November 2020)
24. Infection prevention and control of epidemic- and pandemic- prone acute respiratory infections in health care. Geneva: World Health Organization; 2014 (https://apps.who.int/iris/handle/10665/112656, accessed 17 December 2020).
25. Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level. Geneva: World Health Organization; 2016 (https://apps.who.int/iris/handle/10665/251730, accessed 17 December 2020)
26. WHO guidelines on hand hygiene in health care. Geneva: World Health Organization; 2009 (https://apps.who.int/iris/handle/10665/44102, accessed 29 November 2020)
27. Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19: Interim guidance. Geneva: World Health Organization; 29 July 2020 (https://apps.who.int/iris/rest/bitstreams/1292822/retrieve, accessed 15 December 2020)
28. Considerations for the provision of essential oral health services in the context of COVID-19. Geneva: World Health Organization; 3 August 2020 (https://apps.who.int/iris/handle/10665/333625, accessed 23 November 2020)
29. Mask use in the context of COVID-19. Geneva: World Health Organization; 1 December 2020 (https://apps.who.int/iris/handle/10665/337199, accessed 23 November 2020)
30. Transmission of SARS-CoV-2: implications for infection prevention precautions. Scientific Brief. Geneva: World Health Organization; 9 July 2020. (https://apps.who.int/iris/handle/10665/333114, accessed 22 November 2020)
31. Ye, G., Lin, H., Chen, S., Wang, S., Zeng, Z., Wang, W., et al., 30 April 2020. Environmental contamination of SARS-CoV-2 in healthcare premises. Journal of Infection 81, e1–e5. (https://doi.org/10.1016/j.jinf.2020.04.034, accessed 22 November 2020)
32. Cleaning and disinfection of environmental surfaces in the context of COVID-19. Geneva: World Health Organization; 16 May 2020 (https://apps.who.int/iris/handle/10665/332096, accessed 24 November 2020)
33. McDougall, R.J., Gillam, L., Ko, D., Holmes, I., Delany, C., 2020. Balancing health worker well-being and duty to care: an ethical approach to staff safety in COVID-19 and beyond. J Med Ethics medethics-2020-106557. (https://doi.org/10.1136/medethics-2020-106557, accessed 20 December 2020)
34. Richards, T., Scowcroft, H., 2020. Patient and public involvement in covid-19 policy making. BMJ m2575. (https://doi.org/10.1136/bmj.m2575, accessed 20 December 2020)\
35. Critical shortage or lack of personal protective equipment in the context of COVID-19. Manilla: World Health Organization, Regional Office for the Western Pacific; 28 June 2020 (https://apps.who.int/iris/handle/10665/333631, accessed 29 November 2020)
36. Bokolo Anthony Jnr., 2020. Use of Telemedicine and Virtual Care for Remote Treatment in Response to COVID-19 Pandemic. J Med Syst 44, 132. (https://doi.org/10.1007/s10916-020-01596-5, accessed 20 December 2020)
37. Gan, C.C.R., Tseng, Y.-C., Lee, K.-I., 2020. Acrylic window as physical barrier for Personal Protective Equipment (PPE) conservation. Am J Emerg Med 38, 1532–1534. https://doi.org/10.1016/j.ajem.2020.04.044
38. Gupta, S., Gupta, S., Gujrathi, A.V., 2020. Use of transparent curtains on bedside of patients with COVID-19. Clin Exp Dermatol 45, 754–754. (https://doi.org/10.1111/ced.14256, accessed 24 November 2020)
39. Liang, T., 2020. Handbook of COVID-19 prevention and treatment. The First Affiliated Hospital, Zhejiang University School of Medicine. Compiled According to Clinical Experience, 68. (https://covid-19.conacyt.mx/jspui/handle/1000/25, accessed 20 December 2020)
40. Criteria for releasing COVID-19 patients from isolation. Geneva: World Health Organization; 17 June 2020 (https://apps.who.int/iris/handle/10665/332451, accessed 22 November 2020).
41. Personal protective equipment burn rate calculator. Atlanta: Centers for Disease Control and Prevention; 7 April 2020 (https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/burn-calculator.html, accessed 26 November 2020)
42. Nowakowski, P., Kuśnierz, S., Sosna, P., Mauer, J., Maj, D., 2020. Disposal of Personal Protective Equipment during the COVID-19 Pandemic Is a Challenge for Waste Collection Companies and Society: A Case Study in Poland. Resources 9, 116. (https://doi.org/10.3390/resources9100116, accessed 26 November 2020)
43. COVID-19 disease commodity package v5. Geneva: World Health Organization; 21 July 2020 (https://www.who.int/emergencies/what-we-do/prevention-readiness/disease-commodity-packages/dcp-ncov.pdf?ua=1, accessed 26 November 2020)
44. Ha, J.F., 2020. The COVID-19 pandemic, personal protective equipment, and respirator: a narrative review. International Journal of Clinical Practice, p.e13578. (https://doi.org/10.1111/ijcp.13578, accessed 24 November 2020)

45. Toomey, S., Conway, Y., Burton, C., Smith, S., Smalle, M., Chan, X.H., et al., 3 June 2020. Extended use or re-use of single-use surgical masks and filtering facepiece respirators: A rapid evidence review. The Centre for Evidence-Based Medicine, Evidence Service to support the COVID-19 response. (https://www.cebm.net/covid-19/extended-use-or-re-use-of-single-use-surgical-masks-and-filtering-facepiece-respirators-a-rapid-evidence-review/, accessed 23 November 2020)
46. Barycka, K., Torlinski, T., Filipiak, K.J., Jaguszewski, M., Nadolny, K., Szarpak, L., 2020. Risk of self-contamination among healthcare workers in the COVID-19 pandemic. Am J Emerg Med. (https://doi.org/10.1016/j.ajem.2020.09.055, accessed 14 December 2020)
47. Jain, U., 2020. Risk of COVID-19 due to Shortage of Personal Protective Equipment. Cureus 12, e8837. (https://doi.org/10.7759/cureus.8837, accessed 15 December 2020)
48. Tiki Breathing Face Protection. Sweden: Tiki Safety; 2019. [Online]. (https://www.tikisafety.com/products/downloads#manuals, accessed 29 November 2020)
49. Serban, A. 2020. Alternate Respirator Options During the N95 Mask Shortage. [Online]. (https://safety.honeywell.com/en-us/news-and-events/blog/alternate-respirator-options-during-the-n95-mask-shortage, accessed 29 November 2020)
50. Panteleon, B. 2020. Disinfecting Exam Gloves: MedTech Europe Releases Informative Document on PPE in the Context of COVID-19. [Online]. (https://assets.medline.eu/Documents/Glove_Disinfection_Guidance_General_April_2020.pdf, accessed 29 November 2020)
51. Decontamination of 3M Filtering Facepiece Respirators, such as N95 Respirators, in the United States – Considerations (Revision 11). Minnesota: 3M Company; September 2020. [Online] (https://multimedia.3m.com/mws/media/1824869O/decontamination-methods-for-3m-filtering-facepiece-respirators-technical-bulletin.pdf, accessed 22 November 2020)
52. Options for the decontamination and reuse of respirators in the context of the COVID-19 pandemic. Stockholm: European Centre for Disease Prevention and Control; 8 June 2020 (https://www.ecdc.europa.eu/sites/default/files/documents/Options-for-shortage-of-surgical-masks-and-respirators.pdf, accessed 22 November 2020)
53. UHN rolls out N95 Reprocessing Program. Toronto: University Health Network; 1 June 2020. (https://www.uhn.ca/corporate/News/Pages/UHN_rolls_out_N95_Reprocessing_Program.aspx, accessed 22 November 2020)
54. Ippolito, M., Iozzo, P., Gregoretti, C., Grasselli, G., & Cortegiani, A. (2020). Facepiece filtering respirators with exhalation valve should not be used in the community to limit SARS-CoV-2 diffusion. Infection Control & Hospital Epidemiology, 1-4. (https://doi.org/10.1017/ice.2020.244, accessed 20 December 2020)
55. Novak, J.I., Loy, J., 2020. A quantitative analysis of 3D printed face shields and masks during COVID-19. Emerald Open Res 2, 42. (https://doi.org/10.35241/emeraldopenres.13815.1, accessed 29 November 2020)
56. Flanagan, S.T., Ballard, D.H., 2020. 3D Printed Face Shields: A Community Response to the COVID-19 Global Pandemic. Academic Radiology 27, 905–906. (https://doi.org/10.1016/j.acra.2020.04.020, accessed 29 November 2020)
57. Mostaghimi, A., Antonini, M.-J., Plana, D., Anderson, P.D., Beller, B., Boyer, E.W., et al., 2020. Regulatory and Safety Considerations in Deploying a Locally Fabricated, Reusable Face Shield in a Hospital Responding to the COVID-19 Pandemic. Med S2666634020300088. (https://doi.org/10.1016/j.medj.2020.06.003, accessed 29 November 2020)
58. Considerations for optimizing the supply of powered air purifying respirators. Atlanta: Centers for Disease Control and Prevention; 3 November 2020 (https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/powered-air-purifying-respirators-strategy.html, accessed 26 November 2020)
59. Elastomeric respirators: Strategies during conventional and surge demand situations. Atlanta: Centers for Disease Control and Prevention; 13 October 2020 (https://www.cdc.gov/coronavirus/2019-ncov/hcp/elastomeric-respirators-strategy/index.html, accessed 26 November 2020)
60. Licina, A., Silvers, A., Stuart, R.L., 2020. Use of powered air-purifying respirator (PAPR) by healthcare workers for preventing highly infectious viral diseases—a systematic review of evidence. Syst Rev 9, 173. (https://doi.org/10.1186/s13643-020-01431-5, accessed 29 November 2020)
61. Chiang, J., Hanna, A., Lebowitz, D., Ganti, L., 2020. Elastomeric respirators are safer and more sustainable alternatives to disposable N95 masks during the coronavirus outbreak. Int J Emerg Med 13, 39. (https://doi.org/10.1186/s12245-020-00296-8, accessed 29 November 2020)
62. Bharatendu, C., Ong, J.J.Y., Goh, Y., Tan, B.Y.Q., Chan, A.C.Y., Tang, J.Z.Y., et al., 2020. Powered Air Purifying Respirator (PAPR) restores the N95 face mask induced cerebral hemodynamic alterations among Healthcare Workers during COVID-19 Outbreak. Journal of the Neurological Sciences 417, 117078. (https://doi.org/10.1016/j.jns.2020.117078, accessed 29 November 2020)
63. Chakladar, A., Jones, C.G., Siu, J., Hassan-Ibrahim, M.O. and Khan, M., 2020. Microbial contamination of powered air purifying respirators (PAPR) used during the COVID-19 pandemic: an in situ microbiological study. *medRxiv*.(https://doi.org/10.1101/2020.07.30.20165423, accessed 29 November 2020)
64. Hines, S.E., Brown, C.H., Oliver, M., Gucer, P., Frisch, M., Hogan, R., er al., 2020. Cleaning and Disinfection Perceptions and Use Practices Among Elastomeric Respirator Users in Health care. Workplace Health Saf 68, 572–582. (https://doi.org/10.1177/2165079920938618, accessed 29 November 2020)

65. Powered air purifying respirators (PAPRS) as an alternative to N95 respirators in a health care setting: supplemental information. Toronto: Health Quality Ontario; 7 April 2020 (https://www.hqontario.ca/Portals/0/documents/evidence/reports/powered-air-purifying-respirators-as-an-alternative-to-n95-respirators-in-a-health-care-setting.pdf, accessed 29 November 2020)
66. Park, S.H., 2020. Personal Protective Equipment for Healthcare Workers during the COVID-19 Pandemic. Infect Chemother 52, 165–182. (https://doi.org/10.3947/ic.2020.52.2.165, accessed 20 December 2020)
67. Use of gloves in healthcare and non-healthcare settings in the context of the COVID 19 pandemic: Technical report. Stockholm: European Centre for Disease Prevention and Control; 2 July 2020 (https://www.ecdc.europa.eu/en/publications-data/gloves-healthcare-and-non-healthcare-settings-covid-19, accessed 22 November 2020)
68. Kratzel, A., Todt, D., V'kovski, P., Steiner, S., Gultom, M., Thao, T.T.N., et al., 2020. Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 by WHO-Recommended Hand Rub Formulations and Alcohols. Emerg. Infect. Dis. 26, 1592–1595. (https://doi.org/10.3201/eid2607.200915, accessed 28 November 2020)
69. U.S. Food and Drug Administration (FDA), 2020. *Medical Glove Conservation Strategies: Letter To Health Care Providers*. US FDA. (https://www.fda.gov/medical-devices/letters-health-care-providers/medical-glove-conservation-strategies-letter-health-care-providers, accessed 29 November 2020)
70. Anedda, J., Ferreli, C., Rongioletti, F., Atzori, L., 2020. Changing gears: Medical gloves in the era of coronavirus disease 2019 pandemic. Clinics in Dermatology S0738081X20301589. (https://doi.org/10.1016/j.clindermatol.2020.08.003, accessed 29 November 2020)
71. Recommended Guidance for Extended Use and Limited Reuse of N95 Filtering Facepiece Respirators in Healthcare Settings; 27 March 2020 (https://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html#risksextended, accessed 26 November 2020)
72. Toomey, S., Conway, Y., Burton, C., Smith, S., Smalle, M., Chan, X.H., et al., 3 June 2020. Extended use or re-use of single-use surgical masks and filtering facepiece respirators: A rapid evidence review. The Centre for Evidence-Based Medicine, Evidence Service to support the COVID-19 response. (https://www.cebm.net/covid-19/extended-use-or-re-use-of-single-use-surgical-masks-and-filtering-facepiece-respirators-a-rapid-evidence-review/, accessed 23 November 2020)
73. Kramer, A., Schwebke, I., Kampf, G., 2006. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infect Dis 6, 130. (https://doi.org/10.1186/1471-2334-6-130, accessed 20 December 2020)
74. Jerry, J., O'Regan, E., O'Sullivan, L., Lynch, M., Brady, D., 2020. Do established infection prevention and control measures prevent spread of SARS-CoV-2 to the hospital environment beyond the patient room? Journal of Hospital Infection 105, 589–592. (https://doi.org/10.1016/j.jhin.2020.06.026, accessed 20 December 2020)
75. Casanova, L., Rutala, W.A., Weber, D.J. and Sobsey, M.D., 2010. Coronavirus survival on healthcare personal protective equipment. Infection Control & Hospital Epidemiology, 31(5), pp.560-561. (https://doi.org/10.1086/652452, accessed 20 December 2020)
76. Otter, J.A., Donskey, C., Yezli, S., Douthwaite, S., Goldenberg, S.D., Weber, D.J., 2016. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. Journal of Hospital Infection 92, 235–250. (https://doi.org/10.1016/j.jhin.2015.08.027, accessed 30 November 2020)
77. Chughtai, A.A., Stelzer-Braid, S., Rawlinson, W., Pontivivo, G., Wang, Q., Pan, Y., et al., 2019. Contamination by respiratory viruses on outer surface of medical masks used by hospital healthcare workers. BMC infectious diseases, 19(1), pp.1-8. (accessed 20 December 2020)
78. King, M.-F., Wilson, A.M., Weir, M.H., Lopez-Garcia, M., Proctor, J., et al., 2020. Modelling the risk of SARS-CoV-2 infection through PPE doffing in a hospital environment (preprint). Public and Global Health. (https://doi.org/10.1101/2020.09.20.20197368, accessed 20 December 2020)
79. Muñoz-Leyva, F., Niazi, A.U., 2020. Common breaches in biosafety during donning and doffing of protective personal equipment used in the care of COVID-19 patients. Can J Anesth/J Can Anesth 67, 900–901. (https://doi.org/10.1007/s12630-020-01648-x, accessed 20 December 2020)
80. Matson, M.J., Yinda, C.K., Seifert, S.N., Bushmaker, T., Fischer, R.J., van Doremalen, N., et al., 2020. Effect of Environmental Conditions on SARS-CoV-2 Stability in Human Nasal Mucus and Sputum. Emerg. Infect. Dis. 26, 2276–2278. (https://doi.org/10.3201/eid2609.202267, accessed 30 November 2020)
81. Aboubakr, H.A., Sharafeldin, T.A., Goyal, S.M., 2020. Stability of SARS-CoV-2 and other coronaviruses in the environment and on common touch surfaces and the influence of climatic conditions: A review. Transbound Emerg Dis tbed.13707. (https://doi.org/10.1111/tbed.13707, accessed 30 November 2020)
82. Use of gloves in healthcare and non-healthcare settings in the context of the COVID 19 pandemic: Technical report. Stockholm: European Centre for Disease Prevention and Control; 2 July 2020 (https://www.ecdc.europa.eu/en/publications-data/gloves-healthcare-and-non-healthcare-settings-covid-19, accessed 22 November 2020)
83. Recommendations to Member States to improve hand hygiene practices through universal access to public hand hygiene stations to help prevent transmission of the COVID-19 virus: interim guidance. Geneva: World Health Organization; 1 April 2020 (https://apps.who.int/iris/handle/10665/331854, accessed 29 November 2020)

84. Kwok, Y.L.A., Gralton, J., McLaws, M.-L., 2015. Face touching: a frequent habit that has implications for hand hygiene. Am J Infect Control 43, 112–114. (https://doi.org/10.1016/j.ajic.2014.10.015, accessed 30 November 2020)
85. Hirose, R., Ikegaya, H., Naito, Y., Watanabe, N., Yoshida, T., Bandou, R., Daidoji, T., Itoh, Y., Nakaya, T., 2020. Survival of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and Influenza Virus on Human Skin: Importance of Hand Hygiene in Coronavirus Disease 2019 (COVID-19). Clinical Infectious Diseases ciaa1517. (https://doi.org/10.1093/cid/ciaa1517, accessed 27 November 2020)
86. Kratzel, A., Todt, D., V'kovski, P., Steiner, S., Gultom, M., Thao, T.T.N., et al., 2020. Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 by WHO-Recommended Hand Rub Formulations and Alcohols. Emerg. Infect. Dis. 26, 1592–1595. (https://doi.org/10.3201/eid2607.200915, accessed 28 November 2020)
87. Kpadeh-Rogers, Z., Robinson, G.L., Alserehi, H., Morgan, D.J., Harris, A.D., Herrera, N.B., et al., 2019. Effect of Glove Decontamination on Bacterial Contamination of Healthcare Personnel Hands. Clinical Infectious Diseases 69, S224–S227. (https://doi.org/10.1093/cid/ciz615, accessed 20 November 2020)
88. Gao, P., Horvatin, M., Niezgoda, G., Weible, R., Shaffer, R., 2016. Effect of multiple alcohol-based hand rub applications on the tensile properties of thirteen brands of medical exam nitrile and latex gloves. Journal of Occupational and Environmental Hygiene 13, 905–914. (https://doi.org/10.1080/15459624.2016.1191640, accessed 1 December 2020)
89. Garrido-Molina, J.M., Márquez-Hernández, V.V., Alcayde-García, A., Ferreras-Morales, C.A., García-Viola, A., Aguilera-Manrique, G., Gutiérrez-Puertas, L., 2021. Disinfection of gloved hands during the COVID-19 pandemic. Journal of Hospital Infection 107, 5–11. (https://doi.org/10.1016/j.jhin.2020.09.015, accessed 1 December 2020)
90. Scheithauer, S., Häfner, H., Seef, R., Seef, S., Hilgers, R.D., Lemmen, S., 2016. Disinfection of gloves: feasible but pay attention to the disinfectant/glove combination. Journal of Hospital Infection 94, 268–272. (https://doi.org/10.1016/j.jhin.2016.08.007, accessed 1 December 2020)
91. Kimberly-Clark Professional, 2009. Kimberly-Clark Kimtech nitrile gloves chemical resistance guide. (https://www.kimtech.com/nitrilechemicalresistanceguide/K2365_09_01_SN%20Chem%20Guide_v10.pdf, accessed 1 December 2020)
92. MedTech Europe, 2020. Disinfecting Exam Gloves: MedTech Europe Releases Informative Document on PPE in the Context of COVID-19 (https://www.medline.eu/press-releases/disinfecting-exam-gloves-medtech-europe-releases-informative-document-on-ppe-coronavirus, accessed 1 December 2020)
93. Strategies for optimizing the supply of disposable medical gloves. Atlanta: Centers for Disease Control and Prevention; 27 October 2020 (https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/gloves.html, accessed 26 November 2020)
94. Strategies for addressing expected glove shortages. Plymouth Meeting: ECRI; 24 April 2020 (https://www.ecri.org/EmailResources/Health%20Devices/ECRI_COVID-19_Alert_H0586.pdf, accessed 1 December 2020)
95. Kampf, G., Lemmen, S., 2017. Disinfection of gloved hands for multiple activities with indicated glove use on the same patient. Journal of Hospital Infection 97, 3–10. (https://doi.org/10.1016/j.jhin.2017.06.021, accessed 29 November 2020)
96. Rebmann, T., Carrico, R., Wang, J., 2013. Physiologic and other effects and compliance with long-term respirator use among medical intensive care unit nurses. American Journal of Infection Control 41, 1218–1223. (https://doi.org/10.1016/j.ajic.2013.02.017, accessed 1 December 2020)
97. Sinkule, E.J., Powell, J.B. and Goss, F.L., 2013. Evaluation of N95 respirator use with a surgical mask cover: effects on breathing resistance and inhaled carbon dioxide. Annals of occupational hygiene, 57(3), pp.384-398. (https://doi.org/10.1093/annhyg/mes068, accessed 20 December 2020)
98. Roberge, R.J., Coca, A., Williams, W.J., Palmiero, A.J. and Powell, J.B., 2010. Surgical mask placement over N95 filtering facepiece respirators: physiological effects on healthcare workers. Respirology, 15(3), pp.516-521. (https://doi.org/10.1111/j.1440-1843.2010.01713.x, accessed 20 December 2020)
99. Powell, J., Pollard, J., Rottach, D., Sinkule, E., 2020. Considerations for Covering N95s to Extend Use. [Blog] *NIOSH Science Blog*, (https://blogs.cdc.gov/niosh-science-blog/2020/06/16/covering-n95s, accessed 1 December 2020)
100. MacIntyre, C. R., Seale, H., Dung, T. C., Hien, N. T., Nga, P. T., Chughtai, A. A., et al,. (2015). A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. BMJ Open, 5(4), e006577. (https://doi.org/10.1136/bmjopen-2014-006577 , accessed 1 December 2020)
101. Lustig SR, Biswakarma JJH, Rana D, Tilford SH, Hu W, Su M, et al. Effectiveness of Common Fabrics to Block Aqueous Aerosols of Virus-like Nanoparticles. ACS Nano. 2020;14(6):7651-8. Epub 2020/05/23. (https://doi.org/10.1021/acsnano.0c03972, accessed 3 December 2020)
102. Reuse of face masks and gowns during the COVID-19 pandemic. Melbourne: Australian Government Department of Health; 21 May 2020 (https://www.tga.gov.au/node/904289, accessed 2 December 2020)
103. Decontamination and reprocessing of medical devices for health-care facilities. Geneva: World Health Organization; 2016. (https://apps.who.int/iris/handle/10665/250232, accessed 29 November 2020)
104. Guidelines for Environmental Infection Control in Health-Care Facilities. Background G. Laundry and Bedding. Atlanta: Centers for Disease Control and Prevention; 2003 (https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/laundry.html, accessed 2 December 2020)

105. Interim Guidance for Processing Single-Use Gowns in Response to Product Shortages during COVID-19. Richmond: Association for Linen Management; 2020 (https://cdn.ymaws.com/www.almnet.org/resource/resmgr/document_library/ALMCOVID19ReprocessGownGuida.pdf, accessed 2 December 2020)
106. Mahmood, S.U., Crimbly, F., Khan, S., Choudry, E., Mehwish, S., 2020. Strategies for Rational Use of Personal Protective Equipment (PPE) Among Healthcare Providers During the COVID-19 Crisis. Cureus. (https://doi.org/10.7759/cureus.8248, accessed 2 December 2020)
107. Poller, B., Lynch, C., Ramsden, R., Jessop, K., Evans, C., Tweed, K., et al., 2020. Laundering single-use gowns in the event of critical shortage: experience of a UK acute trust. Journal of Hospital Infection 106, 629–630. (https://doi.org/10.1016/j.jhin.2020.08.017, accessed 2 December 2020)
108. Cleaning and disinfection of environmental surfaces in the context of COVID-19. Geneva: World Health Organization; 16 May 2020. (https://www.who.int/publications/i/item/cleaning-and-disinfection-of-environmental-surfaces-inthe-context-of-covid-19, accessed 2 December 2020)
109. NPPTL Respirator Assessments to Support the COVID-19 Response. Washington: The National Institute for Occupational Safety and Health; 9 November 2020. (https://www.cdc.gov/niosh/npptl/respirators/testing/DeconResults.html, accessed 2 December 2020)
110. Options for the decontamination and reuse of respirators in the context of the COVID-19 pandemic. Stockholm: European Centre for Disease Prevention and Control; 8 June 2020 (https://www.ecdc.europa.eu/sites/default/files/documents/Options-for-shortage-of-surgical-masks-and-respirators.pdf, accessed 22 November 2020)
111. Technical and Regulatory Aspects of the Extended Use, Reuse, and Reprocessing of Respirators during Shortages. Washington; World Health Organization Regional Office for the Americas; 10 June 2020 (https://iris.paho.org/handle/10665.2/52431, accessed 29 November 2020)
112. Food and Drug Administration. Enforcement Policy for Face Masks and Respirators During the Coronavirus Disease (COVID-19) Public Health Emergency (Revised) Guidance for Industry and Food and Drug Administration Staff Preface Public Comment [Internet]. 2020 (https://www.fda.gov/regulatoryinformation/search-fda-guidance-documents/enforcement-policy-face-masks-and-respirators-during-coronavirusdisease-covid-19-public-health, accessed 4 May, 2020)
113. Important Regulatory Considerations for the Reprocessing of Single Use N95 Respirators during the COVID-19 Response: Notice - Canada.ca [Internet]. (https://www.canada.ca/en/healthcanada/services/drugs-health-products/medical-devices/activities/announcements/covid19-notice-reprocessing-n95-respirators.html, accessed 10 May, 2020)
114. Implementing Filtering Facepiece Respirator (FFR) Reuse, Including Reuse after Decontamination, When There Are Known Shortages of N95 Respirators. Atlanta: Centers for Disease Control and Prevention; 19 October 2020 (https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/decontamination-reuse-respirators.html, accessed 2 December 2020)
115. Cadnum, J.L., Li, D., Redmond, S.N., John, A.R., Pearlmutter, B., Donskey, C., 2020. Effectiveness of Ultraviolet-C Light and a High-Level Disinfection Cabinet for Decontamination of N95 Respirators. Pathogens and Immunity 5, 52–67. (https://doi.org/10.20411/pai.v5i1.372, accessed 2 December 2020)
116. Hankenson, F.C., Mauntel, M., Willard, J., Pittsley, L., Degg, W., Burnell, N., Vierling, A., Griffis, S., 2020. Vaporized Hydrogen Peroxide Decontamination of N95 Respirators in a Dedicated Animal Research Facility for Reuse During a Novel Coronavirus Pandemic. Applied Biosafety 25, 142–149. (https://doi.org/10.1177/1535676020936381, accessed 2 December 2020)
117. Ludwig-Begall, L.F., Wielick, C., Dams, L., Nauwynck, H., Demeuldre, P.-F., Napp, A., et al., 2020. The use of germicidal ultraviolet light, vaporized hydrogen peroxide and dry heat to decontaminate face masks and filtering respirators contaminated with a SARS-CoV-2 surrogate virus. Journal of Hospital Infection 106, 577–584. (https://doi.org/10.1016/j.jhin.2020.08.025, accessed 2 December 2020)
118. Saini, V., Sikri, K., Batra, S.D., Kalra, P., Gautam, K., 2020. Development of a highly effective low-cost vaporized hydrogen peroxide-based method for disinfection of personal protective equipment for their selective reuse during pandemics. Gut Pathog 12, 29. (https://doi.org/10.1186/s13099-020-00367-4, accessed 2 December 2020)
119. Ibáñez-Cervantes, G., Bravata-Alcántara, J.C., Nájera-Cortés, A.S., Meneses-Cruz, S., Delgado-Balbuena, L., Cruz-Cruz, C., et al., 2020. Disinfection of N95 masks artificially contaminated with SARS-CoV-2 and ESKAPE bacteria using hydrogen peroxide plasma: Impact on the reutilization of disposable devices. American Journal of Infection Control 48, 1037–1041. (https://doi.org/10.1016/j.ajic.2020.06.216, accessed 2 December 2020)
120. Cheng, V.C.C., Wong, S.-C., Kwan, G.S.W., Hui, W.-T., Yuen, K.-Y., 2020. Disinfection of N95 respirators by ionized hydrogen peroxide during pandemic coronavirus disease 2019 (COVID-19) due to SARS-CoV-2. Journal of Hospital Infection 105, 358–359. (https://doi.org/10.1016/j.jhin.2020.04.003, accessed 2 December 2020)
121. Schwartz, A., Stiegel, M., Greeson, N., Vogel, A., Thomann, W., Brown, M., et al., 2020. Decontamination and Reuse of N95 Respirators with Hydrogen Peroxide Vapor to Address Worldwide Personal Protective Equipment Shortages During the SARS-CoV-2 (COVID-19) Pandemic. Appl Biosaf. 25, 67–70. (https://doi.org/10.1177/1535676020919932, accessed 2 December 2020)
122. Simmons, S.E., Carrion, R., Alfson, K.J., Staples, H.M., Jinadatha, C., Jarvis, W.R., et al., 2020. Deactivation of SARS-CoV-2 with pulsed-xenon ultraviolet light: Implications for environmental COVID-19 control. Infection Control & Hospital Epidemiology 1–4. (https://doi.org/10.1017/ice.2020.399, accessed 2 December 2020)

123. Fischer, R.J., Morris, D.H., van Doremalen, N., Sarchette, S., Matson, M.J., Bushmaker, T., et al., 2020. Effectiveness of N95 Respirator Decontamination and Reuse against SARS-CoV-2 Virus. Emerg. Infect. Dis. 26, 2253–2255. (https://doi.org/10.3201/eid2609.201524, accessed 2 December 2020)
124. Smith, J.S., Hanseler, H., Welle, J., Rattray, R., Campbell, M., Brotherton, T., et al., 2020. Effect of various decontamination procedures on disposable N95 mask integrity and SARS-CoV-2 infectivity. Journal of Clinical and Translational Science 1–5. (https://doi.org/10.1017/cts.2020.494, accessed 2 December 2020)
125. Daeschler, S.C., Manson, N., Joachim, K., Chin, A.W.H., Chan, K., Chen, P.Z., et al., 2020. Effect of moist heat reprocessing of N95 respirators on SARS-CoV-2 inactivation and respirator function. CMAJ 192, E1189–E1197. (https://doi.org/10.1503/cmaj.201203, accessed 2 December 2020)
126. de Man, P., van Straten, B., van den Dobbelsteen, J., van der Eijk, A., Horeman, T., Koeleman, H., 2020. Sterilization of disposable face masks by means of standardized dry and steam sterilization processes; an alternative in the fight against mask shortages due to COVID-19. Journal of Hospital Infection 105, 356–357. (https://doi.org/10.1016/j.jhin.2020.04.00, accessed 2 December 2020)
127. Ma, Q., Shan, H., Zhang, C., Zhang, H., Li, G., Yang, R., Chen, J., 2020. Decontamination of face masks with steam for mask reuse in fighting the pandemic COVID-19: Experimental supports. J Med Virol 92, 1971–1974. (https://doi.org/10.1002/jmv.25921, accessed 2 December 2020)
128. Campos, R.K., Jin, J., Rafael, G.H., Zhao, M., Liao, L., Simmons, G., et al., 2020. Decontamination of SARS-CoV-2 and Other RNA Viruses from N95 Level Meltblown Polypropylene Fabric Using Heat under Different Humidities. ACS Nano 14, 14017–14025. (https://doi.org/10.1021/acsnano.0c06565, accessed 2 December 2020)
129. Pascoe, M.J., Robertson, A., Crayford, A., Durand, E., Steer, J., Castelli, A., et al., 2020. Dry heat and microwave-generated steam protocols for the rapid decontamination of respiratory personal protective equipment in response to COVID-19-related shortages. Journal of Hospital Infection 106, 10–19. (https://doi.org/10.1016/j.jhin.2020.07.008, accessed 2 December 2020)
130. Jatta, M., Kiefer, C., Patolia, H., Pan, J., Harb, C., Marr, L.C., Baffoe-Bonnie, A., 2020. N95 reprocessing by low temperature sterilization with 59% vaporized hydrogen peroxide during the 2020 COVID-19 pandemic. American Journal of Infection Control S0196655320305769. (https://doi.org/10.1016/j.ajic.2020.06.194, accessed 2 December 2020)
131. Widmer, A.F., Richner, G., 2020. Proposal for a EN 149 acceptable reprocessing method for FFP2 respirators in times of severe shortage. Antimicrobial Resistance & Infection Control 9, 88. (https://doi.org/10.1186/s13756-020-00744-3, accessed 2 December 2020
132. Grossman, J., Pierce, A., Mody, J., Gagne, J., Sykora, C., Sayood, et al., 2020. Institution of a Novel Process for N95 Respirator Disinfection with Vaporized Hydrogen Peroxide in the Setting of the COVID-19 Pandemic at a Large Academic Medical Center. Journal of the American College of Surgeons 231, 275–280. (https://doi.org/10.1016/j.jamcollsurg.2020.04.029, accessed 2 December 2020)
133. Anderegg, L., Meisenhelder, C., Ngooi, C.O., Liao, L., Xiao, W., Chu, S., et al., 2020. A scalable method of applying heat and humidity for decontamination of N95 respirators during the COVID-19 crisis. PLoS ONE 15, e0234851. (https://doi.org/10.1371/journal.pone.0234851, accessed 2 December 2020)
134. Bopp, N.E., Bouyer, D.H., Gibbs, C.M., Nichols, J.E., Ntiforo, C.A., Grimaldo, M.A., 2020. Multicycle Autoclave Decontamination of N95 Filtering Facepiece Respirators. Applied Biosafety 25, 150–156. (https://doi.org/10.1177/1535676020924171, accessed 2 December 2020)
135. Czubryt, M.P., Stecy, T., Popke, E., Aitken, R., Jabusch, K., Pound, R., et al., 2020. N95 mask reuse in a major urban hospital: COVID-19 response process and procedure. Journal of Hospital Infection 106, 277–282. (https://doi.org/10.1016/j.jhin.2020.07.035, accessed 2 December 2020)
136. Ou, Q., Pei, C., Chan Kim, S., Abell, E., Pui, D.Y.H., 2020. Evaluation of decontamination methods for commercial and alternative respirator and mask materials – view from filtration aspect. Journal of Aerosol Science 150, 105609. (https://doi.org/10.1016/j.jaerosci.2020.105609, accessed 2 December 2020)
137. Lieu, A., Mah, J., Zanichelli, V., Exantus, R.C., Longtin, Y., 2020. Impact of extended use and decontamination with vaporized hydrogen peroxide on N95 respirator fit. American Journal of Infection Control 48, 1457–1461. (https://doi.org/10.1016/j.ajic.2020.08.010, accessed 2 December 2020)
138. Maranhao, B., Scott, A.W., Scott, A.R., Maeng, J., Song, Z., Baddigam, R., et al., 2020. Probability of fit failure with reuse of N95 mask respirators. British Journal of Anaesthesia 125, e322–e324. (https://doi.org/10.1016/j.bja.2020.06.023, accessed 2 December 2020)
139. Harskamp, R.E., van Straten, B., Bouman, J., van Maltha-van Santvoort, B., van den Dobbelsteen, J.J., van der Sijp, J.R., Horeman, T., 2020. Reprocessing filtering facepiece respirators in primary care using medical autoclave: prospective, bench-to-bedside, single-centre study. BMJ Open 10, e039454. (https://doi.org/10.1136/bmjopen-2020-039454, accessed 2 December 2020)
140. Celina, M.C., Martinez, E., Omana, M.A., Sanchez, A., Wiemann, D., Tezak, M., Dargaville, T.R., 2020. Extended use of face masks during the COVID-19 pandemic - Thermal conditioning and spray-on surface disinfection. Polymer Degradation and Stability 179, 109251. (https://doi.org/10.1016/j.polymdegradstab.2020.109251, accessed 2 December 2020)

141. Grinshpun, S.A., Yermakov, M., Khodoun, M., 2020. Autoclave sterilization and ethanol treatment of re-used surgical masks and N95 respirators during COVID-19: impact on their performance and integrity. Journal of Hospital Infection 105, 608–614. (https://doi.org/10.1016/j.jhin.2020.06.030, accessed 2 December 2020)
142. Lendvay, T.S., Chen, J., Harcourt, B.H., Scholte, F.E.M., Kilinc-Balci, F.S., Lin, Y.L.,et al. Addressing Personal Protective Equipment (PPE) Decontamination: Methylene Blue and Light Inactivates SARS-CoV-2 on N95 Respirators and Masks with Maintenance of Integrity and Fit (preprint). Public and Global Health. (https://doi.org/10.1101/2020.12.11.20236919, accessed 12 December 2020)
143. Viscusi, D., Bergman, M., Elmer, B., & Shaffer, R. 2009. Evaluation of Five Decontamination Methods for Filtering Facepiece Respirators. The Annals of Occupational Hygiene. (https://doi.org/10.1093/annhyg/mep070, accessed 2 December 2020)
144. Heimbuch, B. K., Wallace, W. H., Kinney, K., Lumley, A. E., Wu, C.-Y., Woo, M.-H., & Wander, J. D. 2011. A pandemic influenza preparedness study: Use of energetic methods to decontaminate filtering facepiece respirators contaminated with H1N1 aerosols and droplets. American Journal of Infection Control, 39(1), e1–e9 (https://doi.org/10.1016/j.ajic.2010.07.004, accessed 2 December 2020)
145. Lore, M., Heimbuch, B. K., Brown, T. L., Wander, J. D., & Hinrichs, S. 2011. Effectiveness of Three Decontamination Treatments against Influenza Virus Applied to Filtering Facepiece Respirators. The Annals of Occupational Hygiene (https://doi.org/10.1093/annhyg/mer054, accessed 2 December 2020)

Acknowledgements

This document was developed in consultation with the following members of:

1) the WHO Health Emergencies Programme (WHE) Ad-hoc COVID-19 IPC Guidance Development Group (in alphabetical order):

Jameela Alsalman, Ministry of Health, Bahrain; Anucha Apisarnthanarak, Thammsat University Hospital, Thailand; Baba Aye, Public Services International, France; Gregory Built, UNICEF, United States of America (USA); Roger Chou, Oregon Health Science University, USA; May Chu, Colorado School of Public Health, USA; John Conly, Alberta Health Services, Canada; Barry Cookson, University College London, United Kingdom (U.K); Nizam Damani, Southern Health & Social Care Trust, United Kingdom; Dale Fisher, GOARN & National University of Singapore; Joost Hopman, Radboud University Medical Center, The Netherlands; Mushtuq Husain, Institute of Epidemiology, Disease Control & Research, Bangladesh; Kushlani Jayatilleke, Sri Jayewardenapura General Hospital, Sri Lanka; Seto Wing Hong, University of Hong Kong, Hong Kong SAR, China; Souha Kanj, American University of Beirut Medical Center, Lebanon; Daniele Lantagne, Tufts University, USA; Fernanda Lessa, Centers for Disease Control and Prevention, USA; Anna Levin, University of São Paulo, Brazil; Yuguo Li, University of Hong Kong, Hong Kong SAR, China; Ling Moi Lin, Sing Health, Singapore; Caline Mattar, World Health Professions Alliance, USA; Mary-Louise McLaws, University of New South Wales, Australia; Geeta Mehta, Journal of Patient Safety and Infection Control, India; Shaheen Mehtar, Infection Control Africa Network, South Africa; Ziad Memish, Ministry of Health, Saudi Arabia; Babacar Ndoye, Infection Control Africa Network, Senegal; Fernando Otaiza, Ministry of Health, Chile; Diamantis Plachouras, European Centre for Disease Prevention and Control, Sweden; Maria Clara Padoveze, School of Nursing, University of São Paulo, Brazil; Mathias Pletz, Jena University, Germany; Marina Salvadori, Public Health Agency of Canada, Canada; Ingrid Schoeman, TB Proof; Mitchell Schwaber, Ministry of Health, Israel; Nandini Shetty, Public Health England, United Kingdom; Mark Sobsey, University of North Carolina, USA; Paul Ananth Tambyah, National University Hospital, Singapore; Andreas Voss, Canisus-Wilhelmina Ziekenhuis, The Netherlands; Walter Zingg, University of Geneva Hospitals, Switzerland.

2) The WHO Technical Advisory Group of Experts on Personal Protective Equipment (TAG PPE):

Faisal Al Shehri, Saudi Arabia Food and Drug Authority, Saudi Arabia; Ayse Ayzlt Kilinc, Istanbul University-Cerrahpasa, Turkey; Razan Asally, Saudi Arabia Food and Drug Authority, Saudi Arabia; Kelly Catlin, Clinton Health Access Initiative; Patricia Ching, WHO Collaborating Center, The University of Hong Kong, China; Mark Croes, Centexbel; Spring Gombe, United Nations; Emilio Hornsey, UK Public Health Rapid Support Team, U.K.; Mohidus Samad Khan, Bangladesh University of Engineering and Technology; Bangladesh, Selcen Kilinc-Balci, United States Centers for Disease Control and Prevention (CDC), USA; Melissa Leavitt, Clinton Health Access Initiative; John McGhie, International Medical Corps; Claudio Meirovich, Meirovich Consulting; Mike Paddock, UNDP; Trish M. Perl, University of Texas Southwestern Medical Center, USA; Judit Rius Sanjuan, UNDP; Ana Maria Rule, Johns Hopkins Bloomberg School of Public Health, USA; Jitendar Sharma, Andra Pradesh, MedTech Zone, India; Alison Syrett, SIGMA; Reiner Voelksen, VOELKSEN Regulatory Affairs; Nasri Yussuf, IPC Kenya.

3) UNICEF observers: Nagwa Hasanin, Sarah Karmin, Raoul Kamadjeu, Jerome Pfaffmann,

4) External reviewers: Selcen Kilinc-Balci, United States Centers for Disease Control and Prevention (CDC), USA; Francesco Basoli, Universita Campus Bio-Medico di Roma, Italy; Sarah Zanchettin, University Health Network, Canada; Alison Syrett, SIGMA, Luxembourg; Brenda Cáceres-Mejía, Hospital de Emergencias Villa El Salvador, Peru.

The WHO Secretariat:

Benedetta Allegranzi, April Baller, Alessandro Cassini, Ana Paula Coutinho Rehse, Dennis Nathan Ford, Murilo Freitas Dias, Carole Fry, Haley Holmer, Landry Kabego, Alexandre Lemgruber, Ying Ling Lin, Madison Moon, Takeshi Nishijima, Leandro Pecchia, Paul Rogers, Nahoko Shindo, Alice Simniceanu, Maha Talaat Ismail, Joao Paulo Toledo, Anthony Twywan, Maria Van Kerkhove, Adriana Velazquez, Vicky Willet, Masahiro Zakoji, Bassim Zayed.

Annex 1: WHO recommended PPE according to the setting, personnel, and type of activity in the context of COVID-19

For PPE specifications, refer to *Technical specifications of personal protective equipment for COVID-19: interim guidance* (22).

Setting	Target personnel	Activity	Type of PPE or procedure
Inpatient and outpatient facilities			
Screening Clinical triage for prioritization of care according to severity (e.g. Manchester classification) should be performed in separate area for individuals suspected of COVID-19 infection	Health workers	Preliminary screening not involving direct contact This category includes the use of no-touch thermometers, thermal imaging cameras and limited observation and questioning, all while maintaining a physical distance of at least 1 metre.	• Medical mask to be worn continuously in areas of known or suspected community, cluster, or sporadic SARS-CoV-2 transmission • Glass/plexiglass screens to create a barrier between health workers and patients • Maintain physical distance of at least 1 metre • When physical distance is not feasible and/or glass/plexiglass screen is not available use eye protection (goggles or face shield) • Perform hand hygiene
Patient room/ward (in any inpatient or outpatient setting where patients are cared for)	Health workers	Providing direct care to patients with COVID-19, in the absence of aerosol-generating procedures (AGPs)	• Medical mask • Gown • Gloves • Eye protection (goggles or face shield) • Perform hand hygiene
		Providing direct care to patients with COVID-19 when AGPs are performed	• Respirator • Fluid resistant gown or gown + apron • Gloves • Eye protection • Perform hand hygiene
	Cleaners	Entering the room of patients with COVID-19	• Medical mask • Gown (fluid resistant gown or gown + apron if body fluid exposure is anticipated) • Heavy-duty gloves • Eye protection (if risk of splash from biological material or chemicals is anticipated) • Closed work shoes • Perform hand hygiene
Surgical settings (e.g. operating theatre, surgical procedure room, dental surgery)			
Operating theatre	Health workers	Performing surgical procedure	• Fluid resistant medical mask or respirator if AGP is anticipated • Fluid resistant gown • Gloves • Eye protection (goggles or face shield) • Perform hand hygiene
During patient transport	Staff involved in patient transport	During transportation of patient with COVID-19 to and from surgery	• Medical mask • Eye protection (goggles or face shield) • Perform hand hygiene
		During transport of patients without COVID-19 to and from surgery	• Medical mask to be worn in areas of known or suspected community, cluster or sporadic SARS-CoV-2 transmission
		Assisting patient with COVID-19 from bed to transport	• Medical mask

			• Gown • Gloves • Eye protection • Perform hand hygiene
Additional settings in inpatient and outpatient facilities			
Areas of hospital where patients are not allowed (e.g. break rooms, cafeteria, staff corridors)	Health workers	Any activity that does not involve contact with patients	• Maintain physical distance of at least 1 metre • Medical mask to be worn continuously in areas of known or suspected community or cluster SARS-CoV-2 transmission • Perform hand hygiene
Laboratory	Lab technician	Manipulation of respiratory samples Specimen handling for molecular testing requires biosafety level (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	• Maintain physical distance of at least 1 metre • Medical mask • Eye protection (ideally goggles) • If BSL-2, gown or lab coat • If BSL-3, fluid resistant gown • Gloves • Perform hand hygiene
Administrative areas	Staff	Administrative tasks that are not performed in patient occupied areas and do not involve patient contact	• Maintain physical distance of at least 1 metre • Medical or validated non-medical fabric mask to be worn continuously in areas of known or suspected community or cluster SARS-CoV-2 transmission • Perform hand hygiene
COVID-19 dedicated intensive/semi-intensive care units and severe acute respiratory infection treatment centres			
Patient care areas	Staff, including health workers	In settings where AGPs are frequently performed, but with no direct interaction with patient	• Maintain physical distance of at least 1 metre • Respirator to be worn continuously • Perform hand hygiene
Patient room	Health workers	Providing direct care to patients with COVID-19	• Respirator • Fluid resistant gown or gown + apron • Gloves • Eye protection • Perform hand hygiene
	Cleaners	Cleaning the occupied room of patients with COVID-19 in ICU/semi-intensive ICU	• Respirator • Gown (fluid resistant gown or gown + apron if body fluid exposure is anticipated) • Heavy duty gloves • Eye protection (if risk of splash from organic material or chemicals). • Boots or closed work shoes • Perform hand hygiene

Alternative Health Care Settings			
Mild and moderate case isolation centres (e.g. COVID-19 hotels)	Staff	Any	• Maintain physical distance of at least 1 metre • Medical mask to be worn continuously • When physical distance from patient is not feasible, yet no direct contact, use eye protection (goggles or face shield)
	Health workers	Performing direct care or assessment	• Medical mask • Gown • Gloves • Eye protection (face shield or goggles) • Perform hand hygiene
	Cleaners	Cleaning rooms of isolated cases	• Maintain physical distance of at least 1 metre • Medical mask • Gown (fluid resistant gown or gown + apron if body fluid exposure is anticipated) • Heavy duty gloves • Eye protection (if risk of splash from organic material or chemicals) • Closed work shoes • Perform hand hygiene
Special considerations for points of entry at airports, ports and ground crossing as applicable			
Administrative areas	Staff	Any indoor setting where ventilation is known to be poor, cannot be assessed, or the ventilation system is not properly maintained, regardless of whether physical distancing can be maintained	• If there is known or suspected community or clustered SARS-CoV-2 transmission, a validated non-medical fabric mask • Maintain physical distance of at least 1 metre • Perform hand hygiene
Screening area		First screening (temperature measurement) not involving direct contact This category includes the use of no-touch thermometers, thermal imaging cameras and limited observation and questioning, all while maintaining a physical distance of at least 1 metre.	• Medical mask to be worn continuously in areas of known or suspected community or cluster SARS-CoV-2 transmission • Glass/plexiglass screens to create a barrier between staff and travellers • Maintain physical distance of at least 1 metre • When physical distance is not feasible and/or glass/plexiglass screen is not available use eye protection (goggles or face shield) • Perform hand hygiene
		Second screening (interviewing passengers with fever for clinical symptoms suggestive of COVID-19 disease and travel history)	• Medical mask • Eye protection • Perform hand hygiene
	Cleaners	Cleaning the area where passengers with fever are being screened	• Maintain physical distance of at least 1 metre • Medical mask • Gown (fluid resistant gown or gown + apron if body fluid exposure is anticipated) • 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 • Perform hand hygiene
	Staff, including health workers	Assisting or caring for traveller being transported to a health care facility as a suspected case of COVID-19	• Medical mask • Gown • Gloves • Eye protection • Perform hand hygiene
	Cleaners	Cleaning isolation area	• Maintain physical distance of at least 1 metre • Medical mask • Gown (fluid resistant gown or gown + apron if body fluid exposure is anticipated) • 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 workers	Transporting patients with suspected or confirmed COVID-19 to the referral health care facility	• Medical mask • Gown • Gloves • Eye protection • Perform hand hygiene
	Driver/Ambulatory	Involved only in driving the patient with suspected or confirmed COVID-19, and the driver's compartment is separated from the patient	• Maintain physical distance of at least 1 metre • Medical mask to be worn continuously in areas of known or suspected community or cluster transmission of COVID-19 • Perform hand hygiene
		No direct contact with patient with suspected or confirmed COVID-19, but no separation between driver's and patient's compartments	• Medical mask • Perform hand hygiene
		Assisting with loading or unloading patient with suspected or confirmed COVID-19	• Medical mask • Gown • Gloves • Eye protection • Perform hand hygiene
	Cleaners	Cleaning after and between transport of patients with suspected or confirmed COVID-19 to the referral health care facility.	• Medical mask • Fluid resistant gown or gown + apron • Heavy duty gloves • Closed work shoes • Eye protection (if risk of splash from organic material or chemicals) • Boots or closed work shoes • Perform hand hygiene

Special considerations for community-based health care including humanitarian settings			
Community-based care	Community health workers	Any community-based interaction or home visit with community members not suspected or confirmed of having COVID-19 (e.g. for antenatal or postnatal care)	• Maintain physical distance of at least 1 metre • Medical mask in areas of known or suspected community, cluster or sporadic SARS-CoV-2 transmission • Other PPE according to standard precautions and risk assessment. • Perform hand hygiene
		Any activity involving direct physical contact or when entering the home of a person with suspected or confirmed COVID-19	• Medical Mask • Gown • Gloves • Eye protection (goggles or face shield) • Perform hand hygiene
		Any activity involving non-direct physical contact (e.g. interview) with a person with suspected or confirmed COVID-19	• Maintain physical distance of at least 1 metre • Medical Mask • Perform hand hygiene
Special considerations for home care			
Home	Health worker or 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
		Providing direct care or assistance to a patient with COVID-19 at home	• Medical mask • Gown • Gloves • Eye protection (goggles or face shield) • Perform hand hygiene
		When handling stool, urine, or waste from patient with COVID-19 being cared for at home	• Medical mask • Gloves • Fluid resistant gown or gown + apron • Eye protection (goggles or face shield) • Perform hand hygiene
Special considerations for rapid-response teams assisting with public health investigations (e.g. contact tracing, screening follow-up, outbreak investigations)			
Anywhere	Rapid-response team investigators	Remote interview of community members with suspected or confirmed COVID-19 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 persons with suspected or confirmed COVID-19 or their contacts Interview should be conducted outdoors	• Maintain physical distance of at least 1 metre • Medical mask • Perform hand hygiene
		Investigation of occupied setting where transmission event has occurred	• Maintain physical distance of at least 1 metre • Medical mask • Perform hand hygiene
		Investigation of unoccupied setting where transmission event has occurred	• If investigating as a team, and there is known or suspected community or cluster SARS-CoV-2 transmission, all investigators should wear a validated non-medical mask • Perform hand hygiene

Special considerations for vaccinations (Alongside all considerations as referred to in *Guidance on developing a national deployment and vaccination plan for COVID-19 vaccines*)			
Anywhere	Vaccinator	Vaccination	• Medical mask in areas of known or suspected community, cluster, or sporadic SARS-CoV-2 transmission • Other PPE according to standard precautions and risk assessment. • Perform hand hygiene

Annex 2: Updated personal protective equipment decontamination and reprocessing methods summary

When considering whether to adopt any PPE disinfection or reprocessing method, the health care setting or external reprocessing facility's ability to safely handle contaminated PPE and perform quality control measures on reprocessed equipment should be evaluated. It is important to note that each reprocessing cycle does not restore the PPE to a "new" performance level and may have a severe deleterious effect on safety and performance that is not apparent to the wearer (102). The number of times PPE is reprocessed should be carefully and systemically monitored (e.g. with a marking or tagging system identifying the number of reprocessing cycles). In addition, quality control systems should be in place to inspect the items before and after every reprocessing cycle to check if any visible soiling is present and to assess the structural integrity and features of PPE items. If any item of PPE is soiled, damaged, or otherwise not suitable for reuse, it should be immediately discarded.

Considerations for the feasibility of adopting PPE decontamination or reprocessing measures for health service settings should include:

- safe transport (where applicable) of potentially contaminated PPE items to facilities for reprocessing
- efficacy of the decontamination or reprocessing process to guarantee that any pathogens transmissible in health settings are effectively removed through disinfection or sterilization
- controls to ensure there is no residual toxicity (e.g. appropriate time allotted for off-gassing if a chemical disinfectant is used)
- pre- and post-reprocessing assessment of the functional integrity and shape of the PPE item
- capacity for performance testing following reprocessing for individual items and batches where applicable
- traceability of reprocessed PPE items to identify batches when investigating any subsequent quality control issues or infections resulting from inadequate reprocessing and remove affected lots from circulation.

If reprocessing of PPE is performed outside of the health care setting, whether in an internal sterile processing/laundering site or an external facility, potentially contaminated PPE should be transported in accordance with the standards of decontamination and reprocessing of medical devices (103) described below.

- Used PPE should be handled carefully and without excessive manipulation to reduce the risk of exposure to staff and patients, or contamination of environmental surfaces.
- Used PPE that will be reprocessed should be transported to a designated reprocessing area as soon as possible, within a reasonable timeframe, after use.
- Used PPE should be transported in covered, fully enclosed, puncture-resistant containers that prevent spill of liquids and are decontaminated after each use.
- On-site transport for potentially contaminated PPE should follow designated routes to avoid high-traffic and patient care areas.
- All carts and containers containing contaminated PPE must be clearly identified.
- Clean and used PPE must not be stored or transported together (for example, on the same cart), due to the risk of cross-contamination.

Gowns

Cotton fabric gowns that will be laundered should be placed in designated containers after use. Used gowns should never be excessively manipulated or shaken before laundering as this may result in contamination of the launderer and surrounding environment (104).

Machine washing

- The volume of gowns placed in a machine should be no more than three quarters of a standard laundry load per cycle (105).
- Gowns should be washed for 30 minutes with hot water (60-90°C) and on a gentle cycle if possible, using laundry detergent.
- Hang gown to fully dry in clean environment after washing.

If machine washing is not possible, cotton gowns can be cleaned and disinfected in a drum.

- Thoroughly scrub the gown using warm water and detergent (106).

- Soak in hot water and soap in a large drum, using a stick to stir, avoiding splashing.
- Soak gown in 0.05% chlorine for 30 minutes.
- Rinse with clean water and let gown dry fully in the sunlight.

Assessment after laundering

- Check that the cuffs, hems, shoulders, sleeves, and ties have retained protective and wearable shape.
- Ensure the material is intact and has no holes or rips in the seams or damage to the ties at the waist; and that if Velcro is part of the design of the gown, that it is still functional (107).
- Ensure clean gowns are folded and bagged appropriately.
- Non-sterile plastic containers or carts used for the transportation of gowns should be cleaned and disinfected before they are returned to clinical areas.

Eye protection

Eye protection may be decontaminated by cleaning and disinfecting immediately after appropriate doffing and hand hygiene is performed OR placed in a designated closed container for later cleaning and disinfection.

Cleaning and disinfection

- Perform hand hygiene.
- Clean and disinfect surface where the eye protection item will be cleaned (108).
- Clean with soap/detergent and water on a clean cloth, and allow time for eye protection item to dry.
- Wipe with a clean cloth or wipe using 70% alcohol or sodium hypochlorite 0.1%.
    - If 70% alcohol is used, allow for at least 1-minute contact time before returning eye protection to clinical use.
    - If 0.1% sodium hypochlorite is used, allow contact time of 10 min, rinse with warm water, and allow to dry before returning eye protection to clinical use.

To assess after cleaning and disinfection

- Is the functional shape of the eye protection maintained?
- Is there damage to the strap/arms/viewing area?
- Is there degradation in visibility?

Respirators

Any respirator reprocessing method that is proposed for local adoption must be regulated by the competent local regulatory authority. Health authorities should ensure any facility implementing a reprocessing plan performs local validation testing before adopting a respirator reprocessing method to ensure that the shape, fit, filtration efficiency, and pressure drop are preserved once the process is completed and to determine a set maximum number of reprocessing cycles. Health authorities should also require facilities to produce a written protocol for the process and guarantee that health workers will be trained in the proper use of the reprocessed respirators.

The decontamination of respirators has received considerable review and practical examination by several public health agencies. Of note, the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Hygiene (United States of America) has developed a frequently updated comprehensive report summary of decontamination results of respirators from various manufacturers (109); and the European Centre for Disease Prevention and Control has developed a narrative review of research studies describing methods for respirator decontamination (110).

Regardless of the efficacy and safety of the proposed method, the practical considerations for adoption of a respirator reprocessing method must include assessment of the capacity of the healthcare facility or external sterile services department to perform all the methods. Further evaluation is needed to ascertain that the decontamination method has been evaluated for the specific respirator model that has been proposed for reprocessing. The number of times a respirator can be safely reprocessed varies by method. However, the United States Centers for Disease Control and Prevention National Institute for Occupational Safety and Health has conducted stress testing on respirator components, including the straps and adjustable nosepiece, and have made the conservative recommendation that a respirator should be donned a maximum of five times (100).

It remains difficult to compare studies that have evaluated respirator reprocessing methods because of the wide variation in practices/methods used for reprocessing as well as evaluation methods and outcomes addressed. A brief summary of key performance factors evaluated in recent studies following reprocessing practices for 4 methods which have demonstrated some consistency in efficacy of methods through available literature is provided in Table 1 and Table 2 below.

Table 1. Key performance factors for respirator reprocessing

		Effective inactivation of infectious organism (various)	Quantitative fit test post-reprocessing	Qualitative fit test post-reprocessing	Integrity (e.g. analysis of filtration layers, straps)	Performance / filtration maintained post-reprocessing	Safety (off-gassing) effectively reduces residual toxicity
Hydrogen peroxide (and derivatives)	**Pass**	Cadnum, 2020 (115) Hankenson, 2020 (116) Ludwig-Begall, 2020 (117) Saini, 2020 (118) Ibanez-Cervantes, 2020 (119) Cheng, 2020 (120) Schwartz, 2020 (121) Simmons, 2020 (122) Fischer, 2020 (123)	Jatta, 2020 (130) Schwartz, 2020 (121) Widmer, 2020 (131) Fisher, 2020 (123) Smith, 2020 (124) Grossman,2020 (132)	Hankenson, 2020 (116) Saini, 2020 (118) Schwartz, 2020 (121)	Jatta, 2020 (130) Saini, 2020 (118)	Jatta, 2020 (130) Saini, 2020 (118)	Grossman,2020 (132) Schwartz, 2020 (121) Widmer, 2020 (131)
	Fail	Smith, 2020 (124)	Not found in review	Lieu, 2020 (137) Maranhao, 2020 (138)	Lieu, 2020 (137)	Not found in review	Not found in review
UV irradiation	**Pass**	Ludwig-Begall, 2020 (117) Fischer, 2020 (123) Simmons, 2020 (122)	Fisher, 2020 (123)	Not found in review	Not found in review	Ou, 2020 (136)	Not found in review
	Fail	Cadnum, 2020 (115) Smith, 2020 (124)	Smith, 2020 (124)	Not found in review	Not found in review	Not found in review	Not found in review
Moist heat	**Pass**	Daeschler, 2020 (125) De Man, 2020 (126) Ma, 2020 (127) Campos (128)	Anderegg, 2020 (133) Bopp, 2020 (134) Daeschler, 2020 (125) Czubryt, 2020 (135)	De Man, 2020 (126) Harskamp, 2020 (139)	Daeschler, 2020 (125)	Anderegg, 2020 (133) Bopp, 2020 (134) Daeschler, 2020 (125) De Man, 2020 (126) Campos, 2020 (128) Ou, 2020 (136)	Not found in review
	Fail	Not found in review	Ou, 2020 (136)	Anderegg, 2020 (133) Harskamp, 2020 (139)	Not found in review	Harskamp, 2020 (139)	Not found in review
Dry Heat	**Pass**	Ludwig-Begall, 2020 (117) Pascoe, 2020 (129) Fischer, 2020 (123)	Fisher, 2020 (123) Ou, 2020 (136)		Celina, 2020 (140)	Pascoe, 2020 (129) Ou, 2020 (136) Celina, 2020 (140)	Not found in review
	Fail	Cadnum, 2020 (115)	Not found in review	Not found in review	Grinshpun, 2020 (141)	Not found in review	Not found in review

Table 2. Results of studies on respirator reprocessing methods

Hydrogen Peroxide (and derivatives):

First Author	Methods	Outcomes of interest
Ludwig-Begall (117)	VHP (59%), non-lumen setting for 28 min (V-PRO maX), 1 cycle	Inactivated PRCV
Saini (118)	VHP (7–8%), <10 min, 1 cycle	Inactivation of *B. stearothermophilus*, *M. smegmatis, E. coli*; no changes to integrity, fit, or performance
Schwartz (121)	VHP (35%), up to 30 cycles, 'gassing' time 25 min, 'gassing dwell' time 20 min	Inactivated *G. stearothermophilus*, qualitative and quantitative fit maintained, off-gassing time of 4 hours
Grossman (132)	VHP (20ºC), 40% relative humidity, 10 g/unit volume H_2O_2 for 4.5h	Off-gassing time ranged from 4-6 hours; small sample of FFRs passed quantitative fit test after 1 cycle
Maranhao (138)	Not described	Qualitative fit test failure rate was 46% after 4 days (95% CI: 31–63%), 50% after 10 days (95% CI: 36–63%), and 55% after 15 days (95% CI: 37–71%)
Jatta (130)	VHP (59%), non-lumen setting for 28 min (V-PRO maX), for 5 and 10 cycles	No significant changes in mean filtration efficiency between control and VHP-treated respirators; no loss of fit or integrity
Widmer (131)	VHP (V-PRO maX); low temperature, details not reported	Maintained quantitative fit after 1 cycle; cost for reprocessing estimated to be 0.5 Euro/respirator

Ultraviolet Germicidal Irradiation:

First Author	Methods	Outcomes of interest
Fischer (123)	UV light (260–285 nm)	Inactivated SARS-CoV-2; maintained quantitative fit after 2 cycles
Simmons (122)	Pulsed-xenon UV light, 5 min	Inactivated SARS-CoV-2
Ludwig-Begall (117)	4 min UV-C light (fluence of 5.2J/cm2 per mask)	Inactivated PRCV
Smith (124)	UV light, details not reported	SARS-CoV-2 not successfully inactivated; extended exposure to UV impaired integrity but FFRs maintained average FIT score >100
Cadnum (115)	UV-C light (1-minute cycle delivered by a UV-C decontamination box or a 30-minute cycle delivered by a room decontamination device)	Did not meet criteria for inactivation of bacteriophages MS2 and Phi6, and MRSA
Ou (136)	UV-C light (Xenex LightStrike Germ-Zapping Robot) for 5 min, up to 10 treatments	Maintained filtration performance for up to 10 cycles

Moist Heat:

First Author	Methods	Outcomes of interest
Campos (128)	60–95°C at either 40–60% or 100% RH	Inactivated SARS-CoV-2; maintained filtration efficiency
Daeschler (125)	60 min at 70°C at either 0%, 25%, 40%, or 50% relative humidity	Inactivated SARS-CoV-2; structural integrity and performance maintained after 10 cycles
de Man (126)	121ºC for 15 min	Inactivated staph epi; qualitative fit, performance maintained
Ma (127)	Steamed on boiling water for 2 hours	Inactivated avian infectious bronchitis virus

Anderegg (133)	85°C, 60-85% humidity for 40 min, 5 cycles	Qualitative degradation (nose bridge); all FFRs passed quantitative fit testing
Bopp (134)	115°C for 1 hour, 121.1°C for 30 min, 130°C for 2 min, and 130°C for 4 min	FFR failed fit test after a single cycle
Harskamp (139)	12 min preheating, followed steam decontamination at 121°C for 17 min	FFP2 retained fit, FFP3 did not; FFP2 maintained filtration capabilities after 3 cycles, FFP3 had decreased filtration after 1 cycle
Ou (136)	Steamed on boiling water for 30 min	FFRs retained filtration efficiency after 10 cycles; failed quantitative fit after 5 cycles

Dry Heat:

First Author	Methods	Outcomes of interest
Fischer (123)	70ºC dry heat	Inactivated SARS-CoV-2, maintained quantitative fit but should not be used for >2 cycles
Pascoe (129)	70°C dry heat, 5-90 min	Inactivated MRSA, maintained filtration efficiency after 3 reprocessing cycles
Ludwig-Begall (117)	102°C (+/- 4°C) for 60 min (+/-15 min)	Inactivated PRCV
Cadnum (115)	70°C for 30 min	Did not meet criteria for inactivation of bacteriophages MS2 and Phi6
Celina (140)	65°C for 24h, followed by 24h at 80°C ('moderate aging') and 24h at 95°C.	All FFRs maintained integrity after 24 h at 65°C, some evidence for material weaknesses at 80°C and 95°C exposure. Varied by FFR model and temperature
Grinshpun (141)	121°C for 30 min, once and then consecutively five times)	Physical damage after single treatment (nose clip, straps); performance compromised
Ou (136)	77 °C for 30 min	Maintained filtration efficiency and quantitative fit

Methylene blue and dry heat:

WHO is currently supporting the *Development of Methods for Mask and N95 Decontamination* study to evaluate methylene blue and light (MBL) and dry heat (DH) as a potentially simple, efficient and inexpensive method to reprocess SARS-CoV-2-exposed medical masks and respirators. In a recent study (142), MBL and DH were applied to respirators and medical mask materials to test inactivation of SARS-CoV-2 and surrogate coronaviruses. The study found that both MBL and DH consistently killed SARS-CoV-2, with some heterogeneity in DH values. The findings suggest MBL could potentially be developed as a new reprocessing method. The National Institute for Occupational Safety and Health (United States of America) has included favorable results regarding the impact of the MBL + DH on the performance of the tested respirator models in their update on testing of decontamination methods on respirators (109).

Methods not to be considered

Some methods should be avoided due to their resulting damage to the mask, residual toxicity that may become reactivated with moisture during use, or loss of filtration efficiency. They include standard laundering/washing methods, disinfection with sodium hypochlorite or alcohol (141, 143), and microwave oven irradiation (143, 144). Microwave ovens have shown some biocidal effect when combined with moisture to use properties of radiation with steam heat; however, problems that require careful consideration include a lack of substantial review of standard microwave oven radiation capacities with respirator disinfection; inability to ensure controls for uniform distribution of steam; and concern that the metal noseband of respirators may combust (143-145).

WHO continues to monitor the situation closely for any changes that may require an update of this interim guidance. Otherwise, this interim guidance document will expire 12 months after the date of publication.

© World Health Organization 2020. Some rights reserved. This work is available under the CC BY-NC-SA 3.0 IGO licence.

WHO reference number: WHO/2019-nCoV/IPC_PPE_use/2020.4