

In brief

Extended use or reuse of personal protective equipment

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Summary

- Reuse or extended use of personal protective equipment (PPE) labelled for single use only, has been considered when there is a critical shortage.
- Reuse and extended use methods include: using PPE for a prolonged period without removing between multiple patients (patients who are COVID-19 positive¹ or on droplet precautions²); storing used N95 respirators away for days at a time (CDC: minimum five days)³ before reuse; and decontaminating PPE using chemical, heat or ultraviolet radiation methods before reuse.
- Peer-reviewed literature most commonly reviews or evaluates the reuse of filtering facepiece respirators by various decontamination methods. Vaporised hydrogen peroxide method, followed by ultraviolet germicidal irradiation and moist heat method were found to be the most promising methods in terms of efficacy and safety.
- Key regulatory and health organisations suggest considering reuse and extended use of PPEs only in severe shortage situations where it is critically necessary.^{2, 4-6}

Published recommendations

- In Australia, the Therapeutic Goods Administration (TGA) states that in order to make single-use products suitable for reuse, they must be reprocessed. Decontamination for reuse of used single-use PPE is only recommended when critically necessary to address supply shortages during the COVID-19 pandemic.⁴
- The NSW Clinical Excellence Commission (CEC) neither recommends nor endorses any strategies for single use personal protective equipment (PPE) reuse that differ from standard infection prevention and control practices. However, it notes that, in times of a pandemic and global supply shortages, temporary emergency strategies can be considered.⁵
- The Victoria Health and Human Services states that, “extended use is the practice of wearing PPE for repeated close contact encounters with several different COVID-19 patients without removal between encounters”.¹ The extended use of PPE is dependent on the context (pandemic) and the cohort (outbreak setting).¹ Extended use of gowns may occur in screening clinics where there are multiple people waiting for COVID-19 swab collection and when providing care in a COVID-19 room or ward area as long as patients do not have known co-infections or colonisations, for example, a multi-drug resistant organism.¹
- WHO recommends the following strategies during severe shortage of PPE:⁶
 - 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-standardised or repurposed products as PPE items).

- The US Centers for Disease Control and Prevention (CDC) recommends the following strategies for optimising the supply of face masks.²
 - Conventional capacity strategies: use facemasks according to product labelling and local, state and federal requirements
 - Contingency capacity strategies: extended use of facemasks (wearing the same facemask as PPE during encounters with several different patients, without removing the facemask between encounters); restrict facemasks for use only by healthcare providers when needed as PPE
 - Crisis capacity strategies: use facemasks beyond the manufacturer-designated shelf life; limited re-use of facemasks with extended use; store N95 respirators in a breathable paper bag at the end of each shift with a minimum of five days between each N95 respirator use, rotating the use each day between N95 respirators.
- The European Centres for Disease Prevention and Control (ECDC) lists the following as the guiding principles for reuse of respirators.⁷
 - Respirators which have been visibly contaminated or are damaged or not fitting, should be discarded and cannot be taken for re-use or decontamination procedures.
 - Respirators may be protected by a medical face mask in order to prevent soiling.
 - Use of new 'expired respirators' (manufacturers expiry date) is possible if they were properly stored until use.

Evidence

Extended use

- One systematic review suggested rotated use of N95 respirators (that is, three respirators used every three days, or five respirators used every five days) be an alternative option to other chemical, heat and UV light decontamination methods.⁸
 - It requires at least 72 hours between uses to allow for novel coronavirus to become non-viable on the surface.⁸
 - The healthcare professional can store the N95 respirator in a clean, date-marked paper bag in a designated area and reuse after at least 72 hours.⁸
 - While simple and easy to implement, the evidence supporting this method was not validated.⁸
 - The survival time of the virus on respirator surfaces may depend on the viral load and may exceed 72 hours.⁸
- Other strategies to extended use include wearing a second mask or a face shield over the respirator to reduce the amount of gross contamination. However, evidence supporting the effectiveness of these methods is lacking.⁸

Reuse by decontamination

- Decontamination is “a process to reduce the number of pathogens on used filtering facepiece respirators before reusing them”.³
- Most decontamination methods reported in the published literature refers to the decontamination of N95 respirators, not cloth or surgical masks.⁹ Studies were generally conducted in controlled laboratory settings.¹⁰

- The decontamination methods for respirators include (from most to least commonly described): ultraviolet germicidal irradiation, hydrogen peroxide, dry heat, microwave oven, sodium hypochlorite, moist heat, autoclave, ethanol, ethylene oxide, electric rice cooker, isopropanol solution, cleaning wipes, bar soap, water, multi-purpose high-level disinfection cabinet, and chlorine dioxide.¹¹
- One systematic review looked at parameters for respirator decontamination methods and rated them against set criteria in terms of efficacy, risk, cost, time to decontamination, complexity and reusability. It found ultraviolet germicidal irradiation, hydrogen peroxide, steam, ozone, ethylene oxide, dry heat and moist heat to be sufficiently satisfactory methods. Other methods such as alcohol disinfection, dry microwave oven irradiation, chlorine disinfection and washing with detergent were not recommended as they affected functionality of the respirators.¹²
- Most systematic review and meta-analysis studies found vaporised hydrogen peroxide method to be the most reliable and safest for decontaminating respirators, followed by ultraviolet germicidal irradiation and the moist heat method.^{9, 13} One systematic review found moist heat (65–80°C at 50–85% relative humidity for 20–30 minutes) and vaporised hydrogen peroxide to provide consistent viral decontamination without compromising mask seal and filtration efficiency.¹⁴ (Table 1)
- The effects of filtering facepiece respirator decontamination may vary by model.³ The CDC recommends that decontamination should only be performed on The National Institute for Occupational Safety and Health (NIOSH) approved filtering facepiece respirators without exhalation valves.³

Table 1: Summary of decontamination methods

Methods	Effectiveness in inactivating microorganisms	Impact on functional integrity (particle filtration efficiency)	Limitations
Vaporised hydrogen peroxide	>4-Log (99.99%) reduction of SARS-CoV-2 ¹⁵ >6-Log (99.9999%) reduction of other microorganisms ¹⁶	No significant impact ¹⁷	<ul style="list-style-type: none"> • Requires expensive and specialised technology and devices⁹ • May degrade the metal nose bands and elastic straps after repeat cycles⁹ • Not suitable for reuse immediately after decontamination due to hydrogen peroxide residues in the inner surface. May require at least three hours before residues become undetectable⁹ • Pressurized chamber systems with higher concentrations of hydrogen peroxide might damage mask components¹⁵
Ultraviolet germicidal irradiation	Mostly >3-Log (99.9%) reduction in microorganisms, dependant on dose administered, sufficient surface	May depend on dose, duration and number of cycles of exposure ⁹	<ul style="list-style-type: none"> • May degrade the elastic straps¹⁹ • May not be able to reach and decontaminate all surface areas depending on the mask design⁹

Methods	Effectiveness in inactivating microorganisms	Impact on functional integrity (particle filtration efficiency)	Limitations
	expose, duration of exposure ¹²	No impact at low dose, ¹⁸ slight deterioration at high dose ¹⁹	
Dry heat	>3-Log reduction in most microorganisms ¹² Found to inactivate SARS-CoV-2 at 70 °C for 60 minutes ²⁰	No significant impact ¹²	<ul style="list-style-type: none"> Excess heat degrades mask material⁹
Moist heat	>3-Log or >6-Log reduction in most microorganisms, depending on method use for generating steam and heat ¹² Found to inactivate SARS-CoV-2 at 70 °C and 50% humidity for 60 minutes ²⁰	No significant impact ¹²	<ul style="list-style-type: none"> Excess heat degrades mask material⁹ Moisture may impact the charging of the mask electrets²¹
Ethylene oxide	>6-Log reduction of microorganisms ¹⁶	No significant impact ⁹	<ul style="list-style-type: none"> Ethylene oxide residues may cause adverse health effects⁹ May need at least 48 hours to desorb harmful particles⁹

To inform this brief, PubMed and Google searches were conducted using terms related to COVID-19, reuse of PPE or extended use of PPE on 19 August 2021. The search was limited to systematic/evidence reviews and for grey literature only key organisation sources were screened for inclusion.

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In brief documents are not an exhaustive list of publications but aim to provide an overview of what is already known about a specific topic. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

- <https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/decontamination-reuse-respirators.html>.
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