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Strategies for managing acute shortages of personal protective equipment during the COVID-19 pandemic

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This paper provides infection prevention and control teams with a checklist of actions and practical strategies that can be used to inform local risk assessments to manage shortages of personal protective equipment (PPE). Re-use and reprocessing of PPE must be a **last-resort temporary measure** that is implemented for a **limited time period** to enable stocks to be replenished. It has been developed by the Infection Prevention Society and Central Sterilising Club expert members and is aligned to Public Health England (PHE)¹, World Health Organisation (WHO)², Centers for Disease Prevention & Control (CDC) guidelines³. Information is also available from the Institute of Healthcare Engineering and Estates Management.

NB. Work on testing and validating technologies for reprocessing is currently being undertaken by the UK Governments and therefore further guidance is likely to emerge over the coming weeks.

1. Revisit current strategies to conserve PPE by optimising use

1.1 Administrative controls

Although PPE is the most visible control measure to prevent transmission, administrative controls can be used to minimise the need for PPE as follows:

- Separate COVID-19 and other patients by designating different care pathways and care facilities.
- Use physical barriers (e.g. glass/plastic screens and curtains) to support social distancing and reduce exposure.
- Establish an inventory management system for your current stock and PPE usage rates to provide early warning of shortages (see CDC calculator³).

1.2 Minimise need for PPE

Reconfigure and streamline systems of work to reduce the number of staff entering areas provided for COVID-19 patients

- Restrict number of staff entering COVID-19 rooms to the minimum required to deliver safe and effective care.
- Plan bedside activities and bundle them to minimise the number of times the room is entered e.g. Use SPACES guidance from British Thoracic Society <https://bit.ly/BTSSPACES>
- Consider ways of reconfiguring activity of staff who usually enter patient rooms but are not involved in direct care e.g. pharmacists, phlebotomists, housekeepers, domestics, by reducing or bundling activity or transferring responsibilities to the staff providing direct care.
- Restrict number of staff having face-to-face contact with COVID-19 patients during doctor's rounds and conduct clinical discussions about the patients care away from the clinical area.
- Restrict number of staff having face-to-face contact with each other in meetings.

1.3 Extend time that PPE can be used

- Designate dedicated healthcare workers/teams to COVID-19 patient care areas so that the PPE can be worn for a session of care¹ (footnote).
- Respirators can be worn for up to 6hrs² without removing when caring for a cohort of patients, but should be removed and discarded on leaving the clinical area, taking a break or completing a shift.¹
- However, the longer a respirator is worn the more likely it will be touched, become wet, soiled or damaged or become difficult to breathe through (and will need to be changed).
- Fluid resistant surgical masks (FRSM) can be used without removing for up to 6 hours.²

1.4 Support rational and appropriate use of PPE

In the context of worldwide shortages of PPE it is essential that it is used as indicated by PHE guidance to ensure that appropriate PPE is available for staff performing the highest risk procedures.

- Gowns, coats or coveralls that are not water-resistant can be protected with a plastic apron during use and therefore provide a reasonable level of protection for direct patient care.
- FFP3/2 respirators and gowns to be worn only for high-risk areas and in the immediate proximity of AGP⁴.
- Double gloving is not necessary as contamination can be easily removed by hand hygiene, gloves should not be gelled but must be changed in the room and hands decontaminated on removal.
- Clinical gloves should not be used by staff who are not involved in direct care of patients, as wearing gloves gives a false sense of security and frequent hand hygiene is more effective.

1.5 Reiterating basic infection control measures

- Hand hygiene with either soap and water or alcohol hand rubs are effective methods of removing SARS-CoV-2 (the virus that causes COVID-19) and can be used to clean hands and forearms after leaving isolation areas.
- Emphasise the importance of changing out of uniform at work and showering after completing a shift preferably at work, or immediately upon arrival at home.

2. Contingency planning for extreme shortages of PPE

Contingency strategies can be used to extend PPE supplies when shortages are anticipated, for example if supplies are likely to run out soon. Planning for critical shortages should be done in advance, with clear triggers for implementation, using locally available processes and standard practice resumed as soon as adequate PPE supplies are available.

- Establish a PPE Action Team, which includes relevant expertise e.g. procurement, facilities, infection control, nursing/medical leads, decontamination lead, Authorised Person (Decontamination) and Authorising Engineer (Decontamination), microbiologist, health & safety, occupational health.

¹ A single session refers to a period of time where a healthcare worker is undertaking duties in a specific care setting/environment

- The PPE Action Team should develop the action plan, agree the criteria that would trigger the implementation of temporary measures for the reuse/ reprocessing of essential PPE, and be responsible for implementation of the plan.
- Consider what might constitute reasonable replacement for PPE e.g. laboratory coats, coveralls, other non-surgical gowns, face guards.
- Look for potential alternative sources/suppliers of PPE e.g. Private healthcare organizations, local businesses, other NHS facilities in areas of low incidence.
- Engage with alternative suppliers/manufacturers, reprocessing and laundry service providers to establish surge capability and capacity in the event of extreme shortages.
- Factors to be considered when identifying reprocessing options for each type of PPE:
 - Will the method inactivate SARS-CoV-2 and other relevant organisms
 - Potential affect on the performance and integrity of the PPE
 - Will the process present any risk to the next wearer
- Establish the systems of work required to implement and manage the whole decontamination cycle and assure the integrity of reprocessed/ decontaminated PPE and arrange secure, safe storage.
- Risk assessments must be undertaken, and procedures written to describe the rationale of the chosen process and how the processing will be managed including collection, delivery and safe handling procedures (ISO 14971).
- Engage and inform staff of the temporary measures and the processes for ensuring their continued safety, including the part they can play in preserving PPE and what they need to do to ensure safe reuse. Deliver training to staff to ensure they follow agreed change in practice.

3. Temporary measures in the context of extreme PPE shortages

The re-use/reprocessing of PPE may have to be considered in situations where there is a critical shortage of PPE when caring for severe or critically ill patients with COVID-19, known co-infection with multi-drug resistant organisms or other organisms transmitted by contact/ droplets. These measures should be considered as temporary and should be avoided when there are adequate supplies of PPE.

The evidence to support reprocessing/re-use is a rapidly evolving field and it is essential to keep up with new developments as they emerge. However, evidence to underpin current re-processing options is contained in WHO, CDC and PPE manufacturer guidance^{2,3,6}. As indicated in section 2, it is essential to consider reprocessing ahead of extreme shortages in order to create a stock that can be used ONLY in emergencies.

3.1 Gowns

3.1.1 Laundering re-usable gowns, coveralls etc.

Using reusable gowns is one way of assuring supplies of PPE. A thermal-based decontamination method is a safe and effective means of eliminating SARS-CoV-2².

Questions to ask:

- Is the material suitable for laundering in accordance with the standard guidance (HTM 01-04) (check manufacturer instructions if possible)?
- Can it be re-processed in line with the standard guidance (HTM 01-04)?

- Does the laundry have capacity and can a system for reprocessing be established (this may need to be developed for items not routinely reprocessed in this way)?
- What ward-based systems are required to ensure that gowns are not discarded into the clinical waste stream but placed in the appropriate laundry bags for rewashing?

3.1.2 Laundering, reprocessing or conservation of single use gowns

This should not be attempted if the gown is damaged or visibly soiled.

a) Laundering single use gowns

The quality of the disposable gown and its specification may impact on reprocessing, the material and structure may be damaged but it might be an option for some protective clothing.

Questions to ask:

- If possible, consult the manufacturers product specification to determine what material the gown is made from and check compatibility with the washing process.
- What happens to the protective properties and structure of the gown material when it is processed through several wash/dry cycles and can these be assured? If repellency is lost, the gown may still have a function if used in conjunction with a plastic apron for patient contact.
- What are the logistics of reprocessing these in the laundry?
 - Is there capacity to process in a timely way?
 - How can safe methods of handling, and transportation can be achieved?
 - What is the shortest acceptable cycle (tunnel washers may need to be avoided to prevent unnecessary damage)?

b) Other reprocessing technologies for single use gowns

Questions to ask:

- Are other compatible reprocessing technologies available (see available technologies section in section 4)
- Identify locally available compatible process options and review with the PPE Action Team?
 - Test that the chosen method is effective and feasible; consult your AP(D) and AE(D).
 - Test how many items can be processed safely in same period.
 - Determine if a feasible and practical reprocessing system can be established.
 - Establish a procedure for managing the logistics for cycling gowns through a re-processing system.
- Limitations of the number of pieces that can be processed at one time and implications for supply?

c) Reuse of gown or other protective clothing by same member of staff (as a last resort)

This should only be considered as a last resort because of the increased risks of contamination during re-donning and is not recommended². Gowns should be protected during use with plastic aprons to minimise contamination and should not be re-used if damaged, soiled or wet.

Questions to ask:

- Is there sufficient space and can hooks be placed for hanging one or more gowns?
- Can the gown be hung in such a way that the outer surface does not contaminate the inner surface of the gown or adjacent gowns?
- Can the outside of gown be clearly labeled with the user's name?

3.2 Respirators (FFP3/FFP2)

3.2.1 Alternative approaches

Question to ask:

- Can reusable respirators be used for key staff who will need to use them regularly for prolonged periods?
- What supplies of FFP2 respirators are available as these can be used in specific circumstances as an alternative to FFP3?
- How long will reusable respirator filters last (check manufacturers instructions) and if necessary how will they be dated?
- Can full face visors be used instead of fluid-repellent surgical masks (FRSM) in clinical areas where staff are not directly involved in patient care?
- How will full-face visors and re-usable respirators be decontaminated?

3.2.2 Re-processing FFP2/3 respirators

Reprocessing single use respirators **is not recommended** and should only be considered when the supply of new respirators is inadequate. There are a number of reasons why reprocessing is a problem, including the reliability, safety, feasibility and practicality of decontamination systems that would be required. In addition, the respirator mask may lose integrity while it is being worn, and damage is unpredictable and cannot be assumed to occur within a particular time period. This may cause failure of protection even if the reprocessing does not damage the mask. Respirators are considered to be for single-person use and would need to be returned to the original user.

If reprocessing is considered, it should only be performed using methods that are supported with data from both the respirator manufacturer and the manufacturer of the processing equipment.

Questions to ask:

- What respirator manufacturer data is available about evaluated methods of decontamination for each type of respirator in use. Refer to respirator manufacturer⁶ and CDC *Decontamination & reuse of filtering facepiece respirators*⁵? (Some processes are not suitable on celluloses or leave residues or salts which may be harmful to the user)
- Is the decontamination process capable of inactivation of viruses in the presence of salts or proteins that may be present from previous respirator use?
- Is the decontamination process compatible with the material of construction of the respirator (including filter materials and headband)?
- Does the decontamination process alter the shape or fit of then respirator?
- Is the filtration efficacy affected by the reprocessing?
- Are there process residuals that could affect the safety for the user?
- How could respirator masks that have been reprocessed be labeled and returned to the original user, and fit checked prior to use?
- Are processing options available locally?
- Is there a dedicated area for re-processing (e.g. endoscopy unit, sterile supplies, outside supplier)?
- What systems would be required to safely collect and transport for reprocessing?

3.2.3 Reuse of FRSM or FFP3 respirators by the same user (as a last resort)

Reuse of respirators during a shift **is not recommended**. Systems that would enable the same mask or respirator to be reused by one member of staff would be very difficult to achieve safely and would probably not be feasible to continue for more than a single shift. It would be preferable to use FFP2 (N95) respirators rather than attempt to retain and reuse.

Reasons:

- It would result in handling of potentially contaminated masks or respirators
- FRSM would be difficult to insert into a bag without contaminating the inner surface of the breathable bag and inner surface of the mask and therefore present a risk to the wearer
- If FFP3 were placed into a container extreme care would be needed to avoid contaminating the inside of the respirator and the container would need to be decontaminated between uses
- The contaminated outer surface of the mask or respirator would have to be touched to refit it (and staff are advised not to touch the front of them)

CDC suggest that an alternative option would be to issue each healthcare worker who requires FFP2/3 when caring for known/suspected COVID-19 patients with a supply of respirators. After each use the respirator mask is stored in a breathable container and marked for re-use once 72 hours has elapsed and the virus could be considered to be no longer viable⁵.

4. Further information about available decontamination/reprocessing technologies

The CDC have published guidance on specific technologies that could be used to reprocess respirators in order to manage critical supply problems which summarises current research about decontamination of respirators before reuse⁵. Work on testing and validating technologies for re-processing PPE is currently being undertaken by the UK Governments and therefore further guidance is likely to emerge over the coming weeks. This section is intended to highlight some of the challenges of using these technologies. Their use should only be considered with the involvement of your AP(D) and AE(D). The following information need to be considered in the context of the questions outlines in section 3.2.2.

4.1 Hydrogen peroxide

There are two types of system:

1. Those that produce gaseous hydrogen peroxide. These have relatively good distribution in an enclosed space. They can penetrate into recesses and non-directly exposed areas to some extent. **Only systems that are known to produce gaseous hydrogen peroxide should be used for reprocessing.**
2. Those that produce droplets which fall under gravity. These are likely to have poorer, more directional distribution in a space. The droplets will fall onto exposed, upward facing surfaces, particularly if in the distribution pathway, but there is far less exposure for other surfaces.

4.2 UV light

- Decontamination requires direct line of sight, a fraction of a millimetre off direct illumination results in no microbicidal action.

- Will not work if shadowed and unreliable if reflected (although some claim to show activity from reflected UV, each surface will have a different UV reflectivity).
- Energy diminishes disproportionately with the distance from the source (inverse square law - e.g. 2 times the distance is $\frac{1}{4}$ and 3 times the distance is $\frac{1}{9}$ th the dose).
- May damage some materials.
- Unlikely to be able to provide sufficient quality assurance to use for this purpose.

4.3 Thermal decontamination or sterilisation

- Steam sterilisation is likely to damage filtration performance of many respirators⁶.
- A washer-disinfector process, as with any other cleaning process is likely to damage the filtration performance, fit and headband of many respirators⁶.
- High humidity methods, where temperature and humidity is raised (60-70°C, 50-60%RH) for 30 minutes, and each respirator individually packaged in a steam sterilisation sterile barrier system pouch, has been shown not to damage the filtration and fit of certain respirators.

4.4 Use of reprocessing system

- Any reprocessing system should be supported by the information in section 3.2. Use of the reprocessing system should conform to all requirements concerning packaging, loading, process monitoring and validation specified by the manufacturer.
- A reprocessing cycle does not represent the same challenge as a *period of use plus reprocessing cycle*. Items are likely to get additional challenges to their integrity during use, so although an item can withstand e.g. 10 reprocessing cycles, this does not demonstrate that it can withstand 10 '*use plus reprocessing*' cycles. PPE should therefore be carefully inspected both before and after the process.

References

- 1) PHE: Considerations for acute personal protective equipment (PPE) shortages. 17th April 2020. <https://bit.ly/PHE1704>
- 2) WHO: Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages. 6th April 2020. <https://bit.ly/WHO0604>
- 3) CDC: Strategies to Optimize the Supply of PPE and Equipment: https://bit.ly/CDC_PPE. Includes:
 - Strategies for Optimizing the Supply of Isolation Gowns. https://bit.ly/CDC_gowns
 - CDC Strategies for Optimizing the Supply of Facemasks. https://bit.ly/CDC_Facemasks
- 4) PHE: COVID-19 personal protective equipment (PPE). Updated 17th April 2020. https://bit.ly/PHE_PPE
- 5) CDC: Decontamination and Reuse of Filtering Facepiece Respirators. https://bit.ly/CDC_Facemasks
- 6) 3M: Decontamination methods for 3M N95 Respirators. https://bit.ly/3M_Respirators

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