JBI EVIDENCE SUMMARY

RESPIRATORY INFECTION: REUSE, OR EXTENDED USE, OF DISPOSABLE MASKS AND RESPIRATORS

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Question

What is the best available evidence for the reuse, or extended use of masks and respirators designed for single use, in acute healthcare settings?

Clinical Bottom Line

Healthcare workers use personal protective equipment (PPE), including surgical masks (sometimes called medical masks), filtering facepiece respirators (FFR), elastomeric respirators and powered air-purifying respirators (PAPR), for infection prevention and control measures.[1,2,3,4] In ideal situations, these protective equipment are disposed after a single patient encounter.[1] However, when there is an unprecedented demand for PPE (e.g. during a pandemic), shortages in supply can lead to extended use or reuse by frontline healthcare workers.[1,2,3]

SURGICAL/MEDICAL MASKS

- Facemasks should be used in line with manufacturer's instructions and local, state and federal requirements, where they are either: i) removed and discarded after each patient encounter (when used as PPE) for the protection of healthcare workers) or ii) removed and discarded when they are soiled, damaged, or difficult to breathe through (when used for source control to cover their noses and mouths to prevent respiratory secretions from spreading).[1](Level 5)
- The Centers for Disease Control and Prevention (CDC) suggests that extended use, reuse or reprocessing of single-use masks be considered only when there is a critical shortage of equipment; this should promptly resume to conventional practices once availability of facemasks returns to normal. There should also be staff training regarding safe use and donning or doffing of masks if reusing or extending use.[1] (Level 5)
- During facemask shortages, consideration should be first given to implementing the extended use of facemasks before considering reusing them. Extended use refers to the practice whereby the healthcare worker wears the same facemask continuously during encounters with multiple patients. The facemask is to be discarded whenever it is removed, and at the end of each work day.[1] (Level 5)
- Where facemask shortage is severe, consideration may then be given to implementing limited reuse of facemasks in addition to extended use, whereby the healthcare worker wears the same masks for multiple patient encounters followed by removal and redonning the mask for further patient encounters.[1] (Level 5)
- Facemasks that fasten to the user via ties (hence subject to tearing upon removal) are to be considered for extended use instead of reuse, while facemasks with elastic ear hooks are more suitable for reuse.[1] (Level 5).
- Where there is reuse of the mask, healthcare workers should leave the patient care area if they need to

remove the mask.[1](Level 5)

- Regardless of whether extended use or limited reuse of facemasks is being carried out, once a surgical/medical mask becomes damp, soiled, damaged, or difficult to breath through, it must be replaced and discarded immediately.[1,2] (Level 5)
- Two studies – a laboratory-based pilot study followed by a clinical study – investigated viral particles from masks worn by healthcare workers for a six- to eight-hour shift. Authors concluded that the contamination on masks increased with use (more than six hours) and frequent clinical contact. It was recommended that protocols on duration of mask use should specify a maximum time of continuous use.[3] (Level 3)

FILTERING FACEPIECE RESPIRATORS

- N95 respirators (or the equivalent) are disposable (to be discarded following each patient contact) and not designed for extended use.[1] However, in certain circumstances healthcare workers reuse these types of FFRs or wear them for extended periods,[4,5,6,7,8] while reverting back to conventional practices once supply resumes.[1]
- Using an experimental design, a study evaluated the efficiency of ultraviolet germicidal irradiation (UVGI) in decontaminating influenza contaminated FFRs. Fifteen United States National Institute for Occupational Safety and Health (NIOSH)-approved N95 FFR models were chosen and 12 of each model were aseptically inoculated with 10 1-µL droplets of H1N1 influenza, on the same four areas (three on the facepiece exterior and one on the strap). After UVGI treatment FFRs were kept in a safety cabinet for processing. Researchers found significant reductions in the mean viable 50% tissue culture infectious dose ($TCID_{50}$) on mucin-soiled facepieces, mucin-soiled straps, sebum-soiled facepieces, and sebum-soiled FFR straps. Authors concluded that FFR-decontamination, using UVGI, can be effective in reducing contamination from influenza and could provide a way to reuse a disposable respirator in healthcare settings.[4] (Level 2)
- A second experimentally designed study examined the physical removal, using commercially available wipe products, of deposited contaminants from three types of N95 FFRs (cup [FFR A], flat-fold [FFR B], and duck bill [FFR C]) contaminated with either infectious or non-infectious aerosols; mucin or viable Staphylococcus aureus (S. aureus). FFRs were cleaned with hypochlorite, benzalkonium chloride, or non-antimicrobial wipes and incubated for 15 minutes at room temperature; contaminants were then extracted and quantified. Specifically, selected wipes were Hype-Wipes (Current Technologies, Inc, Crawfordsville, IN), which contain 0.9% hypochlorite (OCL); 504/07065 Respirator Cleaning Wipes (3M Company, St Paul, MN), which contain benzalkonium chloride (BAC); and Pampers wipes (Proctor & Gamble, Cincinnati, OH), which contain no active antimicrobial ingredients (inert). Filter performance was evaluated after three cleaning cycles, and any physical degradation of FFRs after cleaning appeared to be negligible. Authors concluded that their preliminary evaluation had shown that FFRs can be successfully disinfected by wipes that contain antimicrobial agents, and have reinforced the suitability of this practice, although more studies are required before the practice can be recommended. Specifically, it was reported that:[5] (Level 2)
  - The inert wipe removed mucin more effectively than the BAC wipe (up to 76.41%) and removed S. aureus slightly more efficiently than mucin; however, were only marginally effective on the edge strip and nose pad of two of the FFRs.
  - OCL wipes produced below detection limit values of S. aureus and no mucin, and were effective in disinfecting the perforated edge strip of FFR C and the nose pad of FFR A.
  - BAC wipes partially disinfected the FFR, but degradation of filtration performance was observed. BAC wipes decontaminated S. aureus less effectively than OCL wipes and disinfected the FFR A less effectively that the two other models; less mucin was removed by BAC wipes than by inert wipes.

- An experimental study evaluated five decontamination methods for nine models of NIOSH-certified respirators (three models each of N95 FFRs, surgical N95 respirators, and P100 FFRs). The methods of decontamination were: UVGI; ethylene oxide (EtO); vaporized hydrogen peroxide (VHP); microwave oven irradiation; and bleach; all were compared to controls (FFR as received) and were sniffed for any discernible odor or smell. Ethylene oxide and UVGI were the only methods that did not cause any observable physical changes to the FFRs; component materials on two models (SN95-E and P100-I) melted during microwave oven irradiation. Metallic nosebands became slightly tarnished when bleach or VHP were used. For all FFRs that did not melt (n=129 samples), filtration performance was not adversely affected by the decontamination process. UVGI, VHP and bleach all removed the viral threat, were considered harmless to the user, and did not compromise the integrity of the various elements of the respirators. It was noted that the scent of bleach remained on all FFR models following overnight drying, and low levels of chlorine were found to off-gas from bleach-decontaminated FFRs. Authors concluded that UVGI, EtO, and VHP were the most promising methods for decontamination of FFRs for reuse and that the best results were found when using UVGI.[6] (Level 2)
- Clinical practice guidelines provide additional recommendations regarding the extended use, or limited reuse, of FFRs:[1 7](Level 5)
  - The decision to implement policies that permit extended use or limited reuse of N95 respirators (or equivalent) should be made by the organization in consultation with occupational health and infection control departments. The CDC suggests limited reuse of N95 respirators to no more than five uses per device by the same healthcare practitioner, unless otherwise specified by the manufacturer.
  - During N95 respirators shortage, consideration should be first given to implementing the extended use before considering reusing. Extended use refers to the practice whereby the healthcare worker wears the same respirator continuously during encounters with multiple patients.[1]
- Where N95 respirators shortage is severe, organizations should first look into to switching to respirators that are designed for decontamination and reusing (eg, elastomeric respirators or PAPR. If the latter is not feasible, consideration may then be given to implementing reuse of facemask, whereby the healthcare worker wears the N95 respirator for one patient encounter followed by removal and storing the respirator before using it for another patient encounter for a limited number of donnings. Decontamination may also be considered when carrying out limited reuse. Limited reuse may also be coupled with extended use, where an N95 respirator is worn for multiple patient encounters before storing or decontaminating for subsequent reuse.[1]
  - An effective decontamination method should inactivate the contaminating organism, and not leave any chemical residues that are harmful to the user
  - The function of the respirator should not be compromised in terms of filtration efficiency and fitting performance.[9] (Level 5)
- Decontamination methods found to hold the most potential for FFRs during severe N95 respirators shortage include UVGI, VH peroxide vapor, and moist heat. It is recommended to be performed only on NIOSH-approved FFRs without exhalation valves.[1] (Level 5)
- When reusing decontaminated filtering face pieces, they should be checked for integrity and discarded if there is macroscopic degradation. Strict hand hygiene should be observed when touching the face piece and gloves should be worn when touching the decontaminated filtering face piece. The internal part should not be touched and only minimal touch for the external part (e.g. when adjusting).[9](Level 5)
- A medical face mask or a face shield that can be cleaned may be placed over the respirators to prevent soiling during respirators shortage.[9](Level 5)
- A fit check should be undertaken every time the face piece is reused.[1,9](Level 5)

- Regardless of whether extended use or limited reuse of facemasks is being carried out, respirators that are damaged, malformed, unable to pass a fit check, or contaminated with blood or bodily fluids should be discarded and not be reused.[1,9](Level 5)
- Staff should be trained on how to reuse FFRs, including decontamination of FFR if it is in place.[1](Level 5)

ELASTOMERIC RESPIRATORS

- A feasibility study was undertaken to develop standard operating procedures (SOPs) for healthcare workers to disinfect reusable elastomeric respirators (reusable device with exchangeable cartridge filters) if supplies of N95 respirators are exhausted during pandemic conditions. It was noted that manufacturer's instructions alone were insufficient, for example, making no mention of using PPE for protection from disinfectants when cleaning and disinfecting respirators, or being printed in small font making it difficult to read. Standing operating procedures were developed for one healthcare worker to disinfect a single respirator at one time and final SOPs deviated from manufacturers' instructions to remove the strap before disinfection. It was demonstrated that daily cleaning and disinfecting of the straps for 45 days resulted in minimal loss of effectiveness. Authors concluded that the SOPs were an efficient method of rapidly deploying reusable respirators in the event of a large-scale airborne infectious disease outbreak.[8] (Level 2)

Characteristics Of The Evidence

This evidence summary is based on a structured search of the literature and selected evidence-based health care databases. The evidence in this summary comes from:

- Clinical practice guidelines.[1,2,7,9]
- A descriptive study involving 12 doctors and nurses from infectious diseases, respiratory/chest wards, and intensive care units.[3]
- Experimentally designed studies.[4,5,6]
- A feasibility study involving 21 nurses, nurse practitioners, aides, clinical technician and physicians.[8]

Best Practice Recommendations

- Surgical/medical facemasks should be used in line with manufacturer's instructions and local, state and federal requirements, such as being discarded after each patient encounter (when used as PPE for the protection of healthcare worker) or when they are soiled, damaged or difficult to breathe through (when used as source control). (Grade B)
- Where there is a critical shortage of facemasks or respirators, extended use may be considered but discarded whenever it is removed and at the end of each work day (for facemasks) or after multiple patient encounters (for respirators). (Grade B)
- Limited reuse of facemasks or respirators may be considered if shortage is severe and extended use alone is insufficient. However, for respirators, consideration should be given to switching to respirators that are designed for contamination and reuse (eg, elastomeric respirator) before proceeding with reusing. (Grade B)
- Decontamination with UVGI may be employed when reusing a respirator; however, VHP or moist heat may be considered in the absence of UVGI. (Grade B)
- Regardless of whether extended use or limited reuse of facemasks is being carried out, once a facemask or respirators becomes damp, soiled, damaged, or difficult to breathe through, it should be replaced and discarded immediately. (Grade B)
- A fit check and check of integrity should be undertaken every time the respirator is reused, with the respirator discarded whenever the fit check fails or macroscopic degradation is present. (Grade B)

- Strict hand hygiene should be adhered to when extending or reusing facemasks or respirators. (Grade B)
- Extended use and limited reuse of facemasks or respirators should be discontinued promptly when facemasks supply resumes. (Grade B)
- Healthcare workers should receive proper training on reusing or extending use of facemasks or respirators, if such use is warranted. (Grade B)

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Archived Publications

1. JBI-ES-2014-1 (Published at 12 October 2021)
2. JBI-ES-2014-2 (Published at 15 October 2021)

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For details on the method for development see Munn Z, Lockwood C, Moola S. The development and use of evidence summaries for point of care information systems: A streamlined rapid review approach. Worldviews Evid Based Nurs. 2015;12(3):131-8.