

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

Respiratory protection devices used in healthcare settings include: surgical masks (sometimes called medical masks); filtering facepiece respirators (FFR); elastomeric respirators; and powered air purifying respirators (PAPR).¹ Collectively referred to as respiratory protection, they are commonly used to protect healthcare workers against the transmission of respiratory infection.¹⁻⁴ The choice of respiratory protection depends on factors such as exposure level and work task; however, disposable FFRs are most commonly used in healthcare settings.¹ Surgical/medical masks are used to protect against pathogens (e.g. influenza virus, B. pertussis) transmitted by respiratory droplets (large-particle droplets > 5µ in size), generated by a patient who is coughing, sneezing or talking.¹ The FFR (with N95 [United States], FFP2/3 [Europe], P2 [Australia and New Zealand] and KN95 [China] filter) is capable of capturing greater than or equal to 95% airborne particles less than or equal to 5 µm in size (e.g. Mycobacterium tuberculosis) and is generally disposed of after a single use.^{1,4} Although respirator manufacture recommendations clearly state that the use of cleaning products may disqualify the filtering effects of the FFR, clinical evidence indicates decontamination, cleaning, and reuse of FFRs is being undertaken in situations (e.g. pandemics) where FFRs are in short supply.⁴

SURGICAL/MEDICAL MASKS

Medical/surgical masks are loose-fitting, disposable coverings worn over the nose and mouth – they are not respirators.^{1,2}

- Surgical/medical masks are not tight-fitting, and therefore may leave gaps where harmful particles may enter the mouth and nose. They do not provide protection for the healthcare worker against infectious aerosolized particles and must be discarded after each use and disposed of immediately upon removal.^{1,2} (Level 5)
- Once a surgical/medical mask becomes damp it must be replaced and discarded immediately.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 (> six hours) and 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 and not designed for extended use.¹ However, in certain circumstances healthcare workers reuse these types of FFRs or wear them for extended periods.⁴⁻⁸

- 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 twelve 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 than 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. EtO 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)
- Consensus based guideline recommendations for the extended use, and limited reuse, of FFRs in healthcare settings include the following:⁷ (Level 5)
 - FFRs may be reused under certain conditions in healthcare settings, including: wearing the same FFR for a series of close patient contacts and removing it at the end of each of the close patient contacts before it is discarded; or wearing the same FFR for multiple patient encounters without removal between patient visits (e.g. worn continuously on a shift, or for a few hours, especially in a situation where multiple patients are infected with the same respiratory pathogen). However, at any time an FFR becomes contaminated or damaged, or becomes difficult to breathe through, it must be discarded.
 - The Centers for Disease Control and Prevention (CDC) supports limited reuse of FFRs as a viable option for pathogens in which contact transmission (e.g. fomites) is not a concern. For example, during the care of a patient with tuberculosis, severe acute respiratory syndrome (SARS), or 2009 H1N1 flu.
 - It is not recommended that an FFR is reused, or its use extended, in situations where there is risk of infection from Avian Influenza A (H5N1) or AH7N9, or seasonal influenza if aerosol generating procedures are being undertaken (e.g. positive pressure ventilation, endotracheal intubation, airway suction, high frequency oscillatory ventilation, tracheostomy, chest physiotherapy, nebulizer treatment, sputum induction, and bronchoscopy).
 - In situations where patients are under contact precautions, such as those co-infected with common health care pathogens with the ability for prolonged environmental survival (e.g. Vancomycin-resistant enterococci, *Clostridium difficile*, and norovirus), it may be prudent for healthcare workers to discard FFRs between each close contact.

- Clinical practice guidelines provide additional recommendations regarding the extended use, or limited reuse, of FFRs:^{8,9} (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. Policies should take into account respiratory pathogen characteristics (e.g. routes of transmission, prevalence of disease in the region, infection attack rate, severity of illness, and current recommendations specific to the pathogen) and local conditions (e.g. number of disposable N95 respirators available, current respirator usage rate, success of other respirator conservation strategies).
 - Extended use, compared to reuse, is favored because it is expected to involve less touching of the respirator; therefore, lower risk of contact transmission.

ELASTOMERIC RESPIRATORS

An elastomeric respirator is reusable with cartridge filters that are exchangeable and the facepiece forms a seal against the face providing greater protection.¹ These respirators are disinfected with bleach and water allowing for reuse; however, alcohol may be used for disinfection between periods of patient care by wiping the exterior surface.¹ However, the elastomeric respirator is not commonplace in healthcare settings.¹

- 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 personal protective equipment (PPE) for protection from disinfectants when cleaning and disinfecting respirators, or being printed in small font making it difficult to read. SOPs 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.¹⁰ (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.^{1,2,8,9}
- A descriptive study involving 12 doctors and nurses from infectious diseases, respiratory/chest wards, and intensive care units (ICU).³
- Experimentally designed studies.⁴⁻⁶
- A literature review.⁷
- A feasibility study involving 21 nurses, nurse practitioners, aides, clinical technician and physicians.¹⁰

Best Practice Recommendations

- A surgical/medical mask should only be worn once (single use only) and discarded immediately after use. (Grade B)
- A surgical/medical mask may be worn for up to six hours of continuous wear and should be replaced when damp. (Grade B)
- Respirator (N95 or equivalent) lifespan should be extended rather than intermittently reused because it involves less touching of the respirator and therefore, less risk of contact transmission. (Grade B)
- Extended use of a respirator may be implemented when:
 - Multiple patients are infected with the same respiratory pathogen and patients are placed together in dedicated waiting rooms or hospital wards. (Grade B)
 - The healthcare worker undertakes a series of close patient contacts (e.g. worn continuously on a shift, or for a few hours, especially in a situation where multiple patients are infected with the same respiratory pathogen). (Grade B)
 - For pathogens in which contact transmission (e.g. fomites) is not a concern (e.g. during the care of a patient with TB, SARS, or 2009 H1N1 flu). (Grade B)

- Respirators should not be reused:
 - After aerosol generating procedures, where higher FFR contamination levels are likely to occur. (Grade B)
 - Where patients are under contact precautions, such as those co-infected with common healthcare pathogens with the ability for prolonged environmental survival (e.g., Vancomycin-resistant enterococci, Clostridium difficile, norovirus, and COVID19). (Grade B)
 - If it becomes contaminated or damaged or difficult to breathe through. (Grade B)
- If a respirator is reused, it should be decontaminated with UVGI; however, ethylene oxide (EtO) or VHP may be considered in the absence of UVGI. (Grade B)

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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.

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