

## N95 Respirator Alternatives and Conservation Strategies

### To the Editor

We read with great interest the article,<sup>1</sup> Utility of Substandard Facemask Options for Health Care Workers During the COVID-19 Pandemic, which highlights an important issue facing all health care workers (HCW). Anesthesia providers are especially vulnerable to shortages of personal protective equipment (PPE) as the American Society of Anesthesiologists (ASA) recommends appropriate PPE during all aerosol-generating procedures when working near the airway, such as endotracheal intubation.<sup>2</sup> To use optimal equipment,<sup>1</sup> the HCW must have knowledge of the advantages and disadvantages of the available options. We provide a summary for the conservation of N95 respirators and their alternatives (Figure).

### FILTERING FACEPIECE RESPIRATORS

#### Surgical N95

Conventionally known as medical N95s, these respirators require fit testing and are fluid resistant and rated in the removal of particulate matter. Historically, filtering facepiece respirators (FFRs) were considered single use, but in the pandemic context, the FDA issued Emergency Use Authorizations (EUA) for the decontamination of respirators. New N95 respirators remain the first choice before a decontaminated respirator.<sup>3</sup>

#### Industrial N95

Although industrial N95 respirators require fit testing and are not fluid resistant rated, HCWs are now turning to industrial N95s as a PPE option with the surgical N95 shortage. A full face shield can be worn over the industrial N95 to prevent fluid penetration.

#### Elastomeric Respirator

Elastomeric respirators are designed to be reusable and require fit testing. They have disposable and replaceable filters, inhalation/exhalation valves, and come in half facepiece and full facepiece masks. These elastomeric respirators are certified to provide protection equivalent or greater than N95 FFRs. Elastomeric respirators do not filter exhaled breaths. Elastomeric respirators are required to be cleaned and disinfected between users. Cleaning refers to the removal of soil from surfaces (eg, cosmetics and skin oils) using water and detergent. Disinfection eliminates all pathogenic microorganisms with liquid chemicals.<sup>4</sup> Filters need

to be replaced based on the biological agent to be filtered, the manufacturer guidelines, and the infection control policies of the hospital. In the era of universal masking, a procedure mask may be worn over the exhalation valve.

### POWERED AIR PURIFYING RESPIRATOR

Powered air purifying respirators (PAPRs) provide filtered, positive airflow to the wearer. PAPRs have the motor and blower unit on a belt with a large hose connecting to the head piece. This can be cumbersome and potentially dangerous for a disconnect. MAXAIR Controlled Air Purifying Respirators (CAPRs) are a proprietary form of PAPRs which rearranges the blower and motor unit to the head piece with only a thin cord connecting the headpiece to the belt with the battery pack. The Occupational Safety and Health Administration (OSHA) gives an assigned protection factor (APF) to respirators. PAPRs have the benefit of higher APF than N95 respirators, but they are limited by availability, contraindication to MRI suite due to ferromagnetic parts, and present debatable concerns for exhaust air flow around sterile fields.<sup>5</sup>

### RESPIRATOR CONSERVATION AND ALTERNATIVES STRATEGIES





#### N95 Extended Use Versus Limited Reuse

Extended use of an N95 respirator is defined as wearing the same N95 respirator for repeated encounters with several patients, without removing the respirator between encounters. Per the CDC, the maximum recommended period of use when practicing extended use is 8–12 hours.<sup>3</sup>

Limited reuse of an N95 respirator is defined as wearing the same N95 respirator for multiple encounters with patients and donning and doffing it in between encounters. The CDC suggests up to 5 uses to ensure an adequate safety margin.<sup>6</sup> Furthermore, the HCW should check the respirator for tears, strap breakage, and nosepiece fractures. HCWs should perform their own seal test with each donning and evaluate for increased breathing difficulties. Any of these signs may prompt the user to discard the respirator. A potential model for reuse is a 4- to 5-day cycle of 4–5 respirators in which the HCW wears a different respirator each day. Individual respirators are stored separately in their own paper bag at the end of the day. The HCW should don the next respirator in order of least recently used.

#### Reprocessed Surgical N95

Reprocessed N95s have been through a decontamination process. Under the FDA EUA, Battelle Critical Care Decontamination System was 1 process approved

Respirator Types	Description	Advantages	Disadvantages
<b>PAPR</b> 	<ul style="list-style-type: none"> <li>- Powers air through filter cartridges and delivers to breathing chamber for the wearer</li> </ul>	<ul style="list-style-type: none"> <li>- Higher APF than N95</li> <li>- Compatible fit for all face shapes and facial hair</li> </ul>	<ul style="list-style-type: none"> <li>- More costly than N95</li> <li>- Limited supply due to supply chain availability</li> <li>- Many models not MRI safe</li> <li>- Controversial risk of airflow contamination of sterile field</li> </ul>
<b>FFR</b> <i>Surgical N95</i> 	<ul style="list-style-type: none"> <li>- Conventionally known as N95s</li> </ul>	<ul style="list-style-type: none"> <li>- Removes ≥95% of airborne particles from the inhaled airstream of the wearer</li> <li>- Resistant to fluid penetration</li> </ul>	<ul style="list-style-type: none"> <li>-Historically single use</li> <li>-Limited availability</li> </ul>
<i>Industrial N95</i> 	<ul style="list-style-type: none"> <li>- Respirators with same filtration efficiency as surgical N95, but are not fluid resistant</li> </ul>	<ul style="list-style-type: none"> <li>-Potential for more access to new respirators</li> </ul>	<ul style="list-style-type: none"> <li>-Requires secondary covering (e.g. face shield) for fluid resistance</li> </ul>
<i>Elastomeric Respirator</i> 	<ul style="list-style-type: none"> <li>- Reusable respirators with replaceable filters/cartridges, have inhalation/exhalation valves and come in half facepiece and full facepiece</li> </ul>	<ul style="list-style-type: none"> <li>- Additional option for respirator providing equal or superior filtration compared to surgical N95</li> <li>- Ability to be fully cleaned, in addition to being disinfected</li> </ul>	<ul style="list-style-type: none"> <li>-Requires covering/filtering the exhalation valve</li> <li>-Time and labor-intensive cleaning and disinfecting process</li> <li>-Some users are sensitive to residual disinfectant on mask</li> </ul>
<b>Conservation Strategies</b>			
<b>N95 Extended Use</b>	<ul style="list-style-type: none"> <li>- Wear one N95 respirator for several patients without removing the respirator between patients</li> </ul>	<ul style="list-style-type: none"> <li>- User continues to wear same respirator so decreased risk of self-contamination with donning/doffing</li> </ul>	<ul style="list-style-type: none"> <li>-Impractical for comfort</li> <li>-Precludes eating and drinking for entire shift</li> </ul>
<b>N95 Reuse</b>	<ul style="list-style-type: none"> <li>- Wear one N95 respirator for multiple patients and don/doff respirator between each patient</li> </ul>	<ul style="list-style-type: none"> <li>-Extends use of respirator without need for chemical decontamination</li> <li>-Respirator has only been worn by one user and one user's face shape</li> </ul>	<ul style="list-style-type: none"> <li>-Risk contamination if not don/doffed and stored properly</li> <li>-Requires multiple respirators per person to be in circulation</li> <li>-Must monitor for signs of breakdown</li> </ul>
<b>N95 Reprocessed</b>	<ul style="list-style-type: none"> <li>- Respirators have been collected, sent off-site for a decontamination process and returned back to index user or to a pool of available respirators</li> </ul>	<ul style="list-style-type: none"> <li>-Additional respirators put back into circulation</li> <li>-Replenishes specific sizes and models which otherwise would be impossible to acquire due to supply chain disruptions</li> </ul>	<ul style="list-style-type: none"> <li>-Return to index user is labor intensive</li> <li>-Return to a pool has perceived stigma of being reused (sterilized but not washed)</li> <li>-May have inferior fit due to reshaping of metal nose piece</li> <li>-Must monitor for signs of breakdown</li> </ul>

**Figure.** N95 respirator conservation and alternatives. APF indicates assigned protection factor; FFR, filtering facepiece respirator; MRI, XXX; PAPR, powered air purifying respirator.

to decontaminate N95 respirators.<sup>2</sup> Approved N95 respirators are delivered to the decontamination site for a 4- to 8-hour process: respirators are hung in a

closed space, gased with hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) vapor, and left for a clearance phase during which H<sub>2</sub>O<sub>2</sub> is converted to oxygen and water vapor. The

decontaminated N95 respirators can be returned to the individual person “index user” or to a general pool of reprocessed respirators. Respirators should be marked after each decontamination cycle and disposed of after the maximum reprocessed number has been reached. The maximum number of cycles is a function of the specific decontamination protocol and type of respirator. An important distinction is that N95s are not cleaned. Cosmetic stains, blood contamination, and soiling on the respirator necessitate disposal, not decontamination. The respirators are quality checked and discarded for any visual markings.

### **Cleaning and Disinfecting Elastomeric Respirators**

Little guidance exists regarding the frequency of cleaning and disinfecting and whether these tasks should be centralized or performed by the individual user. OSHA guidelines for cleaning elastomeric respirators involve removing filters, disassembling facepieces, immersing in detergent, scrubbing, submerging in chlorine or iodine disinfectant agent, rinsing, drying, and reassembling.<sup>4</sup> This process would place a high time burden on individual HCWs. The alternative is to have the hospital batch clean and disinfect all elastomeric respirators. This poses an additional workload to sterile processing and incurs extra cost to purchase enough elastomeric respirators to be in circulation.

Hospitals may need to utilize a multipronged strategy to ensure an adequate PPE supply. The options presented here may have varying levels of success based on the hospital size, resources, and capacity for testing patients. However, one thing is universal: the utmost importance for HCWs to be protected.

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