

N95 Mask Decontamination



References

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Background

Due to the SARS-CoV-2 outbreak, the use of personal protective equipment (PPE) has dramatically increased. The virus is thought to be transmitted primarily through respiratory droplets, therefore disposable filtering facepiece respirators (FFRs) are an essential piece of PPE for healthcare providers (HCPs) and others working closely with individuals diagnosed with or exposed to SARS-CoV-2. These masks prevent transmission of infectious disease by direct inhalation or contact with the mucus membranes of the nose or mouth by filtering out pathogens. Disposable FFRs are negative pressure air purifying particulate respirators that differ from other respirators because the filtering media itself is the mask. To be a certified FFR, the mask must be NIOSH approved,

double strapped, and clearly labeled with both a letter designation (N,R,P) indicating resistance to oil degradation, and a number for filtering efficiency (95, 99, 100).¹ In a healthcare setting, masks rated as N95 are the most commonly used.² These FFRs are not resistant to oil (N) and block 95% (95) of airborne particle ≥ 0.3 microns.¹

The increased need for these masks, and decrease in availability, has resulted in requiring HCPs or their employers to ration masks for use. Although these masks were designed for one-time use, many HCPs are required to reuse the FFRs for organizations to maintain adequate protection for all workers and patients. In order to protect their employees and patients, institutions are seeking ways to sterilize these masks to ensure continuity of protection. A common, non-chemical method of sterilization is the use of ultraviolet (UV) light.

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How UV works

UV light is electromagnetic radiation with a wavelength range from 10nm to 400nm, falling between the wavelengths of visible light and x-rays. UV light is divided into three bands: UVA (315nm-400nm), UVB (280-315nm) and UVC (100nm-280nm).³ Radiation in the UVC range has been found to inactivate microorganisms primarily by damaging their genetic material. UV light can cause thymine bases to fuse together, therefore rendering the nucleotide sequence inactive.² This reaction keeps the viral particles from replicating. This feature of UVC radiation allows it to be used to sterilize workspaces, lab equipment, and medical devices.² Short-wave ultraviolet light, Ultraviolet germicidal irradiation (UVGI), has been shown to be effective for sterilizing, but efficacy is dependent on UV dose.⁴

Guideline recommendations

The CDC has issued FFR decontamination guidance for organizations as a crisis capacity strategy during the current pandemic.⁴

The recommendations emphasize that when possible, disposable PPE should not be reused, but that reuse may be necessary to ensure continued protection for HCPs.⁴

In their recommendations, the CDC has summarized research studies performed on different N95-rated FFRs using various sterilization techniques and protocols.⁴ Three methods have shown the most promise: UVGI, vaporous hydrogen peroxide, and moist heat.⁴

When using a sterilization method, the organization should consult the respirator manufacturer about the impact of the chosen method on the respirators before considering any method.⁴ If a manufacturer provides feedback about a protocol that can safely be used with their product, the sterilized FFR may be used in aerosol-generating medical procedures. However, if guidance is not



available from the manufacturer, FFRs can still be decontaminated, but should not be worn by HCPs during aerosol-generating procedures.⁴ Investigators cite concerns with reusing masks including damage to the material in the sterilization process, leading to ineffective filtration or fit, and the possibility that not all pathogens are eliminated from the device.⁴

It is important to note that results available from decontamination methods do not include data specific to the SARS-CoV-2 virus. Some studies have used the SARS-CoV-1 virus when evaluating FFR sterilization, but most studies use an influenza virus for testing.⁴

Even after decontamination, FFRs should be handled carefully.⁴ Prior to donning a decontaminated FFR, HCPs should clean their hands with soap and water or an alcohol-based sanitizer; avoid touching the inside of the FFR; use gloves when donning and performing a seal check; visually inspect the FFR for any evidence of damage or degradation of the filtration material, straps, nose bridge, or nose foam; perform a user seal check; and discard the FFR if a user seal check cannot be performed or is unsuccessful.⁴



References

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UVGI Efficacy

In FFR Sterilization protocols using UVGI, the dose of UV light varied, with a range of 0.5-1.8 J/cm². Antimicrobial efficacy was greater than 99.99% overall. Most studies looked at log reduction in pathogens, not complete elimination of pathogens. There may be limitations to efficacy in killing viral and bacterial particles due to shadow effects and the many layers of the FFR.⁴

A study done by the University of Nebraska Medical Center comparing 60mJ/cm² and 300 mJ/cm² UVC exposure reduced surrogate viral and bacterial organisms by a 6 log factor.⁵ The rationale for this dosing was based off a 2007 study in which single-stranded RNA viruses on surfaces were 99% inactivated by UVGI exposure of 2-5 mJ/cm².⁶

Durability

In the studies using UVGI, available studies protocols revealed 90-100% durability of the FFR after three rounds of UVGI sterilization.⁴

Protocols in Use

A protocol published by University of Nebraska Medical Center uses a 300 mJ/cm² dose of UV light. The protocol uses two UV-emitting towers in a room painted with reflective paint. UV light is applied until the in-room sensor reaches the target dose.⁵ Another protocol developed using a laboratory UV Crosslinker exposes each FFR to a dose of 1J/cm², running the process twice to decontaminate each side of the mask.⁷

How the Boekel UV Crosslinker is being used

The Boekel UV Crosslinker releases a controlled amount of UV radiation for various laboratory purposes. The device is typically used in molecular biology for crosslinking DNA or RNA in Northern or Southern blot analysis. It can also be used for UV curing and it can be used for UV sterilization and sanitation.⁸ The Crosslinker contains five 254nm bulbs, which can be replaced with bulbs of a different wavelength if desired. However, the 254nm bulbs are a suitable wavelength for UVGI.⁸ The unit has adjustable height bulbs, a UV blocking viewing window, and a stainless-steel interior chamber ideal for cleaning. The unit has two modes of operation, time-based and energy-based. In the time-based mode, the user can set the UV light to run for a set amount of time. In the energy-based mode, the unit uses an internal UV sensor to determine the UV cycle endpoint.⁸ Hospitals systems in the United States have been sourcing the Boekel UV Crosslinker because the device is an easily deployable solution for UV sterilization.



References

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