

# Utility of Substandard Face Mask Options for Health Care Workers During the COVID-19 Pandemic

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## GLOSSARY

**CDC** = Centers for Disease Control and Prevention; **COVID-19** = Coronavirus Disease 2019; **HCW** = health care worker; **NIOSH** = National Institute of Occupational Safety and Health; **SARS-CoV-2** = severe acute respiratory syndrome coronavirus 2; **WHO** = World Health Organization

With the emergence and exponential spread of Coronavirus Disease 2019 (COVID-19), the utility and recommendations of face masks and respirators (ie, N95 masks) for various populations have come into question.<sup>1-3</sup> Despite the World Health Organization (WHO) recommendation that the use of face masks is only for those caring for individuals with suspected COVID-19, or for those with active coughing or sneezing, inappropriate purchasing and use by the general public have led to a critically diminishing supply of face masks and respirators.<sup>3,4</sup> This limitation in supply is especially concerning, given the exponential increase in cases of disease from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) worldwide. Health care workers (HCWs), notably those in more impoverished countries, continue to be at particular risk and are faced with using substandard options.<sup>4-6</sup> The US Centers for Disease Control and Prevention (CDC) has suggested that the use of substandard options—including surgical masks, cloth masks, and extended use or reuse of respirators—can be considered, with exercised caution. In this commentary, we attempt to characterize the utility of and provide considerations for the use of these substandard face mask options by HCWs during the COVID-19 pandemic.

## VIRAL TRANSMISSION

The SARS-CoV-2 is a respiratory virus largely spread via droplet and possibly also airborne contact.<sup>1-6</sup> Viral spread largely occurs via exposure of the nasopharyngeal or oropharyngeal mucosa to microdroplets expelled from coughing and/or sneezing by infected individuals. Thus, those persons wearing standard surgical face masks are still at risk for droplet exposure via the lateral, unsealed portions of the face mask.<sup>4-6</sup> On the contrary, standard respirators approved by the National Institute of Occupational Safety and Health (NIOSH), namely N95 masks, are fit and seal tested to ensure filtration of at least 95% of airborne droplets. Few studies characterizing efficacy of cloth masks exist. To a lesser extent, viral transmission occurs by spread of microdroplets from contaminated surfaces onto the face, nasopharyngeal, and oropharyngeal mucosa. Therefore, most mask options are intended for single use only, and must be carefully doffed and disposed. In the setting of a pandemic, the reuse of respirators is also being entertained and warrants careful consideration.

## FILTRATION EFFICACY OF VARYING MASKS

Fit- and seal-tested respirators are considered the gold standard for personal protective equipment against droplet-transmitted infections.<sup>5,6</sup> The filtration efficacy of these respirators varies by manufacturer, but is also largely dependent on the size of the penetrating particles.

For context, the SARS-CoV-2 virion spherical diameter is reported to be approximately 125 nm, as estimated by cryo-electron tomography and cryo-electron microscopy.<sup>7,8</sup> Qian et al<sup>9</sup> report an approximate 99.5% filtration efficacy of N95 respirators for particles 750 nm in size. This filtration efficacy decreases to 95% for particles 100–300 nm in size. N95 respirators are sold by manufacturers only when a 95% filtration efficacy standard per NIOSH requirement is met. Similarly,

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N99 and N100 respirators correspond to 99% and 99.7% filtration efficacies for particles 100–300 nm in size, respectively.<sup>10,11</sup>

On the contrary, surgical face masks are not required to meet similar filtration efficacy standards to be sold. Depending on manufacturers and the use of NIOSH filtration standards, surgical face masks have widely reported filtration efficacies ranging from <10% to ≤90%. Aside from filtration efficacy, risk reduction associated with surgical masks is heavily reliant on good fit and facial seal.

### **SURGICAL MASKS**

MacIntyre et al<sup>12</sup> previously reported that the adherent use of surgical face masks or respirators was superior to not using either form of protection in preventing adults from contracting influenza in affected households. There was no appreciable difference in risk reduction between surgical face masks and respirators (N95 face masks). Interestingly, the benefit of either mask was significantly dependent on adherence of face mask use. Moreover, Aiello et al<sup>13</sup> observed that the risk reduction of viral contraction with surgical face mask use was significant with concomitant hand washing practices. Such findings collectively suggest that the adherent use of even suboptimal face masks, along with recommended hand washing practices, may provide meaningful decrement in the risk of contracting respiratory viral illnesses.

### **CLOTH MASKS**

Many resource-depleted settings are considering the utility of cloth masks, which are often reusable with washing. Cloth masks have been used historically, with variable reports of benefit.<sup>14,15</sup> The best evidence exploring cloth masks comes from a randomized trial in Vietnam that compared the risk of HCWs contracting respiratory viral illnesses using “medical face masks” (presumably equivalent to standard surgical masks) with cloth masks, which were described as 2-layer cotton masks.<sup>14</sup> Briefly, they found that HCWs in the cloth mask intervention arm had a relative risk of 13.0, in reference to those persons in the medical face mask group, for contracting influenza-like illnesses. The authors conclude that cloth masks should not be used when medical face masks are an option.

It should be noted that cloth masks are widely varied and provide varying potential benefit dependent on fabric type, construction, number of layers, and reuse, and cleaning practices.<sup>16</sup> While cloth masks are often manufactured and used in Asian countries, the utility of these cloth masks is also being considered for use in other resource-depleted settings.

Prototypes and benefit of cloth masks have been previously published.<sup>14–16</sup> Rengasamy et al<sup>16</sup> reported that pure cotton, pure polyester, and cotton/polyester

blend cloth masks were all significantly inferior to respirators in filtering out aerosol particles in the 100- to 300-nm range. They were unable to report superiority of any given fabric, but suggested that cloth masks may be comparable to some standard surgical masks, and the efficacy of cloth masks can be improved with appropriate face seal and fit.

In the COVID-19 pandemic, the Chinese State Council reports that masks are not necessary for persons at very low risk of infection, but that nonmedical masks, such as cloth masks, may be used.<sup>3</sup> CDC reports that cloth masks may be a necessary last-resort option only when respirators and surgical masks are unavailable.<sup>4</sup>

### **RESPIRATOR EXTENDED USE AND REUSE**

The US CDC defines extended use as the use of a single respirator across multiple, close-contact patient encounters without doffing and replacing in between patients.<sup>5</sup> It defines reuse as the repeat donning and doffing of the same respirator across multiple, close-contact patient encounters. Both options are inherently substandard to the single-use indications for conventional respirators.<sup>4,5</sup> The risks associated with these options are that of viral transmission via self-inoculation and direct contact after touching a contaminated respirator. Infectious spread with repeat respirator use is not limited to respirator reuse, but also to extended use. One study found that nurses touched their respirators an average of 25 times during a shift.<sup>17</sup>

CDC suggests that while extended-use practices may not decrease respiratory protection, disposal of used respirators should be considered if they are structurally compromised, directly exposed to bodily fluids, in close contact with infected patients, or after scenarios of significant aerosol production (ie, intubations).<sup>5</sup> The use of face shields is recommended to reduce surface contamination of the respirator. In addition, CDC recommends proper doffing and donning protocol, including the use of clean gloves to ensure proper seal and fit after donning to ensure respirator integrity and respiratory prevention with reuse.

### **CONCLUSIONS**

With the exponential spread of COVID-19, HCWs are faced with a diminishing supply of respirators (N95 masks). HCWs, especially those in more impoverished areas of the world, are faced with using substandard options such as surgical face masks, cloth masks, and even extended use or reuse of respirators.

Surgical masks afford varying degrees of respiratory protection, which can be optimized with proper face seal and fit and with proper handwashing techniques. Cloth masks carry unclear and variable benefit, and may be a last-resort option only when respirators and surgical masks are unavailable.

Respirator extended use and reuse can be utilized with compliance of above US CDC considerations to prevent viral transmission. ■■

#### DISCLOSURES

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