

Controversies in Respiratory Protective Equipment Selection and Use During COVID-19

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One contentious issue during the COVID-19 crisis has been the appropriate selection and use of respiratory protective equipment (RPE) for healthcare workers (HCWs) in hospitals and long-term care settings. As of April 2020, discrepancies exist in the recommendations from health authorities such as the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and Canadian Standards Association (CSA). The first of these recommends a surgical mask for routine care and a respirator for high-risk care such as aerosol-generating procedures, while the CDC recommends respirators for all aspects of patient care for these SARS-CoV-2-infected patients, and the CSA risk assessment tool would also result in selection of a respirator.¹⁻³

Given the contradictory guidance, we will discuss several important considerations for hospital leaders in the implementation of a healthcare respiratory protection program during the current pandemic, including a focused review of the empirical data on surgical mask vs face-fitted respirator (most commonly available in healthcare as N95 in North America), continuous use of the RPE throughout an entire shift vs targeted use when caring for patients, and key areas of uncertainty.

SURGICAL MASK OR RESPIRATOR

Surgical masks are traditionally used for protection against droplet transmission of respiratory infections, in which large droplets often fall to the ground within short distances; on the other hand, N95 respirators are used for much smaller airborne pathogens, which can remain suspended in the air for long periods of time. Although empiric studies have supported the superiority of respirators over surgical masks in simulated settings (frequently defined as a calculated concentration ratio outside vs inside the RPE), most clinical studies fail to demonstrate a difference in clinical outcomes such as the prevention of respiratory infection. For instance, an exposure study using saline aerosol to simulate viral particles showed that N95 respirators conferred up to 8 to 12 times greater protection against particulate penetration, compared with surgical masks.⁴ However, these advantages of respirators over surgical masks in

carefully controlled laboratory studies do not seem to translate to decreased infection risk in real-world settings.

The effectiveness of N95 respirators vs surgical masks in preventing respiratory infections has been evaluated in a small number of clinical randomized, controlled trials (RCTs). We identified five systematic reviews and/or meta-analyses published after 2010 and three RCTs published after 1990.⁵⁻¹² The RCTs used laboratory-confirmed respiratory virus or clinical infection in HCWs as a clinical outcome, but studies differed in the implementation of RPE use (ie, continuous or targeted use). In a systematic review and meta-analysis, Long et al identified six RCTs (9,171 participants) and concluded that, with the exception of laboratory-confirmed bacterial colonization, N95 respirators did not reduce the rate of laboratory-confirmed influenza, viral respiratory infections, or influenza-like illness among HCWs, compared with surgical masks.⁵ The authors noted risks of bias in these studies owing to the inability to blind and conceal allocation. In addition, the studies focused on infections that are known to transmit via droplet, such as influenza, so the results might not be applicable in the face of a new pandemic in which the important modes of transmission are not yet clear.

WHOLE-SHIFT OR INTERMITTENT USE

The evidence base evaluating continuous vs targeted use of RPE in healthcare settings is quite small. Continuous use refers to using the RPE during an entire shift, whereas targeted use involves using RPE only when caring for confirmed or suspected respiratory patients. In our literature review we identified only one RCT that included separate study arms for continuous and targeted N95 respirator use.¹³ The authors found a significantly lower rate of clinical respiratory illness among HCWs in the continuous-use group, compared with that in the targeted-use group. Limitations of the study included a relatively short follow-up of 4 weeks and uneven distribution of baseline characteristics, although the authors adjusted for these differences in their analysis. The study, however, did not compare continuous vs targeted use of surgical masks with regard to clinical outcomes. Based on the study results, we can only infer that continuous use of RPE, either surgical mask or N95 respirator, may provide additional benefit to HCWs vs targeted use only.

Given the lack of robust evidence informing continuous or targeted RPE use, we suggest some additional factors to guide decision making. In settings with high HCW compliance with

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universal RPE (above 50%), even noncompliant HCW are protected against clinical respiratory illness, which suggests a herd protective effect when universal RPE use is implemented, likely owing to the prevention of symptomatic or asymptomatic infectious spread among HCWs.¹⁴ It is important to note that the compliance rate may be limited by discomfort of prolonged wear of certain RPEs. One study reported that compliance rate is lower for continuous use (66%) than it is for targeted use (82%).¹³ Accumulated respiratory pathogen deposition on RPEs from an extended period of use that could result in self-contamination to the wearer is a potential concern, although these risks must be balanced against the repeated donning and doffing required by targeted use. Pilot studies examining viral particles left on surgical masks after being worn for entire shifts (or as long as tolerated) found that there were significantly more viral particles detected after 6 hours of continuous wear, which may increase the risk of self-contamination.¹⁵

UNCERTAINTIES

The current literature is applicable to infections that are known to spread via droplet contact, and this is a major limitation in generalizing the available evidence to the SARS-CoV-2 pandemic, in which debate persists regarding the exact mode of transmission. It is postulated that, even in infections traditionally considered to be spread by droplets, such as influenza, aerosol transmission may occur when HCWs are working in close proximity to the exposure source or when the droplet evaporates and becomes droplet nuclei. The United States National Academies of Science, Engineering, and Medicine expert consultation report, published in April 2020, concluded that current studies support the possibility of aerosolization of SARS-CoV-2 virus from normal breathing.¹⁶ As of April 2020, the WHO recommendation for SARS-CoV-2 is to use droplet contact precautions with a surgical mask for regular patient care and N95 respirator for aerosol-generating procedures.¹ Although we have not come across any studies specifically comparing the efficacy between surgical mask to N95 respirator protection while performing aerosol-generating procedures, a systematic review found that certain aerosol-generating procedures, such as endotracheal intubation and noninvasive ventilation, conferred a significantly higher risk of transmission of SARS-CoV-1 to HCWs in 2003.¹⁷ For the current crisis, the CDC is taking a cautious approach in which N95 respirators are recommended for HCWs caring for patients with confirmed or suspected SARS-CoV-2 infection if the supply chain is secure, with advice in place in times of RPE shortage, such as use of expired respirators, other types of equivalent respirators, or respirators not approved by the National Institute for Occupational Safety and Health, as well as optimization of administrative and engineering controls (eg, telemedicine, limiting patient and visitor numbers, physical barriers, optimizing ventilation systems).^{2,18} This advice is unusual in terms of deviating from advising the most appropriate RPE, and we presume it reflects the present global supply problems.

RPEs are only one component of a necessary personal protective equipment ensemble. Although eye protection

(goggles or face shields) is recommended by the WHO and CDC when caring for patients with SARS-CoV-2, there is considerable uncertainty regarding the incremental effectiveness of eye protection because such protection is usually worn in conjunction with RPE. A 2019 Cochrane review did not identify any good-quality studies that could inform judgments regarding the effectiveness of eye protective equipment,¹⁹ and a recent rapid review reporting on the efficacy of eye protection in primary care settings reached a similar conclusion.²⁰ A risk-based approach would be to include eye protection in a well-designed personal protective equipment program.

In the absence of aerosol-generating procedures, N95 respirators confer no additional benefit in preventing HCW respiratory infections when droplet transmission is suspected. However, the applicability of the available evidence is limited given the uncertainties surrounding SARS-CoV-2 transmission. When RPE may become scarce during a pandemic, the risk of potential self-contamination must be weighed against RPE conservation strategies. RPE compliance, herd-protection effects of routine RPE use, and RPE contamination from prolonged use are therefore important elements to consider when implementing hospital policies regarding universal masking because they all impact the potential effectiveness of RPE.

CONCLUSIONS

At the present time we lack definitive evidence on the effectiveness of surgical masks vs respirators and continuous vs targeted RPE use in the hospital setting for SARS-CoV-2. If our goal is to minimize risk of HCW infection, continuous use of N95 respirator could be considered. However, a more pragmatic solution in the setting of a limited supply of N95 respirators would be continuous use of surgical masks while engaged in clinical care of patients under investigation or with confirmed COVID-19.

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