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Editorial

Options for Personal Protective Equipment During the SARS-CoV-2 Pandemic Used in New Orleans, Louisiana

John C. Carlson, MD, PhD *New Orleans, La*

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has strained supplies and distribution of personal protective equipment (PPE). I have helped set up a drive-through COVID testing site, a COVID treatment facility within the New Orleans Convention Center, and a nursing home strike team, adapting infection prevention to settings that have experienced occasional shortages of all types of PPE in an early epicenter of COVID-19. These are strategies that have been used to bridge PPE shortages that may be useful for other clinical settings as patient clinic volumes increase and the breadth of inpatient work expands in the coming months. This Editorial reviews PPE regarding the hands, clothes, eyes, and nose/mouth (Table I).

HANDS

The tropism of respiratory tract pathogens make transmission of SARS-CoV-2 through skin unlikely[1]; thus, virus on hands is not directly dangerous. While respiratory syncytial virus is introduced into the respiratory tract when droplets are transferred to nose/eyes from contaminated hands,[2] the importance of fomite transmission varies with different viruses[3] and the relative importance of self-inoculation in SARS-CoV-2 is yet to be definitively determined. When considered as a vector, gloved hands are still able to transfer pathogens between sites and do not obviate the need for proper hand hygiene.[4] In Singapore, a study of 36 infected health care workers and 50 controls found that gowns and gloves were not found to be important in preventing the spread of the related virus SARS-CoV, whereas hand washing and N95 use was.[5] In Hong Kong, comparison of 11 health care workers infected with SARS-CoV with uninfected controls found only the use of masks (and not gowns, gloves, or handwashing) significant for infection prevention in the final model.[6] Because contaminated hands and surfaces are a mechanism by which some respiratory tract viruses spread[7] and, given the uncertainties of SARS-CoV-2 transmission, we require gloves for patient care for known patients with COVID-19. We discourage double gloving (which is more appropriate for blood-borne pathogens) and the use of gloves outside of patient care to conserve supply, emphasizing the need for frequent hand hygiene. The need for gloves when patients are not known to have SARS-CoV-2 is unclear.

CLOTHES

Standard disposable gowns recommended by the Centers for Disease Control and Prevention (CDC) when caring for patients with COVID-19 are doffed forward. When needed, we don front-opening gowns backward to maintain the forward-doffing approach that minimizes risk for self-contamination. Caution should be exercised if replacing forward-doffing gowns with garbage bags because these are designed to stretch; if used, the back side should be perforated beforehand to allow for forward-doffing. No covering should be removed over the head. Additional care must be taken with doffing coveralls (eg, Tyvek) to avoid self-contamination or contamination of the work environment. Workers unaccustomed to doffing coveralls have a partner assisting in reviewing the steps as doffing occurs. Clothing protection should be used when treating confirmed or suspected patients with COVID-19; it remains unclear whether clothing protection should be used in clinical encounters where SARS-CoV-2 infection is unknown.

EYES

We require goggles or face shields when coming within 6 ft of patients with COVID-19 to protect eyes from airborne droplets. The most important properties of protective eyewear are transparency of the material and comfortable fit that holds the shield in place. Face shields may also reduce N95 mask contamination. We have found that disposable face shields in common use are easily decontaminated without reducing visibility or fit through several cycles. We have used dilutions of standard household bleach (1 cup in 3-gallon water bath), 70% or greater concentrations of alcohol (produced by local distilleries), and quaternary ammonium (commercially used by companies routinely performing decontamination of medical facilities) for decontamination of disposable face shields. The former 2 options take longer to dry; the latter requires manual wiping to remove residue from the face shields before use. These options, along with alternates, are recommended by the US Environmental Protection Agency for decontamination of SAS-CoV-2.[8] 3D printed and laser-cut face shields work well but are less comfortable. These have become readily available from volunteers. In our experience with various designs, these are best used for short patient encounters of 30 minutes or less due to the discomfort of sustained use. Devices that combine respirator and eye protection may be useful when performing aerosol-generating procedures but limit the user's ability to communicate with others or are not

Tulane University, New Orleans, La
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Corresponding author: John C. Carlson, MD, PhD, Tulane University, 1430 Tulane Ave, SL-37, New Orleans, LA 70112. E-mail: John.Carlson@tulane.edu.
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TABLE I. Standard PPE elements and alternatives

Type	Hands	Clothes	Eyes	Nose/mouth
Standard	Gloves + hand hygiene	Front-doffing gown	Face shield	N95
Alternative	Hand hygiene alone	Alternate gowns, coveralls	Decontaminated face shield, goggles	Recycled N95 Verified KN95, FFP2, universal surgical mask use

readily available. Use of face shields should be considered in treating patients who are sneezing or coughing.

NOSE/MOUTH

N95 masks remove 95% of droplets 0.3 to 0.5 microns in size. Infectious droplets are ejected into the air near patients who cough, sneeze, and potentially when they speak, and we require N95s for all workers entering within 6 ft of potentially infectious patients. Critical features of N95 masks are the ability to filter these very small particles and the fit of the mask, which prevents unfiltered air from being inspired through leaks. There are similar standards globally in certifying masks (eg, KN95 masks in China and FFP2 masks in Europe), and it is useful to review these alternatives described by the CDC for times when National Institute of Occupational Safety and Health-approved N95 masks are unavailable.[9] We, as well as other hospitals, have received counterfeits. Those procuring supplies should become familiar with the process of verifying certificates of these products. A wide variety of community-created masks have been proposed as alternatives to N95s but fail to provide adequate filter and/or fit. At the minimum, candidates should pass standard fit testing. We have tried various models in New Orleans and have yet to find a community-created mask capable of passing a fit test.

Shortages of N95 masks have prompted alternative strategies to preserve N95 use for the most critical procedures. The CDC and the Joint Commission on Accreditation of Healthcare Organizations have suggested use of standard surgical masks for procedures where aerosolization is unlikely, as one N95-preserving measure. Surgical masks have filtering functions but not fit, meaning that infectious particles will be inhaled through the gaps in the mask. Surgical masks were designed to prevent infection coming from the surgeon to the patient, and not as PPE protecting the surgeon, though they are now being endorsed as such. The CDC has issued descriptions of reuse strategies to further conserve N95 masks. N95 reuse has become common as supplies are depleted and supply chains are themselves unstable. A common strategy involves the reuse of a mask for an individual patient over multiple visits. For example, the worker uses a fresh mask in the morning, doffs the mask being careful not to touch the inside of the mask, and then reuses the mask when seeing the patient later that day. This increases the risk to the health care worker if the inside of the mask becomes contaminated during the doffing or redonning process. To redon a contaminated mask, gloves are commonly worn, depleting glove supplies. Extended use refers to the continuous use of a single N95 while seeing multiple patients. Because the mask is not removed between patients, risk of self-contamination is low and we have adopted this practice. If the outside of the mask becomes contaminated from inspired air, it is theoretically possible for infectious particles to be ejected back into the ambient air, posing a risk to new patients. Experiments suggest that the likelihood of this happening is low.[10]

Decontamination of masks allows a mask to be reused with minimal risk to the worker or patient. Decontamination can be achieved without compromising the fit or filter of masks using vaporous hydrogen peroxide, ultraviolet germicidal irradiation, and moist heat.[11] Theoretically, masks could be returned to use within the same day. Transport of the mask between sites and processing makes a several day turnaround more common. An additional approach to decontamination is allowing sufficient time to elapse between use for the virions to become noninfectious based on viability studies.[12] The CDC suggests a 5-day interval between uses. As with other methods of decontamination, it is important to discard the mask if there is gross contamination, or if inhalation while wearing the mask fails a user-seal test.[9] We do not allow mask reuse within a shift but save all masks for 5 days in paper bags to be reused. (A nurse using 4 new N95s in a shift will reuse these 4 N95s 5 days later.) This strategy may be useful in other clinical settings where patients are coughing and sneezing.

PPE shortages and fluctuations in the supply chain have added to the overall uncertainty of working during this pandemic. As clinical services, businesses, and educational facilities reopen, the availability of specific PPE elements may vary. Prioritizing protection against airborne droplets and fomite transmission may require creative adaptation in the coming months. It is my hope that these approaches used in New Orleans will be useful to others adapting infection prevention strategies to their environments.

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