Conserving Supply of Personal Protective Equipment—A Call for Ideas

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The editors of JAMA recognize the challenges, concerns, and frustration about the shortage of personal protective equipment (PPE) that is affecting the care of patients and safety of health care workers in the US and around the world. We seek creative immediate solutions for how to maximize the use of PPE, to conserve the supply of PPE, and to identify new sources of PPE. We are interested in suggestions, recommendations, and potential actions from individuals who have relevant experience, especially from physicians, other health care professionals, and administrators in hospitals and other clinical settings. JAMA is inviting immediate suggestions, which can be added as online comments to this article.

Note: The online version displays comments from the initial publication. It is now closed to new comments and suggestions.

Sourcing Personal Protective Equipment During the COVID-19 Pandemic

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As the coronavirus disease 2019 (COVID-19) pandemic accelerates, global health care systems have become overwhelmed with potentially infectious patients seeking testing and care. Preventing spread of infection to and from health care workers (HCWs) and patients relies on effective use of personal protective equipment (PPE)—gloves, face masks, air-purifying respirators, goggles, face shields, respirators, and gowns. A critical shortage of all of these is projected to develop or has already developed in areas of high demand. PPE, formerly ubiquitous and disposable in the hospital environment, is now a scarce and precious commodity in many locations when it is needed most to care for highly infectious patients. An increase in PPE supply in response to this new demand will require a large increase in PPE manufacturing, a process that will take time many health care systems do not have, given the rapid increase in ill COVID-19 patients.

In its current guidance to optimize use of face masks during the pandemic, the Centers for Disease Control and Prevention (CDC) identifies 3 levels of operational status: conventional, contingency, and crisis. During normal times, face masks are used in conventional ways to protect HCWs from splashes and sprays. When health care systems become stressed and enter the contingency mode, CDC recommends conserving resources by selectively canceling nonemergency procedures, deferring nonurgent outpatient encounters that might require face masks, removing face masks from public areas, and using face masks for extended periods if feasible.

When health systems enter crisis mode, the CDC recommends cancellation of all elective and nonurgent procedures and outpatient appointments for which face masks are typically used, use of face masks beyond the manufacturer-designated shelf life during patient care activities, limited reuse, and prioritization of use for activities or procedures in which splashes, sprays, or aerosolization are likely. When face masks are altogether unavailable, the CDC recommends use of face shields without masks, taking clinicians at high risk for COVID-19 complications out of clinical service, staffing services with convalescent HCWs presumably immune to SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), and use of homemade masks, perhaps from bandanas or scarves if necessary.

Many communities in the US and globally are rapidly entering crisis mode. Popular news outlets report unconventional solutions for PPE at local hospitals, such as plastic garbage bags for gowns and plastic water bottle cutouts for eye protection. Plans for resupply through the repurposing of industrial capacity and other means are welcome but seem unlikely to solve the
shortage quickly enough as supply chains become more dysfunctional in the pandemic. A frequent proposal was to acquire PPE from existing supplies in non-health care industries and settings such as construction, research laboratories, nail salons, dentists, veterinarians, and farms, and redirect them to the health care system via charitable appeals, community organizing, financial incentives, or government mandate. One endeavor is Project N95, a national COVID-19 medical equipment clearinghouse to identify high-need regions and to source and distribute PPE and other equipment where it is needed most.

Numerous proposals suggested sterilization of used PPE with agents ranging from ethylene oxide, UV or gamma irradiation, ozone, and alcohol. There were also novel proposals such as mask-fiber impregnation with copper or sodium chloride. These are not new ideas; work was performed after prior viral epidemics to determine the feasibility of sterilizing PPE. Most commenters acknowledged uncertainty about the effects of these sterilizing agents on the structural integrity of PPE, and there is some evidence the fibers in masks and respirators that filter viral particles can degrade and lose their efficacy with PPE reprocessing.

A few people advocated for use of positive pressure airflow helmets; proposals ranged from creating devices from plastic bags insufflated using compressed air and nasal cannula tubing to adoption of commercially available devices used...
in the welding industry. An advantage of this approach is that by not relying on filters, positive airflow devices can be cleaned and reused indefinitely.

Many proposals reflect an era when PPE was made of cloth and laundered. Health care might have been greener if reusable PPE was employed where feasible. Cloth gowns and masks are easily created and stored, and laundry capacity could easily be expanded by recruiting commercial launderers that service hotels and other large organizations who currently sit idle. Many contributors wrote of sewing masks, creating them out of clothing, using novel materials to make them, and using cloth sleeves to extend the use of N95 respirators. As with re-sourced material, most commenters acknowledged uncertainty about the ability of these handmade solutions to filter infectious agents and weather repeated cleaning, although common sense suggests they are better than no PPE at all.

High-grade filters used in respirators such as N95 devices exist in many commercial products. Some ideas involved creating masks from air-conditioning filters or vacuum cleaner bags. These plentiful and commercially available household antiallergen filters have a MERV (minimum efficiency reporting value) rating for their filtering efficiency of 13 or 14, meaning they will reduce the flow of particles larger than 0.3 μm by 50% or 75% respectively. N95 respirators are 95% efficient for these particles and equivalent to a MERV 16 filter. Although the SARS-CoV-2 particle is smaller than 0.2 μm, the water droplets carrying it are larger and largely blocked by these filters. Several commenters suggested using snorkel masks and tubes, which are easily cleaned and reused, and could efficiently use home-sourced filter material placed on the end of the tubing for added protection.

Conservation of existing PPE is important, as recommended by the CDC. Some commenters called for suspending practices that consume large amounts of PPE and are of uncertain effectiveness, such as contact precautions for some infectious diseases, to free up supplies. The idea of using HCWs who have recovered from clinical illness or who have stayed healthy but test positive and are presumed immune and are no longer infectious is an age-old and appealing solution. Hoarding of PPE and other supplies has occurred during the current COVID-19 pandemic, and some proposals suggested rationing or controlling the supply chain through limited, controlled allocation of supplies, a Pyxis-like administration system or regional coordination, for example.

These and scores of other comments are insightful, many have references, provide links to websites and videos with illustration and instructions, and readers should spend time determining which, if any, might best fit their needs and situations. But the ingenuity displayed in the contributions needs to be placed in context. First, few of the ideas can be successful independent of the broader health care enterprise and its vulnerabilities. The commonly suggested process of cohorting low-risk patients for PPE preservation, for example, requires rapid testing to be accurate and efficient, a requirement regrettably not yet met in most US health systems. More important, PPE shortages are a problem for HCWs, but not a problem HCWs are trained to address or should be expected to solve; it’s become cliché to point out that firefighters are not asked to source their own equipment before entering burning buildings. Hospital administrators, health system media relations departments, university leadership, elected officials, and government agencies have a role to play in reaching out to suppliers and organizing a response and develop a reliable supply system. Hospitals successful at procuring supplies should employ rational use of PPE. Better-resourced institutions and some clinician advocates have considered policies requiring all staff to wear face masks in public spaces regardless of high-risk exposures, despite little evidence that this is a judicious use of resources.

JAMA will continue to offer commenting on COVID-19 articles so that clinicians may share their experiences and ideas regarding how to best get through the COVID-19 crisis. When health systems pass this stress test, the operations, organizations, and profession will have learned a thing or two, and be stronger for it.

**ARTICLE INFORMATION**

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**REFERENCES**


