

## Finding the Value in Personal Protective Equipment for Hospitalized Patients During a Pandemic and Beyond

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**D**uring an infectious disease outbreak, enhanced infection control measures are the best line of defense against disease transmission among health-care workers.<sup>1</sup> The use of personal protective equipment (PPE) is one such measure, occurring alongside other preventive precautions including hand hygiene, environmental cleaning, enhanced education, and antimicrobial stewardship efforts (collectively, "transmission-based precautions").

Because of the pandemic spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the cause of COVID-19, there is significant disruption to the global supply of PPE.<sup>2</sup> Order volumes of PPE have increased, prices have surged, and distributors are experiencing challenges meeting order demands.<sup>3</sup> With decreased overseas exports, suppliers have placed hospitals on PPE allocations, and many hospitals' orders for PPE have been only partially filled.<sup>3,4</sup> Unless hospitals have established stockpiles, most only have supplies for 3 to 7 days of routine use, which leaves them vulnerable to exhausting PPE supplies. At the onset of the pandemic, 86% of United States hospitals reported concerns about their PPE supply.<sup>4</sup>

The potential for PPE shortages has led both the Centers for Disease Control and Prevention (CDC) and the World Health Organization to call for the rational and appropriate use of PPE in order to conserve supplies.<sup>2,3</sup> By the time COVID-19 was declared a pandemic, 54% of hospitals had imposed PPE conservation protocols,<sup>4</sup> with more expected to follow in the weeks and months to come. Innovative protocols have been conceptualized and used to conserve PPE in hospitals (Table).

Yet these conservation protocols often fail to identify missed opportunities to improve the value of PPE that already exist in hospital care. By defining the value of inpatient PPE, hospitals can identify opportunities for value improvement. Changes implemented now will maximize PPE value and preserve supply during this pandemic and beyond.

### THE VALUE OF PPE

In order to conserve PPE supply, hospitals might consider limiting PPE to cases in which clear evidence exists to support

its use. However, evidence for PPE use can be challenging to interpret because the impact of preventing nosocomial infections (an outcome that did not occur) is inherently problematic to measure. This makes assessing the value of PPE in preventing nosocomial transmission in specific situations difficult.

The basis of using PPE is its effectiveness in controlling outbreaks.<sup>1</sup> A meta-analysis of six case-control studies from the SARS-CoV outbreak of 2003, which disproportionately infected healthcare workers, suggested that handwashing and PPE were effective in preventing disease transmission. Handwashing alone reduced transmission by 55%, wearing gloves by 57%, and wearing facemasks by 68%; the cumulative effect of handwashing, masks, gloves, and gowns reduced transmission by 91%.<sup>5</sup> A cohort study of healthcare workers exposed to the H1N1 influenza A of 2009 found that use of a facemask or an N95 respirator was associated with negative viral serology suggesting noninfected status.<sup>6</sup> With respiratory syncytial virus (RSV) outbreaks, a narrative synthesis of four studies examining transmission also suggested gowns, facemasks, and eye protection are effective, with eye protection perhaps more effective than gowns and masks.<sup>7</sup> Yet these studies' conclusions are limited by study design differences and small sample sizes.

The evidence supporting PPE use for routine hospital conditions is more challenging to interpret. One pediatric study of seasonal respiratory viruses showed that adding droplet precautions to an existing policy of contact precautions alone decreased nosocomial infections for most viruses evaluated.<sup>8</sup> Yet this study, like many of PPE use, is limited by sample size and possible misclassification of exposure and outcome biases. Because PPE is always utilized in conjunction with other preventive measures, isolating the impact of PPE is challenging, let alone isolating the individual effects of PPE components. In the absence of strong empirical evidence, hospitals must rely on the inherent rationale of PPE use for patient and healthcare worker safety in assessing its value.

In order to protect patients from disease transmission during a pandemic, hospitals might also reconsider whether to use PPE in cases in which evidence is absent, such as routine prevention for colonized but noninfected patients. However, evidence of the possible patient harms of PPE are emerging. Healthcare providers spend less time with isolated patients<sup>9,10</sup> and document fewer vital signs.<sup>11</sup> Patients in PPE may experience delays in admission<sup>12</sup> and discharge<sup>13</sup> and have higher rates of falls, pressure ulcers, and medication errors.<sup>14,15</sup> They may also experience higher rates of anxiety and depression.<sup>16</sup>

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**TABLE. Institutional Strategies for Conservation of Personal Protective Equipment (PPE) during the COVID-19 Pandemic,<sup>a</sup> From Least to Most Burdensome**

Limit large group rounding.	
Dismiss nonessential personnel, such as medical and nursing students.	
Cluster care.	<p>Providers can offer to perform nursing tasks during daily rounds so that nursing colleagues may remain outside the room:</p> <ul style="list-style-type: none"> <li>Administering medications</li> <li>Checking vital signs</li> <li>Assessing intravenous lines</li> <li>Assessing technologies</li> <li>Bringing requested bedside items</li> </ul> <p>Team members can offer to perform pharmacy, social work, and other ancillary care tasks in the same way.</p>
Call patients instead of revisiting bedside.	<p>Using hospital phones, hospital-provided iPads, patient cell phones, or video chats to do the following:</p> <ul style="list-style-type: none"> <li>Check in with patients</li> <li>Ask clarifying questions</li> <li>Provide plan-of-care updates</li> <li>Respond to requests or needs whenever possible</li> </ul>
Encourage consultants to use telemedicine or phone calls whenever possible for clinical assessments.	
Discharge COVID-19 and non-COVID-19 patients from the hospital as soon as medically ready for discharge.	
Create separate care teams and units assigned to known/suspected COVID-19 cases, as permitted by staffing structures, to minimize transmission.	
Reallocate a portion of sterile surgical gowns, gloves, and masks for nonoperating-room use.	
Reuse PPE.	<p>Reuse disposable goggles with intermittent device sanitization between patients.</p> <p>If permitted by your hospital, follow CDC Crisis Strategies<sup>b</sup>:</p> <ul style="list-style-type: none"> <li>Use N95 respirators beyond the manufacturer-designated shelf life.</li> <li>Wear the same N95 respirator for repeated close encounters with several different patients, without removing the respirator.</li> </ul> <p>If permitted by your hospital:</p> <ul style="list-style-type: none"> <li>Wear the same surgical/droplet mask for repeated close encounters (data are less robust; however, it may still be an appropriate practice).</li> </ul>
Evaluate all known/suspected COVID-19 cases using the same PPE before doffing to see nonsuspected cases.	
Temporarily suspend PPE use for patients colonized with multidrug resistant organisms.	

<sup>a</sup>Institutions should consult with their individual infection preventionist for PPE conservation procedures.

<sup>b</sup>Centers for Disease Control and Prevention. Checklist for Healthcare Facilities: Strategies for Optimizing the Supply of N95 Respirators during the COVID-19 Response. [www.cdc.gov/coronavirus/2019-ncov/hcp/checklist-n95-strategy.html](http://www.cdc.gov/coronavirus/2019-ncov/hcp/checklist-n95-strategy.html). Accessed March 16, 2020.

Yet no evidence suggests PPE use for noninfected patients prevents transmission to patients or to healthcare workers. Using PPE when it is not indicated de-emphasizes the value of other preventative precautions (eg, handwashing), unnecessarily depletes PPE supply, and may create patient harm without added benefit. High-value PPE, both during a pandemic and beyond, is defined by a system designed such that healthcare workers use PPE when they need it and do not use PPE when not indicated.

## ORDERING PPE IN A COMPLEX HEALTHCARE ENVIRONMENT

While all hospitalized patients are admitted using standard precautions, decisions surrounding PPE can be nuanced for even experienced clinicians. Although the CDC does provide guidance for PPE use based on symptoms that correlate with potential for transmission (eg, patients with cough should be

placed in at least droplet precautions),<sup>1</sup> guidelines must rely on provider evaluation and interpretation. For instance, three etiologies of cough—pneumococcal pneumonia, RSV bronchiolitis, and pulmonary tuberculosis—would all require different PPE. The clinician must weigh the probabilities of each pathogen and assess the harm of not protecting against certain pathogens in his or her decision.

Amid the stress and cognitive burdens placed on clinicians, accuracy in PPE decisions is easily deprioritized. Clinicians may not completely consider patient-specific indications for PPE, implications for patients and staff, and supply shortages. Although the CDC and many hospitals have PPE initiation and discontinuation criteria, clinicians may favor educated guesswork and reliance on past experience when guidelines are poorly accessible or poorly searchable. Such individual, nonstandardized decisions likely lead to variability in practice patterns, inaccuracies in PPE decisions, and ultimately waste of PPE resources.

## WHERE OUR HOSPITAL USES PPE IN A LOW-VALUE WAY

At our institution, the inconveniences, cognitive burden, and perceived benefit of routine PPE interventions have created a system in which PPE is regularly overused. On our hospital medicine wards, we found that PPE was both overordered on admission (eg, contact/droplet precautions ordered for influenza when droplet precautions only would have sufficed) and unnecessarily continued even after children met discontinuation criteria.

On discharge review from our general pediatric ward in 2019, 18% of children discharged with PPE orders no longer met criteria for PPE. Two conditions—community-acquired bacterial pneumonia and skin and soft-tissue infections—accounted for 47% of discharges with unnecessary PPE orders. At an estimated cost of \$0.13 to \$0.53 for droplet precautions per use, \$0.69 for contact precautions, and \$0.82 to \$1.22 for both, the absolute cost of continuing PPE without indication could be as high as \$61/day per patient when estimating 50 uses per day. This direct cost represents healthcare spending without added value when PPE are not necessary. Furthermore, the additional emotional cost to the patient and family in their hospitalization experience, the cost of clinician time donning and doffing, the environmental cost of PPE waste, and the cost to the limited PPE supply are not considered in these calculations.

During a pandemic characterized by PPE shortages nationwide, allowing missed opportunities for PPE discontinuation to persist is not only wasteful, but inattentive to public health.

## OPPORTUNITIES FOR HOSPITALS TO MAXIMIZE THE VALUE OF PPE

For individual clinicians, opportunities exist to improve PPE usage in daily patient care. Clinicians should not overlook PPE decisions; instead they should make it a practice to review PPE orders daily during rounds as they would lab orders. Clinicians and nursing staff should work together to identify PPE discontinuation opportunities, leveraging the electronic medical record when possible. For the benefit of patients and families, clinicians and bedside staff should recognize and assist in managing patient expectations of PPE.

Hospitals should work to make PPE references easily accessible and interpretable by frontline clinicians. To minimize variability of use, PPE ordering for routine conditions should be standardized and streamlined, including discontinuation criteria. Hospitals should invest in behavioral health programs to support patients with conditions necessitating PPE and develop policies to ensure ancillary services are equally available to all patients. To alleviate concerns about limited clinician time spent with isolated patients, hospitals should assign clinician workloads while accounting for the known increased time needed to care for patients with PPE.

For hospitals with extreme supply shortages, conservation might include decreased use of PPE for conditions in which its use is controversial (eg, patients colonized with methicillin-resistant *Staphylococcus aureus* or multidrug resistant organisms) as has been trialed in institutions prior to this pandem-

ic.<sup>17,18</sup> Such PPE policy changes might occur in addition to, or in conjunction with, the conservation strategies suggested by other institutions (Table).

Healthcare systems should continually reassess the value of PPE for their hospitals and make changes accordingly. In the midst of difficulties directly demonstrating PPE's value, hospitals must rely on the inherent rationale of PPE use in assessing value decisions weighed against harms while balancing healthcare worker protection regulations. Decisions should always occur while continuing other sensible infection-control procedures, such as handwashing and environmental hygiene measures.

To effect maximal change, healthcare systems should invest in redesigning PPE ordering systems at the highest level. This should include harnessing existing technologies to streamline PPE ordering decisions to meet clinicians' cognitive needs. Decision support and auditing technologies could automate and monitor PPE orders efficiently. Likely to be most effective, an investment in creating and maintaining centralized PPE expert management teams to assess, order, and discontinue PPE would minimize individual ordering variation, minimize cost, and maximize value to patients, staff, and hospitals.

## CONCLUSION

In this pandemic, we have the opportunity to rethink how we understand and use PPE in hospitalized patients. It is vitally important now more than ever to consciously conserve the limited supply of PPE resources. As we seek to increase healthcare value while limiting overuse and waste, PPE is a prime target for value-improvement efforts as the effective but also burdensome tool that it is. Hospitalists are well positioned to lead the redesign of how, when, and why PPE is used and to create a more optimized, lasting system that provides maximal value to patients, families, and healthcare workers during this current crisis and beyond.

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