Clinical Challenges in Isolation Care
Researchers reflect on safe and not-so-safe practices of nurses at the bedside.

OVERVIEW: In 2014, the authors published the results of a study investigating nurses’ use of personal protective equipment (PPE) in the care of a live simulated patient requiring contact and airborne precautions. The 24 participants were video-recorded as they donned and doffed PPE. Variations in practices that had the potential to cause contamination were noted. In this article, the authors comment on those variations, analyzing each element of proper PPE protocols and examining why the behaviors are a safety concern for the nurse and a potential risk for disease transmission in the hospital or other clinical area. The authors note that making use of reflective practice for complicated care situations such as infection control may help nurses improve decision making in isolation care.

Keywords: infection-control practices, isolation precautions, personal protective equipment

The recent outbreak of Ebola in West Africa—with several patients treated in U.S. hospitals, including two nurses infected at a hospital in Texas—turned a media spotlight on health care workers’ use of personal protective equipment (PPE). Late last year, the Centers for Disease Control and Prevention (CDC) issued new recommendations for PPE in Ebola cases, which place greater emphasis on the sequence in which clinicians don and doff PPE.1-3

Nurses and patients in clinical care environments may be exposed to a variety of potential safety threats—from dangerous pathogens, drug-resistant bacteria, and hazardous drugs, among other sources—and routes of transmission. Nurses routinely use PPE, including gloves, gowns, eyewear, and masks, among other items, to protect themselves and their patients.4, 5

The importance of health care workers’ use of PPE has been highlighted in other recent disease outbreaks, including severe acute respiratory syndrome (SARS) in 2003 and the influenza A (H1N1) pandemic in 2009. A review of a cluster of SARS cases among health care workers in Toronto showed that poor decisions about the use of PPE during aerosol-generating procedures, inconsistent use of PPE, fatigue, and inadequate infection-control training were associated with transmission.6 After the H1N1 pandemic, a cohort study of California health care workers showed that the use of respiratory protection mitigated transmission of influenza.7

Still, compliance with even more basic infection-control practices such as hand hygiene and standard precautions—the minimal infection-control practices in caring for patients, regardless of their diagnosis—is often suboptimal in many settings.8, 9 The recent Middle East respiratory syndrome coronavirus (MERS-CoV) infections in the United States among traveling health care workers have demonstrated the continued need for preparedness in hospitals related to infection-control measures.10

But the 2014 outbreak of Ebola virus in West Africa11 and the subsequent handling of Ebola patients have garnered unprecedented media attention to nurses’ use of PPE. Media attention has speculated that transmission among nurses and other health care workers could be traced to improper donning or doffing protocols, as well as to inadequate resources necessary to treat such patients safely. Many facilities are now reviewing or establishing protocols to effectively protect nurses and other health care workers.12, 13

The terms used to describe the types of isolation precautions have changed many times in the past 50 years, but the categories of standard, contact, airborne, and droplet are widely recognized today.14 In many countries affected by SARS, recommendations varied on the sequence of PPE removal.15 The original CDC PPE doffing protocol was tested in a human challenge study using contamination of PPE with a nonpathogenic virus; it found the protocol insufficient to protect the health care worker from viral
contamination of the clothes and hands during doffing, but no subsequent amendments to the guideline were made. Instructions for application and removal of PPE from the World Health Organization and the Public Health Agency of Canada's pandemic guideline differ slightly from those of the CDC, but most components are consistent among them (see Table 1). Nurses continue to navigate the challenges of safely using PPE, despite the clinical challenges of providing nursing care while wearing PPE. Challenges vary but include the development of exposed skin between the cuff of the isolation gown and gloves or what to do with contaminated reusable items such as goggles and gowns once the clinical care is complete.

The H1N1 pandemic of 2009 increased interest in infection-control behaviors among health care workers. Investigations included pediatric resuscitation simulations with a known influenza diagnosis and observational studies of real patients with febrile respiratory illness. Both studies found a lack of self-protective behaviors and poor adherence to isolation precautions. A retrospective cohort study conducted after the SARS outbreak in Canada had similar findings regarding self-protective knowledge of health care workers who cared for patients with SARS. In this article, we further examine variations in nursing practices regarding PPE and describe best practices for infection control in patient care.

INVESTIGATION OF ISOLATION BEHAVIORS IN NURSES

In our study at a Midwestern academic health care center, we evaluated isolation-precaution behaviors in 24 nurses caring for a live standardized patient in a simulated scenario. We used an actual hospital room and high-definition video cameras inside and outside the room to record the nurses' care of a “patient” hospitalized with possible tuberculosis who was also on contact precautions, and who requests pain medication. We had previously conducted a pilot study, which involved pain medication administration to a live simulated patient requiring both contact and airborne precautions.

We used signs, carts, and equipment that were identical to what the nurses at the facility used in clinical practice. Signs at the room door indicated the PPE to be worn but not the recommended donning and doffing sequences, which is similar to what would be found in many facilities. As a formal debriefing, we reviewed each nurse’s video-recorded performance with the nurse and asked each nurse to “think aloud,” a form of reflective practice, during viewing. Schön defined reflective practice as one’s “capacity to reflect on action so as to engage in a process.
of continuous learning. In our study, we accomplished this by allowing nurses to view the videos of themselves performing the simulation while they discussed the reasons for their actions. Critical issues emerged from the behavioral analysis, including deficiencies in the quality and sequence of donning and doffing of PPE. Here we present the variations we noted in these practices and analyze them in terms of the safety of nurses, patients, and hospitals.

**Donning and doffing sequence.** We found variability in the sequence for donning PPE. Fourteen of the 24 nurses (58%) performed hand hygiene, followed by putting on the gown, as recommended by the guidelines. Another three (13%) put on the gown and then performed hand hygiene. Sixteen (67%) put on gloves last, as recommended by the CDC and others. Four nurses (17%) applied their N95 respirator after their gloves.

It's important to consider why items are applied or removed in a particular sequence. When donning PPE, two major concerns arise. One is putting the items on in an order that doesn't require adjusting other items as you move through the process. These adjustments may cause the second concern, that nurses may contaminate the external surfaces of the PPE by touching their own face, hair, or nose. This contaminated PPE may ultimately touch the patient in isolation and possibly transmit infection.

Doffing behaviors also varied in the order they were performed. Fifteen of the nurses (63%) removed gloves first, as recommended by the CDC and others. Another six (25%) removed the gown first, and all but one of those six immediately removed both gloves next. Sixteen of the nurses (67%) removed the N95 respirator last or just before hand hygiene, as recommended by the CDC. Nineteen of the 24 (79%) completed the PPE removal with hand hygiene.

The challenge of doffing PPE is that it has potentially been contaminated from contact with the isolated patient. This contamination poses an occupational hazard of illness to the nurse or a hospital-acquired illness to patients or other people in the hospital. Fast and uncontrolled movements have the potential to create aerosols from the PPE during the doffing process or drag dirty PPE surfaces across otherwise clean areas of the nurse’s body, potentially leading to contamination outside of the isolation room. Unexpected touching of a contaminated area is an error that can generally be corrected with good decontamination or washing practices, but inhaled aerosols are more difficult to remedy. Most recommendations focus on removing gloves and gowns first and then facial PPE once the aerosolizing risk is low. Hand hygiene is always the final step, and sometimes it is included throughout the process.

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### Table 1. Recommendations for Donning and Doffing Sequence of Personal Protective Equipment

<table>
<thead>
<tr>
<th>Donning</th>
<th>Centers for Disease Control and Prevention</th>
<th>Public Health Agency of Canada</th>
<th>World Health Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Gown</td>
<td>Hand hygiene</td>
<td>Gown</td>
</tr>
<tr>
<td>2.</td>
<td>Mask or respirator</td>
<td>Gown</td>
<td>Face shield OR mask and eye protection</td>
</tr>
<tr>
<td>3.</td>
<td>Goggles or face shield</td>
<td>Mask/N95 respirator</td>
<td>Gloves</td>
</tr>
<tr>
<td>4.</td>
<td>Gloves</td>
<td>Protective eyewear</td>
<td>N/A</td>
</tr>
<tr>
<td>5.</td>
<td>N/A</td>
<td>Gloves</td>
<td>N/A</td>
</tr>
</tbody>
</table>

| Doffing | | | |
|---------| | | |
| 1.      | Gloves                                   | Gloves                        | Gloves and gown           |
| 2.      | Goggles or face shield                    | Gown                          | Hand hygiene              |
| 3.      | Gown                                      | Hand hygiene                  | Face shield OR eye protection, then mask |
| 4.      | Mask or respirator                        | Eye protection                | Hand hygiene              |
| 5.      | Hand hygiene                              | Mask/N95 respirator           | N/A                       |
| 6.      | N/A                                       | Hand hygiene                  | N/A                       |
Quality of donning and doffing PPE behaviors. Beyond the sequence of donning and doffing, there are specific behaviors related to the different kinds of PPE that also warrant discussion. All 24 nurses in our study demonstrated variation in a number of isolation behaviors for both donning and doffing. Each of these variations has the potential to cause contamination in the patient room.

Gowns and gloves. We found that washable gowns created some challenges for nurses. Washable gowns should not be worn inside out. The gowns commonly have finishes or coatings to prevent the absorption of fluids. Gowns from the isolation cart were often knotted at the neck, and we often saw nurses tying the gown before placing it over the head or simply throwing the knotted gown over the head. Eighteen of the 24 nurses (75%) did not have the gown tied at both the neck and the waist. The gowns were commonly tied only at the neck, which left the lower part of the gown to drape open when the nurse bent over or walked past the bed or other equipment. The nurses were “wearing” the gowns, but in many cases the gown itself had become a hazard as it dragged along contaminated surfaces. Additionally, a gown open in the back may become a trip or fall hazard for some nurses; at least one nurse stepped on the gown when bending over to perform a task. When removing the gown, nurses who simply lifted it over the head instead of untying it first ran the risk of contaminating their face and hair.

Although our study evaluated a combination of contact and airborne precautions, contact precautions alone are frequently implemented in the hospital, using gowns and gloves for resistant pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA). Quality improvement projects have been shown to improve clinicians’ implementation of contact precautions. But there is controversy among infection-control professionals about the clinical practice; for instance, should all patients colonized with MRSA be isolated, or only those infected? Also, both disposable and washable gowns have been evaluated, and a facility’s decisions about the type of gown to be used are based on cost, availability, and desired characteristics such as resistance to fluids.

Although our study evaluated only the use of washable gowns, some safe gowning processes are common to both disposable and washable gowns. For example, slow and intentional movement when removing the gown is a critical step in the doffing process to reduce the creation of aerosols or release of droplets from gross contamination. After removing gloves slowly using the glove-in-glove technique, gowns should be untied and rolled gently with the external surfaces to the inside and then placed completely in the hamper or waste container. Contamination of the hands as the gown brushes over them during removal can be reduced by pulling the sleeves, which should be clean, over the hands and fingers before starting the gown removal process. The gown cuffs are clean because the glove cuff was carefully placed over the gown cuff during donning of the PPE. The slow movements are especially important when contact precautions are used alone because there is no respiratory protection.

Single-use gowns do not completely remove the risks of washable gowns. Tearing them for removal is common, and jerking the gown from the front, tearing it at the back, may also generate aerosol particles. The best practice for all types of gowns is to untie them once gloves have been removed. If a gown must be torn, a gentle motion pulling it apart at the shoulders reduces aerosolization near the nurse’s airway. Additionally, any practice that punctures a hole in the fabric when donning a gown could potentially jeopardize the durability and protective features of the gown material.

N95 respirator or surgical mask. All of the nurses in our study correctly selected the N95 respirator for airborne precautions, according to the hospital’s isolation care policy. Eight of the nurses (33%) removed the N95 respirator in the patient room, four (17%) removed it in the open doorway as they left the room, and 12 (50%) removed it after leaving the room and closing the door, according to the CDC guideline.

There are many components to wearing an N95 respirator properly. The process of formal fit testing to ensure that a respirator seals tightly to the face is inconsistently implemented in most respiratory protection programs, but the testing is commonly suggested every two years or if there are changes in facial contour such as weight change or pregnancy.

Molding the N95 respirator to the face, followed by seal checking the respirator, should be done before entering the patient room to ensure that there is no leaking of air during use. Seal checking is done by covering the front of the respirator with both hands, being careful not to disturb the respirator, and feeling for air leaks during inhalation and exhalation. Strap placement is an important part of getting a good seal on the mask. The straps should be located at the crown of the head and the base of the neck. Cross-
CDC recommends that respirators be removed after leaving the patient room and closing the door.

There has been significant controversy over the appropriate masks to wear for novel viral outbreaks since the emergence of the H1N1 influenza pandemic. In a randomized trial, N95 respirators and surgical masks delivered similar protection levels against influenza in a study of 446 nurses in eight Ontario hospitals. N95 respirators are meant to filter out very fine particles, but surgical masks are only required to be fluid repellent. Surgical masks were primarily designed to protect the patient from the nurse’s respiratory secretions, but health care workers do wear them for protection from patients. While surgical masks do not seal, the mask should still be fitted to the nose and pulled down below the chin to cover the nose and mouth. Surgical masks should suffice for droplet isolation, the most common respiratory pathogen isolation in the hospital.

Protective eyewear. Three nurses (13%) in our study used eye protection in the room. Two wore the eye protection, while a third placed it on the head like a headband for adjustment over the eyes later in the room.

Eye protection is often forgotten as a barrier to droplets and splashes in health care any time there is a risk of splashing. A review of the evidence for standard or universal precautions found an average compliance rate with eye protection of 38%. In a three-month observational study of 11 hospitals in Canada, only 37% of health care workers wore eye protection when caring for patients with febrile respiratory illness. In a study evaluating clinical behaviors during simulated resuscitations of children with influenza, only 61% of the health care workers used eye shields.

Although nurses in practice don’t commonly wear protective eyewear, there are numerous common splash risks in a hospital room or patient care area. Glasses worn to improve vision do not provide adequate protection against splash risks. Single-use eye protection should be used only one time and then discarded. Reusable eyewear is appropriate in the clinical setting, but it should be cleaned after each use. Some eyewear may have coatings that can be damaged by antimicrobial or bleach wipes; therefore, it’s important to review the manufacturer’s directions for use. Soap and water safely remove most contamination from glasses, followed by an eyeglass cleaner as needed for clarity.

Step-by-step instructions taken from guidelines can help a nurse to sharpen her or his infection-control skills, but when the skills are implemented, slight variations in practice may be warranted to maintain safety. Using concepts of reflective practice for complicated situations may be useful in helping nurses to make sound decisions in isolation care. Video-recording nurses’ performance during simulation may also improve care at the bedside; it can allow nurses to review and evaluate their clinical practice. Video-recording and verbal reflection have been used in at least one study to improve clinical care; Whyte and colleagues found that it resulted in improved care in patients suffering from heart failure.

Nurses should pay attention to the key principles for each specific type of PPE, so that regardless of the type of isolation a patient requires, nurses can perform the skills correctly. This is important for patient care because donning and doffing of PPE have the potential to transfer pathogens to both workers and patients. In 2011, there were over 721,000 hospital-acquired infections in the United States and 75,000 patient deaths associated with those infections. It is unknown how many of these infections resulted from poor compliance with PPE or donning and doffing protocols, but the potential exists, and better compliance may reduce these numbers.

While our study investigated infection-control behaviors with a single simulated patient-care scenario, future studies should test interventions that might improve bedside nurses’ infection-control behavior over time. These intervention studies might best be conducted as components of larger educational offerings on infection control and include repeated evaluation of simulations. Pope and colleagues found that simulation altered clinical behaviors that are important for infection control. Interventions might include standard lectures, videos, or interactive learning modules. Further quality improvement processes should also investigate clinical outcomes in specific nursing units where a particular educational intervention is used.

Previous experience and learned behavior inevitably affect the decisions nurses make in keeping themselves and their patients safe. Strategies for monitoring isolation practices will always be necessary in hospital infection-control programs. How can we convince nurses at the bedside to wear their PPE safely? When teaching fails to result in desired outcomes, perhaps peer pressure can effect change. Peer pressure has been shown to be effective at increasing compliance with hand hygiene behavior and may apply to other infection-control behavior, as well.

This is an area where bedside nurses can take the lead—on their units and in their institutions.
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REFERENCES


