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Clinical challenges in isolation care

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Title: Clinical Challenges in Isolation Care: Safe Practices for Nurses at the Bedside

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Abstract:

Nurses navigate the challenges of safely using personal protective equipment (PPE) despite the variation in recommendations on best practices and the clinical challenges of providing nursing care in PPE. Nurses participated in a simulation study to investigate isolation care behaviors in the care of a live standardized patient requiring contact and airborne precautions. The study used a real hospital room in a Midwestern academic health center. Nurses participating in the study were video recorded using small High Definition (HD) cameras, and the video recordings were reviewed and scored by the research team. Critical issues emerged from the behavioral analysis which included the sequence and quality of donning and doffing PPE. The 24 nurses in the study demonstrated variations in a number of isolation behaviors for both donning and doffing. Each of these variations in the practice of donning and doffing PPE has the potential to cause contamination in the patient room. Each element of the PPE must be clearly understood in its role as safety gear for the healthcare worker. The data from our study for these common critical issues will be shared with an analysis of why the behaviors are a safety concern for the nurse and a potential risk for disease transmission in the hospital or other clinical area. Utilizing concepts of reflective practice for complicated care situations may be helpful in helping nurses make appropriate decisions in the isolation care environment.

The clinical care environment includes multiple safety threats for nurses. Personal protective equipment (PPE) items include gloves, gowns, protective eyewear, and respiratory protection. PPE are tools nurses use to protect themselves from threats such as dangerous pathogens, drug resistant bacteria, and hazardous drugs (Centers for Disease Control and Prevention [CDC], 2007; National Institute of Occupational Safety and Health [NIOSH], 2004). The self-protection factors related to disease transmission have been highlighted in recent disease outbreaks such as severe acute respiratory syndrome (SARS) and the pandemic H1N1 influenza A of 2009. Following a cluster of SARS cases among healthcare workers in Toronto, poor decisions about the use of PPE during aerosol generating procedures, inconsistent use of PPE, fatigue, and inadequate infection control training were associated with becoming ill (Ofner-Agostini, et al., 2006). Alternatively, a cohort study of California healthcare workers after the H1N1 pandemic in 2009 showed that use of respiratory protection mitigated transmission of influenza (Jaeger, et al., 2011). Despite these findings, compliance with even more basic infection control practices like hand hygiene and standard precautions is often suboptimal in healthcare settings (Erasmus, et al., 2010; Gammon, Morgan-Samuel, & Gould, 2008). The recent Middle East respiratory syndrome coronavirus (MERS CoV) infections among traveling healthcare workers in the United States have demonstrated the continued need for preparedness in hospitals related to infection control measures (Malani, 2014). The 2014 outbreak of Ebola virus in West Africa has increased attention to proper infection control practices as well (Dixon & Schafer, 2014). Media attention is now focused on healthcare worker transmission due to improper use of doffing protocols.

The terms or labels used to describe the types of isolation have changed multiple times in the last fifty years, but the isolation categories of standard, contact, airborne, and droplet are widely recognized today (Landers, et al., 2010). Variability in recommendations regarding the sequence of PPE removal was noted in many countries impacted by SARS (Puro & Nicastri, 2004). The PPE doffing protocol developed by the CDC (2007) was tested with a human challenge study where it was found to be insufficient to protect the doffer from contamination (Casanova, Alfano-Sobsey, Rutala, Weber, & Sobsey, 2008), but no amendments to the guideline were made based upon the findings. Instructions for application and removal of PPE from the World Health Organization (2008) and the Public Health Agency of Canada's pandemic guideline (2011) differ slightly from the CDC guidance (2007), but most components are consistent among them (Table 1). Nurses continue to navigate the challenges of safely using PPE despite the variation in recommendations on best practices and the clinical challenges of providing nursing care in PPE. After the H1N1 pandemic of 2009, there was increased interest in infection control behaviors among healthcare workers. Investigations included pediatric resuscitation simulations with a known influenza diagnosis (Watson, et al., 2011) and observational studies of real clinical patients with febrile respiratory illness (Mitchell, et al., 2013). Both studies noted a lack of self-protective behaviors and poor adherence to isolation precautions. A retrospective cohort study conducted following the SARS outbreak in Canada had similar findings regarding self-protective knowledge (Shigayeva, et al., 2007). The purpose of this manuscript is to further examine these variations in nursing practice with PPE and describe best practices for infection control behaviors when providing clinical care to patients.

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Investigation of isolation behaviors in nurses

A study was conducted at a Midwestern academic healthcare center evaluating isolation behaviors as nurses provided care to a standardized patient in a simulated patient care scenario (Beam, In press). An overview of this study which explains the research methodology is currently in press. An actual hospital room was used for the study with High Definition (HD) cameras strategically placed to record the nurses. The pain medication administration scenario, which had been previously tested in a pilot study (Beam, et al., 2011), involved a live simulated patient requiring both contact and airborne precautions. The isolation signage, carts, and equipment were identical to what the nurses commonly used in clinical practice. The signage indicated what PPE to wear, but no information on donning or doffing sequence was at the room door. A formal debriefing was a part of the study which included reviewing the nurse's video recorded performance and asking the nurse to "think aloud" as they viewed the recording (Ericsson & Simon, 1993). Critical issues emerged from the behavioral analysis of the 24 nurses which included deficiencies in the sequence and the quality of donning and doffing PPE. The findings from our study for these common critical issues will be shared with an analysis of why the behaviors are a safety concern for the nurse and a potential risk for disease transmission in the hospital or other clinical area.

Major findings

Donning and Doffing Sequence

The study found variability in the sequence for donning PPE (Table 2). Fourteen of the 24 nurses (58%) performed hand hygiene followed by putting on the gown as commonly recommended by the guidelines (CDC, 2007; World Health Organization, 2008; Public Health Agency of Canada, 2011). Another three (13%) put on their gown and then did hand hygiene. Sixteen (67%) put on their gloves last as recommended by the CDC and others. Four nurses (17%) applied their N95 respirator after their gloves.

When evaluating this information related to order, it is important to consider the reasons why items are applied or removed in a particular way. When donning PPE, two major concerns arise. One concern is simply putting the PPE on in an order that does not require adjustment of other PPE as you move through the process. These adjustments may cause the second concern. Nurses may contaminate the external surfaces of the PPE by touching personal areas such as the 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 (Table 3). Fifteen of the nurses (63%) removed their gloves first as recommended by the CDC. Another six (25%) removed their gown first, and all but one of those six immediately removed both gloves next. Sixteen of the nurses (67%) removed their N95 respirator last or just before hand hygiene as recommended by the CDC. Nineteen of the 24 (79%) completed their PPE removal process with hand hygiene.

Doffing the PPE becomes more challenging because now the equipment has potentially dirty surfaces from contact with the isolated patient that pose a hazard to the nurse. While most contamination will adhere to the PPE, fast and uncontrolled movements can create aerosols or drag potentially dirty PPE surfaces across otherwise clean areas of the nurse's body, potentially leading to contamination outside

Accepted manuscript of Beam, E. L., Gibbs, S. G., Hewlett, A. L., Iwen, P. C., Nuss, S. L., & Smith, P. W. (2015). Clinical Challenges in Isolation Care: Safe Practices for Nurses at the Bedside. *American Journal of Nursing*, 115 (4), 44-49. <https://doi.org/10.1097/01.naj.0000463027.27141.32> of the isolation room. Contamination may lead to an occupational illness in the nurse or a hospital-acquired illness in patients or other people in the hospital. 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 (CDC, 2007; World Health Organization, 2008; Public Health Agency of Canada, 2011) focus on removing gloves and gowns first, and then they suggest removing facial PPE once the aerosolizing risk is low. Hand hygiene is always the final step, and sometimes it is included throughout the process.

Quality of donning and doffing PPE behaviors

Beyond the order of donning and doffing, there are specific behaviors related to the different kinds of PPE that also warrant further discussion. All 24 nurses in the study demonstrated variation in a number of isolation behaviors for both donning and doffing (Beam, In press). Each of these variations in the practice of donning and doffing PPE has the potential to cause contamination in the patient room. Each element of the PPE must be clearly understood in its role as safety gear for the healthcare worker.

Gowns and gloves.

In our study (Beam, In press), washable gowns created some common nursing challenges. Washable gowns should not be worn inside out. The gowns commonly have finishes or coatings to prevent the absorption of fluids (Rutala & Weber, 2001). Gowns from the isolation cart were often knotted at the neck ties. The practice of tying the gown before placing it over the head or simply throwing the knotted gown over the head was seen often. The gowns were commonly only tied at the neck which leaves the lower part of the gown to drape open when the nurse bends over or walks past the bed or other room equipment. While technically the nurse is wearing the gown, it has become a hazard in the sense that it is more likely to drag along contaminated surfaces. Additionally, a gown open in the back may become a trip or fall hazard for some nurses. Upon removal of the gown, nurses who simply lift the gown over their head instead of untying it run the risk of bringing soiled gown material into close contact with their face and hair.

While this study evaluated a combination of contact and airborne precautions, contact precautions are frequently implemented in the hospital using gowns and gloves for resistant pathogens like methicillin-resistant *Staphylococcus aureus*. Quality improvement projects have been shown in the literature to improve the implementation of contact precautions (Cromer, et al., 2004; Mawdsley, Garcia-Houchins, & Weber, 2010), but there is notable controversy among infection control professionals about the clinical practice (Zastrow, 2011). Both disposable and washable gowns have been evaluated in the literature, and individual healthcare facility decisions about what type of gown to use should be based upon cost, availability, and desired characteristics (Rutala & Weber, 2001).

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 glove-in-glove technique, gowns should be untied and rolled gently with the external surfaces to

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Single-use gowns do not completely remove the risks noted regarding washable gowns, as tearing gowns for removal is common in clinical practice. The action of jerking a gown from the front to remove it by tearing the gown at the back can also generate aerosol particles. The best practice for all types of gowns is to untie them once gloves have been removed. If gowns must be torn, use of a gentle motion pulling 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 this study correctly selected the N95 respirator for airborne precautions per the hospital's isolation care policy (Beam, In press). Eight of the nurses (33%) removed the N95 respirator in the patient room, four nurses (17%) removed the N95 respirator in the open doorway as they left the room, and another 12 nurses (50%) took off the N95 respirator once they had left the room and closed the door as per the CDC guideline.

There are many components to wearing an N95 respirator properly. The process of formal fit testing to assure that a respirator seals tightly to the face is inconsistently implemented in most respiratory protection programs (Lee, Takaya, Long, & Joffe, 2008), 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 assure that there is no leaking 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 with inhalation and exhalation (Coia, et al., 2013). 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. Crossing the straps can cause the mask to shift during speaking or patient care. Shifts ultimately break the seal of the mask and likely result in self-contamination in the isolation room as the nurse readjusts the respirator. When removing a mask, the straps should be gently brought forward one at a time and the mask stabilized on the face with as little hand contact as possible, since the front of the mask is considered contaminated (CDC, 2007). The CDC recommends that respirators be removed after leaving the patient room and closing the door (2007).

There has been significant controversy over the appropriate masks to wear for novel viral outbreaks since the emergence of pandemic H1N1 influenza (Radonovich, Perl, Davey, & Cohen, 2009). In a randomized trial, N95 respirators and surgical masks were found to deliver similar protection levels in a study of 446 nurses in eight Ontario hospitals (Loeb, et al., 2009). While N95 respirators are meant to

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filter out very fine particles, surgical masks are only required to be fluid repellent (Coia, et al., 2013). Surgical masks were primarily designed to protect the patient from the nurse's respiratory secretions, but healthcare workers do wear them for protection as well (Radonovich, et al., 2009). While surgical masks do not need to seal, the mask should still be form 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 this study used eye protection in the room (Beam, In press). Two wore the eye protection, while a third placed it on their 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 the healthcare setting any time there is a risk of splashing (Coia, et al., 2013). In a review of the evidence for standard or universal infection control precautions, studies reported an average compliance rate with eye protection of 38% (Gammon, Morgan-Samuel, & Gould, 2007). In a three month observational study of 11 hospitals in Canada, only 37% of healthcare workers wore eye protection when caring for patients with febrile respiratory illness (Mitchell, et al., 2013). In a study evaluating clinical behaviors during pediatric resuscitation simulations with a diagnosis of influenza, only 61% of the healthcare workers used eye shields (Watson, et al., 2011). Although protective eyewear is not commonly worn by nurses in practice, there are numerous common splash risks in a hospital room or patient care area. Glasses worn to improve visual acuity 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 which can be damaged by antimicrobial or bleach wipes so it is important to review the manufacturer's directions for use. Soap and water can be used to safely remove most contamination from glasses followed by an eyeglass cleaner as needed for clarity.

Implications for practice

Nursing education needs to focus more on the challenges of self-protection as they relate to PPE use. Step-by-step instructions from guidelines are helpful in learning infection control skills as a nurse, but when the skills are integrated into a care scenario, clinical decision making may warrant slight variations in practice to maintain safety. Utilizing concepts of reflective practice for complicated care situations may be useful in helping nurses make sound decisions in the isolation care environment. Video recording simulation performances may be one way to improve care at the bedside by allowing nurses to review and evaluate their clinical practice. The nurse needs to pay attention to the key principles for each specific type of PPE so that regardless of the type of isolation a patient requires, they are performing the skills correctly.

While our study investigated infection control behaviors in a single patient care experience, future studies should test interventions that might improve infection control behavior over time in nurses at

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the bedside. These intervention studies might best be conducted as components of larger educational offerings on infection control which include repeated evaluation of simulation experiences. 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.

There will always be an element of human nature in the decisions regarding how nurses don and doff their PPE and keep themselves safe. Different 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 desirable practice outcomes, sometimes we must rely on our actions to make the peer pressure that creates change. This is an area where bedside nurses can be the leaders in clinical practice on their individual units and in their institutions.

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Table 1. Recommendations for donning and doffing sequence of Personal Protective Equipment (PPE) by agency

	Centers for Disease Control (2007)	Public Health Agency of Canada (2011)	World Health Organization (2008)
Donning			
1.	Gown	Hand Hygiene	Gown
2.	Mask or Respirator	Gown	Face shield OR Mask and Eye Protection
3.	Goggles or Face Shield	Mask/N95 Respirator	Gloves
4.	Gloves	Protective Eyewear	N/A
5.	N/A	Gloves	N/A
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

Table 2. Donning sequence by study participants

Participant Number	Donning Order, n = 24 nurses
1	HH, Gown, Gloves, N95
2	HH, Gown, N95 (Gloves applied from box inside room after entry).
3	HH, Gown, N95, Gloves
4	HH, Gown, N95, Gloves
5	HH, Gown, N95, Gloves
6	Gown, N95, eye protection, Gloves
7	HH, Gown, N95, Gloves placed on COW to enter room.
8	HH, Gown, Gloves, N95
9	HH, Gown, N95, Gloves
10	Gown, HH, Gloves, N95
11	HH, N95, Gown, Gloves
12	Gown, HH, N95, Gloves
13	HH, Gown, N95, Gloves
14	Gown, N95, Gloves
15	HH, Gown, N95, Gloves
16	N95, HH, Gown, Gloves, eye protection
17	Gown, HH, Gloves, N95
18	HH*, Gown, Mask, Gloves
19	HH, Gown, N95, Gloves
20	Gown, N95, Gloves
21	HH, N95, Gown, Gloves
22	HH, gloves, Gown, N95, eye protection on head.
23	HH, Gown, N95, Gloves
24	HH, Gown, N95, Gloves

*Special note: HH happened off camera.

HH = Hand Hygiene which may be hand washing or use of hand sanitizer.

N95 = N95 Particulate Respirator

Table 3. Doffing sequence by study participants

Participant Number	Doffing Order, n = 24 nurses
1	Gown, Gloves, N95 in room, HH
2	Unties bottom tie of gown, Gloves, Gown, N95 out of room, HH
3	Gloves, HH, Gown, N95 in room
4	Gown and one glove removed together, N95 in room with ungloved hand, Second glove, HH
5	Gloves, Gown, HH, N95 out of room, HH
6	Gloves, Eye protection, N95 in room, Gown, HH
7	Gloves, HH, Gown, HH, N95 out of room
8	Gloves, Gown, HH, N95 out of room, HH
9	Gloves, HH, Gown, N95 out of room, New gloves from isolation cart to clean equipment, Gloves, HH
10	Gloves, Gown, New gloves applied in room to clean equipment, Gloves, N95 out of room, HH
11	Gown, Gloves, N95 out of room, HH
12	Gloves, Gown, HH, N95 out of room
13	Gloves, Gown, N95 out of room, New gloves from isolation cart applied to clean equipment, gloves, HH
14	Gloves, Gown, New gloves applied in room to clean equipment, N95 in open doorway, Gloves, HH
15	Gloves, Gown, N95 in room, HH
16	Gown, Gloves, N95 and protective eyewear in open doorway, HH
17	N95 in room, Gown, Gloves, New gloves from isolation cart to clean equipment, Gloves
18	Gown, Gloves, N95 out of room, New gloves from isolation cart to clean equipment, HH
19	Gloves, Gown, HH, New gloves applied in room to clean equipment, Gloves, N95 out of room, HH
20	N95 in room, Gown, Gloves, HH
21	Gloves, Gown, N95 in room, HH
22	Gloves, HH, Gown, HH, protective eyewear, N95 out of room
23	Gloves, Gown, N95 in open doorway, HH
24	Gown, Gloves, N95 in open doorway, HH

HH = Hand Hygiene which may be hand washing or use of hand sanitizer.

N95 = N95 Particulate Respirator