CONCISE COMMUNICATION

Acceptability and Necessity of Training for Optimal Personal Protective Equipment Use

Michelle Doll, MD, MPH;[1] Moshe Feldman, PhD;[2] Sarah Hartigan, MD;[1,2] Kakotan Sanogo, MS;[1] Michael Stevens, MD, MPH;[1,2] Myriah McReynolds;[1] Nadia Masroor, BS;[1] Kaila Cooper, RN, CIC;[1] Gonzalo Bearman, MD, MPH[1,2]

Healthcare workers routinely self-contaminate even when using personal protective equipment. Observations of donning/ doffing practices on inpatient units along with surveys were used to assess the need for a personal protective equipment training program. In contrast to low perceived risk, observed doffing behaviors demonstrate significant personal protective equipment technique deficits.

Infect Control Hosp Epidemiol 2017;38:226–229

Personal protective equipment (PPE) serves 2 critical functions for the healthcare setting: protecting healthcare providers from occupational hazards and protecting patients from transmission of infection. PPE has come under increased scrutiny as a result of public attention to healthcare-associated infections and global experiences with emerging infectious diseases. Data suggest that despite PPE use, healthcare workers routinely contaminate their skin and clothing during patient care.[1–3] Standardized procedures exist for donning and doffing PPE,[4] and Tomas et al[3] have shown a potential for improvement in self-contamination rates using a training program in which participants visually observed transfer of a fluorescent dye from PPE to areas of self-contaminated skin or clothing.[3]

Self-contamination is generally invisible, thus the downstream consequences are difficult to discern. However, high rates of self-contamination arguably defeat the purpose of PPE. In order to better evaluate PPE use at our institution, we conducted a needs assessment for a PPE training program, as measured both objectively by observation and subjectively by survey.

METHODS

A convenience sample of providers from 3 inpatient units and the emergency department were chosen because of frequent PPE use on these units. The emergency department additionally uses PPE for provider protection during trauma evaluations. An observation tool adapted from Tomas et al[3] was used to perform real-time assessments of donning and doffing behaviors during patient care episodes. No dyes were used to simulate contamination. Observations were conducted in close proximity to the provider in order to accurately record behaviors, thus providers may have been aware of their presence; the reason for observation was provided if asked. "Correct" glove and gown removal methods were defined using the recommendations of the Centers for Disease Control and Prevention.[4]

A survey was constructed using items adapted from our Ebola preparedness survey, and further revised to reflect the Information, Motivation, and Behavioral Skills Model.[5] Information component questions asked about provider understanding of transmission risks in the hospital, understanding of PPE rationale, and availability of resources. Motivation questions asked the likelihood of personally using PPE correctly and likelihood of correcting the PPE techniques of others. Skills questions asked about prior PPE training, perspectives on the need for additional training, and overall confidence in PPE skills.

Students and nonclinical staff were excluded. Survey scores were calculated for each respondent and question by model component. Associations between provider characteristics and doffing behaviors or survey responses were analyzed using the χ^2 or Fisher exact tests. Partial observations and surveys with missing data were included. Investigational review board approval was obtained.

RESULTS

PPE observations were performed on 110 providers. Findings are presented in Table 1a. Ninety observations included doffing behaviors and 82 included donning behaviors. Physicians were the most frequently observed provider type (45 [41%]), followed by nurses (44 [40%]). Other providers included nurse's aides, nutritionists, physical therapists, ultrasound technologists, a trauma technologist, and a respiratory therapist. Reasons for PPE were contact precautions (96 [87%]) or traumas (14 [13%]).

The choice of PPE was appropriate in all observations. The most common order of both donning and doffing was gown first (93% and 96%, respectively) and gloves second (89% and 93%, respectively). Glove removal was correct in 78 (89%) of 88 observations; incorrect methods observed included touching skin at the wrist with "dirty" gloves and continuing to wear gloves after leaving the room. Gowns were most often removed by ripping (83/90 [92%]); however, 6 providers used a component of untying, and 3 used a component of lifting the gown over the head. Gowns were bundled into a ball to discard in 78 (88%) of 89 doffs; yet of these 78 bundles, 19 (24%) were sloppily bundled.

"Dirty" PPE was observed to contact provider skin or clothing in 22 (24%) of 90 doffing observations. Provider skin or clothing contacted the patient environment in 7 (8%) of 90 observations. Doffing behaviors at risk for self-contamination occurred more frequently in nonphysician, nonnurse

https://doi.org/10.1017/ice.2016.252 Published online by Cambridge University Press

TABLE 1. Characteristics of Provider Observations and Survey Participants

a. Provider observations	Freq (%)	b. Provider surveys	Freq (%)
Provider types		Provider types	
Nurse	44/110 (40%)	Nurse	60/103 (58%)
Physician	45/110 (41%)	Physician	21/103 (20%)
Other	21/110 (19%)	Other	22/103 (21%)
Unit		Unit	
Intermediate medical	56/110 (51%)	Intermediate med	22/103 (21%)
General medical 1	9/110 (8%)	General medical 1	9/103 (9%)
General medical 2	28/110 (25%)	General medical 2	23/103 (22%)
Emergency Room	17/110 (15%)	Emergency dept	49/103 (48%)
PPE indication		Years of experience	
Contact isolation	91/110 (83%)	<1	21/97 (22%)
Contact + airborne	2/110 (2%)	2-3	24/97 (25%)
Contact + neutropenic	3/110 (3%)	4-5	19/97 (20%)
Trauma	14/110 (13%)	6-11	15/97 (15%)
		12 +	18/97 (19%)
Hand hygiene performed		How long since last training?	
Room entry	57/79 (72%)	<3 months	16/95 (17%)
Room exit	73/91 (80%)	<1 year	38/95 (40%)
Chosen PPE appropriate	110/110 (100%)	<2 to 3 years	24/95 (25%)
Skin visible at wrist	5/92 (5%)	<4 to 5 years	9/95 (9%)
		>5 years ago	8/95 (8%)
Gown secured with tie	59/95 (62%)	Agreeable to additional PPE training	66/79 (84%)
Gown removal technique		Future training preference	
Rip at neck and waist	83/90 (92%)	Online	7/44 (16%)
Overhead and rip waist	1/90 (1%)	In-person practice	35/44 (80%)
Overhead and untie waist	2/90 (2%)	Both online and in-person	2/44 (5%)
Rip neck and untie waist	4/90 (4%)		
Correct glove removal	78/88 (89%)	Individuals in agreement[a]:	
Total at risk doffs	25/90 (28%)	Information adequate	94/103 (91%)
Contact PPE - skin/clothes	22/90 (24%)	Motivated to use PPE	95/103 (92%)
Contact patient environ.	7/90 (8%)	PPE skills adequate	76/103 (74%)
Gown bundled	78/89 (88%)		
Gown poorly bundled	19/78 (24%)		
Room entry in a group	67/108 (62%)		
Rushed pace	15/102 (15%)		
Provided or received assistance with PPE	0/110 (0%)		

c. Observation factors analyzed for association with an at-risk doff	*P* value	d. Survey factors analyzed for association with individual participant agreement to constructs	*P* value
Provider types	.0261	Provider type and information	.1949
Physician v. nurse	.3975	Provider type and motivation	.3642
Nurse v. other	.0098	Provider type and skills	.3404
Physician v. other	.0758	Yrs experience and information	.2955
Unit	.8217	Yrs experience and motivation	>.99
Group room entry	.2900	Yrs experience and skills	.0703
Gown not secured	.4404	Unit type[b] and information	.7330
Gown bundled poorly	.1253	Unit type[b] and motivation	.1464
Rushed pace	>.99	Unit type[b] and skills	.1164

[a]Participant averaged responses for each construct.
[b]Unit type is inpatient vs emergency department.

providers (9/17 [53%]), followed by physicians (10/37 [27%]); nurses exhibited the best doffing practices (risk in 6/36 [17%]), $P = .03$ (Table 1c). An at-risk doff was more likely to occur if the gown was not bundled or was bundled loosely (42% with risk in this group vs 24% if gown tightly bundled); however, this association did not reach statistical significance ($P = .13$).

Surveys were collected from 103 providers; the response rate was 94%. Responses are summarized in Figure 1a;

https://doi.org/10.1017/ice.2016.252 Published online by Cambridge University Press

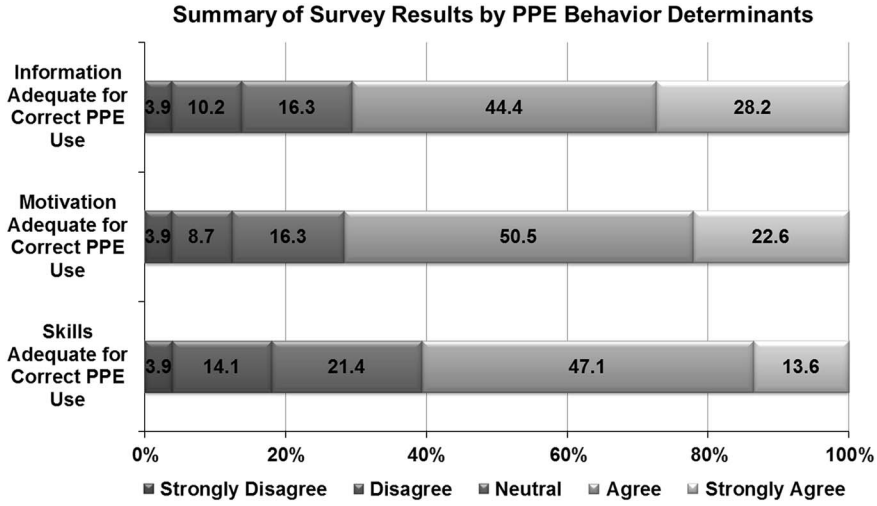


FIGURE 1. Personal protective equipment (PPE) behavior determinants: percentage responding to each level of a 5-point Likert scale by survey question. Question responses are averaged within each construct of the Information, Motivation, and Skills Model.

characteristics of survey participants are presented in Table 1b. Of the 103 providers, most (83 [81%]) reported previous PPE training. Most believed they possessed adequate information regarding PPE and affirmed motivation to use PPE (91% and 92%, respectively). Confidence in PPE skills was endorsed by 74%, yet 80% doubted that they personally self-contaminated during PPE use. The percentage in agreement with the statement, "I feel adequately prepared to safely don or doff all PPE specific to my patient's condition" decreased from 82% to 40% when the scenario changed from a general patient to a patient with a highly communicable and potentially deadly disease such as severe acute respiratory syndrome or Middle East respiratory syndrome. There were no differences in composite survey responses by hospital unit or emergency department, provider type, or years of experience (Table 1d). However, on analysis of individual questions, physicians were more likely to doubt adequate preparation for PPE safety (57% vs 28% for nonphysicians, $P = .02$). Future training was requested as a "hands on" experience in 37 (84%) of 44 responses.

DISCUSSION

Observations of real-time donning and doffing practices on distinct units during patient care episodes exposed deficits in PPE technique, which is consistent with simulation reports from other institutions.[1–3] However, provider perception of self-contamination risk was low, and most agreed they had adequate information, motivation, and skills for PPE use.

There is a notable decrease in confidence in PPE skills when the participants are presented with a hypothetical Middle East respiratory syndrome or severe acute respiratory syndrome scenario introducing a more direct personal risk. These results suggest that providers base their PPE behaviors on a perceived level of risk, with personal risk being prioritized over risk of transmission to others. The discrepancy between provider attitudes and behaviors and the scenario-dependent shift in confidence may indicate that providers understand that their PPE technique is imperfect yet perceive it "good enough" for most situations. This complacency may be an important barrier to PPE-related interventions.

Participants with interest in additional training largely preferred "hands on" practice. Nonphysician, nonnurse providers may be an important group to target on the basis of observation results, whereas physicians indicated a potential need in the survey.

This study has several limitations. The providers were not matched in the observation and survey components of the study, preventing direct comparisons between PPE attitudes and behaviors. Owing to privacy concerns, exact activities of patient care were not collected. Visible soiling was present on PPE in only 2 observations and no cultures were collected to determine whether observed breaches in PPE translated into actual self-contamination. Though providers may have been aware of being observed, this knowledge should have improved PPE techniques. Bias may exist in the subset of providers completing surveys, though this should be limited by high (93%) participation.

In contrast to a low perceived risk of self-contamination, actual observed doffing behaviors indicate a significant potential risk. Future training should allow for in-person experiential learning, should be performed to scale, and should be coupled with an ongoing program of PPE donning/doffing assessment and feedback to ensure reliability in practice.

ACKNOWLEDGMENTS

Financial support. None reported.

Potential conflicts of interest. All authors report no conflicts of interest relevant to this article.

Affiliations: 1. Virginia Commonwealth University Health System, Richmond, Virginia; 2. Virginia Commonwealth University School of Medicine, Richmond, Virginia.

https://doi.org/10.1017/ice.2016.252 Published online by Cambridge University Press

Address correspondence to Michelle Doll, MD, MPH, Virginia Commonwealth University Health System, PO Box 980019, Richmond, VA 23298-0019 (Michelle.Doll@vcuhealth.org).

Received July 1, 2016; accepted September 27, 2016; electronically published November 24, 2016

© 2016 by The Society for Healthcare Epidemiology of America. All rights reserved. 0899-823X/2017/3802-0014. DOI: 10.1017/ice.2016.252

REFERENCES

1. Casanova L, Alfano-Sobsey E, Rutala WA, Weber DJ, Sobsey M. Virus transfer from personal protective equipment to healthcare employees' skin and clothing. *Emerg Infect Dis* 2008;14:1291–1293.
2. Guo YP, Li Y, Wong PL. Environment and body contamination: a comparison of two different removal methods in three types of personal protective clothing. *Am J Infect Control* 2014;42: e39–e45.
3. Tomas ME, Kundrapu S, Thota P, et al. Contamination of healthcare personnel during removal of personal protective equipment. *JAMA Intern Med* 2015;175:1904–1910.
4. Centers for Disease Control and Prevention (CDC). Sequence for donning and removing personal protective equipment. CDC website. http://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf. Accessed June 22, 2016.
5. Fisher JD, Fisher WA. Changing AIDS-risk behavior. *Psychol Bull* 1992;111:455–474.

https://doi.org/10.1017/ice.2016.252 Published online by Cambridge University Press