

Through Their Eyes

Health Care Worker Compliance With Personal Protective Equipment During the COVID-19 Pandemic

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ABSTRACT

Background: Personal protective equipment (PPE) plays a critical role in protecting health care workers (HCWs). During the coronavirus disease-2019 (COVID-19) pandemic, shortages of PPE supplies drastically changed the way PPE was obtained and used by HCWs.

Purpose: The objective was to investigate the impact of the COVID-19 pandemic and patient isolation type on PPE compliance.

Methods: This investigation was a survey of HCWs at a level 1 trauma teaching hospital regarding PPE compliance patterns prior to and during the COVID-19 pandemic.

Results: HCWs reported an increase in PPE compliance during the COVID-19 pandemic. Nearly half (48.6%) of respondents reported that isolation type impacted the decision to wear PPE, of which most were likely to forgo PPE with contact precautions.

Conclusions: HCWs identified multiple barriers to compliance. The underutilization of PPE with contact precautions suggests that the risk of exposure is interpreted as low, and this could be a future target of education.

Keywords: COVID-19 pandemic, health care worker, patient isolation, personal protective equipment

On December 31, 2019, the World Health Organization was notified of a group of pneumonia cases in the city of Wuhan, China, from an unknown cause. These cases were found to be caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the seventh known coronavirus to cause infection and third to cause severe disease in humans to date.¹ Since its discovery, SARS-CoV-2, which causes coronavirus disease-2019 (COVID-19), has become a global pandemic resulting in a sudden, substantial increase in hospitalizations.² At the beginning of pandemic, the sudden outbreak of COVID-19 presented many challenges for front-line health care workers (HCWs) and infection

preventionists due to no existing guidelines for the treatment and prevention of COVID-19.³ As a result, in the absence of any known treatments or vaccines for COVID-19 at the beginning of the pandemic, HCWs and infection preventionists relied on fundamental infection prevention practices to reduce the risk of transmitting COVID-19.³

In the health care setting, standard precautions are used by HCWs to help prevent the transmission of infectious microorganisms, such as SARS-CoV-2, between individuals and/or the environment.⁴ Standard precautions are the first tier of infection control measures that involve the practice of good hand hygiene and use of personal protective equipment (PPE) for anticipated exposures to infectious agents.^{4,5} In instances where standard precautions alone cannot prevent transmission, second-tier precautions, referred to as transmission-based precautions, are applied.⁶ This can involve donning additional PPE such as gowns, face masks, and eye protection based upon isolation type.⁷ Together, the use of PPE with standard and transmission-based precautions has been fundamental in the prevention of hospital-acquired infections (HAIs).^{6,8}

Transmission-based precautions are utilized when a highly transmissible or epidemiologically important pathogen transmitted by contact,

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The authors declare no conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jncqjournal.com).

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Accepted for publication: June 10, 2021

Early Access: July 15, 2021

DOI: 10.1097/NCQ.0000000000000584

droplet, or airborne routes is suspected or known to be colonizing a patient.⁹ By targeting the route of transmission, transmission-based precautions play an important role in preventing the spread of drug-resistant and disease-causing organisms in the health care setting.⁹ The critical role of PPE used in combination with transmission-based precautions to prevent HAI has led to multiple investigations into PPE compliance among HCWs. Despite the known effectiveness of PPE, many studies have demonstrated that PPE compliance and awareness of misuse continue to be poor among HCWs.^{4,8,10} Qualitative investigations have found factors such as discomfort, education, timing, and availability of supplies contributing to poor compliance rates.^{4,11-14}

During the COVID-19 pandemic, disruptions in supply chains, travel restrictions, high demand, and the slow release of supplies resulted in extreme shortages of PPE. This forced health care institutions to consider alternative routes of securing, maintaining, and utilizing supplies. In some instances, HCWs had to rewear the same PPE for multiple shifts to lessen the burden on strained supply chains and ensure some form of PPE was available. While previous studies have unveiled the reasons why HCWs may choose to forgo PPE when entering an isolation room, none to our knowledge have investigated how the presence of the COVID-19 pandemic and PPE shortages may alter HCWs' decision-making process to don PPE on inpatient units. The aim of this investigation was to gain a greater understanding of how the presence of the COVID-19 pandemic and different transmission-based precautions influence PPE compliance to inform infection prevention practices.

METHODS

This investigation was a descriptive and qualitative survey of HCWs regarding PPE compliance and was approved as exempt research by the institutional review board (IRB) at the study facility. A waiver of written formal consent was approved by the IRB given the minimal risk of participation. At the time of survey administration, HCWs were made aware that the survey was going to be utilized for research purposes. The survey was administered to staff working at a 537-bed level 1 trauma teaching hospital in southeast Michigan.

Questionnaire

A 10-question electronic survey was developed by the investigators for the purpose of this study. The survey was distributed by nursing staff leadership to HCWs on August 25, 2020, and was open until September 25, 2020. Nursing leadership and managers for the inpatient units at the study facility received an email from the investigators requesting them to voluntarily forward the research survey along to their staff who provided direct patient care at the time of the request. Agreeable nursing leadership and managers were provided a copy of an email from the investigators inviting HCWs to participate in the research study. No email list of who received the survey was provided to the investigators. As such, the number of HCWs who received the survey was unknown. The survey was administered through a secure online application, which recorded responses anonymously. No incentives were offered to encourage participation. The survey took approximately 10 minutes to complete.

The survey was comprised of 4 sections: demographic data, PPE compliance prior to the COVID-19 pandemic, PPE compliance during the COVID-19 pandemic, and impact of isolation type on PPE compliance. Demographic data including respondents' role at the study facility and length of time they have worked in health care were provided by respondents. HCWs could designate registered nurse (RN), patient care technician (PCT), respiratory therapist (RT), physician assistant/nurse practitioner, physician, or specify other as their role. Length of time was assessed on a scale of 0 to 2, 3 to 5, 6 to 10, and more than 10 years working in health care.

Respondents reported their self-perceived frequency of noncompliance with PPE prior to and during the COVID-19 pandemic using a Likert scale of 0 to 5: (0) never (0% of the time), (1) seldom/rarely (0%-10% of the time), (2) sometimes (10%-30% of the time), (3) often (30%-50% of the time), (4) usually/most of the time (50%-80% of the time), and (5) almost always/always (80%-100% of the time). All respondents, except for those who choose a Likert scale score of never, provided reasons for noncompliance. Respondents could choose multiple answers from 11 provided reasons, which included poor fit/discomfort, time, caused poor dexterity/interfered with patient care, risk exposure appeared low, PPE was not available, limited

ability to communicate with the patient, forgot, did not know how to properly wear and/or use equipment, interfered with ability to form a relationship with the patient, fear of limited PPE supplies available, and specify other.

The last section of the survey assessed the impact of isolation type on the decision to wear PPE. Isolation types at the study facility included contact precautions for pathogens transmitted through contact such as methicillin-resistant *Staphylococcus aureus*, contact-C precautions for patients with known or suspected diarrheal diseases such as *Clostridioides difficile*, droplet precautions for pathogens transmitted through respiratory droplets such as influenza, airborne precautions for pathogens transmitted through aerosols such as measles, and special pathogen precautions for pathogens that are highly infectious and have the capability to cause severe disease including SARS-CoV-2. HCWs who indicated isolation type influenced their decision whether to wear PPE were asked to select the isolation type(s) they were most likely to forgo PPE with.

Study population

The study population included HCWs such as RNs, PCTs, physicians, and mid-level providers, who delivered direct patient care at the study facility. Direct patient care was defined as hands-on activities, which promoted the health of patients. HCWs who indicated a role that did not meet the definition of direct patient care were excluded from the study population.

Statistical analysis

Simple descriptive statistics including numbers and percentages were utilized to analyze participants' responses. The Likert scale used to assess compliance was converted into a continuous scale from 0 to 5, where 0 indicated a participant was always compliant and 5 indicated they were always noncompliant. Average compliance scores were compared between the pre- and COVID-19 pandemic periods from paired responses via the Wilcoxon signed rank test. All statistical analyses were completed in Excel (Microsoft Office 365 Pro, Microsoft Corporation, Redmond, Washington) and SAS (SAS 9.4 Windows Version 1.0.18362, SAS Institute, Cary, North Carolina).

RESULTS

A total of 185 participant responses were included in the analysis from the 200 surveys submitted. Three HCWs responses were removed because they replied with a role that did not meet the study definition of direct patient care. Four respondents were excluded, as they indicated they were always noncompliant with PPE but made follow-up comments that they were always compliant with PPE. Five responses were also removed, as they appeared to be from the same HCW who partially filled out the survey multiple times based on submission times. Two surveys were submitted blank and 1 only had current frequency and HCW type. Study team members were in agreement regarding the removal of these responses for accurate analysis of the study population.

The study population was predominantly RN (76.2%) and PCT (12.4%) (see Supplemental Digital Content Table 1, available at: <http://links.lww.com/JNCQ/A879>). The majority of respondents reported working in health care between 3 and 5 years (52.4%) followed by 6 to 10 years (18.4%) and more than 10 years (16.8%). Of all respondents, 94.1% reported working in health care prior to the COVID-19 pandemic (see Supplemental Digital Content Table 1, available at: <http://links.lww.com/JNCQ/A879>). Only those who reported that they worked in health care prior to the COVID-19 pandemic were asked questions regarding their PPE practice prior to the pandemic.

The percentage of respondents who reported that they never entered an isolation room without PPE increased from 32.2% to 53.0% during the COVID-19 pandemic (Table 1). The average PPE noncompliance score decreased from 2.15 to 1.86 when comparing before and during COVID-19 responses. The Wilcoxon signed rank test revealed this to be a significant difference in PPE compliance with a P value of $< .0001$.

Prior to the pandemic, PCT reported one of the highest levels of PPE compliance with 34.8% of PCT reporting they were never noncompliant with PPE (Table 2). During the COVID-19 pandemic, this shifted to RT, with 60% of RT reporting they were never noncompliant with PPE (Table 3). RN, PCT, and RT all reported average higher levels of compliance during the COVID-19 pandemic (Tables 2 and 3). Sampling size limited the ability to perform inference regarding trends in PPE compliance from

Table 1. Comparison of PPE Compliance Prior to and During the COVID-19 Pandemic

Noncompliance Rate	Before COVID-19 Pandemic (n = 174) n (%)	During COVID-19 Pandemic (n = 183) n (%)
Never (0% of the time)	56 (32.2)	97 (53.0)
Seldom/rarely (0%-10% of the time)	64 (36.8)	54 (29.5)
Sometimes (10%-30% of the time)	36 (20.7)	16 (8.7)
Often (30%-50% of the time)	12 (6.9)	5 (2.7)
Usually/most of the time (50%-80% of the time)	2 (1.1)	1 (0.5)
Almost always/always (80%-100% of the time)	4 (2.3)	10 (5.5)

Abbreviation: PPE, personal protective equipment.

physicians, mid-level providers, and respondents who specified a different role. During both the pre- and pandemic periods, HCWs who reported working more than 10 years reported the highest levels of PPE compliance, with 39.2% and 65% of HCWs reporting they were never non-compliant with PPE, respectively (Tables 2 and 3). Regardless of the length of time worked in health care, all 4 groupings saw an overall

average increase in PPE compliance scores during the COVID-19 pandemic compared with previous (Tables 2 and 3).

Prior to the pandemic, the majority of participants reported that they were noncompliant with PPE due to the risk exposure appeared low (67.8%), time (43.5%), and PPE was not available (13.0%) (Table 4). During the pandemic, the same 3 reasons were the most common

Table 2. HCW Self-Perceived Noncompliance Frequency With PPE Prior to the COVID-19 Pandemic Stratified by HCW Type and Length Working in Health Care^a

Prior to the COVID-19 Pandemic, How Often Would You Enter an Isolation Room for Any Length of Time Without PPE (Gown, Gloves, Masks, and Eye Protection) per Isolation Protocol?							
Variable	Never n (%)	Seldom/Rarely n (%)	Sometimes n (%)	Often n (%)	Usually/Most of the Time n (%)	Almost Always/Always n (%)	Refused n (%)
Type of HCW							
RN	39 (27.7)	48 (34.0)	30 (21.3)	11 (7.8)	1 (0.7)	3 (2.3)	9 (6.4)
PCT	8 (34.8)	6 (26.1)	5 (21.7)	0 (0)	1 (4.4)	1 (4.4)	2 (8.7)
RT	5 (33.3)	8 (53.3)	1 (6.7)	1 (6.7)	0 (0)	0 (0)	0 (0)
PA/NP	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Physician	1 (50)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	1 (50)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Length of time in health care, y							
0-2	5 (27.8)	5 (27.8)	5 (27.8)	0 (0)	1 (4.5)	0 (0)	2 (11.1)
3-5	7 (20.6)	7 (20.6)	12 (35.3)	5 (14.7)	0 (0)	1 (2.9)	2 (5.9)
6-10	5 (16.1)	17 (54.8)	5 (16.1)	2 (6.5)	0 (0)	1 (3.2)	1 (3.2)
>10	38 (39.2)	35 (36.1)	13 (13.4)	5 (5.2)	1 (1.0)	2 (2.1)	3 (3.1)

Abbreviations: HCW, health care worker; PA/NP, physician assistant/nurse practitioner; PCT, patient care technician; PPE, personal proactive equipment; RN, registered nurse; RT, respiratory therapist.

^aPercentages were calculated as row percent.

Table 3. HCW Self-Perceived Noncompliance Frequency With PPE During the COVID-19 Pandemic Stratified by HCW and Length Working in Health Care^a

Variable	Currently, How Often Do You Enter an Isolation Room for Any Length of Time Without PPE (Gown, Gloves, Masks, and Eye Protection) per Isolation Protocol?						
	Never n (%)	Seldom/Rarely n (%)	Sometimes n (%)	Often n (%)	Usually/Most of the Time n (%)	Almost Always/Always n (%)	Refused n (%)
Type of HCW							
RN	73 (51.8)	43 (30.5)	10 (7.1)	4 (2.8)	1 (0.7)	8 (5.7)	2 (1.4)
PCT	10 (43.5)	7 (30.4)	4 (17.4)	0 (0)	0 (0)	2 (8.7)	0 (0)
RT	9 (60.0)	4 (26.7)	1 (6.7)	1 (6.7)	0 (0)	0 (0)	0 (0)
PA/NP	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Physician	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Length of time in health care, y							
0-2	6 (33.3)	8 (44.4)	2 (11.1)	1 (5.6)	0 (0)	1 (5.6)	0 (0)
3-5	12 (35.3)	13 (38.2)	4 (11.8)	2 (5.9)	0 (0)	3 (8.8)	0 (0)
6-10	16 (51.6)	7 (22.6)	4 (12.9)	0 (0)	0 (0)	3 (9.7)	1 (3.2)
> 10	63 (65.0)	22 (22.7)	5 (5.2)	2 (2.1)	1 (1.0)	3 (3.1)	1 (1.0)

Abbreviations: HCW, health care worker; PA/NP, physician assistant/nurse practitioner; PCT, patient care technician; PPE, personal protective equipment; RN, registered nurse; RT, respiratory therapist.

^aPercentages were calculated as row percent.

Table 4. Comparison of Noncompliance Reasons Prior to and During the COVID-19 Pandemic

Reasons for PPE Noncompliance	Before COVID-19 Pandemic (n = 115) n (%)	During COVID-19 Pandemic (n = 79) n (%)
Fear of limited supplies	1 (.9)	14 (17.7)
Did not know how to properly wear and/or use PPE	1 (.9)	0 (0)
Fixing IV pumps/equipment	4 (3.5)	2 (2.5)
No direct contact with patient	5 (4.3)	1 (1.3)
Poor fit/discomfort	5 (4.3)	8 (10.1)
Limited ability to communicate with the patient	6 (5.2)	11 (13.9)
Interfered with ability to form a relationship with the patient	7 (6.1)	2 (2.5)
Emergency/patient safety	9 (7.8)	4 (5.1)
Forgot	10 (8.7)	10 (12.6)
Caused poor dexterity/interfered with patient care	14 (12.2)	8 (10.1)
PPE was not available	15 (13.0)	20 (25.3)
Time	50 (43.5)	35 (44.3)
Risk exposure appeared low	78 (67.8)	45 (60.0)

Abbreviation: PPE, personal protective equipment.

Table 5. Impact of Isolation Type of PPE Compliance

Question	n (%)
Does isolation type influence your decision to not wear PPE? (n = 185)	
Yes	90 (48.6)
No	85 (45.9)
Refused to answer	10 (5.4)
Isolation type most likely to forgo wearing PPE (n = 89)	
Contact	80 (89.9)
Contact-C	17 (19.1)
Droplet	4 (4.5)
Airborne	3 (3.4)
Special pathogens	4 (4.5)

Abbreviation: PPE, personal protective equipment.

reasons that HCWs choose to forgo PPE, with 60.0%, 44.3%, and 25.3% respondents reporting, respectively (Table 4). The reason fear of limited supplies experienced the largest change in percent respondents reporting with an increase from 0.9% to 17.7% when comparing pre- and COVID-19 pandemic reasons (Table 4). As such, fear of limited supplies changed from being the least common reason pre-COVID-19 to the fourth most common reason during the COVID-19 pandemic. The reason PPE was not available experienced the next greatest change, with 13.0% of respondents reporting as a reason pre-COVID-19 and 25.3% of respondents reporting during the COVID-19 pandemic as a reason for noncompliance (Table 4).

Nearly half of all respondents (48.6%) reported that isolation type did impact their decision to not wear PPE into an isolation room (Table 5). Of those who responded that isolation type did influence their decision, the vast majority (89.9%) reported that they were more likely to forgo PPE with contact precautions (Table 5).

DISCUSSION

The present research was a survey regarding PPE compliance of HCWs at a 537-bed level 1 trauma teaching hospital in southeast Michigan. To our knowledge, this is the first investigation into the impact of the COVID-19 pandemic on PPE compliance among HCWs who provide care on inpatient units in the United States. After taking into consideration the paired nature of the

dataset, it was found that on average noncompliance scores decreased during the COVID-19 pandemic period, indicating higher levels of PPE compliance during the COVID-19 pandemic. Nearly half of all respondents reported that isolation type influenced their decision to forgo PPE. From those respondents, the vast majority reported that they were most likely to forgo wearing PPE for contact precautions.

During the H1N1 pandemic of 2009, self-reported use of PPE in Chinese intensive care units found that approximately 55.5% of respondents reported high levels of PPE compliance, as indicated by more than 80% compliance.¹⁵ Our investigation revealed a larger proportion of respondents indicating high levels of PPE compliance, with 82.5% (151/183) of respondents reporting more than 90% compliance during the COVID-19 pandemic. The increased compliance observed in our investigation during the COVID-19 pandemic compared with the H1N1 pandemic may be the result of differences in the virulence of the causative agent and availability of treatments and vaccines for each pandemic. While both influenza and coronaviruses are characterized as infections of the respiratory system, comparisons of the 2 viruses have found that patients with COVID-19 have experienced longer hospital stays and more complications during care compared with H1N1 patients.¹⁶

For highly infectious diseases, which have the capability to be quickly transmitted globally, such as H1N1 and COVID-19, the presence of an effective treatment and vaccine is vital to delay spread.³ While H1N1 already had treatments available such as Tamiflu and vaccines could be quickly developed due to experience with development from the seasonal influenza vaccine, there were no available treatments or vaccines available for COVID-19 at the beginning of the pandemic.³ Consequently, the increased perceived risks associated with increased virulence and lack of a vaccine and known effective treatments for COVID-19 at the beginning of the pandemic could have resulted in greater levels of compliance compared with the H1N1 pandemic.

Previous research investigations into PPE compliance among HCW have found that common reasons for noncompliance have included discomfort, education, self-perceived risks, and availability of supplies.^{10-13,17} Our research corroborates these findings, as HCWs also cited

similar reasons for noncompliance such as time, risk exposure evaluation, and availability of supplies most frequently. Notably, this investigation found a large increase in the number of HCWs citing fear of limiting supplies as a reason for noncompliance during the COVID-19 pandemic. This increase was likely attributed to severe strain on supply chains during the COVID-19 pandemic due to a sudden increase in demand. As a result of severely limited supplies, many HCWs were forced to rewear PPE for multiple shifts to ensure they had at least some form of protection. In a further effort to preserve supplies, these findings suggest that HCWs may have also been choosing to forgo donning PPE, impacting compliance rates.

This investigation relied on the accuracy of participants to estimate their self-perceived frequency of entering isolation rooms without PPE. As such, this study is limited to the honesty of HCWs in their responses and their ability to evaluate their own behavior. This investigation also relied on the assumption that HCWs forgo PPE at times and are aware that they are making the decision to do so. As such, HCWs who are not aware of this decision are likely to underestimate their frequency of noncompliance. Given that the study facility uses bright yellow caddies (fabric organizer to hold PPE) with signs indicating isolation type at the door of patient rooms in isolation, it is likely that HCWs are aware that they are choosing to enter without PPE. Another limitation of this investigation was that the survey was administered approximately 5 months after the first COVID-19 patient was treated at the study facility. The lag time between the start of the pandemic and survey administration allowed for HCWs to have time to revert to their pre-COVID-19 pandemic practices. Consequently, the administration time could have resulted in a nullification of the effect of the COVID-19 pandemic on PPE compliance.

While it has been scientifically proven that isolation precautions and the use of PPE protect HCWs from acquiring and spreading HAI, compliance continues to be a challenge. Even during a time when the pathogen transmission capabilities and harmful outcomes are not fully known, HCWs continued to choose to forgo PPE. Isolation precautions are utilized for pathogens that usually cannot be visually observed, so the perception can be that the threat is low, forgotten, or deemed unimportant. Therefore, education

(preferably in real time) reminding staff about why isolation precautions are utilized and how they not only protect their patients but also themselves is helpful to secure continued compliance. In a world with evolving and newly developing pathogens, it is important to continually evaluate whether isolation precautions for specific organisms and diseases is having a sustained and useful impact.

REFERENCES

- Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;382(8):727-733. doi:10.1056/nejmoa2001017
- Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC. Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review. *JAMA*. 2020;324(8):782-793. doi:10.1001/jama.2020.12839
- da Costa VG, Saivish MV, Santos DER, de Lima Silva RF, Moreli ML. Comparative epidemiology between the 2009 H1N1 influenza and COVID-19 pandemics. *J Infect Public Health*. 2020;13(12):1797-1804. doi:10.1016/j.jiph.2020.09.023
- Neo F, Edward KL, Mills C. Current evidence regarding non-compliance with personal protective equipment—an integrative review to illuminate implications for nursing practice. *ACORN*. 2012;25(4):22-30.
- World Health Organization. Standard precautions in health care. Published 2007. Accessed March 13, 2021. https://www.who.int/docs/default-source/documents/health-topics/standard-precautions-in-health-care.pdf?fvrsn=7c453df0_2
- Siegel JD, Rhinehart E, Jackson M, Chiarello L. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in health care settings. *Am J Infect Control*. 2007;35(10):S65-S164. doi:10.1016/j.ajic.2007.10.007
- Harrod M, Weston LE, Gregory L, et al. A qualitative study of factors affecting personal protective equipment use among health care personnel. *Am J Infect Control*. 2020;48(4):410-415. doi:10.1016/j.ajic.2019.08.031
- Gammon J, Morgan-Samuel H, Gould D. A review of the evidence for suboptimal compliance of health care practitioners to standard/universal infection control precautions. *J Clin Nurs*. 2008;17(2):157-167. doi:10.1111/j.1365-2702.2006.01852.x
- Chan MF, Ho A, Day MC. Investigating the knowledge, attitudes and practice patterns of operating room staff towards standard and transmission-based precautions: results of a cluster analysis. *J Clin Nurs*. 2008;17(8):1051-1062. doi:10.1111/j.1365-2702.2007.01998.x
- Fogel I, David O, Balik CH, et al. The association between self-perceived proficiency of personal protective equipment and objective performance: an observational study during a bioterrorism simulation drill. *Am J Infect Control*. 2017;45(11):1238-1242. doi:10.1016/j.ajic.2017.05.018
- Chelenyane M, Endacott R. Self-reported infection control practices and perceptions of HIV/AIDS risk amongst emergency department nurses in Botswana. *Accid Emerg Nurs*. 2006;14(3):148-154. doi:10.1016/j.aen.2006.03.002
- Regina C, Molassiotis A, Eunice C, et al. Nurses' knowledge of and compliance with universal precautions in an acute care hospital. *Int J Nurs Stud*. 2002;39(2):157-163. doi:10.1016/S0020-7489(01)00021-9
- Bott J. HIV risk reduction and the use of universal precautions. *Br J Midwifery*. 1999;7(11). doi:10.12968/bjom.1999.7.11.8228

14. de Sousa Melo D, Silva e Souza AC, Tipple AF, das Neves ZC, Pereira MS. Nurses' understanding of standard precautions at a public hospital in Goiania—GO, Brazil. *Rev Lat Am Enfermagem*. 2006;14(5):720-727. doi:10.1590/s0104-11692006000500013
15. Hu X, Zhang Z, Li N, et al. Self-reported use of personal protective equipment among Chinese critical care clinicians during 2009 H1N1 influenza pandemic. *PLoS One*. 2012; 7(9):e44723. doi:10.1371/journal.pone.0044723
16. Deng LS, Yuan J, Ding L, et al. Comparison of patients hospitalized with COVID-19, H7N9 and H1N1. *Infect Dis Poverty*. 2020;9(1):1095-1103. doi:10.1186/s40249-020-00781-5
17. Lymer UB, Richt B, Isaksson B. Health care workers' action strategies in situations that involve a risk of blood exposure. *J Clin Nurs*. 2003;12(5):660-667. doi:10.1046/j.1365-2702.2003.00644.x