Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

American Journal of Infection Control 49 (2021) 657–662

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Availability and crisis standards of care for personal protective equipment during fall 2020 of the COVID-19 pandemic: A national study by the APIC COVID-19 task force

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Key Words:
SARS-CoV-2
Surge capacity
Pandemic

A B S T R A C T

Background: The COVID-19 pandemic resulted in personal protective equipment (PPE) shortages in spring 2020, necessitating crisis protocols.
Methods: An online survey was administered to all Association for Professionals in Infection Control and Epidemiology members in October, 2020 to assess PPE availability and crisis standards utilized in fall, 2020.
Results: In total, 1,081 infection preventionists participated. A quarter lacked sufficient disinfection supplies, N95s, isolation gowns, and gloves; 10%-20% lacked eye protection and hand hygiene supplies. Significantly more were reusing respirators than masks (65.6% vs 46.8%, respectively; $P < .001$); a third (32.0%, n = 735) were reusing isolation gowns. About half (45.9%, n = 496) were decontaminating respirators. Determinants of believing current PPE reuse protocols were safe and evidence-based included the infection preventionists being involved in developing COVID-19 protocols (both), having respirator reuse protocols that involve ≤ 5 reuses (both), using reusable respiratory protection (both), decontaminating respirators (perceived safe), and not reusing masks (perceived safe; $P < .05$ for all).
Conclusions: Although most health care facilities had adequate PPE in fall 2020, PPE supply chains were still disrupted, resulting in the need to reuse or decontaminate PPE. Ongoing gaps in PPE access need to be addressed in order to minimize health care associated infections and occupational illness.

BACKGROUND

SARS-CoV-2, the virus that causes COVID-19 disease, was identified in early 2020 and quickly led to a pandemic. Within just a few months of the pandemic, many hospitals and health care facilities reported personal protective equipment (PPE) and infection prevention supply anticipated and actual shortages.[1,2] This required healthcare facilities to begin utilizing crisis capacity strategies to conserve PPE. Health care facilities were forced to implement strategies to reuse, conserve and prioritize the use of eye protection, isolation gowns, masks, and N95 respirators (ie, to implement crisis standards of care [CSC] related to PPE).[3,4] A national study conducted in March 2020 found that many hospitals and healthcare facilities were running dangerously low or even out of face shields, N95 respirators, hand sanitizer, and disinfection supplies.[2] Soon after findings from this study were made public, the Defense Production Act was activated, which included provisions to ramp up production of PPE and other critical supplies.[5] In late spring, the Centers for Disease Control and Prevention (CDC) released guidelines for optimizing PPE supply during the COVID-19 pandemic.[4] These guidelines were designed to provide evidence-based strategies for CSCs for PPE, such as long-term and re-use of PPE. Despite activation of the Defense Production Act and release of the CDC's PPE crisis standard protocols, about half of healthcare facilities continued to report PPE shortages through the

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Conflicts of interest: None to report.
Funding: None to report.

https://doi.org/10.1016/j.ajic.2021.03.015
0196-6553/

summer of 2020 and beyond.[6] A study conducted by the American Nurses Association found that about 79% of nurses felt unsafe due to PPE shortages and the associated use of PPE CSCs. The purpose of this study was to assess PPE availability in fall 2020 of the COVID-19 pandemic and PPE CSCs implemented.

METHODS

A link to an online questionnaire was provided to all members of the Association for Professionals in Infection Control and Epidemiology (APIC) via email newsletters sent to members. The survey was administered through Gravity Forms®, an online survey software program. The survey was open from October 22 to November 9, 2020. Members of the APIC COVID-19 Task Force developed the survey. The survey contained 40 questions plus demographic items. A Likert-type scale was used to assess participants' current access to various types of PPE, including N95s, masks, face shields, goggles, gloves, isolation gowns, and hand hygiene and disinfection supplies. Answer options included *have plenty (no crisis standards of care in place; PPE are single use items), have sufficient amount (crisis standards of care are in place, but we have enough), running a bit low (more has been ordered but we should have enough until it arrives), almost out (unsure if current supplies will last until replacements arrive), and have none*. Participants were also asked whether they had implemented CSCs and other protocols related to PPE, such as their use of universal masking or eye protection; use of reusable respiratory protection; practices related to reuse of respirators and masks; and respirator decontamination strategies. Ten items assessed participants' attitudes and beliefs about the pandemic. APIC staff collected the data and then shared with the authors to conduct a secondary data analysis. The Saint Louis University Institutional Review Board determined that this was not human subject's research.

Data Analysis

The Statistical Package for the Social Sciences (SPSS) 27.0 was used for all analyses. Each PPE type, hand hygiene, and infection prevention supply was recoded into a dichotomous variable, with *running a bit low, almost out*, and *have none* = "no", and *have plenty* and *have sufficient amount* = "yes". Descriptive statistics were reported for all questions. All comparisons across dichotomous groups were assessed using a chi square, such as to detect differences between those who agreed with an attitude and belief statement and whether or not they had implemented CSCs for mask use. Proportions tests were used to evaluate differences in agreement between attitude and belief questions. Regional participation percentages were compared using a chi square goodness of fit test based on US census data. A hierarchical logistic regression was used to determine predictive models for believing their PPE reuse protocols are safe and evidence-based, and that they have adequate PPE. A Hosmer and Lemeshow goodness-of-fit test was used to determine good model fit for each regression. Only final models are reported. A *P*value of .05 was used as the cut off for statistical significance for all analyses.

RESULTS

In all, 1,081 infection preventionists (IPs) completed the survey. Almost all were female (94.5%, n = 990), and over 40 years of age (79.7%; Table 1). Participation was slightly higher among IPs in the Midwest and slightly lower than expected among IPs in the South and West compared to US census data (X^2=11.6, $P < .05$; Table 1). The vast majority (80.0%, n = 859) work at a single facility; all others covered than more one facility type. Over half (58.9%, n = 638) work in a hospital. A quarter (25.1%, n = 198) worked at the smallest sized facility with ≤ 50 beds; 17.6% (n = 139) worked at the largest-size facility with ≥500 beds (Table 1).

Table 1
Participant and facility demographics

Facility demographics	N = 1081* % (n)
States grouped by US census regions	
Midwest	31.7 (343)
South	31.0 (335)
West	20.2 (218)
Northeast	16.3 (176)
US territory	0.8 (9)
Facility location	
Rural	35.7 (386)
Suburban	31.7 (343)
Urban	32.6 (352)
Healthcare facility type†	
Hospital	59.0 (638)
Ambulatory care	27.0 (292)
Long-term care facility	18.4 (199)
Critical access hospital	15.2 (164)
Inpatient rehabilitation center or behavioral health	12.6 (136)
Urgent care	6.3 (68)
Home health or hospice	6.1 (66)
Dialysis	4.1 (44)
Hospital/Facility bed size	
≤ 50 beds	25.1 (198)
51-99 beds	11.5 (91)
100-199 beds	15.7 (124)
200-299 beds	13.3 (105)
300-399 beds	10.5 (83)
400-499 beds	6.3 (50)
≥500 beds	17.6 (139)
Participant demographics	**% (n)**
Gender (Female)	94.5 (990)
Age	
21-30 years	4.1 (43)
31-40 years	17.2 (181)
41-50 years	23.8 (251)
51-60 years	34.5 (364)
≥61 years	20.4 (215)
Education level	
Some college or less	2.2 (24)
Associate's degree	17.7 (191)
Bachelor's degree	44.6 (482)
Master's degree	33.0 (357)
MD, JD, PhD, or equivalent	2.5 (27)
Certified in Infection Prevention (CIC)	48.2 (521)
Years of infection prevention work experience	
≤2 years	18.8 (203)
3-4 years	15.8 (171)
5-10 years	30.1 (325)
≥11 years	35.3 (382)
System director or corporate infection preventionist	45.1 (488)

*Denominators may vary due to missing data.
†Participants could select more than one facility type.

PPE and infection prevention supply availability

Current PPE and infection prevention supply availability was assessed; details are provided in Table 2. About a quarter lack sufficient disinfection supplies, N95s, isolation gowns, and gloves (Table 2). Between 10% and 20% lack sufficient eye protection, hand sanitizer, and hand soap (Table 2). About 40% (n = 422) lack sufficient cloth gowns. Participants were significantly less likely to have N95s, disinfection supplies, and cloth gowns compared to all other PPE and infection prevention supplies ($P < .001$ for all comparisons; Table 2). Approximately three-quarters of IPs reported implementing CSCs for N95s and eye protection (73.0% and 75.8%, respectively). About two-thirds (68.7%, n = 743) have implemented CSCs for masks. Far fewer

Table 2
Access to personal protective equipment and infection prevention supplies

	N = 1,081						
		Current amount available*					
	Current amount available $\bar{x}$ (*sd*)	Have none % (n)	Almost out % (n)	Running A bit Low % (n)	Have sufficient amount % (n)	Have plenty % (n)	Has sufficient amount (yes/no) % (n)
Personal Protectiveequipment							
Masks	3.1 (.65)	0	2.0 (22)	10.3 (111)	62.2 (672)	25.5 (276)	87.7 (948)
Face Shields	3.1 (.68)	0.6 (6)	1.5 (16)	10.5 (113)	61.3 (663)	6.2 (283)	87.5 (946)
Goggles	3.0 (.87)	3.5 (38)	2.5 (27)	11.7 (127)	59.3 (641)	22.9 (248)	82.2 (889)
Gloves	3.1 (.85)	0	3.6 (39)	20.2 (218)	37.5 (405)	38.8 (419)	76.2 (824)
Isolation Gowns	2.9 (.88)	1.9 (20)	3.2 (35)	21.3 (230)	46.3 (500)	27.4 (296)	73.6 (796)
N95 Respirators	2.7 (.92)	5.2 (56)	3.7 (40)	18.2 (197)	60.3 (652)	12.6 (136)	72.9 (788)
Cloth gowns	2.2 (1.6)	29.5 (319)	1.9 (20)	7.7 (83)	36.9 (399)	24.1 (260)	61.0 (659)
Other Infection prevention Supplies							
Hand Soap	3.4 (.70)	0.2 (2)	1.0 (11)	8.9 (96)	43.7 (472)	46.3 (500)	89.9 (972)
Injection Supplies	3.4 (.75)	0.4 (4)	1.5 (16)	9.5 (103)	38.6 (417)	50.0 (541)	88.6 (958)
Hand Sanitizer	3.1 (.78)	0.2 (2)	2.4 (26)	16.5 (178)	45.3 (490)	35.6 (385)	80.9 (875)
Disinfection Supplies	2.9 (.82)	0	4.7 (51)	23.2 (251)	46.6 (504)	25.4 (275)	72.1 (779)

*0 = have none; 1 = almost out (unsure if current supplies will last until replacements arrive); 2 = running a bit low (more has been ordered but we should have enough until it arrives); 3 = have sufficient amount (crisis standards of care are in place, but we have enough); 4 = have plenty (no crisis standards of care in place; PPE are single use items).

have implemented CSCs for isolation gowns or gloves (43.8% and 10.0%, respectively; $P < .001$ for both comparisons).

PPE availability was found to vary by facility type. Long-term care facilities (LTCFs), ambulatory care, and home care were significantly less likely to report having sufficient respirators compared to other facility types ($X^2 = 18.5$, $P < .01$). Critical access hospitals and ambulatory care facilities were less likely than other settings to have sufficient masks ($X^2 = 18.5$, $P < .01$). Hospitals, LTCFs, and urgent care were more likely to have sufficient face shields compared to all other sites ($X^2 = 18.6$, $P < .01$). Ambulatory care and critical access hospitals were less likely to have adequate gloves ($X^2 = 15.9$, $P = .01$). Isolation gown and goggle availability did not vary by facility type.

Current PPE practices, including universal policies and reuse

Almost all healthcare facilities are implementing a universal masking policy for employees and visitors (99.4% and 98.4%, respectively). About a third of IPs (29.9%, n = 323) reported that their facility reserves N95s for aerosol-generating procedures (AGPs); 64.0% (n = 687) reserve N95s for all known or suspected COVID-19 patients and/or AGPs. A small percentage (6.6%, n = 71) reported that they only have access to masks and do not use N95s for any medical care. About two-thirds of participants (63.2%, n = 683) reported that their facility is using some type of reusable respiratory protection. About half (56.5%) have had some staff use a powered air-purifying respirator for respiratory protection; 22.2% (n = 240) have used elastomeric respirators. About a third of IPs reported that their facility has used respirators that are not certified by the National Institute for Occupational Safety and Health (NIOSH); 28.2% have used respirators that exceeded their shelf life. A small percentage reported using KN95 respirators or some other type of non-NIOSH certified respirator in the past three months (4.3% and 1.4%, respectively). About two-thirds (67.5%, n = 730) have implemented a universal eye protection protocol for all staff; a quarter (25.8%) only use eye protection with COVID-19 patients, and 6.7% (n = 72) allow the health care personnel to decide when to wear a face shield or goggle. No facilities implemented a universal eye protection protocol for patients or visitors. Approximately half (56.5%, n = 611) have visitors of COVID-19 patient wear eye protection; 43.5% (n = 470) only have visitors wear eye protection if they are unable to wear a mask.

About two-thirds (65.6%, n = 709) reported that their healthcare facility is currently reusing respirators. Of those reusing respirators (n = 709), two-thirds are allowing 5 reuses (37.4%) or as many as possible (38.6%) before providing staff a new respirator. Almost all facilities that are reusing respirators are having staff store the used respirator in a brown bag or other breathable container (90.9%, n = 637); 3.9% are using an unsealed plastic baggie or container, 1.1% are hanging the respirator, and 4.1% allow staff to choose their storage method. Of those facilities reusing respirators (n = 709), half (49.5%, n = 351) are providing staff with more than one respirator so that they can be rotated and not worn 2 days in a row. Significantly more facilities are reusing respirators compared to reusing masks (65.6% vs 46.8%, respectively; $P < .001$). Of those reusing masks (n = 506), more than half (56.7%) have staff wear the mask as many times as possible before donning a new mask; 16.8% require five reuses, and 12.8% reuse a mask only once. About 20% (19.2%, n = 208) reported that their healthcare staff resorted to wearing a homemade mask at some point during the pandemic because their facility had run out of respirators and masks. About a third (32.0%, n = 735) are currently reusing isolation gowns or have done so in the past three months. Of those reusing gowns (n = 346), half (50.9%) are reusing cloth gowns; 46.2% are reusing synthetic/traditional isolation gowns.

Reported respirator decontamination strategies

About half of all facilities (45.9%, n = 496) reported using some form of respirator decontamination currently or in the past 3 months. The 2 most commonly reported forms of respirator decontamination were vaporous hydrogen peroxide and ultraviolet germicidal irradiation (24.1% and 19.0%, respectively; Table 3). The frequency of other types of respirator decontamination is outlined in Table 3. Of those decontaminating respirators (n = 496), 16.3% (n = 81) are stockpiling

Table 3
Respiratory decontamination methods currently employed or used during the past 3 months

Decontamination method	N = 1081% (n)
Vaporous hydrogen peroxide	24.1 (261)
Ultraviolet germicidal irradiation	19.0 (205)
Batelle®	3.6 (39)
Moist Heat	1.8 (19)
Other	1.9 (20)

the decontaminated respirators for possible future use rather than returning them to staff. About 20% (17.9%, n = 193) are having respirators decontaminated off-site. Of those using off-site decontamination (n = 193), a third (34.2%) are returning the respirators to general stock rather than providing staff their own previously used respirator.

IP's attitudes and beliefs about health care surge capacity, PPE protocols, and the COVID-19 pandemic

The vast majority of IPs have been involved in developing their facility's COVID-19 response protocols and believed their healthcare colleagues trust their opinion about infection prevention (85.8% and 85.5%, respectively; Table 4). More than three-quarters of IPs (79.1%, n = 855) reported being concerned about the impact of medical supply shortages on their facility related to the pandemic and influenza season (Table 4). Significantly more were concerned about medical supply shortages this year compared to previous years because of the pandemic (84.3% vs 79.1%, $P < .001$; Table 4). Almost three-quarters (71.9%, n = 777) were concerned about their facility's healthcare surge capacity during the current influenza season and COVID-19 pandemic (Table 4). Approximately half were concerned about their facility's ability to provide safe patient care and/or protect health care personnel during the current influenza season and COVID-19 pandemic (53.7% and 51.2%, respectively; Table 4). IPs whose facility was currently using CSC protocols for masks reported significantly more concern about the impact of medical supply shortages, health care surge capacity, and the ability to provide safe care or protect health care personnel compared to those who are not using CSCs for masks (Table 4). Most IPs (86.6%, n = 936) believed their facility is currently providing adequate PPE for their staff, although IPs using a mask CSC protocol were less likely to believe this (Table 4). Predictors of believing their facility is currently providing adequate PPE for their staff included the IP being involved in developing COVID-19 protocols, not having worn homemade masks at some point, not having used respirators that exceeded their shelf life, having respirator reuse protocols that involve 5 or fewer reuses, and not current reusing masks ($P < .05$ for all; Table 5). All other demographic variables and attitude and belief statements, including CIC status, were not significant predictors.

Three quarters of IPs (74.5%, n = 805) believed their facility's current PPE reuse protocols are safe; there was no relationship between this belief and using a mask CSC protocol (Table 4). Determinants of believing their facility's current PPE reuse protocols are safe included the IP being involved in developing COVID-19 protocols, having respirator reuse protocols that involve five or fewer reuses, using reusable respiratory protection, using any form of respirator decontamination, and not currently reusing masks ($P < .05$ for all; Table 5).

Table 4
Infection preventionists' attitudes and beliefs about health care surge capacity, personal protective equipment, and the COVID-19 pandemic by use of mask crisis standards of care (CSC) protocol

Statement	All respondents N = 1,081		Mask crisis standards of care (CSC) protocol vs no CSC for masks N = 1,081				
	% That strongly agreed or agreed	n	Mask CSC* N = 195		No mask CSC N = 67		CSC vs no CSC
			% That strongly agreed or agreed	n	% That strongly agreed or agreed	n	*P* value†
My facility is currently providing adequate PPE for our staff	86.6	936	85.1	632	89.9	304	< .05
I have been involved in developing my facility's COVID-19 response protocols	85.8	928	86.1	640	85.2	288	NS
The healthcare staff at my facility trust my opinion about infection prevention	85.5	924	85.9	638	84.6	286	NS
I am **more** concerned about the impact of medical supply shortages on my facility related to the current 2020/2021 influenza season this year compared to previous years because of the pandemic	84.3	911	86.7	644	79.0	267	= .001
I am concerned about the impact of medical supply shortages on my facility related to the current 2020/2021 influenza season	79.1	855	82.9	616	70.7	239	< .001
I believe my facility's current reuse of PPE protocols are safe	74.5	805	73.9	549	75.7	256	NS
I am concerned about my facility's healthcare surge capacity related to the current 2020/2021 influenza season and pandemic	71.9	777	74.6	554	66.0	223	< .01
I believe my facility's current reuse of PPE protocols are evidence-based	70.8	765	71.5	531	69.2	234	NS
I am concerned about my facility's ability to provide safe care during the current 2020/2021 influenza season and pandemic	53.7	581	56.9	423	46.7	158	< .01
I am concerned about my facility's ability to adequately protect healthcare personnel during the current 2020/2021 influenza season and pandemic	51.2	554	54.9	408	43.2	146	< .001

NS, not significant.
*Mask CSC = extended use, reuse, or conservation of masks.
†Determined by the X^2 test.

Table 5
Factors Related to Infection Preventionists' Belief That Facility Personal Protective Equipment Reuse Protocols are Safe and/or Evidence-based from Logistic Regression*

Variable	Reuse protocols are safe		Reuse protocols are evidence-based		Facility is providing adequate PPE	
	OR (95% CI)	*P*	OR (95% CI)	p	OR (95% CI)	*P*
IP helped develop COVID-19 response protocols	5.0 (3.1-7.9)	< .001	3.4 (2.2-5.3)	< .001	2.9 (1.8-4.7)	< .05
Respirator reuse protocol involves 5 or fewer re-uses	1.8 (1.2-2.7)	< .01	1.8 (1.3-2.5)	= .001	1.6 (1.0-2.4)	< .05
Facility uses reusable respiratory protection	1.8 (1.2-2.5)	< .01	1.5 (1.0-2.1)	< .05	NIM	NS
Facility has used any form of respirator decontamination	1.6 (1.1-2.4)	< .05	NIM	NS	NIM	NS
Staff did not wear homemade masks at some point	NIM	NS	1.6 (1.1-2.5)	< .05	1.8 (1.2-3.0)	= .01
Facility has not used respirators that exceeded their shelf life	NIM	NS	NIM	NS	1.8 (1.2-2.8)	< .01
Facility is not currently reusing masks	1.5 (1.0-2.3)	< .05	NIM	NS	1.6 (1.1-2.5)	< .05

CI, Confidence interval; NS, nonsignificant; IP, Infection Preventionist; OR, odds ratio; NIM, not included in model because it was NS

Fewer than three-quarters (70.8%, n = 765) believed their PPE reuse protocols are evidence-based (Table 4). Predictors of believing their PPE reuse protocols are evidence-based included the IP being involved in developing COVID-19 protocols, having respirator reuse protocols that involve 5 or fewer reuses and using reusable respiratory protection.

DISCUSSION

The findings of this study indicate that IPs are reporting better access to PPE and infection prevention supplies in fall, 2020 compared to a similar study conducted with APIC members in spring 2020.[2] However, disinfection supplies, N95s, isolation gowns (including cloth and washable), and gloves continue to be lacking and remain the PPE most often in insufficient supply. This data reflects findings from other COVID-19-related studies examining PPE access throughout the pandemic. For example, Greene and Gibson[7] found that 16.8%-18.8% of sampled LTCFs experienced a PPE shortage during June through July 2020 of the COVID-19 pandemic, with N95s and isolation gowns most likely to be in shortage. McGarry et al[8] found that 20.7% of participating LTCFs reported a severe PPE shortage, defined as one week or less of available supply, with N95s and isolation gowns being reported as the frequent PPE in shortage. The General Accountability Office reported on November 30, 2020[9] that while entities and organizations in most states could fulfill requests for supplies, constraints continued on certain items, including nitrile gloves, which are preferred over latex gloves in healthcare due to their puncture-resistant nature. This sustained shortage of PPE and disinfection supplies across health care facilities remains a concern, as these supplies are critical to protect health care personnel and patients from exposure and infection. As of January 30, 2021, the CDC reported that 387,901 healthcare personnel had become infected with COVID-19, resulting in 1,325 deaths.[10] Gowns worn in health care, such as isolation and surgical gowns, are chosen based on the barrier protection level afforded by that material and the action to be performed, such as used when providing care to a patient in isolation versus during a surgical procedure. Traditional isolation gowns are not made of cloth and are considered to be single-use items. It is not known whether there was an increased risk of occupational illness for those facilities that were forced to switch to cloth/washable gowns instead of traditional isolation gowns. Additional research is needed to learn how PPE and disinfection supply shortages may contribute to these infections during this pandemic, but research has found that a large percentage of nurses felt unsafe working during the pandemic due to PPE shortages.[11]

Findings from this study indicate that the ongoing and intermittent supply challenges have resulted in a number of healthcare facilities implementing PPE contingency and crisis protocols in an attempt to preserve their supplies. Almost 90% of IPs in this study reported perceiving that they have an adequate PPE supply, but only when compromises were made regarding PPE use. Approximately three-quarters of healthcare facilities in this study reported implementing crisis standards for PPE, including N95s, masks, eye protection, and isolation gowns. The CDC defines crisis capacity strategies as "strategies that can be used when supplies cannot meet the facility's current or anticipated PPE utilization rate."[4] Extended use, reuse, and decontamination of respirators, use of respirators beyond their designated shelf life, extended use of isolation gowns and masks, and prioritizing PPE to patient care activities of higher risk to health care personnel are some strategies that CDC recommends to prolong PPE supplies.[4] In this study, about 20% of IPs reported that healthcare personnel at their facilities needed to wear a cloth mask at some point during the pandemic due to lack of single-use mask supplies, a practice that the CDC indicates should be the last resort after all other options have been exhausted.[4] This demonstrates the extreme lack of PPE availability during the pandemic.

An interesting finding from this study is that use of crisis standards for masks was strongly associated with IP concerns about patient and health care worker safety. IPs whose facilities are currently applying crisis protocols for masks reported significantly more concern about the impact of medical supply shortages, health care surge capacity, and the ability to provide safe care or protect health care personnel compared to those who are not using crisis standards for masks.. These concerns for healthcare worker safety related to supply shortages and their implications are substantiated by other research from this pandemic. For example, Sharma et al[12] found that there was a higher likelihood for emotional distress and burnout among intensive care unit personnel reporting insufficient PPE access, these health care personnel were 5.82 times more likely to feel like their hospital could not keep them safe. Norful et al[13] identified PPE stressors, including access to supplies and transmission risk by health care personnel to their families, as a theme in their qualitative study of healthcare personnel examining stress during the early part of the COVID-19 pandemic in the US. PPE crisis standards may also have an impact on healthcare associated infections.[14] In one study, extended use of an underlayer of PPE was found to be associated with an outbreak of *Candida auris*, a multidrug resistant yeast that can cause invasive infections.[15] Additional observational studies to understand how using PPE within crisis standards could impact other health care-associated infections and occupational exposures and infections would help in understanding potential consequences to implementing these protocols.

A notable finding from this study is that nearly one-quarter of IPs do not believe their PPE reuse protocols are safe and about a third do not believe they are evidence-based. However, when the IP was involved with developing COVID-19 PPE protocols, they were significantly more likely to believe their PPE protocols were safe and evidence-based, and to report having adequate PPE for staff. In a 2016 paper by Bubb et al,[16] the IP standards of practice include decision-making "based on professional standards and values that guide professional behavior," which includes holding paramount the safety, health, and welfare of the public in the performance of professional

duties. Bubb et al also underscore the role of the IP to "provide expert knowledge, guidance, and performance of routine risk assessments in [infection prevention and control] with the multidisciplinary teams as appropriate."[16] An APIC State of the Art Report regarding the role of IPs in emergency management also emphasized the importance of having IPs involved in developing PPE crisis protocols.[17] IPs are experts in infection prevention and are uniquely qualified to help inform and develop evidence-based practice related to routine and crisis standards for PPE.[17] It is essential that IPs be involved in the process of developing, implementing, and evaluating PPE protocols in order to ensure a safe work and healthcare environment.

This study is the first to assess the extent to which US health care facilities are currently implementing crisis standards related to PPE, such as reuse of masks and N95s and respirator decontamination. Although recommendations around these practices are evolving, it is critical to assess what is currently being implemented and IPs' attitudes and beliefs about these practices. However, study limitations must also be noted. There is a potential risk of responder bias. Participants may have been more involved than nonresponders in developing PPE crisis standards or COVID-19 response at their facilities, which could lead to bias. Finally, because only APIC members were invited to participate, these findings do not reflect all US health care facilities and likely better represent hospitals compared to LTCFs and other health care settings that are less likely to have an APIC member IP. Additional studies would be needed to better determine PPE crisis standards implemented in nonacute care facilities.

CONCLUSION

This study found that, although most US health care facilities reported having adequate PPE, hand hygiene products, and disinfection supplies in fall, 2020, this was due to the high frequency of PPE crisis standards being implemented. PPE supply chains were still disrupted, resulting in the need to reuse or decontaminate PPE in order for healthcare facilities to have adequate PPE. These practices may result in unsafe work and health care environments and an increased risk of health care-associated and/or occupational infections among patients and healthcare personnel. Ongoing gaps in PPE access need to be addressed in order to minimize health care associated infections and occupational illness.

Acknowledgment

The authors would like to thank the APIC COVID-19 Task Force (in alphabetical order): Rebecca Alvino, Pam Falk, Liz Garman, Jill Holdsworth, Kathleen McMullen, Silvia Quevedo, Terri Rebmann, Barbara Smith, Lisa Tomlinson, and Angela Vassallo.

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