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Contents lists available at ScienceDirect

## American Journal of Infection Control

journal homepage: [www.ajicjournal.org](http://www.ajicjournal.org)

## Major Article

# Availability of personal protective equipment and infection prevention supplies during the first month 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

**Background:** SARS-CoV-2, the virus that causes COVID-19 disease was first discovered in China in December, 2019. The disease quickly spread globally, with the first US case identified in January, 2020; it was declared a pandemic on March 11, 2020. Soon after, anecdotal reports indicated that many US hospitals and healthcare facilities were running low on personal protective equipment (PPE) and supplies.

**Methods:** An online survey was administered to all Association for Professionals in Infection Control and Epidemiology members in March, 2020 to assess access to PPE, hand hygiene products, and disinfection supplies.

**Results:** In all, 1,201 infection preventionists participated. Participants reported running a bit low to almost being out of all PPE types. More had sufficient gloves (63.4%) compared to all other PPE types ( $P < .001$  for all). Face shields and N95 respirators were the least available (13.6% and 18.2% had sufficient supplies, respectively;  $p < .001$  for all). Many (66.9%) had sufficient hand soap, but far fewer had sufficient hand sanitizer (29.5%,  $X^2 = 211.1$ ,  $P < .001$ ). Less than half (45.4%,  $n = 545$ ) had sufficient disinfection supplies.

**Conclusions:** Many US healthcare facilities had very low amounts of PPE, hand hygiene products, and disinfection supplies early on during the pandemic. A lack of these supplies can lead to occupational exposures and illness as well as healthcare-associated transmission of COVID-19 and other diseases.

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## BACKGROUND

SARS-CoV-2, the virus that causes COVID-19 disease was first discovered in China in December, 2019. The disease quickly spread globally, with the first U.S. case identified in January, 2020.<sup>1</sup> It was officially declared a pandemic on March 11, 2020. Large urban areas with many international travelers, such as New York City and Los Angeles, saw the first patient surges,<sup>2</sup> but cases were identified in multiple areas of the US. Hospitals began implementing their emergency management plans, including reverse triage protocols to free up beds for COVID-19 patients or reopening closed hospitals to provide surge capacity. Despite this, healthcare surge quickly exceeded

available resources in multiple areas, especially in New York City and Brooklyn.<sup>3</sup>

Responding to COVID-19 requires multiple types of surge capacity, including having additional regular and intensive care beds, ventilators, and general medical supplies. In addition, having access to personal protective equipment (PPE) and sufficient staff to manage the patient surge are critical to an effective response.<sup>4</sup> Appropriate PPE is required to protect healthcare personnel from occupational exposure and disease, especially with a disease such as COVID-19 that has been found to spread easily in healthcare settings.<sup>5,6</sup> A lack of PPE early during the pandemic led to many healthcare worker exposures and illness.<sup>5,6</sup> In early March, 2020, anecdotal reports indicated that many US hospitals and healthcare facilities were running low on PPE and supplies. The purpose of this study was to assess healthcare access to PPE, hand hygiene products, and disinfection supplies during the early part of the COVID-19 pandemic.

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## METHODS

This study consisted of a survey provided to all members of the Association for Professionals in Infection Control and Epidemiology (APIC; ie, a convenience sample) via Gravity Forms, an online survey software program. The survey was open from March 23 to 25, 2020. A single recruitment email and/or announcement was sent via an APIC newsletter. Members of the APIC COVID-19 Task Force developed the survey. The survey contained 14 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*, *have sufficient amount*, *running a bit low*, *almost out*, and *have none*. Participants were also asked a series of dichotomous questions regarding whether they had accessed supplemental PPE from outside sources, such as the Strategic National Stockpile (SNS), local or state resources, private donations, or do-it-yourself (DIY) efforts (0 = no; 1 = yes). The data was collected by APIC staff 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 subjects research.

### Data analysis

The Statistical Package for the Social Sciences (SPSS) 26.0 was used for all analyses. A dichotomous variable was calculated for each type of PPE and hand hygiene or disinfection supply, with *running a bit low*, *almost out*, and *have none* = 0/no, and *have plenty* and *have sufficient amount* = 1/yes. Descriptive statistics were computed for each question and used to describe the extent to which participants had access to PPE and/or hand hygiene and disinfection supplies. Chi square tests were used to compare all dichotomous groups, such as having access to each type of PPE and/or receiving supplemental PPE from different sources. A chi square goodness of fit test was used to compare regional response percentages by US census data. A p value of .05 was used for all analyses.

## RESULTS

In total, 1,201 infection preventionists completed the survey. There were participants from all states and US territories. There were slightly more participants in the Midwest and slightly fewer in the West than would be expected compared to U.S. census data for those regions ( $X^2 = 48$ ,  $P < .05$ ; Table 1). The majority of respondents were infection preventionists (87.3%,  $n = 1,048$ ) vs being a system Director or working for a corporate healthcare system (Table 1). Most (84%,  $n = 1,009$ ) work at a single facility; 16% ( $n = 192$ ) cover than more 1 healthcare facility type (Table 1). Over half (64.9%,  $n = 780$ ) work in a hospital. About a third (34.0%,  $n = 408$ ) worked at small-sized hospitals and/or facilities having 50 or fewer beds; 21.6% ( $n = 260$ ) worked at one of the large-size hospitals and/or facilities with 301 or more beds (Table 1).

### PERSONAL PROTECTIVE EQUIPMENT AVAILABILITY

Participants were asked about their current availability of various PPE types, including N95 respirators, masks, face shields, goggles, gloves, and isolation gowns; responses are outlined in Table 2. Participants reported running a bit low to almost being out of all types of PPE (Table 2). Participants were more likely to report having sufficient gloves (63.4% had sufficient amount) compared to all other PPE types ( $P < .001$  for all comparisons; Table 2). Face shields and N95 respirators were the least available PPE types (only 13.6% and 18.2% had sufficient amounts, respectively;  $P < .001$  for all comparisons; Table 2).

**Table 1.**  
Participant demographics

	N = 1,201% (n)
States grouped by US census regions*	
Midwest	30.3 (217)
South	32.5 (380)
West	18.6 (217)
Northeast	18.6 (217)
US territory	2.7 (33)
Infection prevention full-time equivalents	
0-1	67.2 (807)
2-5	22.6 (271)
6 or more	10.1 (123)
System director or corporate infection preventionist	12.7 (153)
Hospital/facility bed size	
≤50 beds	34.0 (408)
51-99 beds	13.7 (164)
100-150 beds	11.7 (141)
151-199 beds	6.6 (79)
200-250 beds	8.2 (99)
251-300 beds	4.2 (50)
≥301 beds	21.6 (260)
Healthcare facility type (those who cover 1 site)	N = 1,009
Hospital	52.7 (532)
Ambulatory care	17.4 (176)
Long-term care facility	17.2 (174)
Critical access hospital	7.9 (80)
Inpatient rehabilitation center	1.3 (13)
Behavioral health facility	2.0 (20)
Home health	0.8 (8)
Urgent care	0.2 (2)
Dialysis	0.2 (2)
Corrections health	0.2 (2)

Participants were also asked whether they had received supplemental PPE from outside sources, such as local, regional, or federal sources, private donations, or DIY. Half 52.0%, ( $n = 624$ ) reported receiving PPE from local or state sources, 44% ( $n = 528$ ) from private donations, 30.7% ( $n = 369$ ) DIY, and 22.2% ( $n = 267$ ) from the SNS. Participants were significantly more likely to have received supplemental PPE from any source compared to receiving it from the SNS ( $P < .001$  for all comparisons).

Availability of multiple PPE items was found to vary by facility type. Facilities consisting of 50 or fewer beds and ambulatory care facilities were significantly more likely to have sufficient N95 respirators compared to larger-sized facilities and those that do not have an ambulatory care facility ( $P < .01$  for both). Critical access hospitals were more likely than other facilities to report having sufficient N95 respirators (33.1% vs 16.3%,  $X^2 = 22.7$ ,  $P < .001$ ). Hospitals, urgent care centers, and dialysis facilities were less likely to have sufficient masks ( $P < .01$  for all). Critical access hospitals were more likely than other facilities to report having sufficient masks (28.7% vs 20.0%,  $X^2 = 5.5$ ,  $P < .05$ ). Hospitals and long-term care facilities were less likely than other agencies to have sufficient face shields ( $P < .05$  for both). Hospitals were less likely than other facilities to report having sufficient goggles (20.5% vs 27.9%,  $X^2 = 8.8$ ,  $P < .01$ ). Home health agencies were significantly less likely than other healthcare agencies to report having sufficient gloves (28.6% vs 63.8%,  $X^2 = 7.4$ ,  $P < .01$ ). Gown availability did not vary by facility type.

### AVAILABILITY OF HAND HYGIENE PRODUCTS AND DISINFECTION SUPPLIES

Participants were asked about their current availability of hand soap, hand sanitizer, and disinfection supplies; responses are outlined in Table 2. Participants reported running a bit low to almost having sufficient amounts of hand hygiene products (Table 2). Participants were significantly more likely to report having sufficient hand

**Table 2.**  
Access to personal protective equipment, hand hygiene products, and disinfection supplies

	Current amount available $\bar{x}$ (sd)*	Current amount available					Has sufficient amount (yes/no) % (n)
		Have none % (n)	Almost out % (n)	Running a bit low % (n)	have sufficient amount % (n)	Have plenty % (n)	
Personal protective equipment							
Gloves	2.7 (.72)	0.2 (3)	4.8 (58)	31.6 (379)	53.9 (647)	9.5 (114)	63.4 (761)
Isolation gowns	2.1 (.84)	1.4 (17)	22.9 (275)	44.0 (529)	28.4 (341)	3.2 (39)	31.6 (380)
Masks	1.9 (.78)	1.0 (12)	30.7 (369)	47.3 (568)	19.1 (229)	1.9 (23)	21.0 (252)
Goggles	1.8 (.97)	10.9 (131)	28.1 (338)	37.2 (447)	22.0 (264)	1.7 (21)	23.7 (285)
N95 respirators	1.5 (1.0)	20.7 (249)	27.7 (333)	33.3 (400)	17.3 (208)	0.9 (11)	18.2 (219)
Face shields	1.5 (.90)	12.7 (152)	36.3 (436)	37.5 (450)	13.1 (157)	0.5 (6)	13.6 (163)
Hand hygiene & disinfection supplies							
Hand soap	2.7 (.74)	0.3 (4)	5.0 (60)	27.7 (333)	55.9 (671)	11.1 (133)	66.9 (804)
Disinfection supplies	2.3 (.82)	0.6 (7)	15.6 (187)	38.5 (462)	40.0 (480)	5.4 (65)	45.4 (545)
Hand sanitizer	2.0 (.84)	2.5 (24)	25.1 (302)	42.9 (515)	27.5 (330)	2.0 (24)	29.5 (354)

\*0 = have none; 1 = almost out; 2 = running a bit low; 3 = have sufficient amount; 4 = have plenty

soap compared to hand sanitizer (66.9% vs 29.5%,  $\chi^2 = 211.1$ ,  $P < .001$ ). Less than half (45.4%,  $n = 545$ ) reported having sufficient disinfection supplies (Table 2). Availability of hand soap and disinfection supplies was found to vary by facility type, though hand sanitizer availability did not vary by facility type. Critical access hospitals were more likely than other facilities to report having sufficient hand soap (75.0% vs 65.9%,  $\chi^2 = 4.5$ ,  $P < .05$ ). Hospitals and urgent care centers were less likely than other facilities to have sufficient disinfection supplies ( $P < .05$  for both). Long-term care facilities were more likely than other agencies to have sufficient disinfection supplies (54.6% vs 42.9%,  $\chi^2 = 10.8$ ,  $P = .001$ ).

## DISCUSSION

The findings of this study indicate that most US healthcare facilities lacked sufficient infection prevention supplies during the first month of the COVID-19 pandemic, or at least the perception of having inadequate PPE. Perceived critical shortages were identified in N95 respirators, masks, face shields, goggles, isolation gowns, hand sanitizer, and disinfection supplies. Moving forward, an observational or quantitative study would be useful in helping to better define exact PPE availability and shortages so that more accurate models can be generated to calculate anticipated PPE needs and actual usage. This will allow for better stockpiling, management of available supplies, and allocation when resources are limited.

The lack of PPE, especially respirators, masks, and face shields is particularly worrisome given that these are needed to protect healthcare personnel from exposure and infection. Healthcare workers have been found to be at high risk of illness when providing care to COVID-19 patients, especially when they are performing aerosolizing procedures or having prolonged contact with infected individuals without wearing proper PPE.<sup>5,7</sup> According to the CDC, approximately 9,200 healthcare personnel were infected with COVID-19 between February and April 9, 2020 and these individuals made up about 19% of all infected cases.<sup>7</sup> It is essential that healthcare personnel be provided appropriate PPE to protect themselves as well as their patients, staff, and visitors. Healthcare worker illness can have multiple negative effects, including decreasing healthcare surge capacity and morale, increasing healthcare costs and mortality rates, and being associated with higher rates of sleep disorders, depression, anxiety, and fear among healthcare workers.<sup>3,8-11</sup>

A lack of PPE early on during a pandemic is not a new occurrence. During the first months of the 2009 H1N1 pandemic, many US hospitals reported running out of masks and respirators.<sup>12</sup> During 2009 H1N1, new pandemic planning recommendations were published

outlining guidance for stockpiling PPE to prevent shortages from occurring during future events.<sup>13</sup> In addition, in 2009, APIC published crisis standard of care guidelines for addressing respiratory protection shortages in healthcare during disasters.<sup>14</sup> In theory, these planning documents should have prevented or at least minimized the number of healthcare facilities that experienced depleted PPE stocks so early in the event. However, the massive healthcare surge quickly resulted in depleted PPE stocks. In addition, the US response was complicated by the PPE supply chain disruptions caused by the overwhelming patient surge in China, Italy and other countries leaving many healthcare facilities without adequate PPE.<sup>15</sup>

It is notable that in this study, many US healthcare facilities had obtained supplemental PPE from outside sources yet still reported significant deficiencies in PPE availability. Although local, state, and federal stockpiles exist, they are intended to be supplemental and were not sufficient to aid in response to COVID-19. In early April, just 1 month into the pandemic, the SNS had deployed more than 90% of its stockpiled PPE.<sup>16</sup> In this study, less than a quarter of the infection preventionists reported receiving PPE from the SNS, despite the very high number of facilities lacking PPE. Experts have recommended that the US invest in development and testing of PPE and replenishing of the SNS in order to meet the needs of US healthcare facilities during COVID-19 and future events.<sup>4</sup> In addition, healthcare facilities should closely monitor their PPE stocks, use the CDC's PPE burn rate calculator to estimate when supplies will run low, and implement PPE crisis standards of care sufficiently early to prevent depletion of supplies. When PPE crisis standards of care are not implemented, respirators, masks, and isolation gowns will be quickly depleted due to the high number of healthcare personnel who need to use them and the single-use nature of this PPE. However, even with crisis standards of care in place, PPE may be quickly depleted if huge healthcare surge and/or when supply chain disruptions occur.

Another critical finding in this study was that over half of participating healthcare facilities reported lacking sufficient disinfection supplies. Environmental disinfection is essential to prevent the spread of COVID-19, as there is a risk of transmission from contaminated sources.<sup>17</sup> Research indicates the SARS-CoV-2 can survive on some environmental surfaces for hours to days; thus, disinfection is important to reduce contamination that might contribute to disease spread.<sup>18</sup> In addition, healthcare environmental disinfection is critical to prevent the spread of multidrug resistant organisms and other pathogens that can be spread through contact transmission. A lack of disinfection supplies could contribute to increased rates of healthcare associated infections or occupational exposures to diseases and/or conditions beyond just COVID-19.

A few limitations of this study must be noted. Limitations include the potential issue of responder bias. Non-responders may not have been interested in the survey if their facility was not experiencing patient surge challenges. Alternatively, infection preventionists whose facilities were experiencing overwhelming patient surges may not have had the time to complete the survey or even known that it had been distributed. Another limitation is that infection preventionists' interpretation of "running a bit low" vs "have a sufficient amount" may have differed, though this is impossible to determine. This makes interpretation of the data somewhat challenging. One final limitation is that only APIC members were invited to participate. Therefore, the findings may not be representative of all healthcare facilities as ~ 65% of respondents worked in a hospital. More research is needed to determine PPE supply and sources for US outpatient care facilities, such as ambulatory care and long-term care facilities.

## CONCLUSION

This study found that US healthcare facilities had very low amounts of PPE, hand hygiene products, and disinfection supplies just 1 month into the COVID-19 pandemic. This was partially due to healthcare surge as well as a lack of crisis standards of care for PPE and breaks in supply chain caused by the pandemic. PPE is worn by healthcare workers to prevent the transmission of healthcare acquired infections and protect against occupational exposures. When healthcare workers do not have PPE, the opportunity for transmission of healthcare acquired infections is increased, creating unsafe work environments and unsafe patient care. This study shed light on the critical lack of PPE in US healthcare facilities at a time when healthcare workers needed it most. These gaps in stockpiling and planning need to be addressed before the next major pandemic wave or event; failure to do so will result in excess healthcare associated infection and more occupational exposures and illness.

## Acknowledgment

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

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