

Healthcare professionals' perceptions of critical care resource availability and factors associated with mental well-being during COVID-19: Results from a US survey

Monisha Sharma, Ph.D.¹, Claire J. Creutzfeldt, M.D.^{2,10,12}, Ariane Lewis, M.D.⁵, Pratik V. Patel, M.D.³, Christiane Hartog, M.D.^{6,7}, Gemi E Jannotta, Ph.D., A.R.N.P.³, Patricia Blissitt, Ph.D, A.R.N.P.-C.N.S.⁸, Erin K. Kross, M.D.^{9,10}, Nicholas Kassebaum, M.D.^{1,3}, David M Greer, M.D., M.A.¹¹, J. Randall Curtis, M.D., M.P.H.^{9,10,12}, Sarah Wahlster, M.D.^{2,3,4}

¹ Department of Global Health, University of Washington

² Department of Neurology, Harborview Medical Center, University of Washington

³ Department of Anesthesiology and Pain Medicine, Harborview Medical Center, University of Washington

⁴ Department of Neurological Surgery, Harborview Medical Center, University of Washington

⁵ Departments of Neurology and Neurosurgery, New York University

⁶ Klinik für Anaesthesie und operative Intensivmedizin, Charité Universitaetsmedizin Berlin

⁷ Klinik Bavaria Kreischa

⁸ Department of Biobehavioral Nursing and Health Informatics, University of Washington School of Nursing

⁹ Division of Pulmonary, Critical Care, and Sleep Medicine, Department of Medicine, University of Washington

¹⁰ Cambia Palliative Care Center of Excellence, University of Washington

¹¹ Department of Neurology, Boston University

¹² Cambia Health Foundation

Correspondence to:

Monisha Sharma, ScM, PhD

University of Washington

International Clinical Research Center (ICRC)

Department of Global Health

908 Jefferson St

Seattle, WA 98104

United States of America

Phone (617) 432-2478

msharma1@uw.edu

Summary: Providers report high rates emotional distress/burnout and concerns about insufficient PPE access, which was the strongest predictor of all concerns assessed. Other risk factors for provider concerns include poor communication from supervisors, shortage of ICU nurses, and social stigma. Findings can inform targeted interventions to improve provider well-being.

ABSTRACT

Background: Assessing the impact of COVID-19 on intensive care unit (ICU) providers' perceptions of resource availability and evaluating factors associated with emotional distress/burnout can inform interventions to promote provider well-being.

Methods: Between April 23-May 7, 2020, we electronically administered a survey to physicians, nurses, respiratory therapist (RTs) and advanced practice providers (APPs) caring for COVID-19 patients in the US. We conducted multivariate regression to assess associations between concerns, reported lack of resources and three outcomes: emotional distress/burnout (primary outcome), and two secondary outcomes: 1) fear that hospital is unable to keep providers safe, and 2) concern about transmitting COVID-19 to family/community.

Results: We included 1,651 respondents from all 50 states; 47% nurses, 25% physicians, 17% RTs, 11% APPS. Shortages of intensivists and ICU nurses were reported by 12% and 28% of providers, respectively. The largest supply restrictions reported were for powered air purifying respirators (PAPRs); (56% reporting restricted availability). Provider concerns included worries about transmitting COVID-19 to family/community (66%), emotional distress/burnout (58%), and insufficient personal protective equipment (PPE) (40%). After adjustment, emotional distress/burnout was significantly associated with insufficient PPE access (aRR: 1.43, 95% CI: 1.32 - 1.55), stigma from community (aRR: 1.32, 95% CI: 1.24 - 1.41), and poor communication with supervisors (aRR:1.13, 95% CI: 1.06 - 1.21). Insufficient PPE access was the strongest predictor of feeling that the hospital is unable to keep providers safe and worries about transmitting infection to families/communities.

Conclusion: Addressing insufficient PPE access, poor communication from supervisors, and community stigma may improve provider mental well-being during the COVID-19 pandemic.

Key words: COVID-19, critical care resources, healthcare provider, mental health, burnout, personal protective equipment

Accepted Manuscript

INTRODUCTION

The United States (US) has been disproportionately impacted by the COVID-19 pandemic; despite having less than 4% of the world's population, the US accounts for 28% of COVID-19 infections and 25% of COVID-19-related deaths worldwide.[1] The pandemic has overwhelmed healthcare systems which are struggling to care for massive surges in numbers of critically-ill patients. Maintaining a healthy workforce of healthcare professionals (HCPs) including physicians, nurses, respiratory therapists (RTs), and advanced practice providers (APP) is crucial to providing quality care for the growing volume of patients.[2] As US states start to relax social distancing guidelines, many regions are experiencing a resurgence of COVID-19 cases, placing renewed strain on HCPs and the healthcare system.[3]

Recent studies have found high prevalence of stress and burnout among HCPs on the front lines of the COVID-19 response as they face a rapidly shifting work environment with increasing demands and heightened uncertainty.[4-6] Assessing HCPs' perceptions of resource availability, emotional stressors and job-related concerns during the pandemic can inform targeted interventions to support provider mental health and enable them to continue delivering high quality care to patients.[2] We aimed to characterize intensive care unit (ICU) provider's perceptions of personal protective equipment (PPE), COVID-19 testing, and resource availability during COVID-19, and evaluate whether these factors are associated with HCP emotional distress/burnout and concerns about safety and transmission of the virus to families/communities.

METHODS

Study design

This study followed the STROBE guidelines for the reporting of cross-sectional studies.[7] A research team of physicians, nurses, RTs and APPs designed a 41-question online survey to elicit perspectives across domains including resource availability, personnel shortages and concerns during COVID-19. Prior to administration, the survey was pilot-tested to 30 HCPs and refined based on participant feedback. The overall aim of the survey was to assess the impact of COVID-19 on HCPs globally; however the present analysis is restricted to the US with the goal of assessing HCPs perceptions and concerns nationwide and by geographic region.

Ethical approval

The study was approved by the University of Washington Institutional Review Board. Before survey initiation, respondents were informed that their responses were anonymous, and summary results would be shared with the scientific community. Responses were stored without participant identifiers using REDCap electronic data capture software.[8]

Study population and recruitment

Our target population was physicians, physicians-in-training (residents and fellows), nurses, RTs, and APPs (nurse practitioners, physician assistants, and certified registered nurse anesthetists), self-reporting that they cared for COVID-19 patients in an ICU. The survey was administered between April 23rd 2020-May 7th 2020 to coincide with the initial pandemic peak in many US states. We distributed the survey *via* scientific member societies, email to personal contacts, and social media groups restricted to HCPs caring for COVID-19 patients on platforms including Facebook and Twitter.

Variable categorization

US states were grouped into five commonly used geographic regions: Northeast, Southwest, West, Southeast, and Midwest.[9] A list of states in each region is provided in the Appendix. We categorized states by COVID-19 pandemic stage: 1) pre-peak, 2) during-peak, and 3) post-peak using a three-day rolling average of number of deaths per day[10, 11]. We classified states into COVID-19 pandemic severity category at the mid-point of data collection using a three-day rolling average of number of new cases/100,000 persons as: 1) <250 cases/day, 2) 250-750 cases/day, and 3) >750 cases/day (Supplemental Table 1-3).[12]

Statistical analysis

Descriptive statistics were used to report participant characteristics and survey responses. Our main outcome was HCP emotional distress/burnout in caring for COVID-19 patients, captured as a dichotomous variable. We assessed two secondary outcomes 1) HCPs concerns that their hospital was unable to keep them safe, and 2) concern about transmitting COVID-19 to their families/communities (See appendix for full survey). We conducted univariate and multivariate log-binomial regression with robust standard errors to assess factors associated with outcomes of interest. Exposures that were statistically significant in univariate regression were considered for inclusion in multivariate models. Those that did not improve the model fit using the likelihood ratio test were excluded. Analyses were conducted using R Software.[13-15]

RESULTS

Participant characteristics

Overall, 3,182 participants completed part of the survey and 2,706 met inclusion criteria for the global survey. Of these, 61% (N=1,651) reported practicing in the US and were included in the analysis (Figure 1, Supplemental Figure 1). States with the highest number of respondents were Washington (N=268), California (N=176), Michigan (N=146), Massachusetts (N=120), and New York (N=105), which were some of the hardest hit states in the beginning of the pandemic (Table S1 and S3). Of total participants, 47% were nurses, 25% were physicians or physicians-in-training, 17% were RTs, and 11% were APPs (Table 1). Most HCPs practiced in large, urban teaching hospitals (69%) and 74% were female. Half of HCPs reported having cared for 10-50 COVID-19 patients; 12% reported having cared for >50 COVID-19 patients (highest in the Northeast 24%). Overall, 26 states were surveyed during COVID-19 pandemic peak, 13 were post-peak and 11 were pre-peak (Table S1).

Resource availability

Across geographic regions, 12% of HCPs reported a shortage of intensivists at their hospital, while a shortage of ICU nurses was more commonly reported (28%); 11% reported a shortage of ICU beds (Table 2). All three shortages were reported most often in the Northeast, largely driven by high shortages in New York, New Jersey, and Connecticut (Supplemental Figure 2-4). Availability of most personal protective equipment (PPE) was high across regions; most HCPs reported gloves, surgical masks, and gowns were always available (71-97%) (Table 2). Approximately half of respondents reported that face shields and eye protection were always available; 40% stated that availability was restricted for select HCPs or based on patient characteristics. One third (33%) of HCPs reported N95 masks were always available, while 59% stated availability was restricted. The largest restrictions reported were for powered air purifying respirators (PAPRs); just 15% of HCPs reported that they

were always available, while 56% reported restricted availability. While supply shortages for most types of PPE were low (<10%), 29% of HCPs reported intermittent supply shortages of PAPRs. Overall, 27% of HCPs reported agreeing completely with their hospital's PPE policy, and 46% agreed somewhat. Overall, 10% of HCPs reported complete disagreement with PPE policy (highest in the Southwest 20%). Stratifying by occupation revealed that 50% of physicians agreed completely with hospital PPE policy compared with just 15% of nurses (Table S4). Across regions, 38% of nurses disagreed somewhat or completely with hospital PPE policy compared to just 7% of physicians.

Overall, 37% of HCPs reported that COVID-19 testing was available for all patients (ranging from 19% in the Southwest to 44% in the Northeast), while 63% reported restricted availability based on patient characteristics. No HCPs reported a complete lack of patient testing. Compared to patient COVID-19 testing, reported restrictions were higher for HCP testing, with 13% reporting universal availability and 79% reporting testing restrictions based on HCPs' symptoms/exposures. Overall, 7% of respondents stated testing was completely unavailable for HCPs (highest in the Southwest 18%). Self-reported testing availability differed substantially by provider type (Table S5). While 54% of physicians and 69% of physicians-in-training reported patient COVID-19 testing was available to all patients, just 26% of nurses and 21% of RTs reported universal availability. Similarly, 27% and 20% of physicians and physicians-in-training reported that COVID-19 testing was available for all HCPs, while 6% of nurses and 7% of RTs reported universal availability.

HCPs concerns

The most common HCP concerns were transmission of COVID-19 infection to one's family/community (66%), emotional distress/burnout (58%), and worries about one's own health (49%), which were high across all regions (Table 2 and Supplemental Figure 4). Overall, 40% of HCPs reported insufficient access to PPE, 26% felt that their hospital was unable to keep them safe and

22% reported poor communication with supervisors; all three concerns were highest in the Southwest. Social stigma from the community was reported by 26% of HCPs (highest in the Southwest 38%). Overall, 12% of HCPs reported worries about their financial situation. Concerns were generally more common in nurses, RTs, and APPs compared to physicians and physicians-in-training (Figure 2 and Table S5). Emotional distress/burnout was highest among nurses (64%), APPs (56%) and RTs (55%), compared to physicians and physicians-in-training (49% and 48%, respectively). Compared to physicians, nurses were more likely to report insufficient PPE (47% vs 31%), feeling the hospital is unable to keep them safe (32% vs 14%), poor communication with supervisors (27% vs 12%), and stigma from community (33% vs 11%).

Factors associated with emotional distress/burnout

In multivariate analysis, higher likelihood of emotional distress/burnout was most strongly associated with reporting insufficient PPE access (adjusted relative risk (aRR): 1.43, 95% CI: 1.32 - 1.55) and social stigma from one's community (aRR: 1.32, 95% CI: 1.24 - 1.41) (Table 3). Poor communication with supervisors was also associated with a higher risk of emotional distress/burnout (aRR:1.13, 95% CI: 1.06 - 1.21) as were worries about one's financial situation (aRR: 1.09, 95% CI: 1.01 - 1.18). Compared to HCPs who cared for <10 COVID-19 patients, those caring for ≥10 COVID-19 patients had a higher risk of emotional distress/burnout (aRR: 1.14, 95% CI: 1.05 - 1.23). Perceived shortages of ICU nurses were associated with higher risk of burnout, (aRR: 1.10, 95% CI: 1.03 - 1.18) while limited availability of PAPR was marginally associated (aRR: 1.12, 95% CI: 0.99 - 1.28). Emotional distress/burnout was not significantly associated with geographic region, COVID-19 testing availability, COVID-19 severity, or timing from peak (Table 3a and Table S5). Although nurses and females had a higher risk of emotional distress/burnout in univariate analysis, this association was no longer statistically significant after adjusting for other factors in multivariate

analysis. Similarly, intensivist shortages and lack of ICU beds were not associated with emotional distress/burnout in multivariate regression (aRR close to 1.0, data not shown).

Factors associated with other concerns

After adjustment for covariates, HCPs who reported insufficient access to PPE were 5.82 times more likely to feel that their hospital is unable to keep them safe (95% CI: 4.36 - 7.82) (Table 3b). Limited availability of PAPR (aRR: 1.62, 95% CI: 1.14 - 2.30), lack of ICU nurses (aRR: 1.46, 95% CI: 1.27 - 1.67), poor communication with supervisors (aRR: 1.76 95% CI: 1.52 - 2.04) and social stigma from the community (aRR: 1.23, 95% CI: 1.07 - 1.40) were also associated with HCPs feeling that their hospital is unable to keep them safe. Although females, nurses, APPs, and RTs had a higher risk of reporting that hospitals are unable to keep them safe in univariate analysis, these associations were no longer statistically significant after adjustment in multivariate analysis. Similarly, shortages of intensivists, lack of ICU beds, and testing availability were not associated with the outcome in multivariate regression (aRR close to 1.0, data not shown); COVID-19 testing availability, COVID-19 severity, or timing from peak were not associated with the outcome (Table S6).

Insufficient access to PPE was also the strongest predictor of worries about transmitting COVID-19 to families/community (aRR: 1.48, 95% CI: 1.39 - 1.58). Poor communication from supervisors (aRR: 1.13, 95% CI: 1.07 - 1.19), social stigma from community (aRR: 1.30, 95% CI: 1.23 - 1.38) and lack of ICU nurses (aRR: 1.08 95% CI: 1.01 - 1.15) were also associated with worries about transmitting infection to one's family/community. Physicians were at slightly higher risk of concern about transmission compared to nurses, APPs and RTs, while region and gender did not show significant associations.

DISCUSSION

In this nationwide survey of HCPs caring for COVID-19 patients, we find substantial reported shortages of personnel and PPE, as well as high rates of emotional distress/burnout across geographic regions. Shortages of ICU nurses were more commonly reported than shortages of intensivists or ICU beds, and all three were highest in the Northeast. This is likely related to the higher reported volume of COVID-19 patients in the Northeast during the survey period. Significant numbers of respondents reported restricted availability of N95 masks, face shields, and eye protection, with the largest supply shortages and restrictions reported for PAPRs.

Perceptions about availability of PPE and COVID-19 testing differed by HCP type. Nurses were more likely to report restrictions on N95 masks availability than physicians and physicians-in-training and more likely to report concerns about insufficient PPE and disagreement with hospital PPE policy. While most physicians reported COVID-19 testing was available for all patients, less than a quarter of nurses and RTs reported universal availability. Our results are consistent with another US survey of ICU providers during COVID-19 conducted by the Society for Critical Care Medicine, which found nurses were less likely to report their hospital was prepared to care for COVID-19 patients and more likely to express concerns about PPE shortages compared to physicians.[16] This finding may indicate discrepancies in communication of hospital policies by HCP type. Additionally, nurses often spend more time at the bedside of sick patients and may feel shortages more acutely; they may also have higher levels of supervision compared to physicians. However, the findings may also represent differences in hospital settings. Future research to investigate these discrepancies is needed as they may have important implications for provider well-being and nurse/physician collaboration.

The most commonly reported HCP concerns include worries about transmitting infection to family/community and worries about their own health, consistent with a previous survey of ICU providers in the US[6]. Concerns were generally more common in nurses, APPs, and RTs compared

to physicians or physicians-in-training. The prevalence of emotional distress/burnout in our study was similar to that of another HCP survey conducted during COVID-19 that reported 62% burnout in the US (compared to 58% found in our study), which is higher than pre-pandemic levels of emotional distress/burnout in critical care HCPs (50%).[5, 17, 18]

Provider concerns are likely exacerbated by reported lack of PPE, which was the strongest predictor of all three outcomes assessed: emotional distress/burnout, feeling that the hospital was unable to keep HCPs safe, and worries about COVID-19 transmission to family/community. HCPs who reported insufficient PPE were nearly 6-times more likely to feel that hospitals could not keep them safe, which is a substantially large association; specifically restricted availability of PAPR was a salient predictor. As the pandemic steadily continues in the US, sustained and coordinated efforts to prioritize PPE for HCPs are critical to protecting the mental health and morale of frontline healthcare workers. Additionally, more research is needed to understand the types of PAPR restrictions most associated with stressors among HCPs, as reporting restricted availability could either indicate that HCPs can obtain a PAPR after completing a request process or that their request is denied because it falls outside hospital guidelines for intended use. Future research is also needed to assess types of hospital PPE policies most likely to elicit provider disagreement, including whether policies following CDC guidelines are less likely to elicit disagreement.

Poor communication from supervisors was another modifiable risk factor of emotional distress/burnout and other concerns among HCPs. With unprecedented changes in workload, shifting responsibilities, and rapidly evolving hospital policies during COVID-19, supervisors may feel unsure about how to communicate difficult decisions with transparency. However, leadership serves a crucial role in creating an environment that supports the mental health of HCPs, through tangible support such as availability of PPE and mental health services, as well as expressions of gratitude and appreciation.[19] Targeted training to improve supervisory support systems and promote clear communication may improve HCPs well-being during the pandemic. Stigma from one's community

was associated with higher risk of HCP emotional distress/burnout and concerns and was more commonly reported among nurses (33%) compared to physicians (11%). Although HCPs may be perceived as “healthcare heroes,” they can simultaneously experience distancing from their community due to fears that they are at high risk of having COVID-19.[20] We find a lack of studies in the literature regarding HCPs perceptions of stigma and interventions to reduce stigma, suggesting more research is needed in this important area. Additionally, shortage of ICU nurses was a stronger predictor of HCP concerns and burnout than shortage of intensivists. Since nurses may be more likely to experience burnout, our findings highlight the importance of maintaining an emotionally healthy workforce of nurses to support high-quality care to patients during the pandemic.

Our findings that nurses and females have a higher likelihood of experiencing emotional distress and burnout is consistent with other studies conducted during COVID-19[4, 5]. However, after adjustment in multivariate regression, burnout was no longer associated with gender or occupation. This suggests that the higher likelihood of emotional distress/burnout among nurses and females may be largely mediated by concerns about insufficient access to PPE, poor communication with supervisors, and social stigma. Interventions targeted towards alleviating these concerns may reduce the higher burnout rates observed in these groups.

Our findings should be interpreted within the context of several limitations. The majority of respondents practiced in large urban teaching hospitals so our results may have limited generalizability to rural regions of the US. Further, several states including Washington, Massachusetts, and Michigan were overrepresented in our sample. However, we conducted stratified analyses by geographic region and assessed variations across states. Further, the large sample size from the earliest and hardest hit states may provide important lessons learned to inform HCP mental well-being interventions nationally. In addition, our sampling strategy targeted survey distribution to critical care societies; therefore most respondents specialized in critical care medicine, with lower representation from other specialties (e.g. anesthesiology and surgery).

Further, only 105 respondents in our sample were physicians-in-training. More studies are needed to assess differences in perspectives across specialties and training level. Additionally, due to the cross-sectional nature of our study, we cannot determine the directionality of the relationships assessed or evaluate long-term trends or longitudinal predictors of concerns. Further, due to our sampling approach, we are unable to assess participation rates among persons who saw the survey, which may limit generalizability. Finally, the two-week sampling period provides a snapshot of HCPs' experiences which are likely dynamically changing as the pandemic evolves. For example, we found that <15% of HCPs were worried about their financial situation; however, this proportion may increase over time as hospitals institute layoffs or furloughs.

Experts recommend understanding the specific sources of HCPs' concerns to effectively target interventions, rather than teaching general approaches to stress reduction.[2] We assessed a broad range of HCP perceptions regarding shortages of PPE, personnel, ICU beds, and COVID-19 testing and rigorously evaluated predictors of emotional distress/burnout and other concerns. Our analysis suggests insufficient access to PPE is the strongest predictor of provider concerns and burnout. In addition, addressing poor communication from supervisors, nursing shortages, and social stigma may help mitigate concerns and improve HCP mental well-being during COVID-19 and future pandemics.

NOTES

Acknowledgement:

The study was approved by the University of Washington Institutional Review Board (STUDY00010095).

Funding sources:

The authors of this paper received no direct funding for this publication. MS received support from NIMH K01MH115789. CH reports current funding by the Federal Joint Committee Innovation Funds FKZ 01VSF17010. CC is supported by NINDS NS099421.

Conflicts of interest:

JRD reports grants from National Institutes of Health, Cambia Health Foundation, and National Palliative Care Research Center, outside the submitted work. MS reports grants from National Institutes of Health, outside the submitted work. CH reports grants to the institution from Federal Joint Committee, outside the submitted work. All other authors declare that they have no conflicts of interest.

Accepted Manuscript

REFERENCES

1. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU), Accessed on May 7 2020 from: <https://coronavirus.jhu.edu/map.html>.
2. Shanafelt T, Ripp J, Trockel M. Understanding and Addressing Sources of Anxiety Among Health Care Professionals During the COVID-19 Pandemic. JAMA. 2020. Epub 2020/04/08. doi: 10.1001/jama.2020.5893. PubMed PMID: 32259193.
3. America Is Done With COVID-19. COVID-19 Isn't Done With America. Accessed on 6/24/2020 from: <https://time.com/5852913/covid-second-wave/>.
4. Lai J, Ma S, Wang Y, Cai Z, Hu J, Wei N, et al. Factors Associated With Mental Health Outcomes Among Health Care Workers Exposed to Coronavirus Disease 2019. JAMA Netw Open. 2020;3(3):e203976. Epub 2020/03/24. doi: 10.1001/jamanetworkopen.2020.3976. PubMed PMID: 32202646; PubMed Central PMCID: PMC7090843.
5. Morgantini LA, Naha U, Wang H, Francavilla S, Acar O, Flores JM, et al. Factors Contributing to Healthcare Professional Burnout During the COVID-19 Pandemic: A Rapid Turnaround Global Survey. medRxiv. 2020:2020.05.17.20101915. doi: 10.1101/2020.05.17.20101915.
6. Society of Critical Care Medicine, COVID-19 Rapid-Cycle Survey 2 Report. Accessed on 6/5/2020 from: https://sccm.org/Blog/May-2020/SCCM-COVID-19-Rapid-Cycle-Survey-2-Report?_zs=IKhd1&_zl=xI8l6.
7. STROBE Statement: Strengthening the reporting of observational studies in epidemiology. Accessed from <https://www.strobe-statement.org/index.php?id=available-checklists> on 6/4/2020.
8. REDCap. ITHS. Accessed on May 20, 2020 from: <https://www.iths.org/investigators/forms-templates/citation-information/>.
9. Map of United States regions. Accessed on 6/22/2020 from: <https://www.nationalgeographic.org/maps/united-states-regions/#:~:text=Language%2C%20government%2C%20or%20religion%20can,West%2C%20Southeast%2C%20and%20Midwest>.
10. IHME | COVID-19 Projections. Institute for Health Metrics and Evaluation. Accessed on May 25, 2020 from: <https://covid19.healthdata.org/>.
11. CSSEGISandData/COVID-19. GitHub. Accessed on May 25, 2020 from: <https://github.com/CSSEGISandData/COVID-19>.
12. Johns Hopkins Coronavirus Resource Center: Daily new cases per 100 k people in all 50 states in the US. Accessed on 6/14/2020 from: <https://coronavirus.jhu.edu/data/new-cases-50-states>.
13. R Core Team. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing; 2019. <https://www.R-project.org/>.
14. Rich B. Table1: Tables of Descriptive Statistics in HTML.; 2020. <https://CRAN.R-project.org/package=table1>.
15. Venables WN, Ripley BD. Modern Applied Statistics with S. 4th ed. Springer-Verlag; 2002. doi:10.1007/978-0-387-21706-2.
16. Kaplan LJ, Kleinpell R, Maves RC, Doersam JK, Raman R, Ferraro DM. Critical Care Clinician Reports on Coronavirus Disease 2019: Results From a National Survey of 4,875 ICU Providers. Critical Care Explorations. 2020;2(5):e0125. doi: 10.1097/cce.0000000000000125. PubMed PMID: 02107256-202005000-00005.

17. Embriaco N, Papazian L, Kentish-Barnes N, Pochard F, Azoulay E. Burnout syndrome among critical care healthcare workers. *Curr Opin Crit Care*. 2007;13(5):482-8. Epub 2007/09/01. doi: 10.1097/MCC.0b013e3282efd28a. PubMed PMID: 17762223.
18. Sheno AN, Kalyanaraman M, Pillai A, Raghava PS, Day S. Burnout and Psychological Distress Among Pediatric Critical Care Physicians in the United States. *Crit Care Med*. 2018;46(1):116-22. Epub 2017/10/11. doi: 10.1097/CCM.0000000000002751. PubMed PMID: 29016364.
19. Abbasi J. Prioritizing Physician Mental Health as COVID-19 Marches On. *JAMA*. 2020. Epub 2020/05/21. doi: 10.1001/jama.2020.5205. PubMed PMID: 32432665.
20. Bagchi S. Stigma during the COVID-19 pandemic. *The Lancet infectious diseases*. 2020;20(7):782. Epub 2020/06/28. doi: 10.1016/S1473-3099(20)30498-9. PubMed PMID: 32592670; PubMed Central PMCID: PMC7314449.

Accepted Manuscript

Figure Legends:

Figure 1: Number of respondents by US state

Figure 2: Self-reported concerns by healthcare professional type.

Accepted Manuscript

Table 1: Healthcare professional characteristics by geographic region[†]

	Midwest (N=358)	Northeast (N=408)	Southeast (N=212)	Southwest (N=108)	West (N=565)	Total (N=1,651)
Gender						
Female	284 (79 %)	298 (73 %)	152 (72 %)	79 (73 %)	413 (73 %)	1226 (74 %)
Male	72 (20 %)	108 (26 %)	58 (27 %)	27 (25 %)	147 (26 %)	412 (25 %)
Non-binary	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)	1 (0 %)	1 (0 %)
Not disclosed	2 (1 %)	2 (0 %)	2 (1 %)	2 (2 %)	4 (1 %)	12 (1 %)
Years in clinical practice						
Mean (SD)	11.4 (9.40)	12.4 (10.8)	10.7 (9.38)	8.78 (7.10)	11.6 (8.44)	11.4 (9.36)
Hospital setting						
rural, <100 beds	8 (2 %)	7 (2 %)	4 (2 %)	4 (4 %)	10 (2 %)	33 (2 %)
rural, ≥ 100 beds	20 (6 %)	19 (5 %)	13 (6 %)	9 (8 %)	25 (4 %)	86 (5 %)
urban, no teaching, <200 beds	14 (4 %)	10 (2 %)	12 (6 %)	9 (8 %)	37 (7 %)	82 (5 %)
urban, no teaching, ≥ 200 beds	36 (10 %)	18 (4 %)	32 (15 %)	26 (24 %)	129 (23 %)	241 (15 %)
urban, teaching, <200 beds	20 (6 %)	15 (4 %)	10 (5 %)	6 (6 %)	24 (4 %)	75 (5 %)
urban, teaching, ≥ 200 beds	260 (73 %)	338 (83 %)	141 (67 %)	54 (50 %)	340 (60 %)	1133 (69 %)
Number of COVID-19 patients cared for						
< 10	121 (34 %)	97 (24 %)	106 (50 %)	43 (40 %)	280 (50 %)	647 (39 %)
10 - 50	183 (51 %)	214 (52 %)	89 (42 %)	60 (56 %)	259 (46 %)	805 (49 %)
> 50	54 (15 %)	97 (24 %)	17 (8 %)	5 (5 %)	26 (5 %)	199 (12 %)
Professional title						
ICU director	7 (2 %)	21 (5 %)	13 (6 %)	3 (3 %)	15 (3 %)	59 (4 %)
Attending Physician	41 (11 %)	84 (21 %)	35 (17 %)	11 (10 %)	81 (14 %)	252 (15 %)
Physician in training	11 (3 %)	46 (11 %)	15 (7 %)	1 (1 %)	32 (6 %)	105 (6 %)
Nurse manager	3 (1 %)	1 (0 %)	1 (0 %)	3 (3 %)	7 (1 %)	15 (1 %)
Nurse	158 (44 %)	145 (35 %)	98 (46 %)	55 (51 %)	307 (55 %)	763 (46 %)
Advanced Practice Provider	37 (10 %)	70 (17 %)	28 (13 %)	8 (7 %)	39 (7 %)	182 (11 %)
Respiratory therapist	101 (28 %)	41 (10 %)	22 (10 %)	27 (25 %)	84 (15 %)	275 (17 %)
Specialization area, physicians only (N = 311)						
Critical Care Medicine	38 (79 %)	93 (89 %)	42 (88 %)	13 (93 %)	90 (94 %)	276 (89 %)
Pulmonology	23 (48 %)	70 (67 %)	29 (60 %)	4 (29 %)	66 (69 %)	192 (62 %)

Internal Medicine	9 (19 %)	13 (12 %)	9 (19 %)	1 (7 %)	15 (16 %)	47 (15 %)
Neurology	8 (17 %)	16 (15 %)	8 (17 %)	1 (7 %)	2 (2 %)	35 (11 %)
Specialization area, physicians-in-training only (N = 105)						
Critical Care Medicine	8 (73 %)	26 (57 %)	14 (93 %)	1 (100 %)	28 (88 %)	77 (73 %)
Pulmonology	6 (55 %)	14 (30 %)	13 (87 %)	1 (100 %)	21 (66 %)	55 (52 %)
Internal Medicine	3 (27 %)	8 (17 %)	5 (33 %)	0 (0 %)	9 (28 %)	25 (24 %)
Neurology	2 (18 %)	9 (20 %)	1 (7 %)	0 (0 %)	0 (0 %)	12 (11 %)
Specialization area, nurses only (N = 778)						
Medical ICU	114 (58 %)	103 (48 %)	63 (50 %)	42 (64 %)	231 (65 %)	553 (58 %)
Cardiac ICU	56 (28 %)	46 (21 %)	26 (20 %)	23 (35 %)	103 (29 %)	254 (26 %)
Neuro ICU	60 (30 %)	77 (36 %)	60 (47 %)	22 (33 %)	84 (24 %)	303 (32 %)
Surgical ICU	57 (29 %)	55 (25 %)	31 (24 %)	23 (35 %)	88 (25 %)	254 (26 %)

†Number of respondents in each category vary slightly as some responses are optional; multiple responses are possible per respondent regarding area of specialization so most frequent subspecialties are listed. A full list of HCP specializations is available in the appendix. Years in clinical practice includes years in training. Physicians in training include residents and fellows. ICU: Intensive care unit.

Table 2: Healthcare professional responses regarding availability of personnel, supplies, COVID-19 testing, and concerns by geographic region[†]

	Midwest (N=358)	Northeast (N=408)	Southeast (N=212)	Southwest (N=108)	West (N=565)	Total (N=1,651)
Shortages reported						
Intensivists	32 (10 %)	81 (22 %)	26 (13 %)	10 (10 %)	40 (8 %)	189 (12 %)
ICU Nurses	107 (32 %)	177 (48 %)	40 (20 %)	28 (27 %)	73 (14 %)	425 (28 %)
ICU beds	29 (10 %)	74 (23 %)	16 (9 %)	8 (10 %)	22 (5 %)	149 (11 %)
PPE availability						
Surgical Mask						
Always available	253 (89 %)	133 (84 %)	76 (81 %)	536 (79 %)	171 (75 %)	1169 (81 %)
Availability restricted*	25 (9 %)	18 (11 %)	11 (12 %)	101 (15 %)	40 (18 %)	195 (13 %)
Intermittent supply shortages	5 (2 %)	8 (5 %)	7 (7 %)	44 (6 %)	17 (7 %)	81 (6 %)
N95 mask						
Always available	100 (35 %)	63 (40 %)	40 (43 %)	195 (29 %)	82 (36 %)	480 (33 %)
Availability restricted*	177 (63 %)	85 (53 %)	48 (51 %)	415 (61 %)	125 (55 %)	850 (59 %)
Intermittent supply shortages	6 (2 %)	11 (7 %)	6 (6 %)	70 (10 %)	21 (9 %)	114 (8 %)
Eye protection						
Always available	152 (54 %)	76 (48 %)	50 (53 %)	320 (47 %)	122 (54 %)	720 (50 %)
Availability restricted*	109 (39 %)	61 (38 %)	34 (36 %)	252 (37 %)	85 (37 %)	541 (37 %)
Intermittent supply shortages	22 (8 %)	22 (14 %)	10 (11 %)	109 (16 %)	21 (9 %)	184 (13 %)
Face Shield						
Always available	147 (52 %)	81 (51 %)	46 (49 %)	301 (44 %)	120 (53 %)	695 (48 %)

Availability restricted*	129 (46 %)	63 (40 %)	35 (37 %)	290 (43 %)	89 (39 %)	606 (42 %)
Intermittent supply shortages	7 (2 %)	15 (9 %)	13 (14 %)	89 (13 %)	19 (8 %)	143 (10 %)
PAPRs						
Always available	48 (17 %)	21 (13 %)	10 (11 %)	98 (14 %)	40 (18 %)	217 (15 %)
Availability restricted*	169 (60 %)	83 (52 %)	54 (57 %)	391 (58 %)	117 (51 %)	814 (56 %)
Intermittent supply shortages	66 (23 %)	55 (35 %)	30 (32 %)	191 (28 %)	71 (31 %)	413 (29 %)
Gowns						
Always available	274 (97 %)	150 (94 %)	92 (98 %)	664 (98 %)	219 (96 %)	1399 (97 %)
Availability restricted*	9 (3 %)	9 (6 %)	1 (1 %)	13 (2 %)	6 (3 %)	38 (3 %)
Intermittent supply shortages	0 (0 %)	0 (0 %)	1 (1 %)	3 (0 %)	3 (1 %)	7 (0 %)
Gloves						
Always available	209 (74 %)	106 (67 %)	73 (78 %)	467 (69 %)	173 (76 %)	1028 (71 %)
Availability restricted*	66 (23 %)	38 (24 %)	15 (16 %)	170 (25 %)	47 (21 %)	336 (23 %)
Intermittent supply shortages	8 (3 %)	15 (9 %)	6 (6 %)	43 (6 %)	8 (4 %)	80 (6 %)
Agreement with hospital's PPE policy						
Agree completely	80 (25 %)	92 (26 %)	71 (37 %)	18 (19 %)	132 (27 %)	393 (27 %)
Agree somewhat	152 (47 %)	166 (47 %)	80 (42 %)	37 (38 %)	234 (47 %)	669 (46 %)
Disagree somewhat	58 (18 %)	59 (17 %)	29 (15 %)	23 (24 %)	79 (16 %)	248 (17 %)
Disagree completely	31 (10 %)	34 (10 %)	12 (6 %)	19 (20 %)	50 (10 %)	146 (10 %)
COVID-19 testing availability						
Testing available for patients						
All patients	87 (28 %)	157 (44 %)	66 (34 %)	19 (19 %)	206 (42 %)	535 (37 %)
Select patients (based on symptoms/risk factors)	228 (72 %)	197 (56 %)	131 (66 %)	79 (81 %)	284 (58 %)	919 (63 %)
No patients	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Testing available for HCPs						
All HCPs	38 (13 %)	51 (15 %)	25 (14 %)	9 (9 %)	65 (14 %)	188 (13 %)
Select HCPs (based on symptoms/risk factors)	246 (82 %)	280 (81 %)	133 (73 %)	69 (72 %)	383 (81 %)	1111 (79 %)
No HCPs	15 (5 %)	16 (5 %)	24 (13 %)	18 (19 %)	26 (5 %)	99 (7 %)
HCP concerns						
Insufficient access to PPE	138 (39 %)	166 (41 %)	73 (34 %)	53 (49 %)	231 (41 %)	661 (40 %)
Feel that hospital is unable to keep me safe	92 (26 %)	109 (27 %)	42 (20 %)	41 (38 %)	140 (25 %)	424 (26 %)
Poor communication from supervisors	86 (24 %)	90 (22 %)	41 (19 %)	38 (35 %)	104 (18 %)	359 (22 %)
Worries about own health	196 (55 %)	204 (50 %)	98 (46 %)	61 (56 %)	254 (45 %)	813 (49 %)
Worries about financial situation	40 (11 %)	61 (15 %)	30 (14 %)	18 (17 %)	55 (10 %)	204 (12 %)
Worries about transmitting infection to family and community	254 (71 %)	267 (65 %)	140 (66 %)	73 (68 %)	359 (64 %)	1093 (66 %)

Social stigma from my community	101 (28 %)	94 (23 %)	49 (23 %)	41 (38 %)	138 (24 %)	423 (26 %)
Witnessing colleagues at hospital contract COVID-19	155 (43 %)	159 (39 %)	62 (29 %)	34 (31 %)	191 (34 %)	601 (36 %)
Hearing about other providers contract COVID-19 from news	171 (48 %)	186 (46 %)	82 (39 %)	42 (39 %)	258 (46 %)	739 (45 %)
Emotional distress/burnout	231 (65 %)	233 (57 %)	117 (55 %)	68 (63 %)	302 (53 %)	951 (58 %)
HCP behavior outside hospital to protect family						
Living separately from family	36 (12 %)	46 (15 %)	14 (8 %)	12 (14 %)	38 (9 %)	146 (11 %)
Completely isolated from family	11 (4 %)	11 (3 %)	4 (2 %)	3 (4 %)	10 (2 %)	39 (3 %)
Partially isolated from family	42 (14 %)	65 (21 %)	22 (13 %)	13 (16 %)	85 (20 %)	227 (18 %)
Not isolated but extra precautions	168 (57 %)	158 (50 %)	108 (63 %)	46 (55 %)	243 (56 %)	723 (56 %)
No changes compared to before pandemic	37 (13 %)	35 (11 %)	23 (13 %)	9 (11 %)	58 (13 %)	162 (12 %)

[†]ICU: Intensive care unit. HCPs: healthcare professional.

*Availability restricted for select provider or based on patient characteristics

Table 3: Univariate and multivariate predictors of concerns among healthcare professionals during COVID-19[†]

	RR (95% CI)	P value	aRR (95% CI)	P value
3a) HCP emotional distress/burnout				
Gender				
Male	Ref.		Ref.	
Female	1.25 (1.12 - 1.39)	<0.01	1.09 (0.98 - 1.21)	0.10
Region				
Northeast	Ref.		Ref.	
Midwest	1.13 (1.00 - 1.26)	0.04	1.09 (1.00 - 1.20)	0.06
Southeast	0.96 (0.83 - 1.12)	0.61	1.00 (0.88 - 1.14)	0.99
Southwest	1.10 (0.93 - 1.30)	0.26	0.96 (0.83 - 1.11)	0.59
West	0.93 (0.83 - 1.05)	0.24	0.97 (0.88 - 1.08)	0.57
HCP type				
Attending physicians	Ref.		Ref.	
Physicians in training	0.96 (0.76 - 1.21)	0.74	0.90 (0.73 - 1.10)	0.30
Nurse	1.30 (1.15 - 1.48)	<0.01	1.10 (0.97 - 1.24)	0.16
APP	1.14 (0.96 - 1.36)	0.13	1.04 (0.89 - 1.21)	0.62
RT	1.13 (0.96 - 1.32)	0.14	1.01 (0.88 - 1.17)	0.88
HCP concerns				
Insufficient access to PPE	2.10 (1.94 - 2.29)	<0.01	1.43 (1.32 - 1.55)	<0.01
Poor communication from supervisors	1.69 (1.57 - 1.81)	<0.01	1.13 (1.06 - 1.21)	<0.01
Worries about financial situation	1.54 (1.30 - 1.81)	<0.01	1.09 (1.01 - 1.18)	0.02
Social stigma from community	1.88 (1.65 - 2.14)	<0.01	1.32 (1.24 - 1.41)	<0.01
Shortages reported				
Limited availability of PAPER	1.30 (1.14 - 1.49)	<0.01	1.12 (0.99 - 1.28)	0.07
Lack of intensivists	1.21 (1.10 - 1.34)	<0.01	–	
Lack of nurses	1.33 (1.16 - 1.52)	<0.01	1.10 (1.03 - 1.18)	0.01
Lack of ICU beds	1.24 (1.16 - 1.33)	<0.01	–	
Number of COVID-19 patients cared for				
< 10	Ref.		Ref.	
≥ 10	1.22 (1.11 - 1.33)	<0.01	1.14 (1.05 - 1.23)	<0.01
3b) Feel that hospital is unable to keep HCPs safe				

Gender				
Male	Ref.		Ref.	
Female	1.50 (1.20 - 1.87)	<0.01	1.10 (0.91 - 1.33)	0.34
Region				
Northeast	Ref.		Ref.	
Midwest	0.95 (0.75 - 1.21)	0.69	1.01 (0.83 - 1.23)	0.89
Southeast	0.74 (0.54 - 1.02)	0.07	0.89 (0.69 - 1.14)	0.35
Southwest	1.41 (1.05 - 1.88)	0.02	1.05 (0.83 - 1.34)	0.66
West	0.92 (0.74 - 1.15)	0.48	1.09 (0.90 - 1.32)	0.4
HCP type				
Attending physicians	Ref.		Ref.	
Physicians in training	1.12 (0.67 - 1.87)	0.67	0.86 (0.56 - 1.32)	0.50
Nurse	2.21 (1.66 - 2.95)	<0.01	1.17 (0.88 - 1.56)	0.29
APP	1.62 (1.11 - 2.36)	0.01	1.15 (0.83 - 1.59)	0.41
RT	1.67 (1.19 - 2.36)	<0.01	1.18 (0.87 - 1.60)	0.3
HCP concerns				
Insufficient access to PPE	10.81 (8.20 - 14.24)	<0.01	5.84 (4.36 - 7.82)	<0.01
Poor communication from supervisors	3.83 (3.29 - 4.45)	<0.01	1.76 (1.52 - 2.04)	<0.01
Worries about financial situation	2.30 (1.84 - 2.88)	<0.01	1.17 (1.01 - 1.36)	0.04
Social stigma from community	2.55 (2.11 - 3.09)	<0.01	1.23 (1.07 - 1.40)	<0.01
Shortages reported				
Limited availability of PAPER	2.80 (1.92 - 4.09)	<0.01	1.62 (1.14 - 2.30)	0.01
Lack of intensivists	1.85 (1.55 - 2.22)	<0.01	–	
Lack of nurses	2.12 (1.75 - 2.57)	<0.01	1.46 (1.27 - 1.67)	<0.01
Lack of ICU beds	2.00 (1.70 - 2.36)	<0.01	–	
Number of COVID-19 patients cared for				
< 10	Ref.			
≥ 10	1.20 (1.01 - 1.43)	0.04	–	

3c) Worries about transmitting COVID-19 to family and community

Gender				
Male	Ref.		Ref.	
Female	1.05 (0.96 - 1.14)	0.28	1.01 (0.94 - 1.09)	0.79
Region				
Northeast	Ref.		Ref.	
Midwest	1.09 (0.99 - 1.20)	0.09	1.08 (0.99 - 1.16)	0.08
Southeast	1.01 (0.90 - 1.14)	0.82	1.04 (0.93 - 1.16)	0.49
Southwest	1.04 (0.90 - 1.21)	0.60	0.95 (0.84 - 1.08)	0.45
West	0.98 (0.89 - 1.07)	0.63	1.01 (0.93 - 1.11)	0.76
HCP type				
Attending physicians	Ref.		Ref.	
Physicians in training	0.95 (0.81 - 1.11)	0.49	0.90 (0.78 - 1.04)	0.15
Nurse	0.98 (0.90 - 1.07)	0.7	0.84 (0.77 - 0.91)	<0.01
APP	0.89 (0.78 - 1.02)	0.10	0.83 (0.74 - 0.94)	<0.01
RT	0.89 (0.79 - 1.01)	0.07	0.82 (0.74 - 0.92)	<0.01
HCP concerns				

Insufficient access to PPE	1.84 (1.72 - 1.97)	<0.01	1.48 (1.39 - 1.58)	<0.01
Poor communication from supervisors	1.49 (1.41 - 1.58)	<0.01	1.13 (1.07 - 1.19)	<0.01
Worries about financial situation	1.43 (1.22 - 1.68)	<0.01	–	
Social stigma from community	1.61 (1.42 - 1.82)	<0.01	1.30 (1.23 - 1.38)	<0.01
Shortages reported				
Limited availability of PAPR	1.10 (1.00 - 1.20)	0.06	–	
Lack of intensivists	1.12 (1.03 - 1.22)	0.01	–	
Lack of nurses	1.17 (1.03 - 1.33)	0.02	1.08 (1.01 - 1.15)	0.02
Lack of ICU beds	1.05 (0.98 - 1.12)	0.15	–	
Number of COVID-19 patients cared for				
< 10	Ref.			
≥ 10	1.12 (1.04 - 1.20)	<0.01	–	

[†]PAPR was dichotomized as always available vs restricted availability or intermitted supply shortages. HCP: healthcare professional

Accepted Manuscript

Figure 1

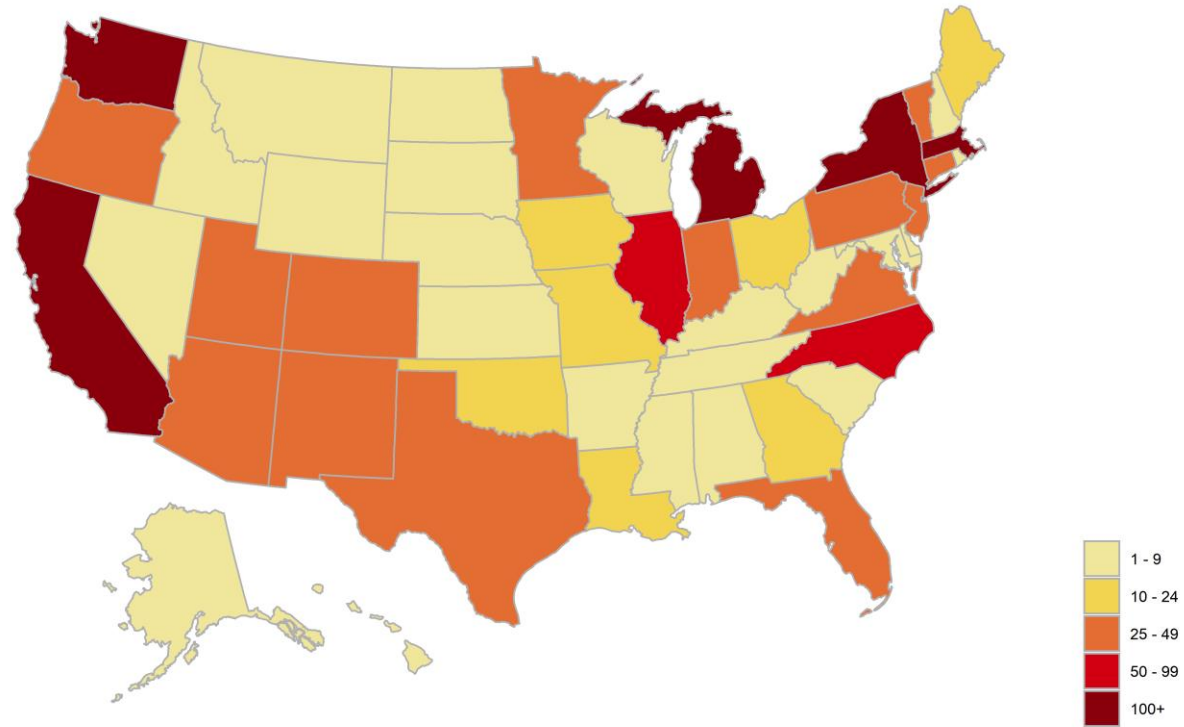


Figure 2

