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Sleep Medicine Health-Care Worker Concerns About COVID-19: An Early Pandemic Survey

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BACKGROUND: The coronavirus disease 2019 (COVID-19) pandemic has produced numerous safety concerns for sleep medicine patients and health-care workers, especially related to the use of aerosol-generating positive airway pressure devices. Differences between physician and sleep technologist concerns with regard to viral exposure and mitigation strategies may inform protocols to ensure safety and promote patient and health-care worker resilience and retention. METHODS: An anonymous online survey aimed at sleep medicine practitioners was active from April 29, 2020 to May 8, 2020. RESULTS: We obtained 379 responses, including from 75 physicians and 283 technologists. The proportion of all the respondents who were extremely/very concerned about the following: exposing patients (70.8%), exposing technologists (81.7%), and droplet (82.7%) and airborne (81.6%) transmission from CPAP. The proportion of respondents who felt that aerosol precautions were extremely/very important varied by scenario: always needed (45.6%); only with CPAP (25.9%); and needed, despite negative viral testing (67.0%). More technologists versus physicians rated the following as extremely/very important: testing parents for COVID-19 (71.2 vs 47.5%; $P = .01$), high-efficiency particulate air filters (75.1 vs 61.8%; $P = .02$), and extremely/very concerned about shared-ventilation systems (65.9 vs 51.5%; shared ventilation $P = .041$). The respondents in northeastern and western United States were more concerned about the availability of COVID-19 testing than were those in other regions of the United States. Among the total number of respondents, 68.0% expected a ≥ 50% drop in patients willing to have in-laboratory testing, with greatest drops anticipated in northeastern United States. CONCLUSIONS: Sleep health-care workers reported high levels of concern about exposure to COVID-19. Physicians and technologists generally showed high concordance with regard to the need for mitigation strategies, but the respondents differed widely with regard to which strategies were necessary. *Key words: Continuous positive airway pressure; polysomnography; sleep technologist; COVID-19; personal protective equipment; sleep disordered breathing; health care survey.* [Respir Care 0;0(0):1–●. © 0 Daedalus Enterprises]

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has quickly altered the landscape of medical practice and delivery since China reported COVID-19 on December 31, 2019, and the United States had its first confirmed case on January 20, 2020.[1] Cases increased primarily in western and northeastern United States in March, with a national emergency declared on March 13, 2020.[2,3] Although early in the pandemic, large droplet spread was considered the dominant mode of transmission; there was concern that aerosol-generating medical procedures may transmit the virus.[4,5] Thus, specialties who required the use of aerosol-generating medical procedures, for example CPAP, and other noninvasive ventilation, including sleep medicine, have been disproportionately affected.[6-9]

Although recent studies of droplet dispersal show that CPAP and noninvasive ventilation produce large droplets, which typically spread < 1 m in distance with the newer mask styles, sleep technologists' work often places them within this range to adjust masks and leads. A meta-analysis found that the risk of SARS-CoV-1 (severe acute respiratory syndrome coronavirus 1) transmission to health-care workers with patients on noninvasive ventilation was increased (odds ratio 3.1, 95% CI 1.4–6.8).[7,8,10] In April-May 2020, our survey showed that > 90% of sleep laboratories

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reported either having stopped or nearly stopped in-laboratory diagnostic and titration studies similar to in-laboratory cessation rates in India (92%) and Europe (80%).[11-13]

Due to uncertainties with regard to transmission of the novel coronavirus, limited availability of testing, lack of a vaccine or specific cure, the Centers for Disease Control (CDC) and societies, including the American Academy of Sleep Medicine, published practice guidance early in the pandemic, which rely on traditional infection control measures, including disinfection, personal protective equipment (PPE), and social distancing;[5,14,15] however, substantial uncertainty remained about which strategies should be used to protect patients and staff with limited access to PPE, COVID-19 testing, and negative pressure rooms.

The COVID-19 pandemic has had major impacts on health-care workers' mental health and well-being, with high transmission rates that lead to significant health-care worker morbidity and mortality.[16-18] Protecting the well-being of health-care workers has been identified as critical for the long-term capacity of the health-care workforce.[19] Little was known about the efficacy of workplace interventions to support health-care professionals during pandemics before the COVID-19 pandemic[20]; however, these are now being actively studied.[21-25] Although implementing infection control measures may help prevent transmission to health-care workers, adequate education and other interventions are likely important for mitigating these other consequences of the pandemic on the workforce.

Understanding the concerns of sleep medicine health-care workers may help inform these interventions. We aimed to assess the perceptions of both sleep medicine physicians and sleep technologists with regard to reopening or expanding sleep services during the early days of the pandemic. Given the limited guidance and differences in resource availability, we expected variability in concerns, especially with regard to the availability of PPE and COVID-19 testing. Our hypothesis was that front-line sleep technologists would have higher concerns about exposure and rate mitigation strategies that pertained directly to the sleep laboratory environment as more important than sleep physicians.

QUICK LOOK

Current knowledge

The coronavirus disease 2019 pandemic has produced numerous safety concerns for sleep medicine patients and health-care providers, especially related to the use of potentially aerosol-generating positive airway pressure devices. Early in the pandemic, uncertainty about mode of transmission, limited availability of personal protective equipment and testing, and local infection rates likely influenced sleep health-care providers concerns and feelings about mitigation strategies.

What this paper contributes to our knowledge

This survey of physicians and sleep technologists early in the coronavirus disease 2019 pandemic found a large variation in the type of personal protective equipment felt to be needed during sleep studies. Sleep technologists were more likely to feel that certain strategies were more important than did the physicians.

Methods

The protocol and the survey were determined to be exempt by the institutional review board of Baystate Medical Center.

On April 29, 2020, we distributed the link to a 139-item, anonymous, and confidential survey to a large group of health-care workers in sleep medicine through social media and society announcements. The link was active from April 29, 2020, through May 8, 2020. A full description of the survey design, distribution, and development has previously been described.[11] The Tufts Research Electronic Data Capture, REDCap,[26] platform housed the survey designed with branching logic based on provider and sleep study types. The respondents were asked to rate concerns and importance on a Likert scale from 1 to 5, with 1 representing "extremely concerned" or "extremely important" and 5 representing "not at all concerned" or "not at all important." We reported the proportion of the responders who answered 1 or 2, which indicated a rating of being extremely or very concerned or important, and referred to this combination as "high" concern or importance.

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Supplementary material related to this paper is available at http://www.rcjournal.com

The authors have disclosed no conflicts of interest.

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Statistical Analysis

We reported summary statistics on a participant level. We collapsed all responses to Likert scale questions into 2 categories: (1) extremely or very concerned/important, and (2) somewhat, slightly, or not at all concerned/important. Due to the smaller number of respondents in some regions, we grouped the northeastern and western United States, and the southeastern, midwestern and southwestern United States respondents for the sake of analysis, because, generally, at the time of the study, northeastern and western United States was experiencing higher levels of COVID-19 and southeastern, midwestern, and southwestern United States lower levels. We used the Fisher exact test to compare categorical variables between the groups. We conducted 2-sided significance testing at a critical test level of 5%. All data management and statistical analysis were performed by using Stata version 16.0 (Stata Corp, College Station, Texas).

Results

Respondents

We received a total of 446 survey responses. We excluded 51 of the 446 responses (11.4%), which had provided only demographic information likely due to inability to advance to page 2 of the survey on certain device types, and another 16 of the 446 (3.6%), which were entirely blank. Therefore, we included a total of 379 of 446 respondents (85%) in the analysis. A non-responder analysis confirmed that demographics of 51 excluded surveys did not differ significantly from included respondents. Demographic information in all 379 respondents, including 75 physicians and 283 sleep technologists, is summarized in Table 1. Certification of the sleep technologists was reported as 40 (14.1%) as dual registered respiratory therapist/registered polysomnography technician, 204 (72.1%) registered as polysomnography technician only, 11 (3.9%) registered as respiratory therapist only, 30 (10.6%) were unregistered, and 3 (1.1%) did not answer. Other reported professions ($n = 7$) included an administrative coordinator, non-technologist sleep manager, registered nurse, registered health-care scientist, and clinical coordinator. Respondents reported being from 13 countries with 92% of respondents from 46 different United States states or territories. We compared our sample against proportions of all of the centers accredited by the American Academy of Sleep Medicine. Our sample had fewer respondents from laboratories that serve both pediatric and adult patients (50.3% of our respondents vs 79.5% of AASM accredited laboratories). Primary geographic differences were fewer respondents in the southeast (17.4 vs 32.3%) and more respondents from the northeast (33.5 vs 17.6%). Our study had more respondents from pediatric-only laboratories (6.1 vs 1.3%) and from private laboratories (15.5 vs 3.2%).

Health-Care Worker Concerns

The proportion of technologists and physicians who reported high levels of concern about exposure of patients and technologists to COVID-19 was similar. In both groups, concern for exposing technologists exceeded that of exposing patients (Table 2). Overall, physicians and sleep technologists expressed similar concerns about exposure to COVID-19 and the availability of resources, with technologists expressing higher concern about the risks of shared ventilation systems. Health-care workers in the northeastern and western United States expressed greater concern about the availability of COVID-19 testing than did the workers in other regions of the United States or the non–United States respondents ($P = .050$) (Supplementary Table 1 [see the supplementary materials at http://www.rcjournal.com]). Other respondent, practice, and laboratory characteristics were not significantly associated with the degree of reported concern with regard to the availability of either PPE or viral testing.

Choice of PPE

No consensus existed with regard to the type of PPE that should be used during in-laboratory testing for patients with unknown testing status, but 309 technologist and physician respondents were in close agreement (Fig. 1). No difference in PPE choice was found by practice location (academic, non-academic/health-maintenance organization, private).

Viral Testing and In-Laboratory Studies

A total of 269 respondents rated the importance of COVID-19 testing patients and their parents before in-laboratory testing, with more technologists than physicians reported that testing of accompanying parents was highly important ($P = .01$) (Fig. 2). Only 6 of 15 of the respondents (40.0%) who identified as pediatricians rated testing of parents as highly important, with 8 of 15 (53.3%) rating testing the accompanying parents as somewhat important. A total of 33 of 57 physicians (57.9%) and 145 of 210 of technologists (69.0%) felt that aerosol precautions were still needed, even with recent, negative COVID-19 viral testing ($P = .12$). When specifically asked about the time of COVID-19 viral testing such that airborne precautions would not be needed, responses between the physicians and technicians were similar ($n = 305$).

Rapid testing (84/302 [27.8%]), testing 1 day (55/302 [18.2%]), 2–3 days (60/302 [19.9%]), and 4–7 days (34/302 [11.3%]) before polysomnography were rated as more important than any previous testing (3.6%). A total

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Table 1. Respondents' Characteristics

Characteristic	All Respondents ($N = 379$)	Physicians ($n = 75$)	Technologists ($n = 283$)
Profession			
Sleep technologists	283 (74.7)	NA	NA
Physicians	75 (19.8)	NA	NA
Psychologists	2 (0.5)	NA	NA
Dentists	1 (0.3)	NA	NA
Advanced practitioners	10 (2.6)	NA	NA
Other	8 (2.1)	NA	NA
Administrative responsibility			
Laboratory medical director	48 (12.8)	47 (62.7)	NA
Laboratory director or lead technician	117 (31.2)	NA	117 (41.3)
Experience in sleep medicine			
<10 y	132 (34.8)	24 (32.0)	36 (33.9)
10 – 20 y	162 (42.7)	31 (41.3)	126 (44.5)
>20 y	85 (22.4)	20 (26.7)	61 (21.6)
Practice affiliation			
Academic hospital	52 (61.9)	44 (60.3)	NA
Non-academic MC or HMO	15 (17.9)	12 (16.4)	NA
Veterans Affairs	4 (4.8)	4 (5.5)	NA
Private practice	13 (15.5)	13 (17.8)	NA
Laboratory location			
Hospital	202 (53.4)	33 (44.0)	160 (56.5)
Medical building	98 (25.9)	26 (34.7)	68 (24.0)
Other*		18 (22.4)	
Laboratory setting			
Urban	164 (44.0)	37 (50.0)	120 (42.9)
Suburban	147 (39.4)	30 (40.5)	109 (38.9)
Rural	62 (16.6)	7 (9.5)	51 (18.2)
Region			
All of the United States	351 (92.6)	67 (89.3)	263 (92.9)
NE, W United States†	158	37	106
SE, SW, MW United States†	189	29	156
Not United States	28 (7.4)	8 (10.7)	19 (6.7)
Population served			
Both	188 (50.3)	36 (48.0)	142 (50.7)
Adult only	163 (43.6)	27 (36.0)	129 (46.1)
Pediatric only	23 (6.1)	12 (16.0)	9 (3.2)

Data are presented as *n* (%).

*Other sleep laboratory locations included hotels, stand-alone laboratories, research laboratories, and using home sleep apnea testing only. There were 6 respondents with unknown sleep laboratory, 1 respondent with unknown regions, and 5 respondents with unknown population served.

† One physician from Puerto Rico and one technologist from unknown United States region were not included in the regional United States data.

NA = not applicable

MC = medical center

HMO = health maintenance organization

MW = midwest

W = west

SE = southeast

SW = southwest

of 58 of 302 of the respondents (19.2%) did not select a specific time because they rated airborne precautions as being of high importance even if the COVID-19 testing result was negative. Of the respondents who felt that airborne precautions were always needed, 51 of 56 (91%) endorsed potential false-negative testing as the reason for concern.

Although the survey summarized the CDC recommendation not to test health-care workers who were asymptomatic, only 66 of 229 of the technologist respondents (28.8%) and 25 of 64 of the physician respondents (39.1%) concurred with this recommendation. A majority of the respondents reported that technologists should be tested for COVID-19 at least once (8/64 physicians [12.5%], 55/229

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Table 2. Proportion of Health-Care Workers Who Reported Being Extremely or Very Concerned About COVID-19 During In-Laboratory Sleep Studies*

Concern	All Respondents	Physicians	Technologists	*P*
Viral exposure or transmission				
Droplet transmission from PAP	263/318 (82.7)	52/65 (80.0)	198/237 (83.5)	.58
Exposing technicians to COVID-19	259/317 (81.7)	55/65 (84.6)	192/236 (81.4)	.72
Airborne transmission from PAP	257/315 (81.6)	51/64 (79.7)	195/236 (82.6)	.59
Contaminated surfaces	230/317 (72.6)	42/65 (64.6)	178/236 (75.4)	.09
Exposing patients to COVID-19	225/318 (70.8)	46/65 (70.8)	167/237 (70.5)	>.99
Shared room ventilation system	198/312 (63.5)	33/64 (51.6)	153/232 (65.9)	.041
Airborne transmission from oxygen	200/325 (63.5)	36/64 (56.3)	154/235 (65.5)	.19
Droplet transmission from oxygen	195/317 (61.5)	37/65 (56.9)	149/236 (63.1)	.39
Availability of resources				
Personal protective equipment	221/285 (77.5)	46/57 (80.7)	163/212 (76.9)	.60
COVID-19 testing	202/282 (71.6)	45/57 (78.9)	146/209 (69.9)	.19
Disposable supplies	195/275 (70.9)	36/57 (63.2)	153/211 (72.5)	.19
Negative pressure rooms	134/273 (49.1)	29/57 (50.9)	101/209 (48.3)	.77
Other concerns*				
Infection control policies that hinder the ability to test	70/125 (56.0)	23/36 (63.9)	46/88 (52.3)	.32
Financial losses due to COVID-19	86/124 (69.4)	24/36 (66.7)	54/88 (61.4)	.83
Added costs of precautions	76/126 (60.3)	22/37 (59.5)	61/87 (70.1)	.84

Data are presented as *n* reported being extremely or very concerned/*n* respondents (%).
*We only asked respondents who self-identified as medical and laboratory directors or lead technologists.
COVID-19 = coronavirus disease 2019
PAP = positive airway pressure

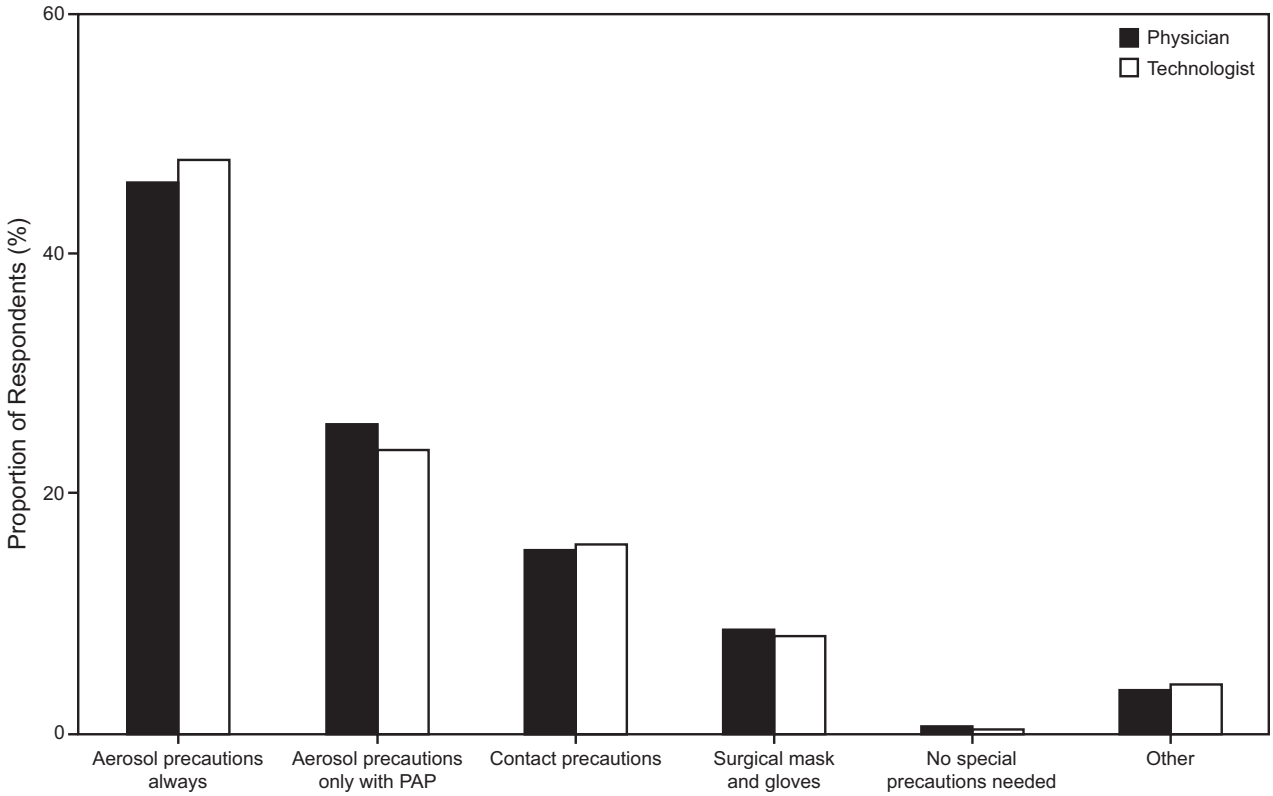

Fig. 1. Proportion of respondents feeling personal protective equipment (PPE) type was important for in-laboratory studies in patients with unknown coronavirus disease 2019 (COVID-19) viral status. PAP = positive airway pressure.

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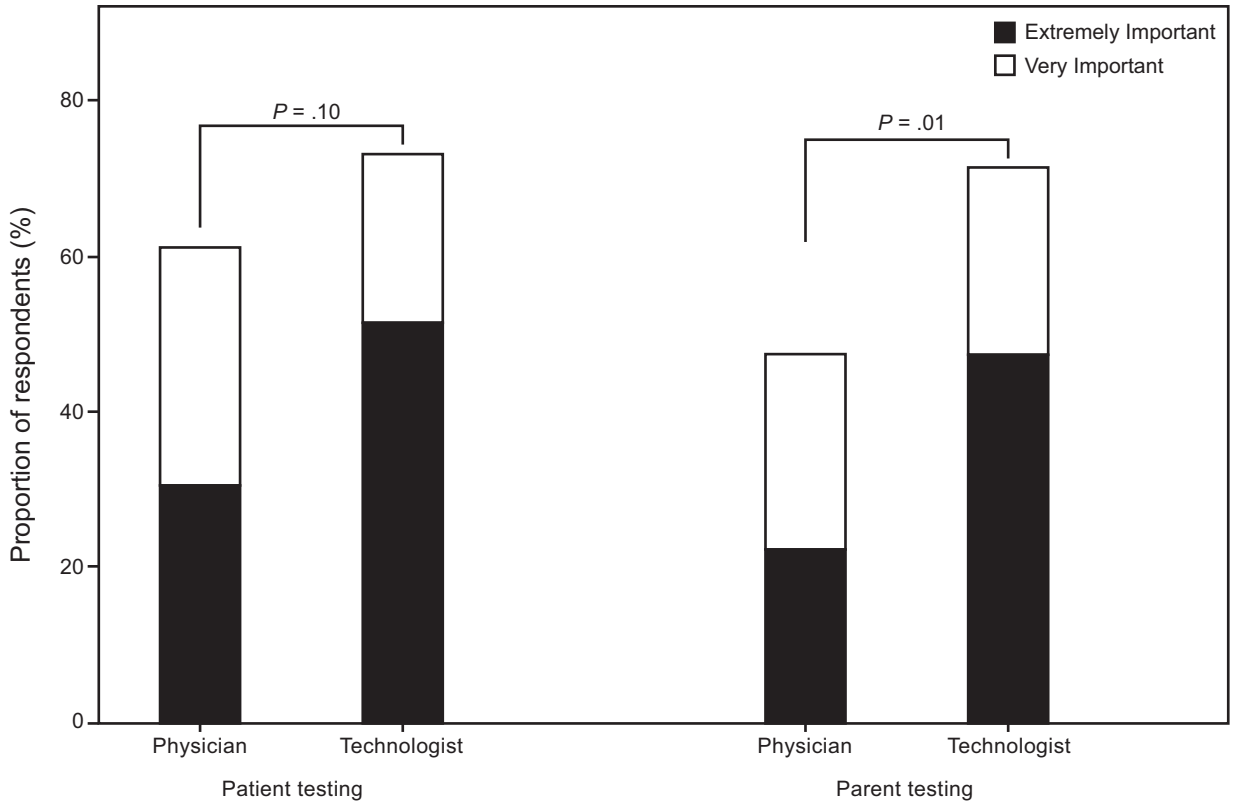

Fig. 2. Importance of coronavirus disease 2019 (COVID-19) viral testing of patients and parents.

technologists [24.0%]) or intermittently (25/64 physicians [39.1%], 93/229 technologists [40.6%]). Other respondents reported that testing should be done before each shift or only if a known exposure occurred, or more frequently if access to PPE is limited.

Perceptions of Specific Mitigation Strategies

Respondents felt that certain mitigation strategies for in-laboratory studies were more important than others, with 91.5% rating limiting visitors as the most important strategy. There generally was consensus between technologist and physicians, with exceptions being super cleaning rooms (90.3% technologists vs 78.9% physicians; $P = .036$) and of high-efficiency particulate air filters or high air exchange rate (78.4% technologist vs 61.8% physicians, $P = .02$) (Supplemental Table 2 [see the supplementary materials at http://www.rcjournal.com]) Similarly, strategies for home sleep apnea testing were felt to be of varying importance (Supplemental Fig. 1 [see the supplementary materials at http://www.rcjournal.com]). We found no significant differences in the rated importance of any type of in-laboratory or home sleep apnea testing mitigation strategies based on practice location but observed a trend with 16 of 32 of the respondents (50.0%) from academic hospitals, 5 of 13 (38.5%) from non-academic/health maintenance organization, and 2 of 15 (13.3%) from private/other ($P = .064$), who rated the use of disposable home sleep apnea testing devices to be highly important (Supplemental Fig. 2 [see the supplementary materials at http://www.rcjournal.com]).

Willingness to Undergo Testing

The respondents were asked about the percentage of patients they believed would be willing to come for in-laboratory studies. A total of 111 of 369 of all of the respondents (30.1%) expected at least a 75% reduction in patients willing to come for in-laboratory testing and an additional 140 of 369 (37.9%) expected at least a 50% drop in patient attendance. From April 29 to May 8, 2020 at the time of the survey, all the respondents in the northeastern United States were more likely to expect at least a 75% (52/121 [43.0%] vs 45/219 [20.5%]; $P < .001$) or at least a 50% (105/121 [86.8%] vs 126/219 [57.5%]; $P < .001$) reduction in patients willing to come in for testing versus the rest of the United States

Most of the physicians and technologists reported that technologists wearing masks and gowns would increase patients' perception of safety when having in-laboratory testing (physicians 53/55 [96.4%], technologists 181/206 [87.9%]; $P = .22$). Technologists were more likely than physicians to report that temperature screening and symptom

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Table 3. Strategies to Improve Health-Care Workers Safety and Resilience

Strategy
Education and Communication
Education about viral transmission and role of different infection control strategies
Involving frontline workers in policy creation
Clear communication about strategies and resources
Health-care workers' safety
Quickly adapting policies as new information arises
Ensuring adequate personal protective equipment and infection control resources
Health-care workers' well-being
Individually addressing personal and family risks
Providing mental and health resources for affected health-care workers
Salary support for sickness and caretaker duties
Monitoring for depression and anxiety by using buddy systems
Flexible schedules

screening (45/57 physicians [78.9%] vs 188/204 technologists, [92.2%]; $P = .007$) would increase patients' perception of safety. Limiting studies to patients who test negative for COVID-19 (33/57 physicians [59.7%], 133/205 technologists [70.2%]; $P = .08$) and testing technologists for COVID-19 virus (36/55 physicians [65.5%], 142/205 technologists [69.2%]; $P = .63$) were less commonly reported to be needed to raise patients' perception of safety before undergoing sleep laboratory procedures.

Discussion

This study represented a unique look at the mindsets, concerns, and beliefs of front line sleep practitioners as the pandemic unfolded and adaptations that were being decided "in the trenches" throughout the field when guidance was still limited. This study is valuable in shedding light on the ways in which laboratories choose strategies and involve stakeholders, with the intent to not just enhance safety but also to address both workers' resilience and retention, and patients' reticence to engage in laboratory-based testing. This was especially evident with respect to whether to use PPE against airborne transmission for diagnostic-only studies or when caring for patients who tested negative for COVID-19. The high proportion who expressed this need for caution may have reflected concerns with regard to pre-symptomatic transmission[27] or false-negative test results or that the risk of airborne transmission may have been underappreciated in available guidance reports. The evolving understanding of the role of aerosol transmission and subsequent changes in precaution recommendations underscores this possibility.[28,29]

It is not surprising that physicians and technologists had similar high ratings for most mitigations strategies that involved exposures that both groups were likely to face, but technologists tended to rate strategies that were specific to the laboratory environment, such as high-efficiency particulate air filers, ventilation systems, and super cleaning rooms, and the need for asymptomatic screening of technologists of greater importance or concern. Similarly, the greater degree of concerns among the technologists and their rating of the need for mitigation strategies against airborne transmission, even with negative COVID-19 testing results, may reflect their greater likelihood of prolonged, close contact with patients on aerosol-generating devices required during in-laboratory studies. The proportion of respondents who rated other mitigation strategies as important varied, but, in general, we found concordance between the physician and technologist respondents and no significant differences by region or laboratory characteristics.

Workforce resilience, mental health, and retention have become important issues during this pandemic and have implications on the sustainability of a strong health-care workforce. From our own experience, several of our technologists have either chosen to leave sleep medicine completely or have chosen to remain reassigned to less frontline work due to COVID-19 concerns. These differences in perceptions found in this survey between frontline sleep technologists and sleep physicians suggest that surveys early in a pandemic with the purpose of identifying areas of concerns, especially those that do not align with scientific understanding, may provide data to design interventions that improve health-care workers' resilience. Interventions that may promote health-care workers' safety and resilience are summarized in Table 3.[19]

The impact of guidance from government and organizations, for example, the American Academy of Sleep Medicine, on actual practice is unknown. A survey done of sleep medicine physicians in India at an unknown time during the pandemic found that most, 54 of 75 respondents (72%), reported not conducting any sleep studies, with only 16 of 75 respondents (21%) reporting performance of in-laboratory studies, with 10 of those reporting, primarily, use of home sleep apnea testing. Only 9 of 16 (56%) who performed in-laboratory studies noted awareness of the American Academy of Sleep Medicine disinfection guidelines, with 7 of 16 (44%) who followed them.[12] Although this study was done in India, which may decrease the likelihood of following guidelines from other countries, it highlights the need for more research about how sleep medicine practices incorporate recommendations and whether it has an impact on patient or provider safety and workforce resilience and retention.

Similar to their own concerns, health-care workers predicted high rates of patient unwillingness to come for testing. Since reopening our laboratory in June 2020, Baystate Medical Center has been experiencing an ~30–40% cancellation rate and an additional 7% no-show rate in in-laboratory

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patients who completed their pre-study COVID-19 testing. Since the start of the pandemic, multiple reports have emerged of emergency department personnel and providers in other specialties seeing lower rates of health-care utilization, even for serious conditions, such as myocardial infarction and stroke.[30,31] Our finding that respondents from the northeastern United States were most likely to anticipate much higher rates of patient unwillingness to undergo sleep studies mirrors the rates of COVID-19 in that region at the time of the survey, but it is unclear if similar concerns will increase in other regions of the country as their rates increase.

One study[31] that provides some information about sleep medicine patients' views is a survey of 112 subjects in New York City with obstructive sleep apnea. It showed that a majority (63%) were concerned that the presence of obstructive sleep apnea made them more likely to have greater medical complications if they were to get COVID-19. Eleven percent of the subjects noted cessation of CPAP therapy during the outbreak, but 21% noted increased use, believing that it would increase clinical benefit during the pandemic.[32] It is unclear, however, how these generally favorable views about the importance of treating obstructive sleep apnea translates into willingness to come to a laboratory for testing. More research with regard to how fears of infection affect utilization of health care and the best ways to overcome these fears are needed. A greater understanding of these issues, including surveying patients, may help laboratories define policies and marketing that help assure patients of safe laboratory practices.

The greater degree of concern in the northeastern United States about the availability of COVID-19 testing and anticipated large drops in patient volume may have reflected the far greater prevalence of the disease in those regions at the time of survey administration, with a concurrent lack of access to test kits and reagents.[33] Since the survey, the United States has experienced at least 3 waves with almost universal spread of COVID-19 across the country, including severe outbreaks in rural areas. In the first year of the pandemic, Kaiser Health News (Kaiser Family Foundation, Washington, DC) counted 3,607 health-care workers' deaths, with none listed as respiratory therapists or sleep medicine technologists,[34] but the American Association for Respiratory Care reported 21 known deaths of respiratory therapists as of February 9, 2021, although there was no evidence for specializing in sleep medicine.[35]

The effect of rapid dissemination of vaccines is starting to be seen, with reductions in transmission rates and hospitalizations, but there are still unknowns with regard to protection against variant strains. Despite all health-care workers being eligible for vaccination, a survey of 1,327 frontline health-care workers showed that 48% of health-care workers had still not received at least 1 dose as of March 19, 2021, with 12% undecided about getting vaccinated and 18% not planning on being vaccinated.[36] As this pandemic has evolved over the past year with widespread transmission, increased availability of PPE, concern about COVID-19 variants, hope but still hesitancy about vaccines, new science and perspectives about virus transmission, and experience with reopening during the pandemic, we would expect different responses if respondents were resurveyed at different points throughout the pandemic.

Our study had several key strengths. We received a sizable proportion of returned surveys with usable responses, and the respondent group represented a variety of provider perspectives, training backgrounds, practice experience, administrative responsibility, pediatric and adult practices, and geographic regions. Also, the study had a sizable response from sleep technologists, who, in this crisis, are often first-line providers in sleep centers. At the time of the survey, knowledge about COVID-19 was evolving rapidly and most laboratories were closed and planning reopening strategies, so responses would be expected to change if the survey were repeated later in the pandemic course. The reasoning for some responses may also vary by respondent circumstance. For example, concern about inadequate engineering controls (eg, absence of negative pressure rooms) or the inability to meet social distancing requirements. Responses may be affected by local prevalence rates, understanding of disease transmission, institutional guidance, availability of testing, containment strategies, and PPE.

In an attempt to lessen the effect of variable knowledge among respondents and to determine whether concerns aligned with recommended strategies, we presented current CDC recommendations before asking relevant questions.[5] The need for testing of health-care workers for SARS-CoV-2 was felt to be important by many respondents despite CDC recommendations to the contrary. The motivation for this response remains unclear, but reports from the Diamond Princess (Carnival Corporation, London, UK) cruise ship were suggestive of asymptomatic or pre-symptomatic contact or droplet transmission, with more confirmatory data emerging after the survey period.[27,37] Arguably, limiting protocolized COVID-19 testing may delay case identification and contact tracing, expose others, and, concurrently, diminish patient confidence. As laboratories re-open, in the future, data are needed to determine whether technologists' concerns lead to refusal or delay to return to work and whether the predictions about patient unwillingness to come for testing are accurate.

Other than concern about availability of COVID-19 testing and anticipation of patient reluctance toward testing, we did not find any major regional differences. This may be partly related to sample characteristics (there were fewer respondents in regions outside of the northeastern United States) and/or the type of laboratories represented by the respondents. The lack of differences in responses based on geographic region may also reflect the timing of the study,

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which was still relatively early in the pandemic, when most laboratories were closed.

We discussed the limitations of our survey method previously, including generalizability outside of the United States, and non-response bias.[11] For this study, we chose to include the opinions from all the respondents, so the opinions of multiple workers from the same laboratory were included; it is unclear whether they would be more likely to have the same opinions. Although our survey methodology may have led to respondents being more educated or passionate about the topic or more affected by COVID-19 at the time of the survey, we believe that analysis of the data still provides important insights about how health-care providers viewed COVID-19 risks and mitigation strategies that can inform further research and policy decisions.

Conclusions

There was alignment between sleep technologists and physicians in many concerns and mitigation strategies for COVID-19, but the differences between physicians and sleep technologists and that between CDC recommendations and health-care workers highlight how strategies needed to provide safe care may differ from those that enhance willingness to use care and maintain a resilient workforce. Current recommendations by federal agencies, for example, the CDC,[5] and guidance from professional societies, for example, the American Academy of Sleep Medicine,[14,15] provide a framework for designing COVID-19 mitigation policies, but local and regional factors, including regional prevalence rates of COVID-19; state, county, and institutional health policies; sleep laboratory space and the availability of COVID-19 testing to screen patients before sleep studies; contact tracing; and confinement of confirmed cases must also be taken into consideration. Further analysis of the impact of the COVID-19 pandemic on sleep testing and which mitigation strategies prove to be most successful both at infection control and maintaining health-care workers well-being and retention, especially as our knowledge about SARS-CoV-2 transmission evolves, are important to understand so that care for patients with sleep disorders can be optimized through the remainder of this pandemic and in the future. Prospective monitoring of the effectiveness of particular mitigation strategies in protecting health-care workers and patients will be helpful in informing future approaches.

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REFERENCES

1. Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First case of 2019 novel coronavirus in the United States. N Engl J Med 2020;382(10):929-936.
2. Goldstein J, McKinley J. Coronovirus in N.Y: Manhattan woman is first confirmed case in state. *The New York Times*. Mar 1, 2020. Available at: https://www.nytimes.com/2020/03/01/nyregion/new-york-coronvirus-confirmed.html. *Accessed May 13, 2021.*
3. Trump D. Proclamation on declaring a national emergency concerning the novel coronavirus disease (COVID-19) outbreak. The White House. March 13, 2020. Available at: https://www.whitehouse.gov/presidential-actions/proclamation-declaring-national-emergency-concerning-novel-coronavirus-disease-covid-19-outbreak/. *Accessed August 29, 2020.*
4. Wilder-Smith A, Chiew CJ, Lee VJ. Can we contain the COVID-19 outbreak with the same measures as for SARS? Lancet Infect Dis 2020;20(5):e102-e107.
5. Centers for Disease Control and Prevention. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/infectioncontrol/control-recommendations.html. *Accessed May 14, 2020.*
6. Raboud J, Shigayeva A, McGeer A, Bontovics E, Chapman M, Gravel D, et al. Risk factors for SARS transmission from patients requiring intubation: a multicentre investigation in Toronto, Canada. PLoS One 2010;5(5):e10717.
7. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. PLoS One 2012;7(4):e35797.
8. Simonds AK, Hanak A, Chatwin M, Morrell M, Hall A, Parker KH, et al. Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections. Health Technol Assess 2010;14(46):131-172.
9. Liu Y, Ning Z, Chen Y, Guo M, Liu Y, Gali NK, et al. Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals. Nature 2020;582(7813):557-560.
10. Hui DS, Chow BK, Lo T, Tsang OTY, Ko FW, Ng SS, et al. Exhaled air dispersion during high-flow nasal cannula therapy versus CPAP via different masks. Eur Respir J 2019;53(4):1802339.
11. Johnson KG, Sullivan SS, Nti A, Rastegar V, Gurubhagavatula I. The impact of the COVID-19 pandemic on sleep medicine practices. J Clin Sleep Med 2021;17(1):79-87.
12. Kanchan S, Saini LK, Daga R, Arora P, Gupta R. Status of the practice of sleep medicine in India during COVID-19 pandemic. J Clin Sleep Med 2021;17(6):1229-1235.
13. Grote L, McNicholas WT, Hedner J, ESADA Collaborators. Sleep apnoea management in Europe during the COVID-19 pandemic: data from the European Sleep Apnoea Database (ESADA). Eur Respir J 2020;55(6):2001323.
14. American Academy of Medicine. Covid-19 mitigation strategies for sleep clinics and sleep centers. 2020. Available at: https://aasm.org/covid-19-resources/covid-19-mitigation-strategies-sleep-clinics-labs. *Accessed May 6, 2020.*
15. American Academy of Medicine. Covid-19 mitigation strategies for sleep clinics and sleep centers - reopening. 2020. Available at: https://aasm.org/covid-19-resources/covid-19-mitigation-strategies-sleep-clinics-labs. *Accessed May 6, 2020.*
16. CDC COVID-19 Response Team. Characteristics of health care personnel with COVID-19 - United States, February 12-April 9, 2020. MMWR Morb Mortal Wkly Rep 2020;69(15):477-481.

17. Shahid H, Haider MZ, Taqi M, Gulzar A, Zamani Z, Fatima T, et al. COVID-19 and its psychological impacts on healthcare staff - a multicentric comparative cross-sectional study. Cureus 2020;12(11):e11753.
18. Weibelzahl S, Reiter J, Duden G. Depression and anxiety in healthcare professionals during the COVID-19 pandemic. Epidemiol Infect 2021;149:e46.
19. World Health Organization (WHO). Mental health and psychosocial considerations during the COVID-19 outbreak. 2020. Available at: https://www.who.int/docs/default-source/coronaviruse/mental-health-considerations.pdf. *Accessed February 27, 2021.*
20. Pollock A, Campbell P, Cheyne J, Cowie J, Davis B, McCallum J, et al. Interventions to support the resilience and mental health of frontline health and social care professionals during and after a disease outbreak, epidemic or pandemic: a mixed methods systematic review. Cochrane Database Syst Rev 2020;11:CD013779.
21. Cabarkapa S, Nadjidai SE, Murgier J, Ng CH. The psychological impact of COVID-19 and other viral epidemics on frontline healthcare workers and ways to address it: a rapid systematic review. Brain Behav Immun Health 2020;8:100144.
22. Blake H, Yildirim M, Wood B, Knowles S, Mancini H, Coyne E, Cooper J. COVID-Well: evaluation of the implementation of supported wellbeing centres for hospital employees during the COVID-19 pandemic. Int J Environ Res Public Health 2020;17(24):9401.
23. Firew T, Sano ED, Lee JW, Flores S, Lang K, Salman K, et al. Protecting the front line: a cross-sectional survey analysis of the occupational factors contributing to healthcare workers' infection and psychological distress during the COVID-19 pandemic in the USA. BMJ Open 2020;10(10):e042752.
24. Plasse MJ. Psychosocial support for providers working high-risk exposure settings during a pandemic: a critical discussion. Nurs Inq 2020: e12399. [Epub ahead of print].
25. Houghton C, Meskell P, Delaney H, Smalle M, Glenton C, Booth A, et al. Barriers and facilitators to healthcare workers' adherence with infection prevention and control guidelines for respiratory infectious diseases: a rapid qualitative evidence synthesis. Emergencias 2021;33 (1):62-64.
26. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: Building an international community of software platform partners. J Biomed Inform 2019;95:103208.
27. Arons MM, Hatfield KM, Reddy SC, Kimball A, James A, Jacobs JR, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. N Engl J Med 2020;382(22):2081-2090.
28. Morawska L, Milton DK. It is time to address airborne transmission of coronavirus disease 2019 (COVID-19). Clin Infect Dis 2020;71 (9):2311-2313.
29. Centers for Disease Control and Prevention. How COVID-19 spreads. October 28, 2020. Updated. Available at: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html. *Accessed January 24, 2021.*
30. Rosenbaum L. The untold toll - the pandemic's effects on patients without Covid-19. N Engl J Med 2020;382(24):2368-2371.
31. Mantica G, Riccardi N, Terrone C, Gratarola A. non-COVID-19 visits to emergency departments during the pandemic: the impact of fear. Public Health 2020;183:40-41.
32. Thorpy M, Figuera-Losada M, Ahmed I, Monderer R, Petrisko M, Martin C, et al. Management of sleep apnea in New York City during the COVID-19 pandemic. Sleep Med 2020;74:86-90.
33. Stein R, Wroth C, Hurt A. U.S. coronavirus testing still falls short. how's your state doing? National Public Radio 2020. Available at: https://www.npr.org/sections/health-shots/2020/05/07/851610771/u-s-coronavirus-testing-still-falls-short-hows-your-state-doing. *Accessed May 7, 2021.*
34. The Guardian and Kaiser Health News. Lost on the frontline 2021 Available at: https://www.theguardian.com/us-news/ng-interactive/2020/aug/11/lost-on-the-frontline-covid-19-coronavirus-us-healthcare-workers-deaths-database. *Accessed April 22, 2021.*
35. American Association for Respiratory Care. Executive Office update: we will never forget them. Feb 9, 2021. Available at: https://www.aarc.org/nn20-covid-19-rt-fund/. *Accessed April 22, 2021.*
36. Kaiser Family Foundation. KFF and Washington Post Frontline Health Care Workers Survey. March 2021. Available at: https://context-cdn.washingtonpost.com/notes/prod/default/documents/4d8d1ddf-c192-40f9-9e3a-7a3fefa0d928/note/91e5f1ac-2cc5-41bb-b164-ecb4d77ed0b5. *Accessed April 22 2021.*
37. Kakimoto K, Kamiya H, Yamagishi T, Matsui T, Suzuki M, Wakita T. Initial investigation of transmission of COVID-19 among crew members during quarantine of a cruise ship - Yokohama, Japan, February 2020. MMWR Morb Mortal Wkly Rep 2020;69(11):312-313.