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

American Journal of Infection Control 50 (2022) 26–31

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

COVID-19 infection rates early in the pandemic among full time clinicians in a home health care and hospice organization

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Key Words:
Workplace exposure
Front-line health-care workers
Home care
Personal protective equipment (PPE)
Racial differences

Background: Patient-facing health care workers (HCW) experience higher rates of COVID-19 infection, particularly at the start of the COVID-19 pandemic. However, rates of COVID-19 among front-line home health and hospice clinicians are relatively unknown.

Methods: Visit data from a home health care and hospice agency in New Jersey early in the pandemic was analyzed to examine COVID-19 infection rates separately for clinicians exposed to COVID-19-contagious patients, and those without exposure to known COVID-19 contagious patients.

Results: Between March 5 and May 31, 2020, among home health clinicians providing in-person care, clinicians treating at least one COVID-19 contagious patient had a case rate of 0.8% compared to 15.7% for clinicians with no exposure to known COVID-19 contagious patients. Among hospice clinicians providing in-person care, those who treated at least one COVID-19 contagious patient had a case rate of 6.5%, compared to 12.9% for clinicians with no known exposure to COVID-19 contagious patients. Non-White clinicians had a higher COVID-19 case rate than White clinicians (10.9% vs 6.2%).

Discussion: Lower rates of COVID-19 infection among clinicians providing care to COVID-19-contagious patients may result from greater attentiveness to infection control protocols and greater precautions in clinicians' personal lives. Greater exposure to COVID-19-contagious patients prior to patient diagnosis ("unknown exposures") may explain differences in infection rates between home health and hospice clinicians with workplace exposures.

Conclusion: Clinicians providing in-person care to COVID-19-contagious patients experience lower rates of COVID-19 infection than clinicians providing face-to-face care with no known exposure to COVID-19 contagious patients. Our findings suggest there was a low incidence of potential workplace infections.

BACKGROUND

Health care workers (HCW) have always been at increased risk for infectious disease outbreaks due to close contact with patients. The COVID-19 pandemic is no exception. While stay-at-home orders lowered risk of infection for the general population, HCW continued to provide face-to-face care, and many knowingly treated COVID-19-positive patients, potentially putting themselves at increased risk of COVID-19 infection. Numerous studies document higher rates of COVID-19 infection among front-line HCW compared to the general population.[1-3] However, rates of COVID-19 among home health and hospice clinicians are relatively unknown.

Not surprisingly, among HCW, patient-facing staff are more likely to test positive.[4,5] A few studies have suggested a dose-response relationship, observing higher rates of infection among HCW caring for a greater number of patients with suspected or confirmed COVID-19.[5,6] A notable exception is lower rates of infection among HCW in Intensive Care Units (ICUs). While HCW in ICUs provide care for suspected or confirmed COVID-19 positive patients, and therefore may have the highest workplace exposure to COVID-19, several studies have documented lower rates of infection compared to other HCW with less exposure.[4-6] It has been suggested more intense training protocols, resulting in more consistent and meticulous use of PPE, or greater access to PPE supply, may explain why this high exposure group has low rates of infection.

Studies that compare and contrast risk based on employment consistently report differences by health care setting.[1] The only study to

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Funding: No outside funding was provided for this research.

Conflict of interests: The authors declare no conflict of interests in the present research.

https://doi.org/10.1016/j.ajic.2021.09.022

provide figures specifically for home health care workers indicated lower rates of infection compared to HCW in inpatient, nursing home, outpatient hospital clinics, and "other" facilities.[1] A few studies have indicated that infection in HCW populations is sometimes the result of spread between colleagues, with outbreaks among clinicians reported in departments with no COVID-19 positive patients.[7] Because home health and hospice clinicians operate relatively independently, with little contact spent in the presence of work colleagues, outbreaks among colleagues present less of a risk.[4] Home health care and hospice workers would generally have reduced exposure, compared to other HCW, since they mostly visit patients in their personal residences, while other HCW provide care where patients co-reside (or at least receive care in the same location), exposing them to a greater potential number of patients.

Mirroring patterns seen in the general population, several studies indicate among HCW, those who are racial/ethnic minorities are significantly more likely to test positive for COVID-19 than their white counterparts.[1,2,4,8] Some scholars suggest that racial stratification in employment could explain some of the observed racial differences. Black, Asian, and minority HCW have been found to be more likely to work in occupations with greater risk of exposure, and within health care are more likely to be employed in higher risk clinical settings such as nursing homes.[1,9] Other researchers have suggested differential infection may be, at least partially, the result of inequalities in the availability of PPE. One study found that minorities were more likely to report inadequate, or reuse of, PPE.[1]

Risk to HCW occur through pathways other than direct patient care. Researchers have suggested that differences in household composition, which vary significantly by race, could explain some of the observed racial differences. In the US, racial/ethnic minorities often reside in households with more members, relative to Whites.[10] Not only is the size of household important, but since minorities are more likely to work in essential jobs, employment risks are shared by all members of the household. Larger household size, and the inherent difficulties of social distancing at home, suggests risk is magnified in households with more people residing in them. Research explicitly examining infection rates among staff at a teaching hospital in the UK, found the greatest risk was associated with COVID-19 infected household contacts[4]; household exposure was found to be a greater risk than workplace exposure.

The current study investigates infection rates among clinicians providing in-person home health and hospice care in a community setting and explores potential infection due to exposure to COVID-19-contagious patients. Finally, the study assesses racial/ethnic differences and whether gender, or the type of job performed increases the likelihood of being infected.

METHODS

Description of sample

Data come from patient electronic medical records (EMR) from the Visiting Nurse Association Health Group (VNAHG), a not-for-profit certified home health provider in New Jersey, Ohio and Florida. Within the EMR, service codes allow a designation of whether visits occurred in-person, and provide an exact measure of the duration of the visit. The sample is limited to HCW providing in-person care to patients living in New Jersey between March 3 and May 31, 2020. Remote visits were excluded from the analyses. Visits logged for longer than 120 minutes were hard-coded to 120 minutes, as this usually indicated a lapse in ending the timestamp for the visit. Our analyses only examine visits performed by full time employees, because part time and per diem employees often work in several health care settings, making it difficult to parse COVID-19 infections due to workplace exposure.

For home health care patients, diagnostic information comes from start of care, resumption of care, and recertification Outcome and Assessment Information Set (OASIS) assessments. COVID-19 designation was determined by an ICD-10 code of U07.1. For hospice patients, COVID-19 diagnoses were recorded as the date the patient was suspected, or confirmed, to have COVID-19 (whichever came first).

We use a 10 day "look back" and 10 day "look forward" window from patient diagnosis to retrospectively designate patients with a COVID-19 diagnosis as contagious based on current scientific knowledge of incubation periods and shedding of virus.[11,12] Visits to COVID-19-positive patients during this window are designated as workplace exposures. Treatment of a COVID-19-contagious patient would need to occur in the 10 days prior to the clinicians' COVID-19-positive test to be counted as a potential workplace infection; in other words, we only report clinician cases as workplace exposure cases when a visit to a COVID-19-contagious patient occurred in the clinician's infection window.

Clinician COVID-19 testing

Starting March 23, 2020, the organization instituted an employee screening tool to be completed by all field clinicians. Any clinician indicating they had symptoms of COVID-19, were cohabitating with someone who was quarantining, or were in a public setting or gathering(s) where face coverings were not universally maintained since their last screening were instructed to remain at home until being contacted by Employee Health. Any clinician who began to experience symptoms while in the field was instructed to leave immediately and call their manager. Employees suspected of being infected were directed to receive a COVID-19 test before returning to work. PCR tests were used to directly screen for the presence of viral RNA, which are considered more reliable than antigen tests; company tests consisted of both saliva samples and nasal swabs. Results of employee COVID-19 tests were recorded in our internal database. Those who sought testing privately were required to report the results back to the organization, and outside test results were included in the internal database. We record the earliest of these dates: (1), the date clinician first reported symptoms, (2), the date the clinician went for a COVID-19 test (through the organization or privately), and (3), the date the clinician was put on leave from work. Because we examine visits between March 3 and May 31, we include clinician COVID-19 tests through June 9 (10 days following the last potential workplace exposure).

Employee racial/ethnic information comes from a human resources database using employees' self-reported race and ethnicity. Due to small cell sizes, and the need to preserve clinician anonymity, we use 2 racial/ethnic categories: White versus Non-White (which consists mainly of African American (n = 227; 57.8%), Hispanic (n = 73; 18.6%), and Asian (n = 73; 18.6% clinicians)). Job discipline designates clinicians into three broad categories: nurse, home health aide, and a catch-all "other" category that includes nutritionists, occupational therapists, social workers, speech pathologists, and other ancillary clinicians that performed in-person care.

Clinicians were designated by the service line in which they practiced: home health or hospice. A small proportion of clinicians provided care in both the service lines during the time period examined. These "cross-over" clinicians are designated to a single service line based on where they performed the majority of visits.

In an effort to reduce workplace exposure to COVID-19-contagious patients, the organization asked for nursing volunteers to treat known COVID-19 patients with a focus on recruiting clinicians who were at lower risk of COVID-19 morbidity and mortality and were able to go through additional training. Volunteers were selected in each service area, and these clinicians received additional training on

Table 1
Important dates of protocols for home health care and hospice clinicians

Date	Protocol
March 9	In person and Zoom COVID-19 training for all field clinicians
March 21	Training for COVID-19 team and access to company COVID-19 testing.
March 21	Fit testing and education on how to don N-95 masks. Patient facing workers were fit-tested for PPE in small groups.
March 23	Clinicians required to wear N95 masks for high risk visits.
March 25	COVID-19 education on online learning platform for all clinical (and non-clinical) staff.
March 26	Implemented surgical masks for all visits for field clinicians
April 15	Implemented protocol for clinicians to ask patients and their close caregivers to wear a face covering.
April 23	Implemented masks and goggles for all field visits.

protocols for treating COVID-19-positive patients, as well as fit testing for N95 masks. All clinicians, regardless of whether they were treating known COVID-19- patients, received comprehensive training on infection control policies and procedures through a combination of intranet resources as well as web-based live meetings. The training included proper donning and doffing of personal protective equipment (PPE), storing and discarding contaminated PPE, and how to keep the environment safe by providing masks to other members of the household while visits were being made. The organizations' protocols and standard practices evolved throughout the pandemic as understanding of transmission and infection developed. As new information became available, and best practices were updated, clinicians were updated by email as well as our employee mobile app. Table 1 provides the dates of critical protocols in the initial stages of the pandemic. Additionally, allotments of hand sanitizer, cleaning materials, and other items required to effectuate optimal infection control were distributed to all clinicians.

Statistical analyses

Categorical and binary variables are reported in raw numbers and frequencies. Fisher's tests evaluate statistical significance between groups. Statistical tests were performed in SPSS, version 25.

The Institutional Review Board of the organization approved this study.

RESULTS

COVID-19 clinician infection rates between March 5 and June 9, 2020

Table 2 reports the number of full-time clinicians providing in-person care, the number of clinicians testing positive for COVID-19, and the resulting COVID-19 case rate separately by service line. Of the 476 home health care clinicians who provided in-person care between March 3 and May 31, 2020, 39 tested positive for COVID-19, for an overall case rate of 8.2%. In hospice, 239 clinicians provided in-person care. Twenty-four of them tested positive for COVID-19, for an overall case rate of 10.0%. The lower portion of Table 2 delineates between clinicians who had a workplace exposure (provided in-person care to at least one diagnosed COVID-19-contagious patient), Home health clinicians who had a workplace exposure had a COVID-19 case rate of 0.8% (2/241), while home health clinicians with no workplace exposure had a COVID-19 case rate of 15.7% (37/235). Within the hospice service line, those with a workplace exposure to a COVID-19-contagious patient had a case rate of 6.5% (7/107), compared to a case rate of 12.9% (17/132) for those with no workplace exposure to a COVID-19-contagious patient.

Table 3 reports the number of visits made to COVID-19-contagious patients, and cumulative exposure to clinicians, as well as the number of COVID-19-contagious patients treated by service line. Home health care clinicians treated 835 COVID-19-contagious patients between March 3 and May 31, 2020. They provided 1,576 visits totaling 88,430 minutes. The vast majority of this care were to patients who had a COVID-19 diagnosis at the time the clinician provided care (known exposures). Visits to known exposures represented 86,547 minutes of face-to-face care, which accounts for over 97% of the total duration of workplace exposure to home health clinicians.

In hospice, clinicians provided 552 visits to 111 COVID-19-contagious patients totaling 33,168 minutes. More than 1/3 of the visits (190/552 =34.4%) to COVID-19-contagious patients by hospice providers were not known exposures at the time care was provided. In terms of duration of exposure, 37% of the total hospice workplace exposure (12,399 minutes) were at-the-time-unknown exposures.

COVID-19 rates by race/ethnicity, gender, and job type

Service lines were combined in order to increase statistical power when testing for differences by clinician characteristics. White clinicians were significantly less likely to test positive for COVID-19 than Non-White clinicians (6.2% vs 10.9%; $P = .03$). Significant differences were not found by gender ($P = .85$). While the findings are not statistically significant ($P = .15$), 10.4% of nurses tested positive for COVID-19 compared to 8.5% of home health aides, and 5.0% among clinicians in the catchall "other" category (Table 4).

DISCUSSION

Overall, clinicians who provided in-person care to patients included in the study had a COVID-19 case rate of 8.2% for home health care clinicians and 10.0% for hospice clinicians. Parsing these rates into those that could potentially be due to workplace exposure to COVID-19-contagious patient(s), revealed clinicians in both service lines with a known workplace exposure were substantially less likely to test positive for COVID-19. Among home health clinicians, non-work exposures led to a 15.7% case rate and workplace exposures led

Table 2
Case rates of COVID-19 among clinicians by service line, and workplace exposure

	Home health (n=476)		Hospice (n=239)	
Number of clinicians who tested positive for COVID-19	39		24	
COVID-case rate	8.2%		10.0%	
	Workplace Exposure (n=241)	No Workplace Exposure (n=235)	Workplace Exposure (n=107)	No Workplace Exposure(n=132)
Number of clinicians who tested positive for COVID-19	2	37	7	17
Case rate by exposure status and service line	0.8%	15.7%	6.5%	12.9%

Table 3
Workplace exposures between March 3 And May 31, 2020 To COVID-19-contagious patients by service line, and whether the patient was known to have COVID-19 at the time care was provided

	Care provided by Home health clinicians	Care provided by Hospice clinicians
Number of Unique Patients	835	111
Total Visits defined by staff treating	1,576	552
Total Duration (minutes)	88,430	33,168
Known Workplace Exposure		
Number of visits to COVID-19-contagious patient(s)	1,546	362
Duration of exposures (sum of all visits in minutes)	86,547	20,769
Unknown Workplace Exposure		
Number of visits to COVID-19-contagious patient(s)	30	190
Duration of exposures (sum of all visits in minutes)	1,883	12,399

to, at most, a 0.8% case rate. Hospice clinicians without a known workplace exposure had a case rate of 12.9%, compared to a case rate of 6.5% for hospice clinicians who had a workplace exposure. These findings suggest workplace exposure for home health and hospice clinicians presented less of a risk for COVID-19 infection than clinicians' exposure at home or in their personal time ("community exposure").[6, 8]

Designating nurses to treat COVID-19-positive patients greatly reduced the number of clinicians with a workplace exposure. However, not all patients diagnosed with COVID-19 started their care with a COVID-19 diagnosis. COVID-19 diagnoses were sometimes made during the course of care. Retrospective analyses allow designation of visits to at-the-time undiagnosed COVID-19 patients as COVID-19-contagious visits and therefore workplace exposures. Patients with a COVID-19 diagnosis entered the service lines in dissimilar ways. In home health, patients predominantly started their care with a COVID-19 diagnosis, likely seeking care for symptoms and sequelae related to COVID-19 infection. Of the 835 COVID-19-contagious patients treated in home health care, 98.9% (826/835) began their care with a COVID-19 diagnosis; the remaining 9 patients (1.1%) transferred to a hospital after the start of their home health care, and resumed service with a COVID-19 diagnosis after being discharged from the hospital. Consequently, the vast majority of visits to COVID-19-contagious patients were known exposures to home health care clinicians; of the 1,576 home health visits to COVID-19-contagious patients, only 30 of them (1.9%) were prior to a COVID-19 diagnosis, and therefore unknown exposures at the time of care. On the contrary, a substantial proportion of hospice patients were diagnosed after their hospice care started. Of the 111 hospice COVID-19-contagious patients receiving care, only 66 (59.5%) had a COVID-19 diagnosis at the start of their care. In other words, home health care clinicians nearly always knew at the time of the visit they were entering a workplace exposure (97.9% of the time). In contrast, more than one-third of hospice exposures were, at the time care was provided, unknown exposures.

While clinicians were trained in protocols to reduce the risk of transmission, providers who treated patients known to have a COVID-19 diagnosis may have more carefully followed protocols. Greater attentiveness to known workplace exposures is a potential explanation for the difference in case rates among exposed home health and hospice clinicians (0.8% vs 6.5%). Four of the 7 hospice clinicians with a workplace exposure who contracted COVID-19 had only at-the-time-unknown workplace exposures. Indeed, past research suggests that PPE use is proportional to treating known/suspected COVID-19 patients, and therefore clinicians' perceived risk of acquiring infection.[6] The greater at-the-time unknown exposure in hospice, and greater infection rate among clinicians with unknown exposure, lends evidence to this explanation.

An alternative explanation for the possible differences found between service lines is the additional exposure of close caregivers present at the time the clinician visited. While clinicians in both service lines are potentially exposed to COVID-19-contagious patients, we believe hospice clinicians have a greater likelihood of exposure from additional people present at the time of the visit (relatives, close friends, and paid help). The very nature of hospice often requires someone to be present with the patient. Therefore, hospice clinicians may face additional workplace exposure beyond the patients they treat. On April 15, 2020, the organization implemented a protocol for clinicians to ask patients as well as their close caregivers to wear a face covering. Six of the 7 hospice clinicians had their positive test prior to implementation of this protocol. Unfortunately, we do not have data on whether other individual(s) were present when the clinician was providing care. A measure of individuals present, and compliance with mask usage, would further refine our measure of workplace exposure.

Another possible explanation for differences in clinician infection by service line are potential differences clinician activities and consequent risk of infection. Hospice patients are more likely to be on oxygen, and studies have indicated that airborne SARS-CoV-2 viral loads were highest near patients receiving supplementary oxygen via nasal cannula.[13]

Consistent with other studies, our study found statistically different case rates of COVID-19 by clinician race/ethnicity. Non-White clinicians were more likely to test positive for COVID-19 than White clinicians (10.9% vs 6.2%; $P = .03$). The small number of COVID-19 infections due to workplace exposures (n = 9) results in small cell sizes and statistical tests are not appropriate to examine potential racial/ethnic differences. However, comparisons between White and Non-White clinicians without a known workplace exposure were possible. Because past studies have indicated that Non-Whites are at greater risk, a one-sided Fischer's Exact Test was applied to explore

Table 4
Clinician COVID-19 status by clinician race/ethnicity, gender, and job type

	Clinician did not test positive for COVID-19 (n=652)	Clinician tested positive for COVID-19 (n=63)	Test of significance
Race			Fisher's Exact Test $P = .03$
White	302 (93.8%)	20 (6.2%)	
Non-White	350 (89.1%)	43 (10.9%)	
Gender			Fisher's Exact Test $P = .85$
Female	560 (91.1%)	55 (8.9%)	
Male	92 (92.0%)	8 (8.0%)	
Job Category			
Nurse	326 (89.6%)	38 (10.4%)	Fisher's Exact Test $P = .15$
Home Health Aide	193 (91.5%)	18 (8.5%)	Fischer's Exact Test $P = 1.00$
Other	133 (95.0%)	7 (5.0%)	Fischer's Exact Test $P = .10$

racial/ethnic differences. Non-White clinicians without a workplace exposure had a COVID-19 case rate of 17.5% (37/212), compared to a case rate of 11.0% (17/155) for White clinicians with no workplace exposure ($P = .05$).

Differences by job type were not statistically significant. However, case rates trended to indicate nurses were more likely to test positive for COVID-19. Due to our small sample size, statistical analyses are unable to reveal small, but real, differences in COVID-19 case rates by job type. The results were surprising, as it was expected home health aides, who spend large quantities of time engaged in hands-on, close contact patient care, would have higher rates of COVID-19 infection.

The data from this study are well-suited to examining workplace exposure to COVID-19-contagious patients and potential subsequent clinician infection. First, the data included the precise duration of in-person visits based on timestamps in the clinicians' work tablets. Consequently, measures of potential workplace exposure do not suffer from recall bias. Furthermore, measures of exposure are specific to each employee at each point in time, and not based on generalized job roles. Second, the data have accurate measures of when patients were diagnosed with COVID-19, allowing a retrospective construction of a period of contagiousness based on general scientific knowledge. Third, the data included a precise date for positive tests among clinicians, allowing a retrospective construction of clinicians' potential infection window. The ability to accurately overlap patients' contagiousness with the clinicians' infection window allows a more precise measurement of potential workplace exposure and subsequent infection. Finally, New Jersey was at the epicenter of early COVID-19 cases, making it a good region to study early COVID-19 infection rates. Newark Liberty International Airport became a major screening and quarantine station. New Jersey's proximity to New York City (NYC), and the extensive public transportation network utilized by many New Jersey residents who travel to New York (often for employment), allowed early spread from New York to New Jersey. By June 1, 2020 New Jersey had 161,246 cumulative cases,[14] representing nearly 10% of the U.S. total,[15] making it second in reported cases only to New York, and therefore a crucial state for studying early infection and transmission.

The present study has several limitations. The analyses presented cannot pinpoint who transmitted the infection. For example, it is possible that infections among clinicians with a workplace exposure stemmed from exposure to a COVID-19-contagious individual at the clinicians' home or in the community. Indeed, several studies of HCW suggest the greatest risk to HCW are not workplace exposures[8]; individuals with a confirmed household contact were at greatest risk for COVID-19 infection.[4] Examining clinicians with a workplace exposure provides an upper-bound case rate of potential work exposures. A limitation of the current study is that we do not have data on potential exposures outside of the workplace (for example household structure, employment of other household members, positive tests of other household members, or rates of positivity in the community in which they lived, and activities engaged in during personal time).

A second limitation is that we do not directly assess patients' level of infectiousness, but use general scientific standards to identify patients' contagious period. It is suggested that patients with severe COVID-19, including immunocompromised persons, are able to shed replication-competent virus for up to 20 days,[16] potentially extending periods of employee exposure. In addition, we used a documented diagnosis of COVID-19 to identify patients that could infect clinicians but there may have also been asymptomatic patients without a COVID-19 diagnosis. Therefore, some of the clinicians categorized as not having a work exposure could have been exposed to undiagnosed COVID-19-contagious patients.

Lastly, rates of clinician COVID-19 infection may be underreported, as minimally symptomatic or subclinical infections may not be known.[3] As testing was very limited early in the pandemic, even for HCW,[17] we may not capture all COVID-19 positive clinicians. Previous studies using convenience samples found substantial undetected and unrecognized SARS-CoV-2 infections.[17-19] Self and colleagues found two-thirds of HCW who had positive test results for SARS-CoV-2 antibodies did not have a previous positive test result demonstrating COVID-19 infection.[18] Despites these limitations, our measure of employee exposure represents a more precise gauge of workplace exposure than most studies,[3,8,20] and we include COVID-19-test results employees sought privately in addition to workplace employee testing.

Our original intent in examining our data was to explore factors associated with positive tests among HCW with patient contact. Due to the small numbers of clinicians testing positive, we had insufficient numbers to perform multivariate analyses. This statistical limitation highlights the strength of the organization's efforts to systematically contain the number of exposed clinicians, provide necessary PPE, continually evolve protocols based on new scientific data, provide up-to-date clinician education, greatly increase virtual care to minimize known workplace exposure, and maintain a safe working environment for employees.

CONCLUSION

Our study provides a first glimpse at potential workplace exposure and infection rates within a home health care and hospice workforce early in the COVID-19 pandemic. The findings highlight that for these clinicians, workplace exposure to known COVID-19-contagious patients was not associated with higher rates of infection. Most of the clinicians' COVID-19 infections occurred when there was no workplace exposure. Greater COVID-19 infection rates among work-exposed hospice clinicians, compared to home health clinicians, may be due to greater unknown workplace exposures (both yet-undiagnosed COVID-19-contagious patients as well as other individual(s) present at the visit), greater risk (i.e. greater viral loads with nasal cannula), or characteristics of the clinicians in these separate service lines. Greater understanding of racial/ethnic differences in COVID-19 case rates is needed.

Acknowledgments

Special thanks to Anne Lefferts for freely giving her time to discuss company-wide PPE protocols, keeping meticulous documentation on the organization's shifting response to the pandemic, and detailed files on dates of COVID-19-testing, clinician symptoms, and out of work notifications. Ashley Huhn was essential in tracking employee exposure, test results, and employee quarantining. Also, Stephanie Finn provided necessary information on how hospice patients were diagnosed and tracked. Finally, a heartfelt thanks to the clinical staff for their dedication to providing outstanding, compassionate health care during challenging times.

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