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Brief Report

What are the sources of exposure in healthcare personnel with coronavirus disease 2019 infection?



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In our facility, 25% of personnel with coronavirus disease 2019 (COVID-19) had a higher-risk exposure to an infected patient or co-worker and 14% reported a higher-risk exposure in the community. All higher-risk exposures to infected patients occurred on non-COVID-19 units, often when there was a delay in diagnosis because COVID-19 was not initially suspected. Higher-risk exposures to co-workers with COVID-19 often involved lapses in compliance with masking in nonpatient care areas such as nursing stations and staff work or break rooms.

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INTRODUCTION

One of primary goals of infection control programs during the coronavirus disease 2019 (COVID-19) pandemic is to minimize the risk for acquisition of infection by healthcare personnel. Factors such as inadequate personal protective equipment, work overload, insufficient diagnostic testing and exposure to infected patients have been associated with risk for infection in healthcare personnel.^{1–5} In addition to infected patients, healthcare personnel are at risk for nosocomial acquisition of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from co-workers with COVID-19 infection. In a recent study from Greece approximately half of all high-risk exposures were to healthcare personnel with COVID-19.⁶ There is an urgent need for additional information regarding sources of work-related exposure to SARS-CoV-2. Therefore, we evaluated the exposure history of healthcare personnel with COVID-19 in an acute care hospital during a 4-month period.

METHODS

Study setting

The Cleveland VA Medical Center is a 215-bed hospital with a dedicated 22-bed COVID-19 ward; eight beds in the medical intensive care unit are also dedicated to care of COVID-19 patients. The first COVID-19 patient was identified in the facility on March 15, 2020. The average daily census of COVID-19 inpatients peaked in May at 18 cases, decreasing to 4 and 7 cases on average in June and July, respectively. For personnel with symptoms concerning for COVID-19 infection, testing was available if requested at the Cleveland VA Medical Center or was obtained through their primary care providers. For asymptomatic healthcare personnel, no testing was offered unless they were identified as being at risk through contact tracing.

Personnel caring for known or suspected COVID-19 patients or performing aerosol-generating procedures wore either a powered air purifying respirator or an N95 respirator with a face shield. On April 27, 2020, universal masking of personnel was implemented throughout the facility and patients were required to wear cloth facemasks when out of their room or when personnel entered the room. Diagnostic testing was initially restricted to symptomatic patients and personnel, but on May 17, 2020 was expanded to include all admissions and prior to many medical procedures. Personnel were screened for COVID-19 symptoms on arrival to work and encouraged

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not to work and/or to request testing if they had symptoms consistent with SARS-CoV-2 infection.

Study design

The study protocol was approved by the Cleveland VA Medical Center's Institutional Review Board. Between March 15, 2020 and July 15, 2020, we examined the exposure history of personnel with COVID-19 infection or asymptomatic carriage. A diagnosis of COVID-19 infection required symptoms consistent with COVID-19 and a nasopharyngeal swab polymerase chain reaction assay positive for SARS-CoV-2. Asymptomatic carriage was diagnosed if there was a positive nasopharyngeal swab test in the absence of symptoms consistent with COVID-19.

All personnel diagnosed with COVID-19 infection or asymptomatic carriage were interviewed by personnel health department employees using a standardized checklist to identify potential exposures. Higher-risk exposures were defined as prolonged (greater than 15 minutes), close (less than 6 feet) contact occurring within 2 days before symptom onset through the time when the source individual met criteria for discontinuation of transmission-based precautions.⁷ For exposures to personnel, we classified contacts that did not meet criteria for higher-risk exposure as lower-risk exposures. Exposures were categorized as contacts with patients, personnel, family members, or individuals in the community with COVID-19. Personnel were classified as nurses, physicians, ancillary staff providing patient care and administrative personnel. Personnel providing patient care were stratified based on whether they worked on the COVID-19 wards or in other areas.

RESULTS

During the 4-month study period, 1,534 personnel had nasopharyngeal swabs collected for SARS-CoV-2 testing, including 1,111 (72.4%) tested due to presence of symptoms and 423 (27.6%) asymptomatic individuals tested as part of contact tracing. Of the 1,534 personnel tested, 96 (6.3%) had nasopharyngeal swabs with positive PCR results, including 90 (93.4%) with and 6 (6.3%) without COVID-19 symptoms. Of the 96 cases, 24 (25.0%) had a higher-risk exposure at work, including 18 exposures to COVID-19 patients and 6 exposures to infected personnel. Ten additional personnel with COVID-19 had a lower-risk exposure to staff members with COVID-19. Higher-risk exposures to family members or to infected individuals in the

community were reported by 7 (7.3%) and 6 (6.3%) of the 96 personnel with COVID-19.

Of the 96 personnel with positive PCR results for SARS-CoV-2, 53 (55.2%) were nursing staff, 3 (3.1%) were physicians, 16 (16.7%) were ancillary clinical staff, and 24 (25.0%) were nonclinical personnel. No cases occurred in personnel working on COVID-19 wards. None of those with a positive result had previously been tested for COVID-19 in our healthcare system.

Figure 1 shows the number of higher-risk exposures to known COVID-19 cases over the course of the study by exposure category. Exposures to infected patients were common early in the outbreak and often occurred when recognition of COVID-19 was delayed due to absence of fever and atypical presentations (eg, diabetic ketoacidosis and confusion or shortness of breath with no other respiratory symptoms). All higher-risk exposures to COVID-19 patients occurred on non-COVID-19 wards.

Table 1 provides a summary of the 6 higher-risk and 10 lower-risk exposures of personnel infected with COVID-19 to other staff members with COVID-19. Exposures to personnel with COVID-19 often occurred when infected personnel were pre-symptomatic (4 of 6 higher-risk exposures) or when they worked despite having symptoms consistent with COVID-19 (eg, sore throat or nasal congestion initially attributed to allergies followed by diagnosis of COVID-19 when symptoms progressed). However, 2 of the infected personnel admitted to working despite having prominent symptoms including cough. Seven of the 10 (70%) lower-risk exposures occurred when the infected personnel were pre-symptomatic or asymptomatic. All higher-risk and lower-risk exposures to personnel with COVID-19 occurred on non-COVID-19 wards.

Five of 6 (83.3%) higher-risk exposures to personnel occurred after universal masking of personnel and patients was implemented. These higher-risk exposures often involved noncompliance with facemask use in nonclinical shared work areas (eg, nursing station, staff work, or break rooms) or during activities such as meals when facemasks were removed, and social distancing was not maintained.

DISCUSSION

We found that 25% of healthcare personnel testing positive for SARS-CoV-2 had a higher-risk exposure at work (more than 15 minutes of exposure within 6 feet of a symptomatic or pre-symptomatic individual), including 18 exposures to COVID-19 patients and

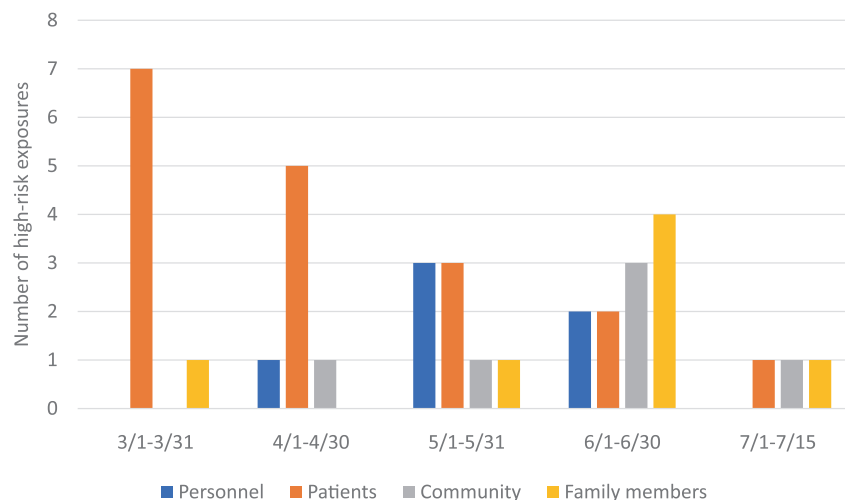


Fig 1. Number of high-risk exposures to known COVID-19 cases over the course of the study by exposure category.

Table 1

Summary of 16 exposures to personnel infected with COVID-19 for personnel subsequently diagnosed with COVID-19

Occupation of COVID-19 case	Occupation of COVID-19 exposure source	Date of source case diagnosis with COVID-19	Symptomatic at time of exposure? Yes/No (symptoms)	Type of exposure
Definite higher-risk exposure to personnel with COVID-19*				
Registered nurse	Registered nurse	4/2/20	Yes (diarrhea, sore throat)	Worked together in office including unmasked contact
Registered nurse	Registered nurse	5/20/20	No	Ate lunch together with no masking or social distancing
Registered nurse	Registered nurse	5/11/20	No	Ate lunch together with no masking or social distancing
Instrument Technician	Registered nurse	5/12/20	No	Ate lunch together with no masking or social distancing
Student nurse	Student Nurse	6/22/20	Yes (cough)	Frequent prolonged unmasked contact during social interactions at work
Ward clerk	Nursing assistant	6/22/20	No	Prolonged contact at nursing station, unreliable use of masks in shared work areas [†]
Lower-risk exposure to personnel with COVID-19				
Physician	Physician	3/29/20	Yes (cough, nasal congestion)	Worked on same unit, interactions with masking by case but not by source with COVID-19
Nursing assistant	Registered nurse	6/29/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Registered nurse	Student nurse	6/20/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Nursing assistant	Student nurse	6/20/20	Yes (cough)	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Registered nurse	Student nurse	6/24/20	Yes (cough)	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Registered nurse	Registered nurse	6/25/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Registered nurse	Nursing assistant	6/25/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Registered nurse	Nursing assistant	6/26/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Registered nurse	Nursing assistant	6/25/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas
Nursing assistant	Student Nurse	6/25/20	No	Unclear contact but worked on same ward with unreliable use of masks in shared work areas

COVID-19, coronavirus disease 2019.

*Higher-risk exposures were defined as prolonged (greater than 15 minutes), close (less than 6 feet) contact occurring within 2 days before symptom onset through the time when the source individual met criteria for discontinuation of transmission-based precautions based on Centers for Disease Control and Prevention criteria.⁶[†]Shared work areas included the nursing station and personnel work and break rooms.

6 to infected personnel. An additional 14% of infected personnel reported higher-risk exposures to family members or other infected individuals in the community. These findings have important implications for efforts to minimize the risk for acquisition of SARS-CoV-2 by healthcare personnel.

For personnel acquiring COVID-19, higher-risk exposures to infected patients were relatively common early in the outbreak. These exposures all occurred on non-COVID-19 units, often when there was a delay in diagnosis of infected patients because COVID-19 was not initially suspected. Such exposures were markedly reduced as availability of testing increased and clinicians had increased awareness of atypical presentations. Implementation of routine admission screening for SARS-CoV-2 also reduced the likelihood that cases would be missed on admission. Only 3 of the 18 (16.7%) exposures associated with acquisition of COVID-19 by personnel occurred after routine admission screening was implemented.

The finding that infected personnel are an important source of exposure to COVID-19 by personnel is consistent with the recent report of Maltezou et al.⁶ In our facility, higher-risk exposures to personnel with COVID-19 often occurred when the source individual was presymptomatic or had symptoms that were initially attributed to noninfectious conditions such as allergies. All higher-risk exposures occurred in nonpatient care settings such as nursing stations and staff work or break rooms. The exposures were due to noncompliance with masking in these settings or occurred during meals when facemasks had to be removed but social distancing was not maintained. There were also numerous instances of exposures to infected personnel that did not qualify as higher-risk exposures, but

that could potentially have resulted in transmission. Many personnel working on the same ward as a source individual had frequent short-duration contacts within 6 feet or shared fomites that might potentially result in transmission.^{8,9}

One notable finding in our study was that no personnel working on the COVID-19 ward or intensive care unit developed COVID-19. The fact that all patients on the wards had known or suspected COVID-19 minimized the risk of unprotected exposure to a patient with unsuspected infection. Observations suggested that compliance with universal masking was excellent on these wards including in nonpatient care areas. Protocols were also in place to ensure frequent cleaning and disinfection, including the nursing stations and staff work or break rooms.

Our study has some limitations. Only one facility was included in a setting with adequate supplies of personal protective equipment and access to diagnostic testing. Additional studies are needed in other settings. Our assessment of exposures and symptoms relied on interviews with personnel. It is possible that some of the information provided was inaccurate particularly if personnel did not acknowledge exposures or working while ill. We did not perform molecular typing to determine the relatedness of source and case SARS-CoV-2 genetic material. Recent studies have demonstrated the value of sequencing analysis in determining the source of acquisition of SARS-CoV-2.¹⁰ Finally, it is notable that 49 of the 96 (51%) personnel with positive tests for SARS-CoV-2 did not have known higher or lower-risk exposures at work or higher-risk exposures in the community. Although a standardized interview was conducted, we cannot exclude the possibility that more intensive and/or anonymous interviews might identify additional exposures.

CONCLUSION

In our facility, 25% of personnel with COVID-19 had a higher-risk exposure to an infected patient or co-worker at work and 14% reported a higher-risk exposure in the community. Improved detection of patients with atypical presentations and efforts to reduce high-risk contacts among personnel may reduce the risk for acquisition of SARS-CoV-2. For personnel, efforts are needed to reduce lapses in compliance with masking in nonpatient care areas. Because most personnel with COVID-19 did not report a higher-risk exposure, there is a need for studies to identify sources of acquisition in the absence of such exposures.

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