


Concise Communication

Transmission risk of severe acute respiratory coronavirus virus 2 (SARS-CoV-2) to healthcare personnel following unanticipated exposure to aerosol-generating procedures: Experience from epidemiologic investigations at an academic medical center

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Abstract

Healthcare personnel (HCP) with unprotected exposures to aerosol-generating procedures (AGPs) on patients with coronavirus disease 2019 (COVID-19) are at risk of infection with severe acute respiratory coronavirus virus 2 (SARS-CoV-2). A retrospective review at an academic medical center demonstrated an infection rate of <1% among HCP involved in AGPs without a respirator and/or eye protection.

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Severe acute respiratory coronavirus virus 2 (SARS-CoV-2), the coronavirus responsible for the coronavirus disease 2019 (COVID-19) pandemic, is thought to spread from person to person through respiratory fluids, including droplets and aerosols.¹ Respirators and eye protection (along with gowns and gloves) are recommended for healthcare personnel (HCP) during clinical care of COVID-19 patients.²

No universally accepted list of aerosol-generating procedures (AGPs) has been established. However, tracheal intubation, open suctioning of the airway, and noninvasive ventilation can generate smaller, more mobile infectious particles, and these have been identified as procedures which may put HCP at higher risk of exposure and infection.³

We performed a retrospective review of investigations among HCP exposed to an AGP performed on infectious COVID-19 patients without a respirator and/or eye protection to better quantify the occupational transmission risk.

Methods

This retrospective assessment was performed at an 889-bed tertiary-care academic hospital in Los Angeles, where nearly 2,300 confirmed COVID-19 patients were admitted during

2020. For routine infection prevention purposes, we reviewed exposure investigations from June to December 2020, in the setting of universal medical mask use by HCP, prior to vaccine availability.

All investigations were conducted by trained infection preventionists through chart review and interviews with exposed staff and unit leadership. HCP were included if they were not wearing a respirator (ie, N95 or powered air purifying respirator) and/or eye protection while present during an AGP on a patient with confirmed COVID-19. Although inclusion criteria were confirmed in each investigation, specific PPE use was not consistently documented for all investigations. HCP wearing both eye protection and a respirator were not considered exposed. All exposed HCP were instructed to self-monitor for symptoms (in addition to routine symptom screening), and they were encouraged to obtain a SARS-CoV-2 test, which used a validated in-house polymerase chain reaction (PCR) assay (LDT1 Accelerate Technologies Fortitude 2.0 kit and LDT2 Accelerate Technologies Resolute kit) via nasopharyngeal swab 5 days after exposure.

Aerosol-generating procedures, defined based on Centers for Disease Control and Prevention (CDC) guidance, included open suctioning of airways, sputum induction, cardiopulmonary resuscitation, endotracheal intubation and extubation, noninvasive ventilation, bronchoscopy, manual ventilation, nebulizer administration, and high-flow oxygen delivery.³

The primary outcome was the proportion of exposed HCP who tested positive at least 2 days after the first exposure date and within 14 days of the last exposure date, among those who

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underwent testing. A secondary outcome was the proportion of exposed HCP with confirmed symptomatic COVID-19 within the same time after exposure. Clinical data about the source patient was abstracted from the medical record as part of the exposure investigation. Analyses was performed using SAS version 9.4 software (SAS Institute, Cary, NC).

Results

Between June 1, 2020, and December 31, 2020, 160 HCP were identified as exposed to an AGP without a respirator or eye protection on 16 unique COVID-19 patients. Among 160 exposures, 115 (72%) occurred during November and December 2020. Sequencing data from the CDC shows that the predominant circulating variant in California at that time was B.1.427 (epsilon variant), and delta variant had not been detected in the United States at that time. Among these 160 HCP, 108 had known SARS-CoV-2 test results within the specified period. The median duration for testing relative to first exposure date was 5 days (interquartile range, 5–7 days). Cycle threshold (Ct) values were available for 12 of 16 patients; the median Ct was 18.7 and 8 patients had a Ct <20. Of 108 exposed HCP, 1 (0.9%) tested positive for SARS-CoV-2. The HCP who tested positive was a nurse who used neither a respirator nor eye protection while exposed to an undiagnosed COVID-19 patient undergoing high-flow oxygenation over 2 days. No additional symptomatic HCP were identified among all 160 exposed HCP, for an overall rate of symptomatic COVID-19 of 0.6% (1 of 160). A descriptive analysis of index patients and exposed HCPs is summarized in Table 1.

Of 16 source patients, 12 were male and 11 were aged ≥ 60 years. Nebulizer treatments were the most frequent AGP resulting in exposures (115 of 160, 72%), followed by intubation and BiPAP. Among 160 exposures, 129 (81%) occurred between 2 days before and 5 days after the onset of symptoms in the source patient.

Among the exposed 160 HCP, most were nurses (61, 38%), followed by physicians (56 of 160, 35%) and nursing assistants (14, 9%). Both respirators and eye protection were missing in 37 (23%), eye protection alone was missing in 25 (16%), respirators alone were missing in 19 (12%). Although all HCP included met the inclusion criteria, data on the specific missing PPE item were not available for 79 (49%).

Discussion

Among HCP exposed to SARS-CoV-2 during an AGP on an infected patient without a respirator and/or eye protection, we observed a SARS-CoV-2 transmission rate of <1%. This finding aligns with other published experiences demonstrating low rates of transmission in healthcare settings compared to household or nonoccupational exposures.⁵ Because these exposures occurred during a period of high compliance with universal mask use among HCP, this transmission rate supports the protective effect of masks to protect HCP from unanticipated COVID-19 exposures, even during high-risk AGP. The single transmission we observed involved a nurse exposed to a patient on high-flow oxygen over 2 days without the use of a respirator and eye protection, suggesting that duration of exposure may be an important variable in assessing risk.

AGPs have been identified as a risk factor for transmission of other novel respiratory pathogens in healthcare settings.⁶

Table 1. Descriptive Analysis of Index Patients and HCPs Involved COVID-19 Exposures During Aerosol-Generating Procedures at an Academic Medical Center

Variable	No. (%)
Index patients (n=16)	
Sex, male	12 (75)
Age, y	
20–39	2 (12.5)
40–59	3 (19)
60–79	7 (44)
≥ 80	4 (25)
Exposed HCP (n=160)	
Sex, male	80 (50)
Age, y	
<20 years old	1 (1)
20–39	99 (62)
40–59	51 (32)
60–79	9 (6)
≥ 80	0
Missing PPE	
Missing respirator	19 (12)
Missing eye protection	25 (16)
Missing respirator and eye protection	37 (23)
Missing respirator and/or eye protection (specific type not documented)	79 (49)
HCP role	
Nurse	61 (38)
Physician	56 (35)
Nursing assistant	14 (9)
Respiratory technician	7 (4)
Scrub technician	5 (3)
Imaging technician	3 (2)
Environmental services	2 (1)
Occupational therapy	2 (1)
Phlebotomist	2 (1)
Physician assistant	2 (1)
Student	2 (1)
Other HCP Roles (1 each): Log technician, Nurse practitioner, Physical therapist, Vascular technician	4 (3)
AGP type ^a	
Nebulizer	115 (72)
Intubation	89 (56)
BiPAP	37 (23)
High-flow nasal cannula	34 (21)
Extubation	32 (20)
Bronchoscopy	23 (14)
Tracheostomy	7 (4)

Note. HCP, healthcare personnel; PPE, personal protective equipment; AGP, aerosol-generating procedure.

^aNot mutually exclusive; some HCP exposed to >1 AGP type.

However, consensus has not been reached regarding what defines an AGP or which AGP poses the highest risk. The most common AGP exposures in our setting were nebulizer treatments, for which the aerosolization risk remains unclear. Respirators and eye protection are recommended for HCP performing AGP on these patients; however, the additional protection provided by N95 respirators compared to medical masks has been debated. Although eye protection is recommended to further reduce transmission risk, the relative risk of transmission through the ocular route is unclear and is thought to be low.⁷

Data from SARS-CoV-2 exposures to HCP remain limited and include case studies and series, though quantifying the level of risk is challenging. Among 121 HCP exposed to the first community-acquired COVID-19 patient in the United States, 2 of the 3 HCP who tested positive were involved in an AGP procedure.⁸ In a separate study, no transmission occurred to 41 HCP exposed during an AGP on an undiagnosed COVID-19 patient.⁹ Comparing transmission rates across different exposures is difficult due to the broad range of variables associated with transmission risk, including different postexposure testing strategies, duration and proximity of exposure, infectivity of the patient, environmental factors, and appropriate use of PPE.

Our study had several limitations. It was conducted at a single center, and it had a retrospective design. Even though all investigations were conducted by trained nurse epidemiologists utilizing a structured assessment tool, data including those for PPE use were not consistently collected, and these findings are subject to recall bias. Other variables, such as exposure duration and proximity to the patient during the AGP, were not assessed. Despite these limitations, our observations of low transmission rate in the setting of universal HCP masking are consistent with other published experience.¹⁰ Although findings from this retrospective review do not warrant changes to PPE guidance, the data reinforce the protection of universal masking even in settings with high transmission risk. We hope this experience can better inform the assessment of occupational risks to HCP following unanticipated exposure to COVID-19 in healthcare settings.

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References

1. Scientific brief: SARS-CoV-2 transmission. Centers for Disease Control and Prevention website. <https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html>. Updated May 7, 2021. Accessed June 24, 2021.
2. Interim infection prevention and control recommendations for healthcare personnel during the coronavirus disease 2019 (COVID-19) pandemic. Centers for Disease Control and Prevention website. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html>. Updated February 10, 2021. Accessed April 28, 2021.
3. Clinical questions about COVID-19: questions and answers. Which procedures are considered aerosol-generating procedures in healthcare settings? Center for Disease Control and Prevention website. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/faq.html>. Updated March 4, 2021. Accessed April 28, 2021.
4. Discontinuation of transmission-based precautions and disposition of patients with SARS-CoV-2 infection in healthcare settings. Centers for Disease Control and Prevention website. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/disposition-hospitalized-patients.html>. Updated June 2, 2021. Accessed June 28, 2021.
5. Cheng H, Jian S, Liu D, Ng T, Lin H. Contact tracing assessment of COVID-19 transmission dynamics in Taiwan and risk at different exposure periods before and after symptom onset. *JAMA Intern Med* 2020;180:1156–1163.
6. 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:e35797.
7. Barnett BP, Wahlin K, Krawczyk M, et al. Potential of ocular transmission of SARS-CoV-2: a review. *Vision (Basel)* 2020;4(3):40.
8. Heinzerling A, Stuckey MJ, Scheuer T, et al. Transmission of COVID-19 to healthcare personnel during exposures to a hospitalized patient—Solano County, California, February 2020. *Morb Mortal Wkly Rep* 2020;69:472–476.
9. Ng K, Poon BH, Kiat Puar TH, et al. COVID-19 and the risk to health care workers: a case report. *Ann Intern Med* 2020;172:766–767.
10. Temkin E, Schwaber MJ, Vaturi A, Nadir E, Zilber R, Barel O, Pavlov L, Carmeli Y. Effect of a national policy of universal masking and uniform criteria for severe acute respiratory coronavirus virus 2 (SARS-CoV-2) exposure on hospital staff infection and quarantine. *Infect Control Hosp Epidemiol* 2021. doi: 10.1017/ice.2021.207.