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Secondary Cases of Delta-Variant COVID-19 Among Vaccinated Healthcare Workers with Breakthrough Infections is Rare

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ABSTRACT

A retrospective cohort study at four academic medical centers with high COVID-19 vaccination rates evaluated breakthrough SARS-CoV-2 Delta variant (B.1.617.2) infections in vaccinated healthcare workers. Few work-related secondary cases were identified. Breakthrough cases were largely due to unmasked social activities outside of work.

KEYWORDS

COVID-19; B.1.617.2; breakthrough; vaccination; healthcare worker;

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INTRODUCTION

SARS-CoV-2 Delta variant (B.1.617.2) rapidly became the dominant coronavirus disease 2019 (COVID-19) strain, increasing from 6.0% to 84% of cases between 5/31/21 to 7/31/21.¹ Delta variant's increased transmissibility and severity of disease pose a substantial concern for exposure in healthcare settings.²

While the COVID-19 vaccines are highly effective at preventing hospitalization and death due to the Delta variant, vaccine effectiveness is reduced for mild disease (41-88%).^{2,3} While a high viral burden has been associated with increased transmission in households and community gatherings,^{4,5} less is known about transmissibility from an infected vaccinated worker in the healthcare setting. We evaluate transmission from infected vaccinated healthcare workers (HCWs) to patients and coworkers during a Delta variant surge in California.

METHODS

In this multicenter retrospective cohort study of vaccine breakthrough infection and secondary infection at four large academic medical centers in the University of California (UC) system (UC Davis, UC Irvine, UC Los Angeles, and UC San Francisco), HCWs were assessed for SARS-CoV-2 infections between 6/1/2021- 7/26/2021. Staff were defined as all healthcare employees, both patient care and non-patient care, plus trainees and students.

Vaccine breakthrough infection was defined as a positive PCR or LAMP (loop mediated isothermal amplification)-confirmed SARS-CoV-2 test occurring ≥ 14 days following the second dose of mRNA COVID-19 vaccine or the single-dose Janssen vaccine. Daily symptom screening, universal masking with at least a surgical grade mask, and social distancing according to CDC recommendations for healthcare settings were in place at all sites; however, masking was relaxed in non-patient care areas and breakrooms in 3 of the 4 medical centers during parts of the study. HCWs reporting any symptoms were evaluated by Occupational Health, furloughed, and tested for SARS-CoV-2. Active efforts to offer monthly asymptomatic SARS-CoV-2 screening had ended at 3 of the sites prior to June 2021 due to high HCW vaccination rates; optional asymptomatic screening continued to be offered at one site.

All HCWs with breakthrough infections underwent contact tracing and epidemiologic investigation by Occupational Health and Infection Prevention programs. For each breakthrough case, the following data were collected: symptom onset, potential infection sources, type and timing of SARS-CoV-2 test, cycle thresholds (Ct values, if available), exposures to coworkers/patients during infectious period, and secondary cases among staff and patients. The following SARS-CoV-2 test methods were used to determine Ct values: Roche Diagnostics cobas 6800 at Hospital A, Cepheid GeneXpert, Abbott m2000, and Abbott Alinity at Hospital B, DiaSorin Simplexa, TaqPath ABI 7500, Roche Diagnostics cobas 6800 at Hospital C, and DiaSorin Simplexa, Hologic Panther Fusion, Abbott Alinity at Hospital D. An exposure to healthcare workers or patients was defined by three institutions as a close contact with a person with a confirmed SARS-CoV-2 infection for ≥ 15 minutes in 24h period who met the standard CDC criteria.⁶ One of the institutions defined an exposure as anything other than both parties wearing masks and the exposed wearing eye protection. All participating institutions used PCR or LAMP-based tests for HCW COVID-19 diagnosis; documentation of positive tests outside of the institutions were accepted. Close contacts of infected coworkers were formally instructed in writing to obtain COVID-19 testing 5 days after exposure. Infected persons

were advised to have household and community contacts undergo COVID-19 testing. Aggregated deidentified data from participating sites were summarized as counts and proportions.

This quality improvement initiative was deemed exempt from human subjects research oversight by all Institutional Review Boards. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.⁷

RESULTS

Among 88,570 HCWs (range across sites: 9,527-32,224), the vaccination rate was 82% (72,624/88,570; range 72-91%), the vast majority vaccinated with mRNA vaccines. A total of 11,836 workers underwent COVID-19 testing, of which 3.7% (440/11,836) were confirmed to have COVID-19 infections with an overall breakthrough case rate among vaccinated HCWs of 0.43% (309/72,624) during the Delta variant surge in California in June and July 2021.⁸

Among HCWs testing positive for SARS-CoV-2, 309 (70%) were fully vaccinated, representing vaccine breakthrough infections (Table 1). Most cases were symptomatic. Of note, 5% of breakthrough infections were in people who underwent asymptomatic testing for other reasons. Of those for whom data were available for source of infection, the predominant suspected source was community acquisition, most commonly social gatherings and household transmission (65% and 31%, respectively) (Table 1). The source was unknown for 40% of cases. Mean PCR cycle threshold was 20.8 (SD=5.2). For three sites for which the number of days from symptom onset to test was known, the mean PCR cycle threshold was 19.6 (SD=4.9) with mean 2.2 days (SD=1.9) from symptom onset.

Overall, COVID-19 infections among vaccinated HCWs contributed to an average of 1.73 work-related exposures at a ratio of 29% (154/535) patients and 71% (381/535) staff (Table 1). Overall proportion of secondary cases due to vaccine breakthrough disease was 0.75% (4/535). Of the four secondary cases, three (75%) were vaccinated.

DISCUSSION

The COVID-19 Delta variant has increased vaccine breakthrough infections due to greater transmissibility compared to prior variants.⁴ High levels of detectable virus based on cycle thresholds associated with Delta variant infection has fueled speculation that infected vaccinated persons may be as contagious as infected unvaccinated persons. While secondary cases from infected vaccinated persons are expected to occur in close contact situations (e.g., households, unmasked social events), infection prevention strategies in healthcare settings coupled with a highly vaccinated workforce would be expected to substantially reduce the risk of transmission by vaccinated persons working while infectious. In four highly vaccinated large healthcare systems, the proportion of secondary SARS-CoV-2 cases was remarkably low, 0.75%, despite numerous exposures resulting from community acquired Delta variant infection among HCWs working during their infectious period. Most of the secondary transmission events occurred due to HCWs eating together unmasked indoors. This finding of minimal workplace transmissions despite multiple introductions of socially derived SARS-CoV-2 infection is in stark contrast to previous evidence of high transmission in healthcare settings earlier in the pandemic.⁹

Vaccinated persons with breakthrough infections rarely transmitted to co-workers or patients despite having low PCR cycle threshold values (high viral burden). This was true even though masking was relaxed in non-patient care areas and breakrooms in 3 of the 4 medical centers due to high vaccination rates and changes in state guidance.¹⁰ It is possible that the vaccinated person's

immune system affected virus survival and potency even though viral detection remained robust. Decreased infectious viral shedding and faster clearance of viral RNA in vaccinated versus unvaccinated individuals has been noted as well.¹¹ Importantly, PCR-based tests are unable to discriminate between live virus or defective viral genomes, making it difficult to assess the implications of cycle thresholds in breakthrough cases.

Similar to a prior report,¹² we found that COVID-19 cases among HCWs were largely driven by social gatherings and household exposures occurring outside of the healthcare setting. During this time-period, social gatherings (e.g., parties, performance arts/community events, frequenting restaurants and bars) were predominantly unmasked in accordance with relaxed state and federal masking guidance. Documented PPE failures were not identified by any of the infected HCWs caring for COVID-19 patients. Our results show that layering infection prevention strategies is highly effective in limiting secondary cases among vaccinated individuals, suggesting that adoption of such strategies in community settings (including masking and social distancing) could substantially mitigate secondary infections among vaccinated individuals in the community, particularly, but not limited to, the work environment.

Limitations of this study include the focus on the first two months of the initial Delta variant surge. The trajectory may change as more cases accrue. We also presumed that these cases represented the Delta variant due to extensive state-wide molecular testing at the time showing Delta dominance. Finally, cycle threshold values were only available for a subset of cases, which may not be fully representative. Variations in the number of exposed HCW and patients by site may have been due to differences in infection control policies vs more stringent contact tracing. Though Hospital C never relaxed their masking guidelines in non-patient areas, this did not decrease their exposures, which were largely community-based social events. Incomplete recording of SARS-CoV-2 test results of secondary contacts may have contributed to an underestimate of the secondary SARS-CoV-2 cases. All HCWs who tested positive for SARS-CoV-2 were included in the results regardless of whether they were symptomatic. None of the medical centers mandated asymptomatic testing (though Hospital A did offer it). Asymptomatic breakthrough infections were uncommon across all sites (0-5% of positive tests); nonetheless the lack of asymptomatic testing may have contributed to an underestimate of transmission.

In summary, SARS-CoV-2 workplace transmission was rare during a Delta variant surge in California despite numerous vaccinated staff working during their infectious period. Because COVID-19 cases were mainly derived from unmasked social activities outside of work, public health mandates assuring layered infection prevention strategies, including masking and vaccination campaigns, are needed to reduce importation of SARS-CoV-2 into healthcare settings, and to potentially decrease transmission of SARS-CoV-2 in the workplace or community-at-large.

NOTES

POTENTIAL CONFLICTS

All authors report no conflicts of interest relevant to this article. SH reports the following support: Federal: CDC, NIH, AHRQ; State: Orange County Health Care Agency, CalOptima (Orange County Medicaid) (all paid to institution). DY reports receiving Centers for Disease Control and Prevention, Prevention Epicenters IV (U54 CK000484) (Co-investigator, contributed effort); reports serving as Vice-President and Board of Trustees member, unpaid, for Society for Healthcare Epidemiology of America.

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TABLE 1: Secondary Cases of SARS-CoV-2 from Infected Vaccinated Healthcare Workers

	Number of Breakthrough SARS-CoV-2 Cases N	Exposures Related to Infected Vaccinated Healthcare Workers			Secondary Cases Related to Infected Vaccinated Healthcare Workers			Suspected Source of COVID-19 Infection			
		Patients N	Exposed Coworkers Providing Direct Patient Care N	Exposed Coworkers Providing Non-Direct Patient Care N	Patients N	Cases Among Direct Patient Care Providers N	Cases Among Non-Direct Patient Care Providers N	Social Gatherings N (%)	Household N (%)	Healthcare N (%)	Other/ Unknown N (%)
Hospital A	43	5	91	19	0	2	0	28 (65)	12 (28)	2 (5)	1 (2)
Hospital B	35	9	45	5	0	0	0	10 (29)	11 (31)	0 (0)	14 (40)
Hospital C	105	0	24	2	0	1	0	17 (16)	16 (15)	4 (4)	68 (65)
Hospital D^a	126	140	195		0	1		65 (53)	18 (15)	40 (32)	
Total	309	154	381		0	4		120 (39)	57 (19)	6 (2)	123^b (40)

^aFor Hospital D, healthcare worker role was not available, and direct and non-direct patient care-related exposures or secondary cases could not be assessed.

^bHospital D attributed all infections without a clear community or household source as healthcare even if appropriate personal protective equipment (PPE) and prevention strategies were followed. For this reason, their counts are classified as unknown, similar to the classification used by the other facilities, since Hospital D was unaware of any breach in PPE.