

## Secondary Cases of Delta Variant Coronavirus Disease 2019 Among Vaccinated Healthcare Workers With Breakthrough Infections is Rare

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In a retrospective, cohort study at 4 medical centers with high coronavirus disease 2019 vaccination rates, we evaluated breakthrough severe acute respiratory syndrome coronavirus 2 Delta variant 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.

Severe acute respiratory syndrome coronavirus 2 (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 31 May 2021 and 31 July 2021 [1]. The 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 a healthcare setting. We evaluated 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 4 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 1 June 2021 and 26 July 2021. Staff were defined as all healthcare employees, both patient care and nonpatient care, plus trainees and students.

Vaccine breakthrough infection was defined as a positive polymerase chain reaction (PCR)– or loop mediated isothermal amplification (LAMP)–confirmed SARS-CoV-2 test occurring  $\geq 14$  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 the Centers for Disease Control and Prevention (CDC) recommendations for healthcare settings were in place at all sites. However, masking was relaxed in nonpatient care areas and breakrooms in 3 of the 4 medical centers during parts of the study. HCWs who reported 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 1 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, and Roche Diagnostics cobas 6800 at hospital C; and DiaSorin Simplexa, Hologic Panther Fusion, and Abbott Alinity at hospital D. An exposure to HCWs or patients was defined by 3 institutions as a close contact with a person with a confirmed SARS-CoV-2 infection for  $\geq 15$  minutes in a 24-hour period who met the standard CDC criteria [6]. One institution defined an exposure as anything other than both parties wearing masks and the exposed wearing eye protection. All participating

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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 guideline [7].

## RESULTS

Among 88 570 HCWs (range across sites, 9527–32 224), the vaccination rate was 82% (72 624 of 88 570; range, 72%–91%); the vast majority were vaccinated with mRNA vaccines. A total of 11 836 workers underwent COVID-19 testing, of which 3.7% (440 of 11 836) were confirmed to have COVID-19 infections with an overall breakthrough case rate among vaccinated HCWs of 0.43% (309 of 72 624) during the Delta variant surge in California in June 2021 and July 2021 [8].

Among HCWs who tested 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. The mean PCR Ct was 20.8 (standard deviation [SD] = 5.2). For 3 sites for which the number of days from symptom onset to test was known, the mean PCR Ct 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 of 535) patients and 71% (381 of 535) staff (Table 1). The overall proportion of secondary cases due to vaccine breakthrough disease was 0.75% (4 of 535). Of the 4 secondary cases, 3 (75%) were vaccinated.

## DISCUSSION

The COVID-19 Delta variant has increased vaccine breakthrough infections due to greater transmissibility compared with prior variants [4]. High levels of detectable virus based on Ct values 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 (eg, 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 4 highly vaccinated large healthcare systems, the proportion of secondary SARS-CoV-2 cases was remarkably low, 0.75%, despite numerous exposures that resulted 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 coworkers or patients despite having low PCR Ct values (high viral burden). This was true even though masking was relaxed in nonpatient care areas and breakrooms in 3 of the 4 medical centers due to high vaccination rates and changes in

**Table 1. Secondary Cases of Severe Acute Respiratory Syndrome Coronavirus 2 From Infected Vaccinated Healthcare Workers**

Hospital	Number of Breakthrough Severe Acute Respiratory Syndrome Coronavirus 2 Cases, n	Exposures Related to Infected Vaccinated Healthcare Workers			Secondary Cases Related to Infected Vaccinated Healthcare Workers			Suspected Source of Coronavirus Disease 2019 Infection			
		Patients, n	Exposed Coworkers Providing Direct Patient Care, n	Exposed Coworkers Providing Nondirect Patient Care, n	Patients, n	Cases Among Direct Patient Care Providers, n	Cases Among Nondirect Patient Care Providers, n	Social Gatherings, n (%)	Household, n (%)	Healthcare, n (%)	Other/Unknown, n (%)
A	43	5	91	19	0	2	0	28 (65)	12 (28)	2 (5)	1 (2)
B	35	9	45	5	0	0	0	10 (29)	11 (31)	0 (0)	14 (40)
C	105	0	24	2	0	1	0	17 (16)	16 (15)	4 (4)	68 (65)
D <sup>a</sup>	126	140		195	0		1	65 (53)	18 (15)		40 (32)
Total	309	154		381	0		4	120 (39)	57 (19)	6 (2)	123 <sup>b</sup> (40)

<sup>a</sup>For hospital D, healthcare worker role was not available, and direct and nondirect patient care–related exposures or secondary cases could not be assessed.

<sup>b</sup>Hospital 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.

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 vs unvaccinated individuals has been noted as well [11]. Importantly, PCR-based tests are unable to discriminate between live virus and defective viral genomes, making it difficult to assess the implications of Ct values 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 (eg, parties, performance arts/community events, frequenting restaurants and bars) were predominantly unmasked in accordance with relaxed state and federal masking guidance. Documented personal protective equipment 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 2 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 that showed Delta dominance. Finally, Ct 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 nonpatient 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 that ensure 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.

## Note

**Potential conflicts of interest.** S. S. H. reports receiving support from the following: *Federal:* Centers for Disease Control and Prevention (CDC), National Institutes of Health, and Agency for Healthcare Research and Quality; *State:* Orange County Health Care Agency, CalOptima (Orange County Medicaid) (all paid to their institution). D. S. Y. reports receiving support from the CDC, Prevention Epicenters IV (U54 CK000484; as coinvestigator, contributed effort) and reports serving as vice-president and board of trustees member, unpaid, for the Society for Healthcare Epidemiology of America. All other authors report no potential conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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