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Short communication

Reducing the rates of household transmission: The impact of COVID-19 vaccination in healthcare workers with a known household exposure

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ABSTRACT

Objective: To determine the impact of COVID-19 vaccination on infection rates in healthcare workers (HCWs) with a household exposure.
Methods: Retrospective cohort study 8410 HCWs (400 fully vaccinated, 1645 partially vaccinated, 6365 unvaccinated), employed by a large integrated healthcare system in the southeastern United States, tested for SARS-CoV-2 between January 1 and February 26, 2021.
Results: Benefit of vaccination persisted even with household exposure, with unvaccinated HCWs being 3.7 to 7.7 times more likely to be infected than partially or fully vaccinated HCW with positive household contacts respectively (partial OR = 3.73, 95% CI 2.17 – 6.47; full OR = 7.67, CI 2.75 – 21.35). Whereas 89.4% of unvaccinated COVID-positive HCWs with known household exposures were symptomatic, 50% of fully vaccinated HCWs had symptoms, reducing risk of secondary spread from and between HCWs.
Conclusions: COVID-19 vaccination provided protection against infection even amongst healthcare workers with close household contact, and after adjusting for community prevalence.

Background: Household transmission of COVID-19 remains a serious concern. Studies have shown secondary attack rates between adults in the same household of 28%, and 38% between spouses, and a noteworthy number of cases (25%) in which one positive household member resulted in positivity for the entire home [1]. While recent reports of infection rates in healthcare workers (HCWs) [2,3] show significant reduction in rates among vaccinated individuals with high occupational exposures, there is a gap in understanding how vaccination impacts infection rates among those in the home setting who are repeatedly exposed to high viral burden without personal protective equipment or ability to quarantine. Given individuals infected at home can contribute to clusters in hospital staff [4], understanding the impact of vaccination on HCW household transmission is crucial.

Objective: To determine the impact of COVID-19 vaccination on infection rates in healthcare workers tested for COVID-19 with a known household exposure.

Methods and Findings: We conducted a retrospective cohort study of HCWs in Atrium Health, the largest vertically integrated healthcare system in the Southeastern U.S., who became eligible for vaccination December 14, 2020. A total of 8410 HCWs (7140 females, 1211 males, 59 unknown; mean age 40, SD = 11.9) were tested for SARS-CoV-2 via nasopharyngeal swabs using reverse-transcriptase-polymerase-chain-reaction (RT-PCR) testing between January 1, 2021 (the first date at which any HCWs were fully vaccinated) and February 26, 2021, a timeframe prior to the delta variant. Of the full cohort, 1206 HCWs tested positive; 808 HCWs reported a known household contact, of which 208 tested positive for COVID-19 (25.7%).

All HCWs reported COVID-19 exposure and symptoms related to COVID-19 (i.e., congestion, cough, headache, fatigue, loss of taste or smell, fever, muscle aches, sore throat, diarrhea, and chest tightness) either at entry to work or via an electronic app that captured daily symptoms and known COVID-19 exposures (and allowed them to automatically arrange for PCR testing). A positive screen resulted in SARS-CoV-2 PCR testing within 48 h; within 72 h of a positive test result, HCWs were contacted by a physician who interviewed them to obtain information regarding symptoms present, onset of symptoms, and risk factors for exposure to SARS-CoV-2. For the purposes of this study, HCWs with a positive result

Abbreviations: HCW, Healthcare worker.

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and exposure other than household contact (i.e. travel, workplace cluster or routine testing). Due to HIPAA protection, verification of household members' positive test could not be obtained. HCWs who reported household exposure were tested at any point if they had COVID symptoms. If the HCW remained asymptomatic they were tested at 5–7 days after last exposure.

For vaccination status HCWs were categorized as non-vaccinated if they did not receive a dose of a COVID-19 mRNA vaccine or they were tested for SARS-CoV-2 less than 7 days after their first dose, partially vaccinated if the test occurred between 7 days post first dose and 14 days post second dose and vaccinated if their test occurred more than 14 days after their second dose. Chi-square and Fisher's Exact test were used to assess infection rates by vaccination status. Furthermore, we examined differences in infection rates among vaccination status groups by vaccine type (Pfizer-BioNTech vs. Moderna) and presence of symptoms.

To further highlight the level of protection vaccination provided HCWs with a positive household contact, logistic regression was used to predict individual positive test. Analyses were adjusted for sex, age, and week of testing; however, results the adjusted model did not significantly differ in direction or significance. Thus, the unadjusted, more parsimonious model is presented.

Unvaccinated HCWs with known household exposure had significantly higher average infection rates (31.7%) and overall HCWs rates (14.3%) highlighting the effect of high-risk exposure on COVID-19 infection. Compared to rates of infection in unvaccinated peers' rates, on average, decreased significantly for partially and fully vaccinated HCWs (partial 11%, full 5.7%). Whereas 89.4% of unvaccinated COVID-positive HCWs with known household exposures were symptomatic, only 50% of partially and fully vaccinated HCWs had symptoms, reducing risk of secondary spread from and between HCWs.

Due to the timing of the study in conjunction with vaccine roll-out procedures, we did not have any fully vaccinated HCWs who received the Moderna vaccine. Within partially vaccinated HCWs, only 8.9% of those who received the Pfizer-BioNTech were COVID-positive, whereas 23.1% of those who received Moderna were infected. This finding likely reflects the delay in protection provided by the Moderna vaccine identified in previous research.

At the individual level, the benefit of vaccination persisted even with household exposure, with unvaccinated being 273% to 667% more likely to be infected than partially or fully vaccinated HCW with household contacts positive respectively (partial OR = 3.73, 95% CI 2.17 – 6.47; full OR = 7.67, CI 2.75 – 21.35).

Discussion: Consistent with results from clinical trials [5,6] and early data from mRNA COVID-19 vaccine roll out in different settings, [2,3] unvaccinated HCWs in our study had a significant increase in COVID-19 infection compared to HCWs partially or fully vaccinated, even after adjusting for significantly declining community infection rates over time. This protective effect occurs most prominently more than 2 weeks after the second dose, but benefit is seen with a single dose (the difference between approximately 60% reduction in odds of infection with a single dose vs reduction in the high 80 %s with both doses). Our results are consistent with previous research on vaccine effectiveness in HCWs [7]. Thus, our study extends real-world data showing the protective benefit of COVID-19 vaccination in healthcare workers and highlights the benefit in preventing household transmission during times when the alpha variant of SARS-CoV-2 was predominant.

Even more impressive was the impact of vaccination on those with close, prolonged, unprotected contact with an infected individual in their home. Multiple studies have shown secondary transmission rates ranging from 16 to 30% when a household member has COVID-19 [8].

While we found similarly high rates of infection in unvaccinated individuals, partial and full COVID-19 vaccination provided excellent protection in HCWs with positive household contacts despite the higher levels of exposure.

Household transmission is a large source of disease transmission due to the repeated long-term exposure of family members over time. Our results show that early in the pandemic, when the alpha-variant was dominant, COVID-19 vaccines were effective at reducing the risk of household transmission. More recent studies have suggested that household transmission was more likely with the delta than the alpha variant [9], with protection from vaccination decreased. Currently data on impact of COVID-19 boosters on household transmission is limited but as seen from our data earlier in the pandemic evaluating risk of household transmission as well as who is considered fully vaccinated will be important to continue to evaluate especially in high risk individuals such as HCWs [10]. Accordingly, our results provide insights into the history of vaccine effectiveness, and as we understand viral dynamics of future SARS-CoV-2 strains, they may help guide future assumptions about vaccine impact.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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