









Concise Communication

Severe acute respiratory coronavirus virus 2 (SARS-CoV-2) outbreaks in nursing homes involving residents who had completed a primary coronavirus disease 2019 (COVID-19) vaccine series—13 US jurisdictions, July–November 2021

W. Wyatt Wilson MD^{1,2} , Amelia A. Keaton MD², Lucas G. Ochoa MS² , Kelly M. Hatfield MSPH², Paige Gable MPH² , Kelly A. Walblay MPH³, Richard A. Teran PhD^{1,3} , Meghan Shea MPH⁴, Urooj Khan MPH⁴, Ginger Stringer PhD⁴ , Joanne G. Colletti RN⁵, Erin M. Grogan RN⁵, Carly Calabrese MPH⁶, Andrew Hennenfent DVM⁶, Rebecca Perlmutter MPH⁷, Katherine A. Janiszewski MPH⁸, Ishrat Kamal-Ahmed PhD⁹, Kyle Strand BS⁹, Emily Berns MPH¹⁰, Jennifer MacFarquhar MPH^{10,11}, Meghan Linder MPH¹², Dat J. Tran MD¹² , Patricia Kopp BSMT¹³, Rebecca M. Walker MSN¹³, Rebekah Ess MSPH¹⁴, Jennifer S. Read MD¹⁵, Chelsey Yingst MPH¹⁶, James Baggs PhD² , John A. Jernigan MD², Alex Kallen MD², Jennifer C. Hunter DrPH²  and the MOVIN Surveillance Team

¹Epidemic Intelligence Service, Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, ²Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases, CDC, Atlanta, Georgia, ³Chicago Department of Public Health, Chicago, Illinois, ⁴Colorado Department of Public Health and Environment, Denver, Colorado, ⁵Connecticut Department of Public Health, Hartford, Connecticut, ⁶Iowa Department of Public Health, Des Moines, Iowa, ⁷Maryland Department of Health, Baltimore, Maryland, ⁸Massachusetts Department of Public Health, Jamaica Plain, Massachusetts, ⁹Nebraska Department of Health and Human Services, Lincoln, Nebraska, ¹⁰North Carolina Department of Health and Human Services, Raleigh, North Carolina, ¹¹Division of State and Local Readiness, Center for Preparedness and Response, CDC, Atlanta, Georgia, ¹²Oregon Health Authority, Portland, Oregon, ¹³South Carolina Department of Health and Environmental Control, Columbia, South Carolina, ¹⁴Utah Department of Health, Salt Lake City, Utah, ¹⁵Vermont Department of Health, Burlington, Vermont and ¹⁶West Virginia Department of Health and Human Resources, Charleston, West Virginia

Abstract

Among nursing home outbreaks of coronavirus disease 2019 (COVID-19) with ≥ 3 breakthrough infections when the predominant severe acute respiratory coronavirus virus 2 (SARS-CoV-2) variant circulating was the SARS-CoV-2 δ (delta) variant, fully vaccinated residents were 28% less likely to be infected than were unvaccinated residents. Once infected, they had approximately half the risk for all-cause hospitalization and all-cause death compared with unvaccinated infected residents.

(Received 8 February 2022; accepted 21 April 2022; electronically published 16 January 2023)

Author for correspondence: W. Wyatt Wilson, E-mail: wuw7@cdc.gov

Monitoring Outbreaks of Variants in Nursing Homes (MOVIN) Surveillance Team: Hira Adil MBBS³, Stephanie R. Black MD³, Daniel Galanto MPH³, Marie Heppel BS³, Elizabeth Shane MPH³, Winter Viverette MAIO³, Shannon N. Xydis BS³, Christy Zelinski MPH³, Carly Lipke BS⁴, Brooke McCain MPH⁴, Brandi Tolle MPH⁴, Wesley Hottel PhD⁶, Valérie Webb PhD⁶, Christina Brandeburg MPH⁸, Meagan Burns MPH⁸, Timelia Fink MPH⁸, Melissa Cumming MPH⁸, Matthew Doucette BS⁸, Glen Gallagher PhD⁸, Andrew Lang PhD⁸, M. Salman Ashraf MBBS⁹, Kevin Cueto MPH⁹, Matthew Donahue MD⁹, Jonathan Figliomeni MPH⁹, Alexander Vasa MPH⁹, Amanda E. Faulkner MPH¹², Rebecca Pierce PhD¹², Megan Davis MS¹³, Jennifer L. Donehue MPH¹³, Christy Greenwood BS¹³, Terri Hannibal MSN¹³, Alison Jamison-Haggwood MSN¹³, LaKita D. Johnson MPH¹³, Rachel A. Radcliffe DVM¹³ and Hannah V. Ruegner MPH¹³

Cite this article: Wyatt Wilson W, *et al.* (2023). Severe acute respiratory coronavirus virus 2 (SARS-CoV-2) outbreaks in nursing homes involving residents who had completed a primary coronavirus disease 2019 (COVID-19) vaccine series—13 US jurisdictions, July–November 2021. *Infection Control & Hospital Epidemiology*, 44: 1005–1009, <https://doi.org/10.1017/ice.2022.123>

In June 2021, the severe acute respiratory coronavirus virus 2 (SARS-CoV-2) B.1.617.2 (δ or delta) variant emerged as the predominant SARS-CoV-2 variant in the United States. Its emergence coincided with an increase in infections among vaccinated persons, possibly attributable to enhanced viral transmission compared with previous variants, viral immune evasion, and waning vaccine-derived immunity.^{1,2} Nursing home (NH) populations comprise predominately older adults, who are disproportionately affected by coronavirus disease 2019 (COVID-19) and are susceptible to declining vaccine-derived immunity.^{3,4} Between July 26 and November 30, 2021, the Centers for Disease Control and Prevention (CDC) partnered with US public health jurisdictions to perform prospective surveillance of outbreaks involving residents who were at least fully vaccinated with a primary

© The Society for Healthcare Epidemiology of America, 2023. To the extent this is a work of the US Government, it is not subject to copyright protection within the United States. To the extent this work is subject to copyright outside of the United States, such copyright shall be assigned to The Society for Healthcare Epidemiology of America and licensed to the Publisher. Outside of the United States, the US Government retains a paid-up, non-exclusive, irrevocable worldwide license to reproduce, prepare derivative works, distribute copies to the public and display publicly the Contribution, and to permit others to do so. Published by Cambridge University Press on behalf of The Society for Healthcare Epidemiology of America.

COVID-19 vaccine series to describe outbreak characteristics, and the risk of infection and disease severity by vaccination status.

Methods

Participating health departments collected outbreak, facility, and resident information from NHs with eligible outbreaks, defined as those including 3 or more infections within a 14-day period in residents who were at least fully vaccinated. Participating jurisdictions were recruited via an informational e-mail to state epidemiologists followed by a call hosted by the CDC field support team for interested jurisdictions. Infection in a fully vaccinated resident was defined as a positive SARS-CoV-2 viral nucleic acid amplification or antigen test from a respiratory specimen in a resident who had completed a primary COVID-19 vaccination series at least 14 days earlier. A primary COVID-19 vaccination series is defined as 2 doses of an mRNA COVID-19 vaccine (Pfizer-BioNTech or Moderna) or 1 dose of Johnson and Johnson (Janssen).

At the onset of the outbreak, the following facility-level information was collected once: resident census stratified by vaccination status (fully vaccinated with a primary series plus an additional dose (booster or third vaccine dose), fully vaccinated with a primary series, partially vaccinated with a primary series, or unvaccinated). The following outbreak information was also collected: onset date (collection date of first positive SARS-CoV-2 specimen among residents or staff), completion date (14 days after last identified SARS-CoV-2 infection in a resident or staff), and whether the initial infection was detected in a staff member or resident. The information collected on infected residents included their presence in the facility at outbreak onset, vaccination status, presence or absence of COVID-19 symptoms, all-cause hospitalization, all-cause death, and SARS-CoV-2 variant type. Detection of symptoms and hospitalization were reported through outbreak completion; mortality was reported through 14 days after outbreak completion. Outbreak duration was the number of days from outbreak onset until outbreak completion.

Infection attack rates and risk ratios were estimated for residents present at outbreak onset using Poisson generalized estimating equation models with log links accounting for facility-level clustering. The risk for selected outcomes among infected residents was compared by vaccination status using generalized estimating equation binomial regression models with log links. Analyses were conducted using SAS version 9.4 software (SAS Institute, Cary, NC) using $\alpha = 0.05$ and limited to completed outbreaks ending on or before November 30, 2021. This activity underwent ethical review at CDC and was conducted consistent with applicable federal law and CDC policy (45 CFR part 46.102(l)(2), 21 CFR part 56; 42 USC Sect 241(d); 5 USC Sect 552a; 44 USC Sect 3501 et seq).

Results

From July 26 to November 30, 2021, 469 outbreaks meeting surveillance criteria were reported in 433 (18.4%) of 2,348 NHs represented in the surveillance catchment area of the 13 participating US jurisdictions (Table 1). The surveillance catchment constituted 85% of the 2,762 licensed NHs within participating jurisdictions and 15.1% of 15,600 NHs nationwide.⁵ Among 469 initial cases, 271 (57.8%) occurred in a staff member, 121 (44.6%) of whom were unvaccinated. The median numbers of resident cases were similar when the initial outbreak case was a staff member (median, 11 cases) compared with a resident (median, 9 cases; Wilcoxon rank-sum $P = .104$).

Among the 249 completed outbreaks with full resident data, 134 (53.8%) had viral sequences reported for at least 1 infected resident. The SARS-CoV-2 δ (delta) variant was the predominant sequence identified in 132 (98.5%) outbreaks. The median outbreak duration was 36 days (IQR, 26–50 days). Estimated infection attack rates were lower among fully vaccinated residents (12.7 per 100 residents; 95% CI, 11.1–14.5) than among unvaccinated residents (17.6 per 100 residents; 95% CI, 14.5–21.2) who were present at outbreak onset (RR, 0.72; 95% CI, 0.61–0.85; $P = .0001$) (Table 2). The risk for developing COVID-19 symptoms was similar for fully vaccinated and unvaccinated infected residents (RR, 0.96; 95% CI, 0.87–1.06). Among infected residents who were fully vaccinated, the risks for all-cause hospitalization (RR, 0.57; 95% CI, 0.47–0.68) and all-cause death (RR, 0.53; 95% CI, 0.42–0.68) were significantly lower than they were among unvaccinated infected residents (Table 2).

Discussion

Among 433 NHs in 13 US jurisdictions, 469 SARS-CoV-2 outbreaks involving 3 or more infections among residents who had received at least primary COVID-19 vaccination began during July 26–November 30, 2021. These outbreaks predominantly involved the SARS-CoV-2 δ (delta) variant. The CDC National Healthcare Safety Network data demonstrated that vaccine effectiveness against SARS-CoV-2 infection declined among NH residents with an mRNA COVID-19 vaccination from 75% before the SARS-CoV-2 δ (delta) variant emerged to 53% during June–July 2021, when the δ (delta) variant emerged.⁶ Because this finding occurred ~6 months following the mid-December 2020 rollout of mRNA vaccines to NH populations, the extent to which waning of vaccine-induced immunity or enhanced virus transmission contributed to decreased vaccine effectiveness was unclear. Although this study did not specifically analyze the impact of waning immunity, it occurred during the 4 months following July 2021 and found that vaccination still provided protection against SARS-CoV-2 infection. Continued NH surveillance is important to understand newer variants with enhanced transmission potential, such as the SARS-CoV-2 \omicron (omicron) variant,⁷ and how booster doses affect the risk for infection and severe outcomes.

This study had several limitations. Overall, 87% of US NH residents completed a primary COVID-19 vaccination series because of early efforts targeting populations in these settings.⁸ Consequently, unvaccinated residents might differ by medical history, infection-induced immunity from prior SARS-CoV-2 infection, length of residence, or end-of-life care, potentially affecting infection and outcomes risk estimates that were unable to be further ascertained. Despite a standardized protocol, outbreak investigation and implementation of CDC-recommended testing practices likely varied between jurisdictions, which may have affected the number, size, and duration of outbreaks captured.⁹ This outbreak investigation describes outbreaks with 3 or more infected residents who were at least fully vaccinated and assesses the risk of infection and disease severity by vaccination status in the context of these outbreaks. Thus, this study potentially overestimates attack rates among vaccinated residents outside of this context. Given the large number of facilities under surveillance and limited staff resources, resident census and vaccination reporting were restricted to one time at outbreak onset, and we could not account for changes to vaccination status during an outbreak. Furthermore, resident movements (eg, resident days in the facility) were not ascertained. Because of this, formal

Table 1. Characteristics of Nursing Home Outbreaks Involving Three or More SARS-CoV-2 Infections in Residents Who Were at Least Fully Vaccinated—13 US Jurisdictions, July–November 2021

Characteristic	No. (%)	IQR	Range
Total	469 (100)	—	
Distribution of jurisdictions			
Chicago	12 (2.6)	—	
Colorado	71 (15.1)	—	
Connecticut	52 (11.1)	—	
Iowa	3 (0.6)	—	
Maryland	44 (9.4)	—	
Massachusetts	63 (13.4)	—	
Nebraska	20 (4.3)	—	
North Carolina	46 (9.8)	—	
Oregon	40 (8.5)	—	
South Carolina	43 (9.2)	—	
Utah	19 (4.1)	—	
Vermont	4 (0.9)	—	
West Virginia	52 (11.1)	—	
Distribution of initial cases			
Staff member ¹	271 (57.8)	—	
Fully vaccinated and an additional dose ²	2 (0.7)	—	
Fully vaccinated ²	125 (46.1)	—	
Partially vaccinated	15 (5.5)	—	
Unvaccinated	121 (44.6)	—	
Resident ³	168 (35.8)	—	
Fully vaccinated and an additional dose ²	2 (1.2)	—	
Fully vaccinated ²	131 (78.0)	—	
Partially vaccinated	6 (3.6)	—	
Unvaccinated	19 (11.3)	—	
Unable to determine (staff member and resident both positive on day 0)	27 (5.8)	—	
Unknown or missing	3 (0.6)	—	
Resident census in outbreak facilities			
Median resident census	86 (—)	(59–113)	(13–398)
Median % of fully vaccinated and an additional dose ²	0 (—)	(0–0)	(0–100)
Median % of fully vaccinated ²	84.9 (—)	(83.1–85.8)	(0–100)
Median % of partially vaccinated	1.2 (—)	(0–1.8)	(0–36.4)
Median % of unvaccinated	7.0 (—)	(3.4–9.7)	(0–58.7)
Outbreak characteristics⁴			
Residents with infection, median	10 (—)	(6–17)	(3–57)
Outbreak duration, median d	36 (—)	(26–50)	(12–112)
Predominant SARS-CoV-2 outbreak variant	—	—	
Delta (B.1.672 and AY.1–AY.107 lineages)	132 (53.0)	—	
Alpha (B.1.1.7 and Q lineages)	1 (0.4)	—	
Alpha and beta (B.1.351)	1 (0.4)	—	
Unknown or missing	115 (46.2)	—	

Note. IQR, interquartile range.

¹8 (3%) staff members had missing or unknown vaccination status.

²Fully vaccinated with a primary series of COVID-19 vaccine (≥ 14 d after receipt of 1 dose of Johnson and Johnson [Janssen] or after 2 doses of an mRNA COVID-19 vaccine).

³10 (6%) resident initial cases had missing or unknown vaccination status.

⁴Data were restricted to completed outbreaks with full resident data (n = 249).

Table 2. Crude and Adjusted¹ (Panel A) SARS-CoV-2 Infection Attack Rates per 100 Residents² (222 completed outbreaks)^{3,4} and (Panel B) Outcome Risk Ratios for Symptomatic SARS-CoV-2 Infection, All-Cause Hospitalization and All-Cause Death⁵ Among Infected Residents (249 completed outbreaks) by Vaccination Status⁶—13 US Jurisdictions, July–November 2021

Panel A	Vaccination Status	Residents With Infection	Residents at Risk	Crude AR per 100 Residents	Adjusted AR per 100 Residents (95% CI)	Adjusted RR (95% CI)
SARS-CoV-2 infection	Unvaccinated	387	1,953	19.8	17.6 (14.5–21.2)	Ref
	Fully vaccinated	2,267	17,482	13.0	12.7 (11.1–14.5)	0.72 (0.61–0.85)
Panel B	Vaccination Status	Infected Residents With Outcome	Infected Residents at Risk for Outcome	Crude Risk	Adjusted Risk (95% CI)	Adjusted RR (95% CI)
COVID-19 symptoms	Unvaccinated	232	402	0.58	0.59 (0.53–0.66)	Ref
	Fully vaccinated	1,393	2,400	0.58	0.57 (0.54–0.61)	0.96 (0.87–1.06)
All-cause hospitalization	Unvaccinated	100	402	0.25	0.25 (0.21–0.30)	Ref
	Fully vaccinated	321	2,400	0.13	0.14 (0.12–0.16)	0.57 (0.47–0.68)
All-cause mortality	Unvaccinated	78	359	0.22	0.22 (0.18–0.27)	Ref
	Fully vaccinated	259	2,202	0.12	0.12 (0.10–0.14)	0.53 (0.42–0.68)

Note. AR, attack rate; Ref, referent; RR, risk ratio; IQR, interquartile range; CI, confidence interval.

¹ARs and RRs are adjusted for facility level clustering using generalized estimating equation models.

²Median days to infection was not significantly different for fully vaccinated residents (12 d; IQR, 6–21) compared with unvaccinated residents (12 d; IQR, 6–22) by Wilcoxon rank sum test ($P = .234$).

³27 additional outbreaks were excluded as the number of cases exceeded the number of total residents ($n=8$) or if the facility did not have any unvaccinated residents ($n=19$).

⁴Outbreaks were considered complete 14 days after last newly identified SARS-CoV-2 infection in a resident or staff member.

⁵Death outcomes were not reported for cases in 22 outbreaks.

⁶Residents who received an additional COVID-19 vaccine dose or who were partially vaccinated were not included.

vaccine effectiveness estimates were not calculated. The outcome follow-up period was specific to the outbreak end date, which led to variation in follow-up times of individual infected residents. Although median days to infection was not different by vaccination status, adjusted estimates were unable to account for potential variations in time from infection to outcomes by vaccination status or outcomes occurring beyond the follow-up period. These data reflect outbreaks in 13 US jurisdictions, limiting a broader generalizability. Although 98% of sequenced isolates were identified as the SARS-CoV-2 δ (delta) variant, specimens with sequence results were only available for half of all completed outbreaks. Finally, we did not determine types of symptoms, symptom severity, or reasons for hospitalization and death among infected residents. This may have limited our ability to interpret differences in these outcomes by vaccination status.¹⁰

In NH outbreaks involving infections among residents who had at least completed a primary COVID-19 vaccination series during the SARS-CoV-2 δ (delta) variant predominant phase of the pandemic, primary COVID-19 vaccination was protective against infection and, among infected residents, against all-cause hospitalization and death. NH residents and staff members should stay up to date with COVID-19 vaccination, including additional and booster doses, to protect against SARS-CoV-2 infection, severe illness, and death.

Acknowledgments. The authors acknowledge the CDC COVID-19 Response Laboratory TF Strain Surveillance and Emerging Variants team; Surveillance Branch National Healthcare Safety Network team, Prevention and Response Branch Long-Term Care Facility Team, Division of Healthcare Quality Promotion, CDC; Colorado Department of Health COVID-19 Infection Prevention Unit; Colorado Department of Health COVID-19 Regional Epidemiology Response Teams; Colorado Department of Health COVID-19 Residential Care Epidemiology Team; Brynn Berger, Meenalochani Ganesan, Jordan Gilbert, Kaitlin Greenberg, Shermalyn Greene, Massachusetts State Public Health Laboratory Molecular Diagnostic and Next Generation

Sequencing; Erica Wilson, Justin Albertson, Oregon State Public Health Laboratory; Oregon COVID-19 Response and Recovery Unit; West Virginia Bureau of Public Health Outbreak Team; West Virginia Rapid Development Laboratory.

Financial support. No financial support was provided relevant to this article.

Conflicts of interest. Meghan Linder reports support for attending meetings or travel through the Council of State and Territorial Epidemiologists in the past 36 months. Dat Tran reports grants from an Epidemiology and Laboratory Capacity cooperative agreement and the State Health Information Exchange Cooperative Agreement Program in the past 36 months. Melissa Cumming reports holding a nonsalaried membership of the FDA Blood Products Advisory Committee in the past 36 months. M. Salman Ashraf reports grants from Merck and nonsalaried membership of the Society for Healthcare Associated Epidemiology (SHEA) and Infectious Disease Society of America (IDSA) in the past 36 months. Glen Gallagher reports support for attending the 2021 ASCP meeting in the past 36 months. Rebecca Pierce reports leadership role in SHEA Leadership in Epidemiology, Antimicrobial Stewardship and Public Health (LEAP) Steering Committee in the past 36 months.

References

1. Dougherty K, Mannell M, Naqvi O, Matson D, Stone J. SARS-CoV-2 B.1.617.2 (delta) variant COVID-19 outbreak associated with a gymnastics facility—Oklahoma, April–May 2021. *Morb Mortal Wkly Rep* 2021;70:1004–1007.
2. Tartof SY, Slezak JM, Fischer H, *et al*. Effectiveness of mRNA BNT162b2 COVID-19 vaccine up to 6 months in a large integrated health system in the USA: a retrospective cohort study. *Lancet* 2021;398:1407–1416.
3. Bialek S, Boundy E, Bowen V, *et al*. COVID-19 Response Team. Severe outcomes among patients with coronavirus disease 2019 (COVID-19)—United States, February 12–March 16, 2020. *Morb Mortal Wkly Rep* 2020;69:343–346.
4. Bajema KL, Dahl RM, Prill MM, *et al*. Effectiveness of COVID-19 mRNA vaccines against COVID-19-associated hospitalization—five Veterans' Affairs medical centers, United States, February 1–August 6, 2021. *Morb Mortal Wkly Rep* 2021;70:1294–1299.

5. Harris-Kojetin L, Sengupta M, Lendon JP, Rome V, Valverde R, Caffrey C. Long-term care providers and services users in the United States, 2015–2016. In: *Vital Health Statistics*. Atlanta, series 3 no. 43. Atlanta: CDC; 2019.
6. Nanduri S, Pilishvili T, Derado G, *et al*. Effectiveness of Pfizer-BioNTech and Moderna vaccines in preventing SARS-CoV-2 infection among nursing home residents before and during widespread circulation of the SARS-CoV-2 B.1.617.2 (delta) variant—National Healthcare Safety Network, March 1–August 1, 2021. *Morb Mortal Wkly Rep* 2021;70:1163–1166.
7. US Department of Health and Human Services. Science brief: Omicron (B.1.1.529) variant. Centers for Disease Control and Prevention website. <https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/scientific-brief-omicron-variant.html>. Published 2021. Accessed December 15, 2021.
8. US Department of Health and Human Services. Nursing home COVID-19 vaccination data dashboard. Centers for Disease Control and Prevention website. <https://www.cdc.gov/nhsn/covid19/ltc-vaccination-dashboard.html>. Published 2021. Accessed December 16, 2021.
9. US Department of Health and Human Services. Testing: create a plan for testing residents and HCP for SARS-CoV-2. Centers for Disease Control and Prevention website. https://www.cdc.gov/coronavirus/2019-ncov/hcp/long-term-care.html#anchor_1631031062858. Published 2021. Accessed January 13, 2021.
10. Khoury DS, Cromer D, Reynaldi A, *et al*. Neutralizing antibody levels are highly predictive of immune protection from symptomatic SARS-CoV-2 infection. *Nat Med* 2021;27:1205–1211.