Effectiveness of COVID-19 mRNA vaccines against infection during an outbreak of SARS-CoV-2 Beta (B.1.351) variant in a skilled nursing facility – Virginia, March-April 2021

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Abstract

In April 2021, we assessed mRNA vaccine effectiveness (VE) in the context of a COVID-19 outbreak in a skilled nursing facility. Among 28 cases, genomic sequencing was performed on four specimens on four different patients, and all were classified by sequence analysis as the Beta (B.1.351) variant. Adjusted VE among residents was 65% (95% Confidence Interval: 25-84%). These findings underscore the importance of vaccination for prevention of COVID-19 in skilled nursing facilities.

Keywords: Vaccine Effectiveness, SARS-CoV-2, skilled nursing facility

Background

Post-authorization studies of COVID-19 mRNA vaccines have demonstrated high vaccine effectiveness (VE) against infection and symptomatic disease in residents of skilled nursing facilities; however, data on the effectiveness against the SARS-CoV-2 Beta (B.1.351) variant of concern are limited in this population. In April 2021, the Virginia Beach Health Department and Virginia Department of Health (VDH) identified the Beta variant in four of four sequenced specimens from a COVID-19 outbreak in a skilled nursing facility. We evaluated COVID-19 mRNA VE against infection among residents of this skilled nursing facility in the context of this outbreak.

Methods

This 92-bed facility houses both short and long-stay residents and provides a spectrum of skilled nursing and nursing home care. During January 2021, the Pfizer-BioNTech COVID-19 vaccine was offered and administered to residents and staff at two COVID-19 vaccine clinics held at the facility as part of the Federal Retail Pharmacy Program. After a period without SARS-CoV-2 infections in the facility, the first case in this outbreak was identified on March 10, 2021. In accordance with the Centers for Disease Control and Prevention (CDC) and VDH testing guidance for congregate living facilities at the time of the outbreak, on identification of the first case, the facility began screening residents and staff twice-weekly using the BinaxNOW antigen test (Abbott). [1] If an antigen test was positive, a SARS-CoV-2 reverse transcription polymerase chain reaction (RT-PCR) test (referred to as PCR hereafter) was performed for confirmation. Symptomatic residents with a negative antigen test also received confirmatory PCR. Per facility practice, any resident testing positive for SARS-CoV-2 infection via PCR or symptomatic with a positive antigen test was immediately transferred to the COVID-19 isolation wing for 14 days. Asymptomatic residents with a positive antigen test received a confirmatory RT-PCR. If the RT-PCR test

was positive the resident was transferred to the isolation wing. In addition to testing performed by the facility, VDH conducted PCR and antigen testing on all residents on April 22.

We conducted a retrospective cohort analysis among residents present in the facility from March 8 (two days prior to first positive specimen) to April 30, 2021 (two weeks after the last PCR positive case of this outbreak). Cases were defined as a laboratory-confirmed SARS-CoV-2 infection by detection of SARS-CoV-2 ribonucleic acid (RNA) using nucleic acid amplification test (NAAT, such as RT-PCR) or antigen-based test. Any positive result was considered evidence of SARS-CoV-2 infection, regardless of symptoms, test platform, or discordant test results from the same day. SARS-CoV-2 test results were abstracted for all eligible residents from the Virginia Electronic Disease Surveillance System (VEDSS) and facility antigen test records. Genomic sequencing was performed by the Virginia Public Health Laboratory's Division of Consolidated Laboratory Services using SARS-CoV-2 ARTIC V3 protocol for amplicon sequencing[§§] and reported through VEDSS.

Residents were included in the cohort analysis if they were in the facility at any time during the outbreak period (March 8 – April 30) and had a documented SARS-CoV-2 test (antigen or PCR) during their stay in the facility. Residents contributed person-time starting on March 8, 2021, or at admission if after that date, and were censored at discharge, diagnosis of SARS-CoV-2 infection, or at the end of the outbreak period, April 30, 2021. The case onset date was the earlier date of symptom onset and first positive test date.

Vaccination status was abstracted from the Virginia Immunization Information System (VIIS) and facility medical records. Vaccination status was classified as unvaccinated for residents with no record of vaccination, and fully vaccinated (≥14 days after dose 2). Residents who had received one dose but were not fully vaccinated were excluded. Only individuals receiving the mRNA vaccine products (Pfizer-BioNTech or Moderna) were included in the analysis; one resident receiving the Janssen product was

excluded. Patients with SARS-CoV-2 infection in the 90 days prior to the outbreak period (from December 8, 2020, to March 7, 2021) were also excluded.

Resident demographics, including sex, age, race and ethnicity, were collected from the facility medical records and VEDSS. Data on underlying medical conditions on all residents were abstracted from facility medical records. Evidence of SARS-CoV-2 infection prior to the outbreak period, defined as documented positive SARS-CoV-2 NAAT or antigen test before March 8, 2021, was obtained from VEDSS. Among cases, presence of symptoms, date of symptom onset, and clinical outcomes (hospitalization, intensive care unit admission, death), were abstracted from VEDSS, facility medical records, and records from medical care sought outside the facility. Residents were considered symptomatic cases if they had a laboratory-confirmed SARS-CoV-2 infection with new onset or increased severity of a clinically relevant symptom[§] within 7 days before or 14 days after the positive test collection date within the investigation period.

A time-to-event Cox proportional hazards model with standard adjustment for age (<75 years or ≥75 years), presence of 2 or more underlying medical conditions, and race (White or not White) was used to estimate the VE against infection of full vaccination with mRNA vaccines versus unvaccinated status with VE = 100% × (1−hazard ratio). Sensitivity analysis was performed restricting to residents without known prior infection >90 days prior to the investigation period. Data were collected using REDCap electronic data capture tools hosted at the CDC, and analyses were conducted using SAS (Version 9.4, SAS Institute, Cary, NC). This investigation was reviewed by the VDH Institutional Review Board and CDC and was conducted consistent with applicable federal law and CDC policy. [§§§]

Results

From March 8 – April 30, 2021, among 116 residents in the facility, 91 were eligible for inclusion (Supplemental Document). Forty-nine (54%) residents contributed fully vaccinated person-time and 42

(46%) contributed unvaccinated person-time [Table]. Among fully vaccinated residents, 45 received the Pfizer-BioNTech product and 4 received the Moderna product. No residents contributed both unvaccinated and fully-vaccinated person-time during the outbreak period. Among all vaccinated residents, one individual was partially vaccinated at the beginning and became fully vaccinated prior to the end of the outbreak period, and thus contributed person-time only once fully vaccinated. Five of 79 (6%) staff members tested positive during the outbreak period. Vaccine effectiveness was not assessed among staff due to the small number of cases and absent sequencing data for these cases who have community exposure.

Among all eligible residents, 33 were male (36%) and the mean age was 74.7 years. A majority (67%) were White race, 28% were Black race, and 89% identified as non-Hispanic (Table). Thirty-eight (41%) had a history of prior infection before December 8, 2020. Six individuals had history of prior infection less than 90 days from the start of the investigation period and were excluded from the analysis.

During this outbreak, 28 cases of SARS-CoV-2 occurred among residents in the facility [Supplemental Figure 2]. All four sequenced outbreak-associated specimens were the Beta variant, all from testing on March 22, 2021. Among the 28 cases, 20 (71%) were symptomatic, 13 (46%) were hospitalized. Five (17%) cases died.

The unadjusted VE for full vaccination was 64% (95% Confidence Interval [CI]: 22-83%) for documented infection, and VE against infection adjusted for age, race, and comorbidities was 65% (95% CI: 25-84%). A sensitivity analysis limiting to the 53 individuals without known prior infection excluded two cases and resulted in an adjusted VE against infection of 58% (95% CI: 1-82%).

Discussion

These findings suggest that in the setting of a Beta variant outbreak among residents in a skilled nursing facility, mRNA vaccines against COVID-19 were effective, with a VE of 64% against documented infection. The results are consistent with VE estimates for other SARS-CoV-2 variants among older adults living in long term care facilities (LTCFs), which have described VE for documented infection between 54-74% [2,3] Although this cohort was small and only four specimens were sequenced, these results contribute to the sparse VE literature available for the Beta variant and add insight to effectiveness of mRNA vaccines among residents of LTCFs.

While data are limited, our estimates are also consistent with VE estimates associated with this variant. [4,5] Estimates from Qatar, where Beta was the dominant variant in early 2021, demonstrate lower vaccine effectiveness for documented infection, than the B.1.1.7 (Alpha) variant [4,6]. A recent study among LTCFs experiencing Beta variant outbreaks in France found a VE of 49% (95% CI: 14-69) against infection and 86% (95% CI: 67-94) against severe disease.[7] Circulation of the Beta variant has remained low in the United States, and though it has been associated with outbreaks, it represents <0.1% of sequenced samples as of December 1, 2021.[8]

This investigation is subject to at least the following limitations. First, while all sequenced cases were found to be the Beta variant, only four were sequenced and it is possible other cases in the outbreak were not Beta, including the five cases among staff excluded from this analysis. Second, due to small sample size, our results have wide confidence intervals and were not stratified by mRNA vaccine product. Third, serial antigen testing was used to determine disease status and asymptomatic infected individuals with lower viral loads may have been missed. However, limited data suggest that serial antigen tests conducted every 2-3 days have similar sensitivity to PCR for detecting infection during the full course of an infection. [9,10] Finally, differences in behavior among those vaccinated and unvaccinated, such as masking or social distancing, were not assessed in this analysis.

This investigation demonstrates the effectiveness of mRNA vaccination among residents of a skilled nursing facility in the setting of a Beta variant outbreak. Though the variant currently has low circulation in the United States, understanding the protection from vaccination for this variant is important for public health planning if closely-related variants emerge. In addition to other non-pharmaceutical mitigation measures, vaccination of residents and staff in skilled nursing facilities remains key to preventing COVID-19. Additionally, even in facilities with high vaccine coverage, infection prevention and control efforts remain important for protecting residents and limiting the transmission of COVID-19.

FOOTNOTES:

§ Symptoms include: fever, chills, cough, shortness of breath, difficulty breathing, myalgias, headache, sore throat, new loss of taste or smell, rhinorrhea or nasal congestion, abdominal pain, nausea/vomiting, diarrhea, unexplained fall, confusion/altered mental status, anorexia, or lethargy

§§ Artic V3 amplification protocol: https://artic.network/resources/ncov/ncov-amplicon-v3.pdf

§§§ This investigation was defined as having met the requirements for public health surveillance as outlined in 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq."

NOTES

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC).

Supplement sponsorship

This article appears as part of the supplement “Vaccines, Variants, and Vigilance: Strengthening the COVID-19 Public Health Response through Partnerships and Collaborations”, supported by the Infectious Diseases Society of America through Cooperative Agreement NU50CK000574 with the U.S. Centers for Disease Control and Prevention.

Conflicts of Interest

All authors submitted ICMJE forms and have no conflicts to report.

REFERENCES

1. CDC. Testing of Residents in Long Term Care Facilities. Testing Guidelines for Nursing Homes | CDC. Accessed August 12, 2021.
2. 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. MMWR Morb Mortal Wkly Rep 2021;70:1163-1166.
3. Britton A, Jacobs Slifka KM, Edens C, et al. Effectiveness of the Pfizer-BioNTech COVID-19 Vaccine Among Residents of Two Skilled Nursing Facilities Experiencing COVID-19 Outbreaks — Connecticut, December 2020–February 2021. MMWR Morb Mortal Wkly Rep 2021;70:396–401.
4. Abu-Raddad et al. Effectiveness of the BNT162b2 Covid-19 Vaccine against the B.1.1.7 and B.1.351 Variants. NEJM July 2021.
5. Pearson CAB, Russell TW, Davies NG, et al. Estimates of severity and transmissibility of novel South Africa SARS-CoV-2 variant 501Y.V2. Retrieved from: pdf (cmmid.github.io)
6. Chemaitelly, H., Yassine, H.M., Benslimane, F.M. et al. mRNA-1273 COVID-19 vaccine effectiveness against the B.1.1.7 and B.1.351 variants and severe COVID-19 disease in Qatar. Nat Med (2021).
7. Lefevre et al. Impact of B.1.351 (beta) SARS-CoV-2 variant on BNT162b2 mRNA vaccine effectiveness in longterm care facilities of eastern France: a retrospective cohort study. MedRxJuly 2021
8. Ehrlich HY, Harizaj A, Campbell L, et al. SARS-CoV-2 in Nursing Homes after 3 Months of Serial, Facility-wide Point Prevalence Testing, Connecticut, USA. Emerg Infect Dis. 2021;27(5):1288-1295.
9. CDC. Variant Surveillance: CDC COVID Data Tracker. Accessed August 12, 2021.
10. Okoye, N.C., et al., Performance Characteristics of BinaxNOW COVID-19 Antigen Card for Screening Asymptomatic Individuals in a University Setting. J Clin Microbiol, 2021. **59**(4).
11. Levine-Tiefenbrun et al. Initial report of decreased SARS-CoV-2 viral load after inoculation with the BNT162b2 vaccine. Nature Medicine, 2021.

Table 1. Characteristics and outcomes of residents in a Virginia skilled nursing facility experiencing an outbreak of the Beta variant, by vaccine status, March 8-April 30, 2021.

	Fully Vaccinated (%)^	**Unvaccinated (%)**	**Total (%)**
Total residents	49	42	91
Sex			
Male	20 (40.8%)	14 (33.3%)	34 (37.4%)
Age group in years			
<60	8 (16.3%)	1 (2.4%)	9 (9.9%)
60-64	3 (6.1%)	6 (14.3%)	9 (9.9%)
65-69	10 (20.4%)	5 (11.9%)	15 (16.5%)
70-74	4 (8.2%)	9 (21.4%)	13 (14.3%)
75-79	6 (12.2%)	9 (21.4%)	15 (16.5%)
80-84	4 (8.2%)	4 (9.5%)	8 (8.8%)
≥85	14 (28.6%)	8 (19.0%)	22 (24.2%)
Race			
American Indian/Alaska Native	0 (0.0%)	0 (0.0%)	0 (0.0%)
Asian	0 (0.0%)	0 (0.0%)	0 (0.0%)
Black	15 (30.6%)	11 (26.2%)	26 (28.6%)
Other/multiple races	1 (2.0%)	0 (0.0%)	1 (1.1%)
White	33 (67.3%)	28 (66.7%)	61 (67.0%)
Unknown	0 (0.0%)	3 (7.1%)	3 (3.3%)
Ethnicity			
Hispanic	3 (6.1%)	3 (7.1%)	6 (6.6%)
Non-Hispanic	44 (89.8%)	37 (88.1%)	81 (89.0%)
Unknown	2 (4.1%)	2 (4.8%)	4 (4.4%)
Known prior SARS-CoV-2 infection			
None	24 (49.0%)	29 (69.0%)	53 (58.2%)
Yes: > 90 days prior to start of outbreak (prior to Dec 8)	25 (51.0%)	13 (31.0%)	38 (41.8%)
Underlying medical conditions			
Obesity	5 (10.2%)	7 (16.7%)	12 (13.2%)
Chronic kidney disease	8 (16.3%)	11 (26.2%)	19 (20.9%)
End stage renal disease requiring dialysis	3 (6.1%)	0 (0.0%)	3 (3.3%)
Diabetes	16 (32.7%)	14 (33.3%)	30 (33.0%)
Cancer	6 (12.2%)	5 (11.9%)	11 (12.1%)
Autoimmune Condition	0 (0.0%)	1 (2.4%)	1 (1.1%)
Cardiovascular Disease	24 (49.0%)	18 (42.9%)	42 (46.2%)
Hypertension	27 (55.1%)	25 (59.5%)	52 (57.1%)
Chronic respiratory disease[¥]	8 (16.3%)	8 (19.0%)	16 (17.6%)
Immunosuppressive disease or medication	2 (4.1%)	2 (4.8%)	4 (4.4%)

Other*	10 (20.4%)	11 (26.2%)	21 (23.1%)
Neurologic condition	46 (93.9%)	41 (97.6%)	87 (95.6%)
≥1 of above conditions	46 (93.9%)	41 (97.6%)	87 (95.6%)
≥2 of above conditions	41 (83.7%)	36 (85.7%)	77 (84.6%)
Documented SARS-CoV-2 infection during outbreak	10 (20.4%)	18 (42.9%)	28 (30.8%)
Clinical outcomes among cases (n=28)			
Symptomatic COVID-19 infection**	6 (60.0%)	14 (77.8%)	20 (71.4%)
Hospitalization	2 (20.0%)	11 (61.1%)	13 (46.4%)
Intensive care unit admission	0 (0.0%)	1 (5.6%)	1 (3.6%)
Death	1 (10.0%)	4 (22.2%)	5 (17.9%)
Sequence results available (n=4)			
Beta variant (B.1.351)***	3 (75.0%)	1 (25.0%)	4 (100%)

^ Fully vaccinated is defined as ≥14 days after dose 2.

[¥] Asthma, chronic obstructive pulmonary disease, sleep apnea, other chronic respiratory disease

*Other conditions included: malnutrition, chronic hepatitis C, cirrhosis, colitis.

**Percentage of documented infections by vaccine status. Residents were considered symptomatic if they had a laboratory-confirmed SARS-CoV-2 infection with new onset or increased severity of a clinically relevant symptom (fever, chills, cough, shortness of breath, difficulty breathing, myalgias, headache, sore throat, new loss of taste or smell, rhinorrhea or nasal congestion, abdominal pain, nausea/vomiting, diarrhea, unexplained fall, confusion/altered mental status, anorexia, or lethargy) present within 7 days before or 14 days after the positive test collection date within the investigation period.

***Percentage of residents with sequenced results available by vaccine status.