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Adverse Events Following One Dose of mRNA COVID-19 Vaccination among U.S. Nursing Home Residents with and without a Previous SARS-CoV-2 Infection

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Abstract

Objectives: To compare rates of adverse events following COVID-19 vaccination among nursing home residents with and without previous SARS-CoV-2 infection.

Design: Prospective cohort.

Setting and Participants: 20,918 nursing home residents who received the first dose of mRNA COVID-19 vaccine from December 18, 2020 through February 14, 2021 in 284 facilities within Genesis Healthcare, a large nursing home (NH) provider spanning 24 U.S. states.

Methods: We screened the electronic health record for adverse events, classified by the Brighton Collaboration, occurring within 15 days of residents' first COVID-19 vaccine dose. All events were confirmed by physician chart review. To obtain risk ratios, multilevel logistic regression model that accounted for clustering (variability) across nursing homes was implemented. To balance the probability of prior SARS-CoV-2 infection (previous positive test or ICD-10-CM

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Conflict of Interest Statement:
SG reports conflicts with vaccine manufacturers related to grants, consulting and speaking engagements: Sanofi, Seqirus, Pfizer. SG also consults with other pharmaceutical companies such as Longevoron, Janssen, and Merck. SG has grants with Sunovion and Essity. The other authors have no conflicts of interest.

diagnosis) more than 20 days prior to vaccination, we used inverse probability weighting. To adjust for multiplicity of adverse events tested, we used a false discovery rate procedure.

Results: Statistically significant differences existed between those without (n=13,163) and with previous SARS-CoV-2 infection (symptomatic (n=5,617) and asymptomatic (n=2,138)) for all baseline characteristics assessed. Only one adverse event was reported among those with previous SARS-CoV-2 infection (asymptomatic), venous thromboembolism (46.8 per 100,000 residents 95%CI 8.3, 264.5) which was not significantly different from the rate reported for those without previous infection (30.4 per 100,000 95%CI: 11.8, 78.1). Several other adverse events were observed for those with no previous infection, but were not statistically significantly higher than those reported with previous infection after adjustments for multiple comparisons.

Conclusions and Implications: Although reactogenicity increases with pre-existing immunity, we did not find that vaccination among those with previous SARS-CoV-2 infection resulted in higher rates of adverse events than those without previous infection. This study stresses the importance of monitoring novel vaccines for adverse events of in this vulnerable population.

Brief Summary:

Our study suggests that frail, nursing home residents with a previous SARS-CoV-2 infection, whether symptomatic or not, were not at higher risk of adverse events following vaccination, compared with those who had no previous infection.

Keywords

Adverse events after vaccination; nursing home; COVID-19 vaccination; SARS-CoV-2 Infection

Introduction

Little is known about vaccine-related adverse events following COVID-19 vaccination among adults with prior SARS-CoV-2 infection. One study found that adults with pre-existing natural immunity at time of vaccination more frequently reported side effects such as injection site pain, swelling and erythema as well as systemic symptoms such as fatigue and headaches, after the first dose of either of the mRNA vaccines, compared to those without a previous infection.[1] Given that reactogenicity increases with pre-existing immunity, such side effects are biologically plausible. However, age-related declines in immune system function might suggest that we would not observe the same reactogenicity in the nursing home population. Regardless, no studies have assessed significant adverse events, such as acute myocardial infarction or stroke, following COVID-19 vaccination among older adults with previous SARS-CoV-2 infection.

We observed in a prior study that, compared to unvaccinated nursing home residents, vaccinated residents experienced similar adverse events rates following the first or second COVID-19 mRNA vaccine dose.[2] In that study, residents were classified as vaccinated or unvaccinated, regardless of previous SARS-CoV-2 infection, except those who had tested positive for SARS-CoV-2 within 20 days prior to vaccination were excluded to be consistent with CDC guidelines.[3] Here we compare rates of adverse events following vaccination for nursing home residents with: (1) with no prior infection; (2) symptomatic infection prior

vaccination, excluding within 20 days of vaccination; and (3) asymptomatic infection prior to vaccination, excluding within 20 days of vaccination.

Methods

Our study population included 20,918 nursing home residents of 284 facilities within Genesis Healthcare, a large nursing home provider spanning 24 U.S. states. De-identified electronic health record (EHR) data from January 2020 to present were collected from the study population containing daily residents' dispositions, vaccinations, diagnoses, SARS-CoV-2 testing records, nursing documentation on symptoms, and other clinical data. Genesis coordinated with The Centers for Disease Control and Preventions (CDC)'s Pharmacy Partnership of Long-term Care Program to provide each of their nursing homes with three COVID-19 vaccine clinics carried out over a three-month period to vaccinate residents and staff. The vaccine received (e.g., Moderna or Pfizer-BioNTech) varied by state. The Brown University Institutional Review Board approved this study.

Study Design

The study residents received their first dose of mRNA vaccine between December 18, 2020 and February 14, 2021. Consistent with CDC guidelines,[3] we excluded residents with a positive SARS-CoV-2 diagnostic test within 20 days prior to vaccination, as well as those treated with SARS-CoV-2 monoclonal antibodies for 90 days prior to vaccination.

Exposure groups

The three groups compared included those who, at time of vaccination, had (1) no previous diagnosis of SARS-CoV-2, (2) previous infection with symptoms (more than 20 days before vaccination), and (3) previous infection without symptoms symptoms (more than 20 days before vaccination). For residents with prior SARS-CoV-2 infection, we obtained symptom data from change in condition notes which nurses complete when residents present with any new symptoms. We classified residents as having asymptomatic or symptomatic infection based on whether they had any SARS-CoV-2-related symptoms from five days before up to 14 days after a positive test or diagnosis.

Outcomes

Serious outcomes such as mortality were monitored for seven days post-vaccination. If a resident died in the hospital shortly after transfer, or when they were expected to return to a Genesis facility, Genesis was notified of the death, and thus the death was captured in this analysis. Other adverse events that could manifest somewhat longer post-vaccination were monitored for 15 days using ICD-10-CM codes included in residents' EHR problem lists. Those events, listed in Table 1, were classified by the Brighton Collaboration[4] using ICD-10-CM codes for diagnoses and exclusions available from the CDC's Vaccine Safety Datalink.[5] For most events, prevalent cases were excluded to ensure capturing only incident cases.

Physician Chart Reviews

Physician chart review was conducted on all flagged cases of adverse events to confirm the diagnoses. To do this, the de-identified EHR record was shared back with Genesis for secure linkage to the original medical record number, so that the physician could review the resident's chart directly in the nursing home's EHR. The purposes of the chart reviews were to identify whether events were incident (new onset), recent prevalent conditions (within the past 30 days), or incorrectly coded diagnoses.

Statistical Analysis

We used SAS version 9.4 software for data management and to compute frequencies and chi-squared tests to assess statistical differences in baseline characteristics of residents. Adverse events identified, and their rates and 95% Wilson's confidence intervals (CI) were calculated per 100,000 residents.[6] We used STATA version 16 software for the adjusted analysis, using multilevel logistic regression which adjusted for clustering (variability) across nursing homes. To balance the probability of prior SARS-CoV-2 infection more than 20 days prior to vaccination, we used inverse probability weighting. This was incorporated into the logistic regression model to adjust for the baseline probability of prior SARS-CoV-2 infection. A sandwich estimator was used to account for correlation within facilities.[7,8] Variables in the propensity score model included age, sex, race/ethnicity, diabetes, COPD, chronic kidney disease, congestive heart failure, coronary artery disease, dementia, hypertension, activities of daily living score, mortality risk and cognitive function scale score. To adjust for multiplicity, we used a false discovery rate procedure.[9]

Sensitivity analysis

Although the focus of this study was to determine whether adverse event rates after vaccination differed between those with and without previous SARS-CoV-2 infection, we also compared the incidence of adverse events among the vaccinated and unvaccinated groups. Because our population was mostly vaccinated by mid-February 2021, the best unvaccinated comparator group was the 'yet-to-be vaccinated', unvaccinated population from our previous study.[2] Details on the unvaccinated group are published elsewhere.[2] To obtain a large enough sample of residents with previous infection, with and without symptoms, we included all residents who received the first dose from December 18, 2020 through February 14, 2021.

Results

We included 20,918 residents across 284 nursing homes that received their first mRNA vaccine dose between December 18, 2020 and February 14, 2021. Statistically significant differences existed between those without (n=13,163) and with previous SARS-CoV-2 infection (symptomatic (n=5,617) and asymptomatic (n=2,138)) for all baseline characteristics assessed. (Table 2) For example, higher proportions of residents with prior infection, symptomatic or asymptomatic, were long-stay (lived in the nursing home 100 or more days) than those with no prior infection. Male residents were more likely to have had no previous SARS-CoV-2 infection than female residents. Similarly, residents <65 years were more likely to have had no previous SARS-CoV-2 infection than were older residents;

and cognitively intact residents were also more likely to have had no previous infection compared with cognitively impaired residents. Those with previous symptomatic infection were more likely to have comorbidities than the other two groups.

Adverse Events

Chart reviews were conducted to verify events identified using ICD-10-CM codes. One case occurred within 15 days after vaccination among those who had no previous SARS-CoV-2 infection (7.6 per 100,000 (95% CI: 1.3, 43.0)) that did not occur among those with a previous SARS-CoV-2 infection for the following events: acute myocardial infarction, Bell's Palsy, hemorrhagic stroke, ischemic stroke, and pulmonary embolism. In addition, three cases of seizures occurred among those with no previous infection whereas none occurred among those with previous infection. Four cases of venous thromboembolism occurred among those with no previous infection (30.4 per 100,000 (95% CI: 11.8, 78.1)) and one case occurred among those with a previous asymptomatic infection (46.8 per 100,000 (95% CI: 8.3, 264.5)).

Compared to residents with no previous SARS-CoV-2 infection, we observed statistically significantly lower adjusted mortality rates among residents with previous symptomatic infection (risk ratio (RR): 0.61, 95%CI: 0.49, 0.76) and residents with previous asymptomatic infection (RR: 0.51, 95%CI: 0.35, 0.73).

In sensitivity analyses comparing rates of adverse events among residents vaccinated with no previous SARS-CoV-2 infection to the unvaccinated from our previous study,[2] we found no statistically significant difference in rates for venous thromboembolism (RR: 0.46, 95%CI 0.05, 4.02) or for pulmonary embolism (RR: 0.42, 95%CI 0.04, 4.58). After adjustment for multiple testing, we found that none of these *p*-values were statistically significant: acute myocardial infarction (0.51); Bell's Palsy (0.51); hemorrhagic stroke (0.51); ischemic stroke (0.42); seizures (0.42); pulmonary embolism (0.53); and venous thromboembolism (0.53).

Discussion

Although reactogenicity increases with pre-existing immunity,[10] we did not observe higher rates of adverse events among nursing home residents with versus without prior natural infection. In fact, our study suggests that SARS-CoV-2 infection, regardless of whether it was symptomatic or asymptomatic, did not increase the risk of adverse events following COVID-19 vaccination. Although we identified some adverse events following vaccination among those with no previous SARS-CoV-2 infection that did not occur among the unvaccinated, no differences in rates were statistically significant after adjustment for multiplicity using a false discovery rate procedure.[9]

One reason for the lower mortality among those with previous SARS-CoV-2 infection, symptomatic or asymptomatic, compared to those with no previous infection could be selective survival, or immortal time bias.[11] In other words, those who survived SARS-CoV-2 infection and were healthy enough to get vaccinated months later may have been less likely to die than those coming into the nursing home with no previous infection, even after adjustments for comorbidities. Because of the disparity in long-stay (i.e., those with previous

infection were more likely to be long-stay than those with no previous infection), we ran the mortality analyses excluding short-stay residents, and mortality remained statistically significantly lower among those with previous SARS-CoV-2 infection, symptomatic or asymptomatic, than those with no previous infection (results not presented). Moreover, younger (<65 years) residents were more likely to have had no previous infection whereas older (aged 85 years and older) residents were more likely to have had a previous asymptomatic infection. Thus, those older adults with previous asymptomatic infection may have been 'healthier' than the younger adults who entered the nursing home without a previous infection.

Our study had a few key limitations. First, there were significant differences in baseline characteristics between those with no previous SARS-CoV-2 infection and those with previous symptomatic or asymptomatic infection. We used inverse probability weighting to adjust for the baseline probability of previous SARS-CoV-2 infection based on observed values. However, there are still indications that there may be other unobserved factors that may influence the lack of significant evidence for differences in adverse events rates among these populations. Second, to conduct timely analyses, adverse events were only included if they were diagnosed by the medical provider with a supporting ICD-10-CM code. Third, the relatively small sample size to assess rare adverse events resulted in an inability to generate precise estimates. However, the extremely low number of suspected adverse events was reassuring and an important finding of the study.

This study contributes new evidence that older, frail nursing home residents with previous SARS-CoV-2 infection do not seem to be at higher risk of adverse events following the first dose of mRNA vaccine than their vaccinated counterparts with no previous infection, nor do they seem to be at a higher risk of adverse events compared to their unvaccinated counterparts. In addition, it is important to stress the finding in our previous study that mortality rates after vaccination were not higher than mortality rates among the unvaccinated.[2] This research supports previous reports from the original randomized trials of these vaccines,[12,13] although nursing home residents were not included in those trials. Moreover, the mRNA-based vaccines have demonstrated safety, and offer the prospect of being life-saving for nursing home residents who have borne a disproportionate share of morbidity and mortality from COVID-19.[14]

Conclusions and Implications

Our study suggests that frail, nursing home residents with a previous SARS-CoV-2 infection, whether symptomatic or not, were not at higher risk of adverse events following vaccination, compared with those who had no previous infection. This study further stresses the importance of having the infrastructure to support near real-time monitoring of adverse events, safety and efficacy of novel vaccines in this vulnerable population.

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References

1. Krammer FS, PARIS team, Simon V. Robust spike antibody responses and increased reactogenicity in seropositive individuals after a single dose of SARS-CoV-2 mRNA vaccine. . MedRxiv [Preprint]. 2021.
2. Bardenheier BH, Gravenstein S, Blackman C, et al. Adverse events following mRNA SARS-CoV-2 vaccination among U.S. nursing home residents. Vaccine. 2021;39(29):3844–3851. [PubMed: 34092431]
3. Centers for Disease and Prevention. Frequently Asked Questions about COVID-19 Vaccination. https://www.cdc.gov/coronavirus/2019-ncov/vaccines/faq.html. Published 2021. Accessed 07/15/2021.
4. Brighton Collaboration. Priority List of Adverse Events of Special Interest: COVID-19. The Task Force for Global Health. https://brightoncollaboration.us/wp-content/uploads/2021/01/SO2_D2.1.2_V1.2_COVID-19_AESI-update-23Dec2020-review_final.pdf. Published 2020. Accessed 03/11/2021.
5. Vaccine Safety Datalink. Rapid Cycle Analysis (RCA) to monitor the safety of COVID-19 vaccines in near real-time within the Vaccine Safety Datalink. Centers for Disease Control and Prevention. https://www.cdc.gov/vaccinesafety/pdf/VSD-1342-COVID19-RCA-Protocol_FinalV1.1_508.pdf. Published 2021. Accessed 06/01/2021.
6. Brown LD, Cai TT, DasGupta A, et al. Interval estimation for a binomial proportion - Comment - Rejoinder. Statistical Science. 2001;16(2):101–133.
7. Royall RM. Model Robust Confidence-Intervals Using Maximum-Likelihood Estimators. International Statistical Review. 1986;54(2):221–226.
8. Cattaneo MD. Efficient semiparametric estimation of multi-valued treatment effects under ignorability. J Econometrics. 2010;155(2):138–154.
9. Benjamini Y, Hochberg Y. Controlling the False Discovery Rate - a Practical and Powerful Approach to Multiple Testing. J R Stat Soc B. 1995;57(1):289–300.
10. Ossato A, Tessari R, Trabucchi C, Zuppini T, Realdon N, Marchesini F. Comparison of medium-term adverse reactions induced by the first and second dose of mRNA BNT162b2 (Comirnaty, Pfizer-BioNTech) vaccine: a post-marketing Italian study conducted between 1 January and 28 February 2021. Eur J Hosp Pharm. 2021.
11. Hernan MA, Sauer BC, Hernandez-Diaz S, Platt R, Shrier I. Specifying a target trial prevents immortal time bias and other self-inflicted injuries in observational analyses. Journal of clinical epidemiology. 2016;79:70–75. [PubMed: 27237061]
12. Polack FP, Thomas SJ, Kitchin N, et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. The New England journal of medicine. 2020;383(27):2603–2615. [PubMed: 33301246]
13. Chen M, Yuan Y, Zhou Y, et al. Safety of SARS-CoV-2 vaccines: a systematic review and meta-analysis of randomized controlled trials. Infect Dis Poverty. 2021;10(1):94. [PubMed: 34225791]
14. Grabowski DC, Mor V. Nursing Home Care in Crisis in the Wake of COVID-19. Jama. 2020;324(1):23–24. [PubMed: 32442303]

Table 1.

Adverse Events Monitored

Acute Disseminated Encephalomyelitis (ADEM)
Acute Myocardial Infarction (AMI)
Acute Respiratory Distress Syndrome (ARDS)
Anaphylaxis
Appendicitis
Bell's Palsy
Convulsions/Seizures
Disseminated Intravascular Coagulation
Encephalitis/Myelitis/Encephalomyelitis/Encephalopathy
Guillain-Barré syndrome (GBS)
Thrombotic thrombocytopenic purpura (TTP)
Immune thrombocytopenia (ITP)
Multisystem Inflammatory Syndrome in Adults (MIS-A)
Myocarditis / pericarditis
Narcolepsy and cataplexy
Stroke, hemorrhagic
Stroke, ischemic
Transverse myelitis (TM)
Venous thromboembolism (VTE)
Pulmonary Embolism (PE)
Death

Table 2.

Demographic and Clinical Characteristics of Vaccinated Nursing Home Residents by Previous SARS-CoV-2 Status

		No Previous SARS-CoV-2 diagnosis or positive test	Previous SARS-CoV-2 diagnosis or positive test with symptoms	Previous SARS-CoV-2 diagnosis or positive test without symptoms	
		N (%)	N (%)	N (%)	
Long Stay (> 100 days)	14681 (73.2)	8072 (63.8)	5107 (94.8)	1502 (74.5)	<0.01
Short Stay (≤ 100 days)	5380 (26.8)	4587 (36.2)	278 (5.2)	515 (25.5)	
Sex					<0.01
Male	7973 (38.1)	5156 (39.2)	2038 (36.3)	779 (36.5)	
Female	12938 (61.9)	8001 (60.8)	3579 (63.7)	1358 (63.5)	
Age Group (years)					0.01
<65	3874 (18.5)	2494 (19.0)	1027 (18.3)	353 (16.5)	
65-74	4891 (23.4)	3037 (23.1)	1379 (24.6)	475 (22.2)	
75-84	5918 (28.3)	3719 (28.2)	1602 (28.5)	597 (27.9)	
≥85	6235 (29.8)	3913 (29.7)	1609 (28.6)	713 (33.4)	
Race/Ethnicity					
Black	2551 (12.2)	1533 (11.7)	764 (13.6)	254 (11.9)	<0.01
Hispanic	980 (4.7)	566 (4.3)	298 (5.3)	116 (5.4)	<0.01
Comorbidities					
COPD	5614 (27.1)	3441 (26.5)	1660 (29.7)	513 (24.3)	<0.01
Dementia	9232 (44.6)	5336 (41.1)	2870 (51.3)	1026 (48.5)	<0.01
Coronary artery disease	5385 (26.0)	3366 (25.9)	1532 (27.4)	487 (23.0)	<0.01
Diabetes	8124 (38.9)	5054 (38.5)	2313 (41.2)	757 (35.4)	<0.01
Congestive heart failure	4944 (23.9)	3105 (23.9)	1426 (25.5)	413 (19.5)	<0.01
Chronic kidney disease	5714 (27.6)	3638 (28.0)	1572 (28.1)	504 (23.8)	<0.01
Hypertension	16394 (79.3)	10175 (78.4)	4577 (81.8)	1642 (77.7)	<0.01
Cognitive Function Scale					<0.01
Cognitively Intact	6009 (29.0)	4152 (31.9)	1301 (23.2)	556 (26.3)	
Mildly Impaired	4961 (23.9)	3094 (23.7)	1352 (24.2)	515 (24.4)	
Moderately Impaired	6811 (32.9)	4034 (31.0)	2035 (36.4)	742 (35.2)	

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		No Previous SARS-CoV-2 diagnosis or positive test	Previous SARS-CoV-2 diagnosis or positive test with symptoms	Previous SARS-CoV-2 diagnosis or positive test without symptoms	
		N (%)	N (%)	N (%)	
Severely Impaired	2949 (14.2)	1746 (13.4)	905 (16.2)	298 (14.1)	
ADL score, mean (SD)	19.2 (5.5)	19.0 (5.5)	19.7 (5.5)	18.6 (5.8)	<0.01
ADL dependency quartile					
0-17	5521 (26.4)	3567 (27.2)	1330 (23.7)	624 (29.3)	
18-20	5935 (26.8)	3769 (28.7)	1273 (22.7)	551 (25.8)	
21-22	4457 (21.4)	2692 (20.5)	1301 (23.1)	464 (21.7)	
23-28	5306 (25.4)	3099 (23.6)	1711 (30.5)	496 (23.2)	

Note: Includes all residents that received at least one dose of vaccine

*
Indicates chi-squared test p-value

Table 3.

Adverse Events Diagnosed among Vaccinated Residents by Previous SARS-CoV-2 Status

	No Previous SARS-CoV-2 diagnosis or positive test n=13,163		Previous SARS-CoV-2 diagnosis or positive test with symptoms n=5,617				Previous SARS-CoV-2 diagnosis or positive test without symptoms n=2,138		
					Previous symptomatic vs no previous	Previous symptomatic vs asymptomatic			Previous asymptomatic vs no previous
	n	Unadjusted Rate Per 100,000[1]	n	Unadjusted Rate Per 100,000[1]	Adjusted Risk Ratio	Adjusted Risk Ratio	n	Unadjusted Rate Per 100,000[1]	
15-day event rates									
Acute Myocardial Infarction (AMI)	1	7.6 (1.3, 43.0)	0	-	-	-	0	-	-
Bell's Palsy	1	7.6 (1.3, 43.0)	0	-	-	-	0	-	-
Convulsions/Seizures	3	22.8 (7.8, 67.0)	0	-	-	-	0	-	-
Stroke, hemorrhagic	1	7.6 (1.3, 43.0)	0	-	-	-	0	-	-
Stroke, ischemic	1	7.6 (1.3, 43.0)	0	-	-	-	0	-	-
Venous thromboembolism (VTE)	4	30.4 (11.8, 78.1)	0	-	-	-	1	46.8 (8.3, 264.5)	1.77 (0.20, 15.78)
Pulmonary Embolism (PE)	1	7.6 (1.3, 43.0)	0	-	-	-	0	-	-
7-day event rates									
Death	93	706.5 (577.1, 864.7)	31	551.9 (389.1, 782.3)	0.61 (0.49, 0.76)	1.20 (0.81, 1.77)	12	561.3 (321.4, 978.5)	0.51 (0.35, 0.73)

[1] Wilson's 95% Confidence Intervals

Adjusted risk ratios: Inverse probability weighting was used to adjust the probability of previous SARS-CoV-2 diagnosis by age, gender, race/ethnicity, diabetes, COPD, renal disease, hypertension, congestive heart failure, coronary heart disease, dementia, cognitive function, mortality risk and physical function.

Note: Residents with a positive SARS-CoV-2 test within 20 days of vaccination (since they should not have been vaccinated), or who were on monoclonal antibodies within 90 days of vaccination were excluded. Previous SARS-CoV-2 diagnosis or positive test were 21 or more days prior to vaccination. Symptoms presented within the 5 days prior to or up to 14 days after the previous SARS-CoV-2 diagnosis or positive test.