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COVID-19 Vaccination Improved Outcomes in the Treatment of Geriatric Hip Fractures Between December 2020 and January 2022

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Abstract

Introduction: Geriatric hip fracture patients are at high risk for perioperative morbidity and mortality from COVID-19. This study analyses the impact of COVID-19 vaccination on geriatric hip fracture outcomes. We hypothesise that having the COVID-19 vaccine improves outcomes for geriatric patients treated for hip fracture.

Methods: Between December 2020 and January 2022, 506 patients treated for hip fracture were analysed for demographics, hospital quality measures, and outcomes. Patients were grouped according to vaccine series administration status. During the study period, there were 329 (65%) unvaccinated patients (NV), 14 (3%) partially vaccinated (PV) patients, 138 (27%) fully vaccinated (FV) patients, and 25 (5%) patients received a booster shot (BV). Variables were compared using chi square, independent sample *t*-tests or ANOVA as appropriate. Multivariable logistic regression was used to independently assess the impact of vaccination.

Results: The rate of minor complications decreased if any vaccination status was achieved (NV: 37.99%, PV: 21.34%, FV: 28.26%, BV: 20.00%; $p = 0.054$). Vaccinated patients had a decreased need for Intensive Care Unit (ICU) level care (NV: 14.89%, PV: 7.14%, FV: 5.80%, BV: 8.00%; $p = 0.038$). There were no differences in inpatient or 30-day mortality, major complications, length of stay, home discharge, or readmission within 30 or 90 days. Vaccination against COVID-19 was independently protective against the need for ICU level care. Additionally, female gender and vaccination against COVID-19 decreased the rate of minor complications. Older age and higher comorbidity burden increased the rate of minor complications.

Discussion: In the hip fracture population, vaccination against COVID-19 was protective against the need for ICU level care and decreased overall minor complications. Larger studies are needed to determine if vaccination decreases mortality in this population. These findings have resource allocation implications including ICU bed availability during pandemics and patient outreach to improve vaccination status.

Keywords

COVID-19 vaccination, geriatric, hip fracture, ICU, outcomes

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Introduction

Since the onset of the COVID-19 pandemic in the spring of 2020, the landscapes of both medicine and society have changed drastically. As of 10 March 2022, the worldwide case total for COVID-19 stands at 450,229,635 with 6,019,085 deaths. There have been 10,704,043,684 vaccine doses administered worldwide.[1] The United States case total stands at 79,248,406 with 961,620 deaths. 81.4% of people ⩾5 years have received at least 1 dose of the COVID-19 vaccine. As of 10 March 2022, in the United

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States, 254.4 million people (76.6% of the US population) have been partially vaccinated, 216.4 million people (65.2%) have been fully vaccinated, and 95.6 million people (44.2%) have received a booster dose.[2] With new and rapidly changing variants, these numbers as well as the wider societal and medical impacts, change daily.

Older individuals and those who are immunocompromised are at the highest risk for severe COVID-19 infection with increased risk of hospitalisation, needing the intensive care unit (ICU), requiring a ventilator, and dying.[3] According to the Centers for Disease Control and Prevention (CDC), more than 81% of COVID-19 related deaths occur in people >65 years old. The number of deaths among people <65 years old is 80 times higher than the number of deaths among people aged 18–29 years.[3]

Amidst this backdrop of COVID-19, geriatric hip fractures have continued to occur with regular frequency.[4] Hip fractures are a public health concern due to their increasing frequency in the geriatric population, their high rate of mortality and morbidity, and their overall cost to the healthcare system.[5–7] Timely medical optimisation and surgical intervention is critical to improve functional outcomes and reduce morbidity and mortality risk. 2 separate studies from the spring of 2020 during the pandemic onset within New York City demonstrated that COVID-19 positivity was an independent risk-factor for inpatient mortality in geriatric hip fracture patients.[8,9] Strategies to minimise perioperative risk in this vulnerable population are critical for public health.

As the pandemic has evolved, the medical community has developed the knowledge base and novel tools to combat COVID-19 more effectively, especially with the introduction of vaccines in late 2020. In the US, this started with the Pfizer-BioNTech (Pfizer) vaccine that was granted FDA Emergency Use Authorization (EUA) in December 2020 (and was granted full FDA approval in August 2021 for individuals >16 years old). The second vaccine to be released was the Moderna vaccine which also received EUA approval in December 2020 (full FDA approval granted in January 2022 for individuals >18 years old). The third vaccine to be approved in the US was the Johnson & Johnson (Janssen) 1-shot vaccine in February 2021.[10] Vaccination, even partial, has been shown to be effective in protecting against COVID-19 infection.[11] Further studies have demonstrated that the COVID-19 vaccine is a protective factor against hospital admissions, complications, and death as a result of COVID-19.[12]

With the emergence of the Delta variant and then the Omicron variant, the FDA authorised vaccine booster shots in the face of waning COVID-19 immunity.[13] The defensive antibodies developed through COVID-19 vaccination were found to decrease after around 6–7 months with decreasing vaccine effectiveness.[14,15] Research has shown that individuals who have been fully vaccinated including a booster shot have the most protection against COVID-19 infection.[16,17] Booster shots have been particularly emphasised for individuals age ⩾65 years and those who are immunocompromised.

The purpose of this study was to determine what impact the introduction of the COVID-19 vaccine and subsequent booster shot had on patients treated for hip fractures. We hypothesise that the COVID-19 vaccine and subsequent booster shot improves outcomes for geriatric hip fracture patients.

Methods

An Institutional Review Board approved geriatric trauma database was queried for all patients aged ⩾55 years who sustained a hip fracture through a low-energy mechanism between December 2020 and January 2022 and were treated at 1 academic medical centre. Patients were included if they had a subtrochanteric, femoral neck, or intertrochanteric hip fracture [AO/OTA fracture classifications: 31A, 31B, 32(A-C)]. Patients were excluded if they were <55 years or were injured in a high energy mechanism.

Demographics for each patient were collected, including age, body mass index (BMI), sex, hip fracture classification, baseline ambulatory status, and comorbidities (compiled via the Charlson Comorbidity Index (CCI)). Injury presentation variables collected were Glasgow Coma Scale (GCS), Abbreviated Injury Severity scores (AIS) for both the Head/Neck (AIS H/N) and Chest (AIS C). Patients were identified as COVID-19 positive if they had a positive COVID-19 RT-PCR test on admission to the hospital for their hip fracture. Patients were considered partially vaccinated (PV) if they had received only their first dose of the COVID-19 vaccine (Pfizer/Moderna), fully vaccinated (FV) if they had received either 2 shots of Pfizer/Moderna or 1 shot of Janssen, or boosted (BV) if they had received full vaccination as well as a booster shot prior to admission.

Hospital quality measures were collected and included length of stay (LOS) and need for ICU level care. Complications were recorded during each patient's index hospitalisation. Minor complications were considered to be pneumonia, acute renal failure/acute kidney injury (ARF/AKI), surgical site infection (SSI), decubitus ulcer, urinary tract infection (UTI), and anaemia. Major complications were considered to be sepsis/septic shock, deep vein thrombus/pulmonary embolism (DVT/PE), myocardial infarction (MI), stroke, acute respiratory failure (ARF), and cardiac arrest. Mortality measures collected included inpatient mortality and mortality within 30 days of hospital discharge. Readmission was considered within 30 and 90 days.

Patients were divided into PV, FV, BV, and non-vaccinated (NV) cohorts. A primary analysis was done comparing any vaccination status (included PV, FV, and BV

Table 1. Patient demographics.

Variables	Non-vaccinated	Partial	Full	Boosted	All patients	*p*-Value
Demographics	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	
Patients	329	14	138	25	506	
Age (years; mean ± SD)	80.41 ± 28.76	78.29 ± 7.99	79.59 ± 10.95	78.52 ± 8.89	80.03 ± 10.85	0.691
BMI (mean ± SD)	24.19 ± 8.75	23.48 ± 4.54	23.94 ± 4.86	24.38 ± 6.30	24.11 ± 5.14	0.918
CCI	1.41 ± 0.80	2.00 ± 1.92	1.75 ± 1.95	1.32 ± 1.49	1.51 ± 1.74	0.154
Gender						
Male	100 (30.40%)	3 (21.43%)	52 (37.68%)	10 (40.00%)	165 (32.61%)	0.288
Female	229 (69.60%)	11 (78.57%)	86 (62.32%)	15 (60.00%)	341 (67.39%)	
Race						
White	238 (72.34%)	10 (71.43%)	107 (77.54%)	21 (84.00%)	376 (74.31%)	0.692
Black	18 (5.47%)	0 (0.00%)	8 (5.80%)	0 (0.00%)	26 (5.14%)	
Hispanic	19 (5.78%)	1 (7.14%)	8 (5.80%)	0 (0.00%)	28 (5.53%)	
Asian	30 (9.12%)	2 (14.29%)	8 (5.80%)	1 (4.00%)	41 (8.10%)	
Other	10 (3.04%)	1 (7.14%)	5 (3.62%)	2 (8.00%)	18 (3.56%)	
Unknown	14 (4.26%)	0 (0.00%)	2 (1.45%)	1 (4.00%)	17 (3.36%)	
Ambulatory status						
Community	203 (61.70%)	9 (64.29%)	93 (67.39%)	22 (88.00%)	327 (64.62%)	0.184
Household	111 (33.74%)	5 (35.71%)	40 (28.99%)	2 (8.00%)	158 (31.23%)	
Non-ambulatory	15 (4.56%)	0 (0.00%)	5 (3.62%)	1 (4.00%)	21 (4.15%)	
COVID-19+	20 (6.08%)	0 (0.00%)	7 (5.07%)	1 (4.00%)	28 (5.53%)	0.759
Vaccine brand						
Pfizer	0 (0.00%)	7 (50.00%)	68 (49.28%)	19 (76.00%)	94 (18.58%)	–
Moderna	0 (0.00%)	4 (28.57%)	50 (36.23%)	6 (24.00%)	60 (11.86%)	
Janssen	0 (0.00%)	0 (0.00%)	13 (9.42%)	0 (0.00%)	13 (2.57%)	
Unknown	0 (0.00%)	3 (21.43%)	7 (5.07%)	0 (0.00%)	10 (1.98%)	

SD, standard deviation; BMI, body mass index; CCI, Charlson Comorbidity Index.

combined) patients to non-vaccinated (NV) patients. A subgroup analysis was performed comparing each vaccination status type to non-vaccinated patients. Demographic data were characterised through descriptive summary statistics. Continuous variables were compared with independent sample *t*-tests or the analysis of variance test (ANOVA). Categorical variables were compared with the chi-square test. Multivariable logistic regression analysis was performed to determine factors that affected outcomes based on initial univariate analysis. Statistics were calculated utilising IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Significance was defined with an alpha of 0.05.

Results

Between December 2020 and January 2022, there were 506 patients treated for hip fracture >55 years old. 329 patients (65%) were non-vaccinated, 14 (3%) were partially vaccinated, 138 (27%) were fully vaccinated, and 25 (5%) were boosted. There were 165 men (33%) and 341 women (67%). Mean age was 80.03 ± 10.85 years. Mean BMI was $24.11 \pm 5.14\,kg/m^2$ and mean CCI was 1.51 ± 1.74. Most patients were community ambulators (65%) at baseline. Most patients presented with OTA fracture classification 31A (55%) or 31B (44%). Most patients were repaired with a short intramedullary nail (218, 43%) or underwent a hemiarthroplasty (112, 22%) as treatment (Tables 1 and 2).

Between the non-vaccinated patients and all vaccinated cohorts there was no difference in age, gender, BMI, CCI, or ambulatory status among cohorts (Table 1). In both groups, treatment protocols were similar ($p = 0.189$) with most patients being repaired with a short intramedullary nail or undergoing a hemiarthroplasty (Table 2).

28 (6%) patients were COVID+ on admission, each of whom was symptomatic. Of the COVID+ patients, 20 (71%) were non-vaccinated and 8 (29%) were vaccinated (PV, FV, or BV). Among the vaccinated COVID+ patients, 0 (0%) were partially vaccinated, 7 (25%) were fully vaccinated, and 1 (4%) was boosted.

Patients with any vaccine status had a lower rate of both inpatient death (1.13% vs. 3.34%; $p = 0.133$) and 30-day mortality (4.52% vs. 6.69%; $p = 0.325$), however, this difference did not reach statistical significance (Table 3). Patients with any vaccine status had a significantly lower rate of minor complications compared to non-vaccinated patients (26.55% vs. 37.99%, $p < 0.01$). This difference in

Table 2. Patient injuries, treatments, and discharge locations.

Variables	Non-vaccinated	Partial	Full	Boosted	All patients	*p*-Value
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	
Fracture classification						
31A	182 (55.32%)	5 (35.71%)	74 (53.62%)	15 (60.00%)	276 (54.55%)	0.839
31B	145 (44.07%)	9 (64.29%)	63 (45.65%)	10 (40.00%)	227 (44.86%)	
32A	2 (0.61%)	0 (0.00%)	1 (0.72%)	0 (0.00%)	3 (0.59%)	
Treatment						
CRPP	34 (10.33%)	1 (7.14%)	15 (10.87%)	2 (8.00%)	52 (10.28%)	0.189
Hemiarthroplasty	64 (19.45%)	7 (50.00%)	34 (24.64%)	7 (28.00%)	112 (22.13%)	
THA	25 (7.60%)	0 (0.00%)	11 (7.97%)	1 (4.00%)	37 (7.31%)	
Long IMN	36 (10.94%)	0 (0.00%)	11 (7.97%)	0 (0.00%)	47 (9.29%)	
Short IMN	146 (44.38%)	5 (35.71%)	55 (39.86%)	12 (48.00%)	218 (43.08%)	
Sliding hip screw	5 (1.52%)	0 (0.00%)	3 (2.17%)	1 (4.00%)	9 (1.78%)	
Nonoperative	13 (3.95%)	0 (0.00%)	4 (2.90%)	1 (4.00%)	18 (3.56%)	
Transferred	1 (0.30%)	1 (7.14%)	0 (0.00%)	0 (0.00%)	2 (0.40%)	
Discharge location						
Home	34 (10.33%)	0 (0.00%)	13 (9.42%)	2 (8.00%)	49 (9.68%)	0.204
HHS	66 (20.06%)	4 (28.57%)	34 (24.64%)	8 (32.00%)	112 (22.13%)	
SNF	164 (49.85%)	8 (57.14%)	61 (44.20%)	8 (32.00%)	241 (47.63%)	
ARF	42 (12.77%)	1 (7.14%)	25 (18.12%)	7 (28.00%)	75 (14.82%)	
Other	22 (6.69%)	1 (7.14%)	5 (3.62%)	0 (0.00%)	28 (5.53%)	

CRPP, closed reduction percutaneous pinning; THA, total hip arthroplasty; IMN, intramedullary nail; HHS, home with health services; SNF, skilled nursing facility; ARF, acute rehabilitation facility.

minor complication rate was more pronounced in COVID+ patients (12.50% vs. 60.00%, $p = 0.023$).

There was no difference in rate of major complications between cohorts. Any vaccination status was associated with a decreased need for ICU level care (6.21% vs. 14.89%, $p < 0.01$). There was no difference in length of stay, rate of home discharge, readmission within 30 days, or readmission within 90 days. A subgroup analysis was performed comparing each vaccination status (PV vs. FV vs. BV) to non-vaccinated patients and similar results were obtained (Table 3).

Any vaccination status against COVID-19 was found to be independently protective against the need for ICU level care (OR 0.655, 95% CI 0.470-0.913, $p = 0.013$) (Table 4).

Factors associated with a decrease in minor complications were female gender (odds ratio [OR] 0.629; 95% confidence interval [CI], 0.416–0.951; $p = 0.028$) and a vaccination status against COVID-19 (OR 0.767; 95% CI, 0.628–0.937; $p < 0.01$). Factors associated with an increase in minor complications included older age (OR 1.040; 95% CI, 1.020–1.062; $p < 0.01$) and higher CCI (OR 1.140; 95% CI, 1.021–1.272, $p = 0.019$) (Table 5).

Discussion

The COVID-19 vaccines have been shown to be protective against COVID-19 infection and serious illness.[12,18,19] Public data from California in November 2021 demonstrated that patients who are vaccinated are 12.5x less likely to be hospitalised with COVID-19, and 13x less likely to die as a result of COVID-19.[20] A recent CDC study published in the New England Journal of Medicine compared the effectiveness of full and partial Pfizer and Moderna vaccination in health care workers. Both Pfizer and Moderna are 2-shot messenger RNA vaccines.[10,21,22] For Pfizer, vaccine effectiveness was found to be 77.6% for partial vaccination (1 shot) and 88.8% for full vaccination (2 shots). For Moderna, vaccine effectiveness was found to be 88.9% for partial vaccination (1 shot) and 96.3% for full vaccination (2 shots).[11] The Janssen vaccine is a 1-shot viral vector vaccine.[10] In clinical trials, the Janssen vaccine was found to be 66.3% effective at preventing COVID-19 infection.[23]

The vaccines have changed the fight against COVID-19, especially in the immunocompromised and elderly population. Vaccination efforts in high-risk populations have been instrumental in reducing mortality and risk of severe illness in these high-risk populations. In this study, we analysed the impact of the COVID-19 vaccine and booster in geriatric patients treated for hip fracture in 1 health system during the pandemic. Amidst the already high rates of mortality and morbidity found in hip fracture patients, having a thorough understanding of the impact of COVID-19 on this population and ways to minimise risks is a public health concern.

There have been many studies around the globe that have consistently shown that vaccination against COVID-19 is protective against severe infection, hospitalisation,

Table 3. Outcomes comparing the COVID+ versus COVID- patients within cohorts.

Outcomes	Non-vaccinated	Vaccinated	*p*-Value[a]	Partial	Full	Boosted	*p*-Value[b]
Complications	*n* (%)	*n* (%)		*n* (%)	*n* (%)	*n* (%)	
All patients	329	177		14	138	25	
COVID+ patients	20 (6.08%)	8 (4.52%)	0.464	0 (0.00%)	7 (5.00%)	1 (4.00%)	0.759
Major complications	45 (13.68%)	22 (12.43%)	0.683	0 (0.00%)	20 (14.49%)	2 (8.00%)	0.394
COVID+	9 (45.00%)	1 (12.50%)	0.105	0 (0.00%)	1 (14.29%)	0 (0.00%)	0.258
COVID-	36 (11.65%)	21 (12.43%)	0.812	0 (0.00%)	19 (14.50%)	2 (8.33%)	0.387
Minor complications	125 (37.99%)	47 (26.55%)	**<0.01**	3 (21.43%)	39 (28.26%)	5 (20.00%)	0.054
COVID+	12 (60.00%)	1 (12.50%)	**0.023**	0 (0.00%)	1 (14.29%)	0 (0.00%)	0.072
COVID-	113 (36.57%)	46 (27.22%)	**0.036**	3 (21.43%)	38 (29.01%)	5 (20.83%)	0.155
Hospital quality measures	*n* (%)	*n* (%)		*n* (%)	*n* (%)	*n* (%)	
Length of stay (days)	6.22 ± 3.24	5.58 ± 4.77	0.235	5.00 ± 3.26	5.78 ± 5.08	4.84 ± 3.61	0.548
COVID+	12.70 ± 10.53	7.75 ± 5.39	0.221	–	8.00 ± 5.77	6.00 ± 0.00	0.542
COVID-	5.81 ± 2.79	5.48 ± 1.88	0.529	5.00 ± 0.45	5.66 ± 1.72	4.79 ± 0.60	0.820
Need for ICU	49 (14.89%)	11 (6.21%)	**<0.01**	1 (7.14%)	8 (5.80%)	2 (8.00%)	**0.038**
COVID+	3 (15.00%)	1 (12.50%)	0.864	0 (0.00%)	1 (14.29%)	0 (0.00%)	0.916
COVID-	46 (14.89%)	10 (5.92%)	**<0.01**	1 (7.14%)	7 (5.34%)	2 (8.33%)	**0.034**
Home discharge	101 (30.70%)	61 (34.46%)	0.387	4 (28.57%)	47 (34.06%)	10 (40.00%)	0.721
COVID+	6 (30.00%)	4 (50.00%)	0.318	0 (0.00%)	3 (42.86%)	1 (100.00%)	0.855
COVID-	95 (30.74%)	57 (33.73%)	0.503	4 (28.57%)	44 (33.59%)	9 (37.50%)	0.326
Readmission	*N* (%)	*N* (%)		*N* (%)	*N* (%)	*N* (%)	
Within 30 days	17 (5.17%)	17 (9.60%)	0.069	1 (7.14%)	15 (10.87%)	1 (4.00%)	0.163
COVID+	0 (0.00%)	2 (25.00%)	**0.037**	0 (0.00%)	2 (28.57%)	0 (0.00%)	0.071
COVID-	17 (5.50%)	15 (8.88%)	0.171	1 (7.14%)	13 (9.92%)	1 (4.17%)	0.378
Within 90 days	39 (11.85%)	26 (14.69%)	0.432	1 (7.14%)	24 (17.39%)	1 (4.00%)	0.180
COVID+	1 (5.00%)	2 (25.00%)	0.190	0 (0.00%)	2 (28.57%)	0 (0.00%)	0.306
COVID-	38 (12.30%)	24 (14.20%)	0.605	1 (7.14%)	22 (16.79%)	1 (4.17%)	0.269
Mortality	*N* (%)	*N* (%)		*N* (%)	*N* (%)	*N* (%)	
Inpatient	11 (3.34%)	2 (1.13%)	0.133	0 (0.00%)	2 (1.45%)	0 (0.00%)	0.474
COVID+	4 (20.00%)	0 (0.00%)	0.172	0 (0.00%)	0 (0.00%)	0 (0.00%)	0.393
COVID-	7 (2.27%)	2 (1.18%)	0.405	0 (0.00%)	2 (1.53%)	0 (0.00%)	0.786
Within 30 days	22 (6.69%)	8 (4.52%)	0.325	1 (7.14%)	6 (4.35%)	1 (4.00%)	0.762
COVID+	5 (25.00%)	1 (12.50%)	0.466	0 (0.00%)	1 (14.29%)	0 (0.00%)	0.727
COVID-	17 (5.50%)	7 (4.14%)	0.515	1 (7.14%)	5 (3.82%)	1 (4.17%)	0.869

ICU, Intensive Care Unit. Bold text highlights significant values.
[a]*p*-Value compares non-vaccinated and vaccinated cohorts. Vaccinated = PV + FV + BV cohorts combined.
[b]*p*-Value compares non-vaccinated, partially vaccinated, fully vaccinated, and boosted cohorts.

and death and that any adverse events associated with the vaccine are mild and short-lasting.[24–28] While our study was underpowered to demonstrate a significant difference in inpatient and 30-day mortality rates, there were lower rates observed in the vaccinated cohorts at each time-point. Future study with a larger cohort may better demonstrate the protective effects of the vaccine regarding this outcome.

Studies from early in the pandemic demonstrated high rates of ICU need, with patients who required elevated levels of care often experiencing very poor outcomes.[24] Minimising a patient's need for ICU level care, especially during a pandemic, has significant resource allocation implications. When ICU bed capacity is full, sick patients who should otherwise be treated in an ICU get triaged to non-ICU settings which can negatively impact their care. This study demonstrates that patients with any vaccination status experienced a lower need for ICU level care regardless of COVID positivity. This is expected in COVID+ patients as the vaccine has been shown to decrease illness severity.[11] In COVID- patients however, the impact of the vaccine lowering ICU need may be multifactorial. The overall burden of COVID+ patients in the hospital may be less due to vaccination, allowing for more resources to be

Table 4. Multivariable regression on need for ICU level of care.

Multivariable analysis	Need for ICU			
Independent variables	Odds ratio	Standard error	*p*-Value	95% confidence interval
Age	1.030	0.015	0.051	0.998–1.060
Female gender	1.146	0.312	0.663	0.486–2.401
Baseline ambulatory status	1.38	0.240	0.180	0.862–2.208
Charlson Comorbidity Index	1.062	0.079	0.446	0.910–1.239
COVID-19+ on admission	1.145	0.576	0.814	0.370–3.540
COVID-19 vaccination	0.655	0.170	**0.013**	0.470–0.913

ICU, Intensive Care Unit. Bold text highlights significant values.

Table 5. Multivariable regression on minor complications.

Multivariable analysis	Minor complications			
Independent variables	Odds ratio	Standard error	*p*-Value	95% confidence interval
Age	1.040	0.010	<**0.01**	1.020–1.062
Female gender	0.629	0.211	**0.028**	0.416–0.951
Baseline ambulatory status	1.315	0.178	0.123	0.929–1.864
Charlson Comorbidity Index	1.140	0.056	**0.019**	1.021–1.272
COVID-19+ on admission	1.566	0.410	0.274	0.701–3.501
COVID-19 vaccination	0.767	0.102	<**0.01**	0.628–0.937

Bold text highlights significant values.

directed to COVID- patients. This in turn may help provide the means for better medical management on the floor before a patient's status worsens to the point of needing admission to the ICU.

This study demonstrated that vaccination is also protective against the development of minor complications during the index hospitalisation for both COVID+ and COVID- patients. Vaccination protects against a more severe COVID infectious course, perhaps allowing for more comprehensive medical management on the floor. This may allow for earlier mobilisation, and more regimented rehabilitation, reducing the risk of decubitus ulcer and UTI, highlighting potential downstream effects of the vaccine.[25] Additionally, geriatric patients who are weakened from surgery or illness are at higher risk for developing hospital acquired pneumonia (HAP) that frequently develops within at least 48 hours of admission.[26–28] Vaccinated patients who are protected from a more severe COVID course are able to be discharged faster, decreasing the risk of HAP.

This study has several limitations. The data only encompassed 1 health system's experience. While this health system is located in a diverse metropolitan area, the patient population may be different from those in other urban or rural areas and the results may not translate to other health systems. Additionally, this study is prone to biases that are common with retrospective studies. As the pandemic continues to fluctuate and change, our findings may not fully represent the impact of vaccination on new changes in COVID-19 variants. Finally, the discrepancy in vaccine brand and variation in timing of when each patient received their vaccine pre-admission all limit the amount we can conclude regarding COVID-19 vaccination.

Vaccination against COVID-19 is likely effective in preventing death from the virus. It is also protective against the need for Intensive Care Unit (ICU) level care and decreases the risk of inpatient minor complication among hip fracture patients, especially in the COVID-19 positive population. To our knowledge, this is the first study to examine the broader impact of the COVID-19 vaccine in geriatric hip fracture patients.

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