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History of COVID-19 and Overall Survival Among Medicare Beneficiaries Hospitalized with Acute Ischemic Stroke, Medicare Cohort 2020-2021

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Abstract

Background: COVID-19 is associated with increased risk of Acute Ischemic Stroke (AIS). The present study examined the impact of prior COVID-19 diagnoses on overall survival among older AIS patients.

Methods: We included 250,079 Medicare Fee-For-Service (FFS) beneficiaries aged ≥65 years with AIS hospitalizations from 04/01/2020 through 12/31/2021. Overall survival was defined as the time from date of AIS hospitalization to date of death, or through end of follow-up on 03/31/2023. We used a Cox proportional hazard model to examine the association between history of COVID-19 and overall survival among AIS beneficiaries, and we obtained age, sex, race/ethnicity, Social Vulnerability Index (SVI), National Institutes of Health Stroke Scale score, and comorbidity-adjusted survival estimates.

Results: Among 250,079 Medicare FFS beneficiaries with AIS, 98,327 (39.3%) died during a median of 590 days (IQR, 169–819 days) of follow-up with a total of 365,606 person-years. The 1-year adjusted overall survival was 62.0%, 67.4%, and 68.8% in beneficiaries with hospitalized COVID-19, with non-hospitalized COVID-19 and no COVID-19 respectively ($p<0.001$). Compared to AIS without history of COVID-19, the adjusted mortality hazard ratios were 1.30 (95% CI, 1.26–1.34) and 1.06 (95% CI, 1.03–1.10) for those with a history of hospitalized and non-hospitalized COVID-19, respectively. The patterns of overall survival by COVID-19 history were largely consistent across age groups, sex, race/ethnicity, and SVI groups.

Conclusions: A history of COVID-19 diagnoses, especially with a history of severe COVID-19, was associated with a significantly higher risk of all-cause mortality among Medicare FFS beneficiaries hospitalized with AIS.

Keywords: Acute ischemic stroke; Hospitalizations; Survival; COVID-19

Introduction

Stroke is the fifth leading cause of death and a leading cause of long-term disability in the United States (U.S.) [1]. Recent studies suggested that COVID-19 diagnosis is associated with increased risk of Acute Ischemic Stroke (AIS), especially shortly after exposure [2]. Patients with ischemic stroke and concurrent COVID-19 had worse outcomes compared to those without COVID-19 [3]. However, few studies have examined the effects of prior COVID-19 diagnosis on overall survival among older U.S. adults hospitalized with AIS.

This study aimed to assess the overall survival among older AIS Medicare beneficiaries with a history of COVID-19 diagnoses, especially among those with severe COVID-19, as compared to those without a history of COVID-19.

Materials and Methods

We used the real-time Medicare monthly files to identify Medicare Fee-For-Service (FFS) beneficiaries aged 65 years or older, hospitalized with AIS from 04/01/2020 through

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12/31/2021. AIS was defined as having a hospital admission with primary diagnosis of International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) code I63. If beneficiaries had more than one date of AIS hospitalization during the study period, the first hospitalization date was chosen. We obtained the first diagnosis of COVID-19 from Medicare Part A (inpatient claims) and Part B (physician's office claims) using ICD-10-CM code U07.1. We identified AIS beneficiaries as having a history of COVID-19 when the first COVID-19 diagnoses date was earlier than the AIS admission date; those with a history of COVID-19 were classified by hospitalization status to reflect severity. We used National Institutes of Health Stroke Scale (NIHSS) scores (ICD-10-CM code: R29.7) to assess stroke severity. We incorporated the Social Vulnerability Index (SVI) by counties published in 2020 by the US Centers for Disease Control and Prevention (CDC) [4]. The final analytical study population had 250,079 Medicare FFS beneficiaries diagnosed with AIS.

We calculated the median (Interquartile Range, IQR) and mean (Standard Error, SE) of age, SVI, and the time between the first COVID-19 diagnosis and AIS hospitalization. We calculated the percentage distribution of age group, sex, race/ ethnicity, NIHSS groups (0–9, 10–19, 20–29, 30+), SVI groups (low 0–0.33, moderate 0.34–0.66, high 0.67–1.0), the percent of deaths during follow-up, and the medical history of comorbidities at baseline, among AIS beneficiaries by status of COVID-19 history: with hospitalized COVID-19; non-hospitalized COVID-19; and no COVID-19 diagnoses. The comorbidities assessed included: history of stroke or Transient Ischemic Attack (TIA), ischemic heart disease, hypertension, hypercholesterolemia, diabetes, atrial fibrillation, heart failure, chronic kidney disease, acute myocardial infarction, peripheral vascular disease, chronic obstructive pulmonary disease, and tobacco use. These comorbidities were based on the Chronic Conditions Warehouse definitions from Centers for Medicare and Medicaid Services [5]. About 37% of AIS beneficiaries had missing NIHSS scores, and we used multiple imputation to impute the missing values with 25 imputed datasets using PROC MI in SAS (SAS Institute).

We defined the survival time as the number of days from the date of AIS hospitalization to the date of death or end of follow-up (03/31/2023), whichever came first. We performed the survival and subgroup analyses by age groups (66–74 years, 75–84 years and ≥85 years), sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and others [non-Hispanic other races], and SVI (low, moderate, high). We estimated the mean (SE) survival time and used the log-rank test to compare overall survival among AIS beneficiaries by COVID-19 history status. We performed Cox proportional hazards regression analyses to examine the association between COVID-19 history status and mortality adjusting for age, sex, race/ethnicity, NIHSS scores, SVI, and comorbidities. To assess the proportional hazard assumption, we examined log-log plots and Schoenfeld residuals. To better understand the absolute differences in survival, we estimated 1-year adjusted overall survival by COVID-19 status. SAS, version 9.4 was used for the analyses, and a two-sided p-value of <0.05 was considered statistically significant.

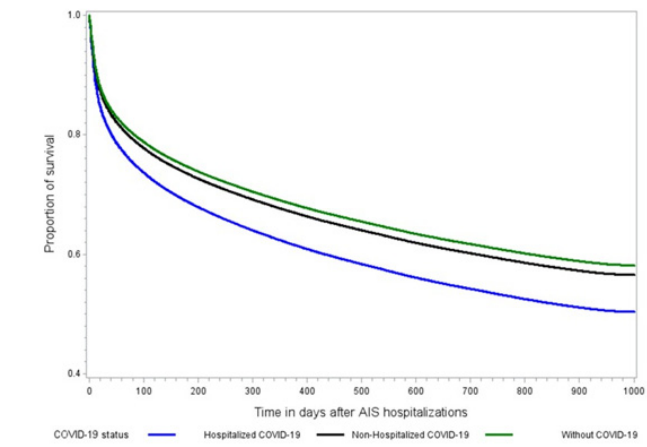

Figure 1: Overall Survival among AIS patients with and without history of COVID-19, Medicare 2020-2021.

This study uses de-identified claims data that are exempt from IRB review, was reviewed by Centers for Disease Control and Prevention (CDC), and conducted by adhering to applicable federal law, CDC policy, and the CDC-CMS Interagency agreement and data use agreement.

Results

There were 250,079 Medicare FFS beneficiaries hospitalized with AIS as the primary diagnosis between 04/01/2020, and 03/31/2021. Among them, 98,327 (39.3%) died during a median follow-up of 590 days (IQR: 169–819), with a total of 365,606 person-years (Table 1).

Overall, 17,188 (6.9%) AIS Medicare FFS beneficiaries had a history of COVID-19 diagnoses, and among them, 8,345 (48.6%) were hospitalized with COVID-19. The median time between the first COVID-19 diagnosis and AIS hospitalization was 102 days (IQR: 15–251) and 169 days (IQR: 69–298) among hospitalized and non-hospitalized COVID-19 beneficiaries respectively. Among those hospitalized for COVID-19, approximately 16% had AIS within 7 days after COVID-19 diagnosis, vs. about 4% of with non-hospitalized COVID-19.

There were significant differences in demographic and clinical features across the three groups, by COVID-19 status. Compared to beneficiaries without COVID-19 diagnoses, AIS Medicare FFS beneficiaries with a history of hospitalized COVID-19 were older, more likely to be women or non-Hispanic Black (Table 1). There were significant differences in SVI among beneficiaries with and without COVID-19 (p<0.001). There were significantly more beneficiaries with a history of COVID-19 living in high SVI communities (46%) than those without COVID-19 (41%); still more than 40% in both groups lived in High SVI areas. Stroke severity at admission was ranked NIHSS>19 for 15.8%, 10.5% and 8.8% of beneficiaries with a history of hospitalized COVID-19, non-hospitalized COVID-19, and no COVID-19, respectively (p<0.001). The proportions of deaths were 53.1%, 41.6%, and 38.7% among beneficiaries with hospitalized COVID-19, non-hospitalized COVID-19, and no COVID-19, respectively. The prevalence of comorbidities, except hypercholesterolemia and tobacco use, was the highest among beneficiaries with a history of hospitalized COVID-19, as compared to other groups.

Mean overall survival was 488.3 (4.5), 587.0 (4.3), and 678.5 (0.9) days among AIS Medicare FFS beneficiaries with hospitalized COVID-19, non-hospitalized COVID-19, and no COVID-19, respectively (p<0.001). The adjusted overall 1-year survival was 62.0% (95% Confidence Intervals [CI] (61.2–62.8%), 67.4% (95% CI, (IQR: 15–251) and 169 days (IQR: 69–298) among hospitalized with hospitalized COVID-19, non-hospitalized COVID-19, and no COVID-19, respectively (Figure 1, Table 2). The adjusted mortality hazard ratio (HR) was 1.30 (95% CI, 1.26–1.34) and 1.06 (IQR: 15–251) and 169 days (IQR: 69–298) among hospitalized and non-hospitalized COVID-19, respectively, compared to those without COVID-19. Beneficiaries aged ≥85

Table 1: Demographic information among Acute Ischemic Stroke (AIS) beneficiaries by COVID-19 status, Medicare 2020-2021

	Overall n (%) or statistics (N=250079)	With a history of hospitalized COVID-19 (n=8345)	With a history of non-hospitalized COVID-19 (n=8843)	No COVID (n=232891)	P-value
Age at AIS					
Median	79.5	80.7	79.9	79.4	
Range (IQR)	73.0-86.3	73.9-87.1	73.5-87.1	72.9-86.2	
Mean (SE)	79.9 (0.02)	80.7 (0.09)	80.4 (0.09)	79.8 (0.02)	<0.001
Age in groups					
65-74	67673 (27.1)	2106 (25.2)	2308 (26.1)	63259 (27.2)	
75-84	97234 (38.9)	3152 (37.8)	3400 (38.4)	90682 (38.9)	
85+	85172 (34.1)	3087 (37.0)	3135 (35.5)	78950 (33.9)	<0.001
Men	110759 (44.3)	3460 (41.5)	3694 (41.8)	103605 (44.5)	<0.001
Race/ethnicity					
Non-Hispanic White	203586 (81.4)	6221 (74.5)	7127 (80.6)	190238 (81.7)	
Non-Hispanic Black	24703 (9.9)	1182 (14.2)	828 (9.4)	22693 (9.7)	
Hispanic	12000 (4.8)	641 (7.7)	547 (6.2)	10812 (4.6)	
Other race	9790 (3.9)	301 (3.6)	341 (3.9)	9148 (3.9)	<0.001
Social Vulnerability Index					
Median	0.60	0.64	0.64	0.60	<0.001
Range (IQR)	0.35-0.79	0.38-0.80	0.37-0.82	0.35-0.79	
Mean (SE)	0.56 (0.001)	0.59 (0.003)	0.59 (0.003)	0.56 (0.001)	
Social Vulnerability Index by tertile					
Low	57814 (23.1)	1750 (21.0)	1879 (21.2)	54185 (23.3)	
Moderate	88565 (35.4)	2738 (32.8)	2841 (32.1)	82986 (35.6)	
High	102920 (41.2)	3838 (46.0)	4097 (46.3)	94985 (40.8)	
Missing	780 (0.3)	19 (0.2)	26 (0.3)	735 (0.3)	<0.001
NIHSS in group					
0-9	189187 (75.7)	5308 (63.6)	6451 (73.0)	177428 (76.2)	
10-19	38290 (15.3)	1720 (20.6)	1462 (16.5)	35108 (15.1)	
20-29	19564 (7.8)	1129 (13.5)	795 (9.0)	17640 (7.6)	
30+	3038 (1.2)	188 (2.3)	135 (1.5)	2715 (1.2)	<0.001
Time between first COVID-19 and AIS (Days)					
Median	139	102	169	NA	
Range (IQR)	39-277	15-251	69-298	NA	
Mean (SE)	171.6 (1.1)	147.9 (1.6)	193.9 (1.5)	NA	<0.001
Time between first COVID-19 and AIS in groups					
0-7 days	1657 (9.6)	1328 (15.9)	329 (3.7)	NA	
>7 and ≤30 days	2163 (12.6)	1375 (16.5)	788 (8.9)	NA	
>30 and ≤120 days	4083 (23.8)	1806 (21.6)	2277 (25.7)	NA	
>120 days	9285 (54.0)	3836 (46.0)	5449 (61.6)	NA	<0.001
Death as 03/31/2023	98327 (39.3)	4433 (53.1)	3677 (41.6)	90217(38.7)	<0.001
Follow-up in days					
Median	590	458	510	601	<0.001
Range (IQR)	169-819	32-662	95-674	185-832	
Comorbidities					
Stroke/TIA	73384 (29.3)	3102 (37.2)	2931 (33.1)	67351(28.9)	<0.001
Ischemic heart disease	141298 (56.5)	5614 (67.3)	5665 (64.1)	130019(55.8)	<0.001
Hypertension	215652 (86.2)	7685 (92.1)	7981 (90.3)	199986(85.9)	<0.001
Hypercholesterolemia	204866 (81.9)	7222 (86.5)	7693 (87.0)	189951(81.6)	<0.001
Diabetes	115080 (46.0)	4933 (59.1)	4726 (53.4)	105421(45.3)	<0.001
Atrial fibrillation	59813 (23.9)	2394 (28.7)	2457 (27.8)	54962(23.6)	<0.001
Heart failure	86771 (34.7)	4002 (48.0)	3762 (42.5)	79007(33.9)	<0.001
Chronic kidney disease	119353 (47.7)	5109 (61.2)	4711 (53.3)	109533(47.0)	<0.001
AMI	20137 (8.1)	838 (10.0)	743 (8.4)	18556(8.0)	<0.001
PVD	50780 (20.3)	2618 (31.4)	2456 (27.8)	45706(19.6)	<0.001
COPD	74888 (29.9)	3268 (39.2)	3217 (36.4)	68403(29.4)	<0.001
Tobacco use	23713 (9.5)	765 (9.2)	720 (8.1)	22228(9.5)	<0.001

AIS: Acute Ischemic Stroke; AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease and Bronchiectasis; IQR: Interquartile Range; NIHSS: National Institutes of Health Stroke Scale; PVD: Peripheral Vascular Disease; SE: Standard Error; TIA: Transient Ischemic Attack.

Table 2: Adjusted 1-year Survival (95% CI) after acute ischemic stroke and adjusted hazard ratios (95% CI) by COVID-19 status, Medicare 2020-2021.

	With a history of hospitalized COVID-19	With a history of non-hospitalized COVID-19	No COVID	P-value
All beneficiaries				
Mean (SE) survival in days	488.3 (4.5)	587.0 (4.3)	678.5 (0.9)	<0.001
1-year survival (%)	62.0 (61.2,62.8)	67.4 (66.6,68.2)	68.8 (68.6,68.9)	<0.001
Hazard ratio	**1.30 (1.26-1.34)**	**1.06 (1.03- 1.10)**	Reference	
Age 65-74 years				
Mean (SE) survival in days	528.5 (0.3)	631.5 (7.0)	767.4 (1.5)	<0.001
1-year survival (%)	69.8 (68.3,71.4)	77.8 (76.4,79.2)	77.3 (77.0,77.6)	<0.001
Hazard ratio /	**1.42 (1.33-1.52)**	0.97 (0.90-1.05)	Reference	
Age 75-84 years				
Mean (SE) survival in days	523.6 (7.1)	618.6 (6.2)	716.5 (1.3)	<0.001
1-year survival (%)	66.3 (65.0,67.6)	73.0 (71.8,74.3)	72.9 (72.7,73.2)	<0.001
Hazard ratio	**1.33 (1.26- 1.4)**	1.00 (0.94-1.06)	Reference	
Age 85+ years				
Mean (SE) survival in days	403.4 (7.2)	452.7 (7.3)	557.5 (1.6)	<0.001
1-year survival (%)	50.6 (49.2,52.0)	53.0 (51.6,54.5)	57.0 (56.7,57.3)	<0.001
Hazard ratio	**1.23 (1.18-1.29)**	**1.14 (1.09-1.19)**	Reference	
Men				
Mean (SE) survival in days	499.1 (6.6)	568.3 (5.8)	694.1 (1.3)	<0.001
1-year survival (%)	63.9 (62.7,65.2)	70.6 (69.4,71.8)	70.5 (70.2,70.8)	<0.001
Hazard ratio	**1.31 (1.25-1.37)**	1.00 (0.95-1.05)	Reference	
Women				
Mean (SE) survival in days	469.8 (5.8)	563.8 (5.7)	665.3 (1.2)	<0.001
1-year survival (%)	60.5 (59.5,61.6)	65.0 (64.0,66.1)	67.4 (67.1,67.6)	<0.001
Hazard ratio	**1.31 (1.25-1.37)**	1.00 (0.94-1.05)	Reference	
Non-Hispanic White				
Mean (SE) survival in days	481.4 (5.2)	586.4 (4.8)	678.5 (1.0)	<0.001
1-year survival (%)	61.5 (60.6,62.4)	67.4 (66.5,68.3)	68.8 (68.7,69.0)	<0.001
Hazard ratio	**1.34 (1.29-1.38)**	**1.06 (1.02- 1.10)**	Reference	
Non-Hispanic Black				
Mean (SE) survival in days	498.1 (11.5)	539.5 (12.5)	656.4 (2.7)	<0.001
1-year survival (%)	63.0 (60.8,65.2)	66.7 (64.2,69.4)	67.8 (67.2,68.4)	<0.001
Hazard ratio	**1.21 (1.11-1.31)**	1.04 (0.94-1.16)	Reference	
Hispanic				
Mean (SE) survival in days	468.3 (14.0)	505.2 (14.1)	684.0 (4.0)	<0.001
1-year survival (%)	64.3 (61.5,67.3)	67.0 (63.8,70.3)	69.1 (68.2,69.9)	<0.001
Hazard ratio	**1.21 (1.08-1.36)**	1.09 (0.95-1.25)	Reference	
Other race				
Mean (SE) survival in days	366.8 (15.8)	571.0 (19.5)	676.2 (4.4)	<0.001
1-year survival (%)	62.5 (58.4,66.8)	70.3 (66.4,74.3)	69.0 (68.1,69.8)	<0.001
Hazard ratio	**1.30 (1.10-1.52)**	0.94 (0.79-1.13)	Reference	
Low Social Vulnerability Index				
Mean (SE) survival in days	486.6 (9.7)	557.6 (8.6)	688.4 (1.8)	<0.001
1-year survival (%)	62.4 (60.7,64.2)	67.7 (66.0,69.4)	69.9 (69.5,70.3)	<0.001
Hazard ratio	**1.36 (1.27-1.45)**	**1.1 (1.02-1.18)**	Reference	
Moderate Social Vulnerability Index				
Mean (SE) survival in days	479.0 (7.6)	584.6 (7.5)	681.4 (1.5)	<0.001
1-year survival (%)	59.9 (58.5,61.4)	68.4 (67.0,69.8)	69.2 (68.9,69.5)	<0.001
Hazard ratio	**1.32 (1.25-1.39)**	1.04 (0.98- 1.1)	Reference	
High Social Vulnerability Index				
Mean (SE) survival in days	485.2 (6.5)	584.3 (6.3)	668.0 (1.4)	<0.001
1-year survival (%)	61.6 (60.4,62.8)	66.4 (65.2,67.6)	67.7 (67.4,68.0)	<0.001
Hazard ratio	**1.27 (1.22-1.33)**	**1.05 (1.0-1.11)**	Reference	

CI: Confidence Interval; SE: Standard Error

years who were hospitalized for COVID-19 had the lowest mean overall survival, with 1-year adjusted survival 50.6% (IQR: 15–251) and 169 days (IQR: 69–298) among hospitalized with a history of hospitalization for COVID-19 had the shortest overall survival compared with their counterparts - non-hospitalized COVID-19 or no COVID-19. Beneficiaries living in low SVI communities had better survival than those living in high SVI communities, regardless of COVID-19 status. Subgroup analyses showed beneficiaries with history of hospitalized COVID-19 had significantly lower survival than those without COVID-19 across age, sex, race/ethnicity and SVI groups. In addition, beneficiaries aged ≥85 years, and non-Hispanic White beneficiaries with history of COVID-19, regardless of its severity, had significantly lower overall survival than those without COVID-19 diagnoses.

Discussion

This study's findings suggest significantly lower overall survival following AIS admissions among Medicare FFS beneficia-

ries aged 65 years or older with a history of COVID-19 diagnoses in the United States. Compared to AIS beneficiaries without COVID-19 diagnoses, the risk of mortality was 30% and 6% higher among beneficiaries with a history of hospitalized and non- hospitalized COVID-19, respectively.

The negative impact of COVID-19 on overall survival in this study is consistent with other studies [2,6–11]. Many studies assessed the incidence, risk factors, and outcomes of AIS in hospitalized patients with COVID-19, reporting an increased risk of AIS among COVID-19 patients and higher risk of in-hospital mortality [2,6,7]. A meta-analysis of observational cohort studies reported that stroke patients with COVID-19, had an almost 5-times higher probability of in-hospital mortality compared to their noninfected counterparts [8]. Several studies found that ischemic stroke patients with COVID-19 had more severe strokes and higher mortality than those without COVID-19 [3,9-11]. However, most studies focused on the outcomes among hospitalized patients with COVID-19; we are not aware of any study examining overall survival among AIS patients with history of COVID-19 by hospitalization status. Our study shows that the AIS Medicare FFS beneficiaries with a history of COVID-19 had significantly shorter mean overall survival (488 days and 587 days for hospitalized and non-hospitalized COVID-19) vs. 679 days without history of COVID-19. The corresponding adjusted 1-year overall survival was 62%, 67% and 69%, respectively.

Evidence indicates that acute cardiovascular complications represent an essential clinical manifestation of COVID-19, and COVID-19 appears to have both short-term and long-term effects on the risk of cardiovascular disease, including stroke [12-14]. Consistent with our findings, a study on the largest North American cohort of patients hospitalized with AIS and concurrent COVID-19 reported significantly higher mortality compared to historic non-COVID data indicating potentially poor outcomes associated with infection severity [13]. In addition, several studies suggested that the risk of ischemic stroke was significantly higher 28 days before and during after COVID-19 diagnosis as compared to the control periods, COVID-19 associated ischemic strokes were more severe, with worse functional outcomes and significantly higher mortality than non-COVID-19 associated ischemic strokes [2,12]. In our study, 32% and 13% of beneficiaries with history of hospitalized and non-hospitalized COVID-19, respectively, had AIS admissions within 30 days of the first COVID-19 diagnosis. The higher proportion of Medicare FFS beneficiaries with a history of hospitalized COVID-19 occurring ≤30 days before AIS hospitalization may partly explain the worse overall survival that we observed. However, we conducted sensitivity analyses by excluding the beneficiaries with ≤30 days interval from COVID-19 diagnosis to AIS hospitalization, and the association was slightly attenuated with adjusted mortality HRs of 1.26 (95% CI, 1.21-1.30), and 1.04 (95% CI, 1.01–1.08) for beneficiaries with hospitalized and non-hospitalized COVID-19, respectively.

Our study found the highest proportion of severe NIHSS, and comorbidities (except tobacco use), among the AIS Medicare FFS beneficiaries with history of hospitalized COVID-19. Subgroup analyses showed that the beneficiaries with history of COVID-19 hospitalizations had the worst overall survival as compared to those without COVID-19 across all age, sex, race/ethnicity, and SVI groups. The worse outcomes among the beneficiaries with history of hospitalized COVID-19 might be associated with more severe NIHSS, more baseline comorbidities, greater probability of ICU admissions, and longer length of stay during AIS admissions [15]. However, during the COVID-19 pandemic, studies reported that the overall quality of treatment and care for patients with AIS did not decline [16,17].

It is well documented that social inequities increase health disparities, and SVI data from CDC is a valuable tool for documenting the disparities in access to advanced stroke care [18,19]. In our study, we found more than 40% of AIS Medicare FFS beneficiaries lived in high SVI communities, and significantly more beneficiaries with a history of COVID-19 lived in high SVI communities, compared to their counterparts without COVID-19 diagnoses. Beneficiaries with a history of hospitalized COVID-19 living in high SVI communities had the worst 1-year overall survival, compared to those with a history of non-hospitalized COVID-19 and no COVID-19 diagnoses. Studies have reported that SVI is associated with cardiovascular risk factors and stroke mortality, and mortality rates attributable to stroke increased from lowest to highest SVI [20,21]. Among beneficiaries with hospitalized COVID-19, the 1-year adjusted overall survival of those living in moderate SVI communities was lowest. This might be due to the high risk of death among non-Hispanic White beneficiaries (we found the worst 1-year survival among non-Hispanic White beneficiaries with hospitalized COVID-19) who were more likely to live in low and moderate SVI areas [22]. Future studies are needed to explore the possible association between SVI and survival, and to identify risk factors associated with patients living in socially vulnerable communities.

This study's findings may have important implications. A history of COVID-19, especially hospitalized COVID-19, was associated with significantly higher risk of all-cause mortality. Forty percent of AIS Medicare FFS beneficiaries lived in high SVI communities, and disproportionately higher numbers of such AIS beneficiaries had a history of COVID-19. These data may inform the future treatment and care for stroke patients to reduce long-term effects of COVID-19 and may highlight the disparities in stroke survival between those who lived in low and high socially vulnerable communities.

Our study has several limitations. First, AIS hospitalizations, COVID-19 diagnoses, and all-cause mortality were based on administrative records and limited to Medicare FFS beneficiaries aged 65 years or older. We may have omitted some beneficiaries with diagnosed COVID-19, diagnosed AIS, or incorrect diagnoses dates of COVID-19, due to our using preliminary Medicare monthly data. Second, NIHSS scores were based on ICD-10 codes, which may potentially be inaccurate. Third, although our analysis adjusted for several covariates and selected commodities, we cannot rule out the possibility that the beneficiaries with a history of hospitalized COVID-19 might have an overall worse health status and decreased survivals after AIS. However, the differences in survivals between non-hospitalized COVID-19 and no-COVID-19 stroke patients may be informative and more likely associated with history of COVID-19. Lastly, the findings based on FFS beneficiaries may not be generalizable to Medicare beneficiaries covered under health maintenance organization plans, due to possible differences in beneficiary characteristics with the two types of coverage.

Conclusions

Our findings suggest that a history of COVID-19 diagnoses, especially those with a history of severe COVID-19, is associated with significantly reduced survival among Medicare FFS beneficiaries hospitalized with AIS.

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