

CLINICAL AND POPULATION SCIENCES

Stroke Hospitalizations Before and During COVID-19 Pandemic Among Medicare Beneficiaries in the United States

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BACKGROUND AND PURPOSE: Emergency department visits and hospitalizations for stroke declined significantly following declaration of coronavirus disease 2019 (COVID-19) as a national emergency on March 13, 2020, in the United States. This study examined trends in hospitalizations for stroke among Medicare fee-for-service beneficiaries aged ≥ 65 years and compared characteristics of stroke patients during COVID-19 pandemic to comparable weeks in the preceding year (2019).

METHODS: For trend analysis, we examined stroke hospitalizations from week 1 in 2019 through week 44 in 2020. For comparison of patient characteristics, we estimated percent reduction in weekly stroke hospitalizations from 2019 to 2020 during weeks 10 through 23 and during weeks 24 through 44 by age, sex, race/ethnicity, and state.

RESULTS: Compared to weekly numbers of hospitalizations for stroke reported during 2019, stroke hospitalizations in 2020 decreased sharply during weeks 10 through 15 (March 1–April 11), began increasing during weeks 16 through 23, and remained at a level lower than the same weeks in 2019 from weeks 24 through 44 (June 7–October 31). During weeks 10 through 23, stroke hospitalizations decreased by 22.3% (95% CI, 21.4%–23.1%) in 2020 compared with same period in 2019; during weeks 24 through 44, they decreased by 12.1% (95% CI, 11.2%–12.9%). The magnitude of reduction increased with age but similar between men and women and among different race/ethnicity groups. Reductions in stroke hospitalizations between weeks 10 through 23 varied by state ranging from 0.0% (95% CI, –16.0%–1.7%) in New Hampshire to 36.2% (95% CI, 24.8%–46.7%) in Montana.

CONCLUSIONS: One-in-5 fewer stroke hospitalizations among Medicare fee-for-service beneficiaries occurred during initial weeks of the COVID-19 pandemic (March 1–June 6) and weekly stroke hospitalizations remained at a lower than expected level from June 7 to October 31 in 2020 compared with 2019. Changes in stroke hospitalizations varied substantially by state.

GRAPHIC ABSTRACT: An online [graphic abstract](#) is available for this article.

Key Words: COVID-19 ■ hospitalization ■ Medicare ■ pandemic ■ United States

After a national emergency was declared for the coronavirus disease 2019 (COVID-19) pandemic on March 13, 2020, in the United States, states started to issue stay-at-home orders to slow severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission.¹ The pandemic has resulted in major shifts among

hospitals and health care systems as many elective surgeries and other procedures were canceled to contend with the anticipated surge in critically ill patients with COVID-19.² However, unexpectedly, emergency department visits and hospitalizations of non-COVID-19 life-threatening conditions, like stroke or heart attack,

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Nonstandard Abbreviations and Acronyms

AIS	acute ischemic stroke
COVID-19	coronavirus disease 2019
FFS	fee-for-service
WPC	weekly percentage change

also declined significantly during the early period of the COVID-19 pandemic.^{3–9} The observed reduction in stroke hospitalizations during the COVID-19 pandemic could have significant unintended consequences; each year nearly 800 000 Americans have a new or recurrent stroke (on average 15 000 stroke per week) and ≈150 000 die, accounting for 1 in 20 deaths in the United States.¹⁰ Early treatment is crucial in maximizing the benefit of stroke interventions such as thrombolytics and thrombectomy for ischemic stroke¹¹ and blood pressure control for hemorrhagic stroke.¹² Delayed treatments are associated with increased risk of serious long-term disability and death from stroke.^{13,14} We analyzed Medicare data among Medicare fee-for-service (FFS) beneficiaries aged ≥65 years who were hospitalized with a stroke from January 1, 2019, to October 31, 2020, to understand the changes in weekly stroke hospitalizations that occurred during the COVID-19 pandemic and to assess if the change in weekly rate of stroke hospitalization during the pandemic differed by patient characteristics or geographic location.

METHODS

The Medicare data used in this study cannot be shared by authors because of the data use agreement, but the investigators can request the data access through Centers for Medicare and Medicaid Services.

We identified all Medicare FFS beneficiaries aged ≥65 year with at least 11 months of continuous enrollment in Medicare Part A (hospitalization) and Part B (outpatient care) in 2019 and at least 9 months of enrollment in 2020. We used the Medicare monthly Research Identifiable File from Part A to calculate the weekly number of stroke hospitalizations (<https://www.cms.gov/Research-Statistics-Data-and-Systems/Research/ResearchGenInfo/ResearchDataAssistanceCenter>). The Research Identifiable File Part A contains inpatient hospital records for Medicare FFS beneficiaries; stroke hospitalizations were defined as those having a primary diagnosis of stroke using *International Classification of Diseases, Tenth Revision* codes (I60–I69 for all types of cerebrovascular disease [all-stroke]; I63 for acute ischemic stroke [AIS] and I60–I61 for hemorrhagic stroke [subarachnoid hemorrhage and intracerebral hemorrhage]).

To examine the timing and duration of reductions in stroke hospitalizations, we conducted trend analyses on the weekly number of stroke hospitalizations from week 1 in 2019 through week 44 in 2020 by stroke type (all-stroke, AIS, and hemorrhagic stroke) and by age group (65–74, 75–84, and ≥85 years), sex, race/ethnicity (non-Hispanic White, non-Hispanic

Black, Hispanic, and other) as supplemental material using Joinpoint Regression Program (version 4.8.0.0, National Cancer Institute); we calculated the weekly percentage change (WPC) in stroke hospitalizations for each trend segment. We limited modeling to a maximum of 3 joinpoints with 4 trend segments and used the weighted Bayesian Information Criterion for model selection.

To quantify the magnitude of stroke hospitalization changes during the early weeks of the COVID-19 pandemic, when compared with the same time periods in the previous year, we compared the total number of stroke hospitalizations for 2 periods of time based on the Joinpoint results: weeks 10 through 23 in 2020 (compared to same weeks in 2019) to assess the initial impact of the COVID-19 pandemic and weeks 24 through 44 in 2020 (compared to the same weeks in 2019) as the period of the pandemic after the initial impact. Comparisons were by age group, sex, and race/ethnicity and tested for differences based on χ^2 tests and presented adjusted *P* values by using Holm method for multiple comparisons.¹⁵ To evaluate changes in stroke hospitalizations by patient state of residence, we compared stroke hospitalizations during weeks 10 through 23 in 2019 (the pre-COVID-19 period) to hospitalizations during weeks 10 through 23 in 2020 (during the COVID-19 pandemic) within each state. We calculated the median age and length of hospital stay (interquartile range) pre-COVID-19 and during the COVID-19 pandemic and tested for differences in the median based on Mood method of the RVAideMemoire package in R software. We also estimated in-hospital death rates. We calculated the percent reduction of stroke hospitalizations during 2 time periods: between weeks 10 through 23 in 2019 and 2020 and between weeks 24 through 44 in 2019 and 2020. We divided the difference in number of stroke hospitalizations between 2019 and 2020 (numerator) by the number of stroke hospitalizations in 2019 (denominator) and multiplied by 100. We used bootstrap resamples with 1000 bootstrap samples to determine the 95% CI with lower 95% CI <0 as insignificant change.¹⁶

The study findings are reported in accordance with the Reporting of Studies Conducted Using Observational Routinely Collected Health Data recommendations (Figure 1 in the [Data Supplement](#) shows the study flow diagram).¹⁷ This study was reviewed by Centers for Disease Control and Prevention and conducted consistent with applicable federal law and Centers for Disease Control and Prevention policy (See eg, 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq).

RESULTS

The weekly number of all-stroke hospitalizations decreased slightly from week 1 in 2019 through week 9 in 2020 (WPC, –0.08% [95% CI, –0.14% to –0.02%]), followed by a sharp decline from week 10 through week 15 in 2020 (WPC, –5.98% [95% CI, –7.5% to –4.43%]) (Table 1 and Figure 1). Hospitalizations started trending towards those seen in 2019 thereafter, with a WPC of 3.09% (95% CI, 1.94%–4.25%) from weeks 15 through 23, and remained at a lower than normal level from weeks 23 through 44 (WPC, 0.05% [95% CI, –0.23%

Table 1. Trends in Weekly Number of Stroke Hospitalizations and Weekly Percentage Change By Type of Stroke Among Medicare Fee-for-Service Beneficiaries Aged ≥ 65 Years—United States, 2019–2020

Stroke type	Trend 1*		Trend 2*		Trend 3*		Trend 4*	
	Week/year†	WPC (95% CI)	Week/year†	WPC (95% CI)	Week/year†	WPC (95% CI)	Week/year†	WPC (95% CI)
All-stroke	1–52/2019–9/2020	–0.08 (–0.14 to –0.02)	9–15/2020	–5.98 (–7.52 to –4.43)	15–23/2020	3.09 (1.94 to 4.25)	23–44/2020	0.05 (–0.23 to 0.32)
Acute ischemic stroke	1–52/2019–10/2020	–0.07 (–0.12 to –0.02)	9–15/2020	–6.03 (–7.58 to –4.45)	15–22/2020	3.56 (2.18 to 4.96)	22–44/2020	0.04 (–0.18 to 0.27)
Hemorrhagic stroke	1–29/2019	–0.85 (–1.15 to –0.54)	29/2019–4/2020	0.63 (0.28 to 0.98)	4–15/2020	–2.68 (–4.06 to –1.28)	15–44/2020	0.40 (0.08 to 0.72)

WPC indicates weekly percentage change.

*Joinpoint analyses with up to 3 joinpoints and 4 trend segments. Analysis used Joinpoint Regression Program, Version 4.8.0.0, National Cancer Institute.

†Time interval of trends may change across different types of stroke due to results of Joinpoint analyses.

to 0.32%]). The pattern of change was largely consistent by age group, sex, race/ethnicity, and for all-stroke and AIS (Table 1, Figure 1A and 1B and Table I in the [Data Supplement](#)). There was no clear pattern of changes for hemorrhagic stroke; it appeared to decline during the initial period of COVID-19 circulation (WPC, –2.68% [95% CI, –4.06% to 1.28%] from weeks 4 to 15) and increased slightly from weeks 15 through 44 in 2020 (Table 1 and Figure 1C).

During a 14-week time interval (weeks 10 through 23; March 1 to June 6, 2020), all-stroke hospitalizations among FFS beneficiaries were reduced by 22.3% (95% CI, 21.4%–23.1%) compared with weeks 10 through 23 in 2019 (March 3–June 8). From weeks 24 through 44, the reduction of all-stroke hospitalizations remained 12.1% (95% CI, 11.2%–12.9%) lower than the level during the same period in 2019 (Table 2). A greater percent reduction in all-stroke hospitalizations was observed with older age (24.9% [95% CI, 23.2%–26.5%] among those ≥ 85 years versus 20.9% [95% CI, 19.3%–22.4%] among persons 65–74 years, $P=0.003$) for weeks 10 through 23 in 2020 compared to the same weeks in 2019. The corresponding comparison for weeks 24 through 44 were 15.5% [95% CI, 13.9%–17.0%] versus 9.9% [95% CI, 8.4%–11.3%], $P<0.001$). The magnitude of reduction was similar between men and women, and among race/ethnicity groups ($P>0.05$). The pattern of change in AIS hospitalizations was similar to that of all-stroke. The magnitude of reduction from weeks 10 through 23 in hemorrhagic stroke hospitalizations was smaller than that of AIS (17.4% [95% CI, 14.7%–20.2%] versus 21.6% [95% CI, 20.6%–22.6%], $P<0.05$). The pattern of change was similar between all-stroke and AIS. There was no significant difference in reduction of hemorrhagic stroke hospitalizations by age group, sex, or race/ethnicity (Table 2). Although the differences in the median length of stay were significant ($P<0.05$) because of the large sample size, the median and interquartile range remained the same. The number of stroke deaths decreased from 2019 to 2020, but there were no differences in in-hospital death rates comparing pre-pandemic to the COVID-19 pandemic period (6.1% [95%

CI, 5.9%–6.3%] versus 6.2% [95% CI, 6.0%–6.4%] for all-stroke for week 10 through 23 and 5.8% [95% CI, 5.7%–6.0%] versus 5.8% [95% CI, 5.7%–6.0%] for week 24 through 44 [$P>0.05$]).

Stroke hospitalization trends from weeks 10 through 23 varied significantly by state ranging from no change in New Hampshire (0.0% [95% CI, –15.9% to 13.7%]) to a 36.2% decline (95% CI, 24.8%–46.7%) in Montana during 2020 compared with the same time period in 2019 for all-stroke, from –6.1% (95% CI, –26.5% to 11.1%) in New Hampshire to 37.0% (95% CI, 23.1%–47.6%) in Montana for AIS, and from –10.8% (95% CI, –37.0% to 9.7%) in Massachusetts to 57.4% (95% CI, –32.0% to 76.6%) in Maine for hemorrhagic stroke. Ten states had insignificant changes in AIS stroke hospitalizations, and 32 states had insignificant changes in hemorrhagic stroke hospitalizations comparing weeks 10 through 23 in 2019 to 2020 (Figure 2A through 2C).

DISCUSSION

We observed a sharp decline in the number of weekly stroke hospitalizations from weeks 10 through 15 in 2020 (WPC, 5.98%) among Medicare FFS beneficiaries aged ≥ 65 years followed by an increase during weeks 15 through 23 to levels slightly below those seen during the same weeks in 2019. However, changes in stroke hospitalizations during the initial period of COVID-19 pandemic (weeks 10 through 23) varied significantly by state.

Several studies reported significant reductions in stroke patients admitted to hospitals during the early phase of COVID-19 pandemic in the United States and in other countries.^{3,4,6,9,18–24} Although most of these studies focused on the initial decline of stroke hospitalizations amidst the COVID-19 pandemic, our study examined the timing, duration, and magnitude of the reduction by including more recent data with longer trend analysis. Based on the National Inpatient Sample of the Healthcare Cost and Utilization Project, there were 579 825 all-stroke hospitalizations in 2017 among

people aged ≥ 65 years with an average expected weekly all-stroke hospitalizations of 11 150 (<https://hcupnet.ahrq.gov/#setup>). In contrast, approximately 34 700 fewer all-stroke hospitalizations occurred during weeks 10 through 23 in 2020 and 28 100 fewer during weeks 24 through 44 among individuals aged ≥ 65

infection is associated with increased risk of stroke.^{25,26} Under these circumstances, one may expect to see a continued increase in stroke hospitalizations as the pandemic continues. The reasons for lower than expected stroke hospitalizations following the initial impact of COVID-19 pandemic are not clear; further studies are

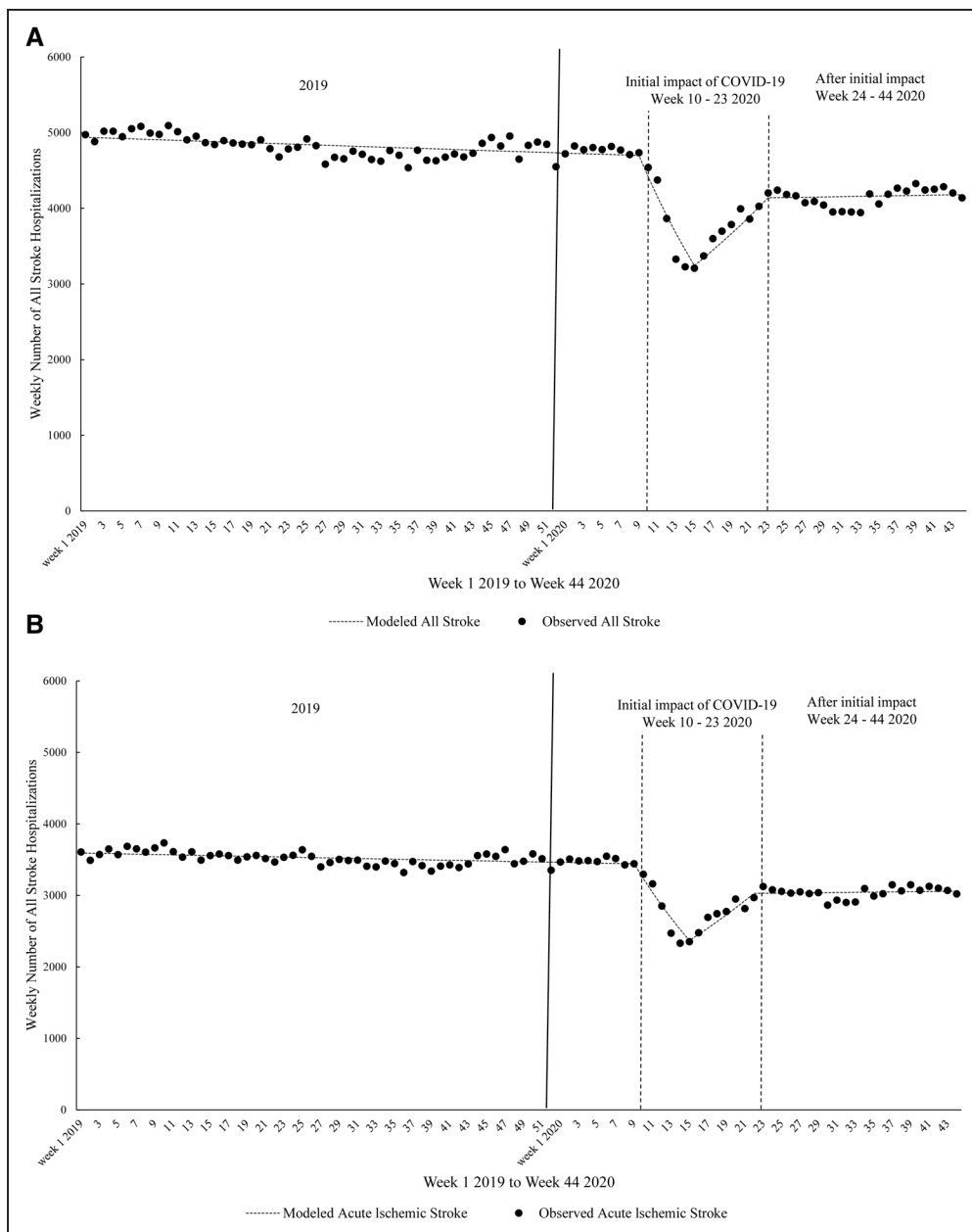


Figure 1. Trends in weekly numbers of stroke hospitalizations among Medicare fee-for-service beneficiaries aged ≥ 65 years from weeks 1 in 2019 through 44 in 2020, by stroke type, United States.

A, All-stroke. B, Acute ischemic stroke. C, Hemorrhagic stroke. COVID-19 indicates coronavirus disease 2019. (Continued)

years in the vstrokes that occurred after hospital admission). Further studies are needed to determine the consequences of hospitalization avoidance in older stroke patients. Studies have suggested that SARS-CoV-2

needed to better understand the reasons why stroke hospitalizations are lower during a pandemic that likely increases stroke risk and to explore the impact of lower hospital-seeking behavior.

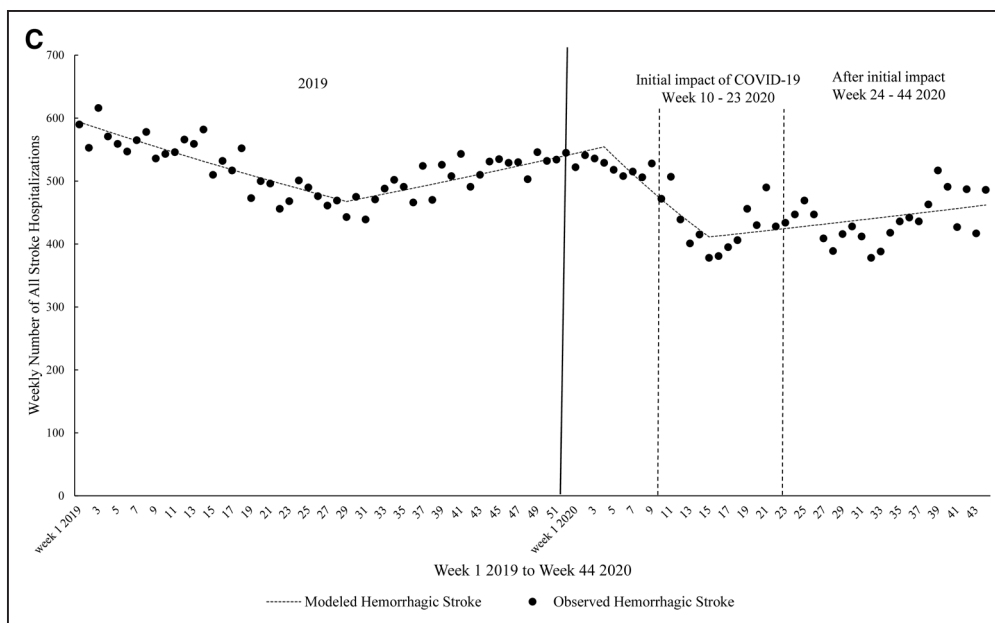


Figure 1 Continued.

The observed reduction in stroke hospitalizations increased with increasing age. Studies suggest that older adults tend to overlook the signs of stroke and delay seeking care.^{27,28} Among older adults, those living alone or with less caregiver support are more likely to experience a prehospital delay in stroke treatment and care, which may partly explain the larger reduction in stroke hospitalizations by age during the COVID-19 pandemic.^{29,30} In addition, social isolation during the early phase of COVID-19 pandemic may have resulted in missed or untimely recognition of stroke symptoms and lead to a delay in seeking care.

The findings of our study suggest that the reduction in stroke hospitalizations during the early phase of COVID-19 pandemic was similar between men and women and among different racial and ethnic groups consistent with findings of other studies.^{3,23} However, studies have documented significant racial-ethnic disparities in utilization of emergency medical services systems and often delayed arrival at emergency department for stroke treatment and care in the period before COVID-19 pandemic,³¹ as well as a disproportionate impact of COVID-19 on persons of color during the COVID-19 pandemic period.^{32,33} In this study, however, it appears that the effect of COVID-19 on the reduction of stroke hospitalizations was proportionally distributed across sex and race/ethnicity groups among Medicare FFS beneficiaries. Further studies may examine whether there may be any differences in the reduction of stroke hospitalizations by socioeconomic status, insurance coverage, healthcare access, rural and urban, and among non-FFS Medicare beneficiaries.

Our study is the first to examine the variations in the reduction of stroke hospitalizations by state. Nine states had nonsignificant differences, and 12 states had a reduction in all-stroke hospitalizations greater than 25% comparing weeks 10 through 23 in 2019 to the same time period in 2020. The reasons for the significant variation in reductions by states are not clear. The states with a smaller number of stroke hospitalizations were more likely to have nonsignificant changes in stroke hospitalizations during the early phase of COVID-19 pandemic, likely partially due to smaller sample sizes. The starting dates, duration, and type of stay-at-home orders varied by states. For example, California started mandatory stay-at-home order on March 19 and South Carolina on April 6, 2020, and 6 states did not have mandatory stay-at-home orders during March and May 2020 (Arkansas, Iowa, Nebraska, North Dakota, South Dakota, and Wyoming) (<https://www.nashp.org/governors-prioritize-health-for-all>). The differences in starting dates, duration, type of stay-at-home orders, and the timing of the geographic spread of SARS-CoV-2 may also contribute to states variations in percent reduction of stroke hospitalizations. Further studies are needed to examine the reasons for the significant variation in the reduction of stroke hospitalizations by states because of the COVID-19 pandemic.

Our findings showed the percent reduction in AIS hospitalizations was greater than that of hemorrhagic stroke. Other studies found that the decline in the number of patients admitted with mild strokes (a National Institutes of Health Stroke Scale score ≤ 5) was greater than that of moderate or severe strokes in the United Kingdom

and Norway,^{34,35} and the preliminary findings from Paul Coverdell National Acute Stroke Program suggested the National Institutes of Health Stroke Scale was significantly higher among hospitalized stroke patients comparing pre-COVID-19 and during the COVID-19 pandemic time periods (Paul Coverdell National Acute Stroke Program, personal communication, October 5, 2020). Despite more moderate or severe stroke were admitted to the hospitals during the pandemic, our study found no differences in in-hospital death rates among Medicare beneficiaries comparing pre-pandemic to the COVID-19 pandemic period consistent with the findings of other studies.^{36,37} Studies suggested that stroke treatments and quality of care were preserved during the pandemic that may partly explain the lack of temporal change in death rates.³⁶⁻³⁹ Hemorrhagic stroke is generally more severe than AIS and associated with considerable risk of mortality.⁴⁰ The severity of hemorrhagic stroke may partly explain the differences in reduction of AIS and hemorrhagic stroke hospitalizations as a result of COVID-19 pandemic. However, information on stroke severity was not available in Medicare data. The smaller number of hemorrhagic stroke hospitalizations compared to AIS may also contribute to the finding of fewer reductions that were statistically significant.

Significant reduction in stroke hospitalizations may be due to multiple reasons, including fear of exposure to COVID-19 in hospitals or healthcare settings, stay-at-home orders, and social distancing guidance that may make people more likely to be alone, or there could be true changes in incidence of stroke.^{4,5,19,41,42} In addition, it is possible that some hospitalized FFS beneficiaries with COVID-19 having stroke may be classified as COVID-19 instead of stroke. Further study is needed to determine the effect of deferred care-seeking behavior and changes in incidence of stroke on the reduction of stroke hospitalizations during COVID-19 pandemic.

Stroke is the fifth leading cause of death in the United States, and approximately every 40 seconds, an American will experience a stroke.¹⁰ This life-threatening condition requires timely emergency care to avoid serious complications, long-term disability, or death regardless of the COVID-19 pandemic status.⁴ As part of its framework for provision of non-COVID-19 health care during the COVID-19 pandemic, the Centers for Disease Control and Prevention recommends seeking timely health care for non-COVID-19 time-sensitive conditions, such as stroke and heart attack during COVID-19 (<https://www.cdc.gov/coronavirus/2019-ncov/hcp/framework-non-COVID-care.html>). The Stroke Council of the American Heart Association/American Stroke Association published guidelines for the care of stroke patients and for reducing the risk of infectious exposure at hospital or health care settings during the COVID-19 pandemic.^{43,44} It is recommended that patients seek immediate care for life-threatening conditions like stroke (https://www.cdc.gov/stroke/signs_symptoms.htm).

There are several limitations of this analysis. First, this study used the Medicare preliminary data that is updated on monthly basis and the latest data included in our analysis (week 44 in 2020, October 25–October 31) was updated in January 2021. The number of weekly stroke hospitalizations may be subject to change. However, Centers for Medicare & Medicaid Services suggested that >95% of Medicare FFS in-hospital claims were received within 3 months (<https://www.cms.gov/files/document/medicare-covid-19-data-snapshot-fact-sheet.pdf>). Second, Medicare inpatient claims have no information on the severity of stroke; therefore, we could not assess potential differences in the reduction of stroke hospitalizations by severity. Third, Medicare data is an administrative claims database that has important strengths, including the ability to answer a wide range of health care–related questions such as understanding the epidemiology of the chronic diseases, quantifying the costs related to health care interventions, and studying the effects of policy changes on prescribing patterns and clinical outcomes, but it is not designed to be a surveillance system or to track the trends and changes in time-sensitive conditions, including stroke. In addition, the coding of stroke diagnosis using *International Classification of Diseases, Tenth Revision* in Medicare databases may not reflect the final diagnosis by the treating physicians. However, studies suggested that the sensitivity of *International Classification of Diseases, Tenth Revision* codes for any cerebrovascular disease (I60-I69) in the administrative health databases was over 80%.⁴⁵ Fourth, Medicare databases do not have information on the duration of prehospital delay between the time of stroke symptoms onset and seeking medical care. This information may be particularly important during the pandemic. Fifth, we had limited sample size to examine the timing and duration of weekly reduction in stroke hospitalizations at state level and focused on comparing the difference during the initial effects of COVID-19 pandemic by state. Sixth, we restricted our study to Medicare FFS beneficiaries which included about 60% of Medicare beneficiaries, thus our findings may not be generalizable to non-FFS beneficiaries. About 80% of Medicare beneficiaries in this study identified as non-Hispanic Whites, and our findings may reflect primarily the changes in stroke hospitalizations among non-Hispanic White beneficiaries.

CONCLUSIONS

Our findings suggest that the number of stroke hospitalizations was reduced significantly during the early phase of COVID-19 pandemic compared with the same period in 2019 among Medicare FFS beneficiaries and remained at a lower than usual level following the initial impact of pandemic in the United States. Public health agencies and other organizations should enhance communication efforts to remind the public about the signs and symptoms of stroke. Stroke is a medical emergency,

Table 2. Percent Reduction in Number of Medicare Fee-for-Service Beneficiaries Aged ≥65 Years Hospitalized With Stroke From Week 10 to 23 and Week 24 to 44 in 2019 and 2020 by Stroke Type and Selected Characteristics—United States, 2019–2020

Characteristics	Initial impact of COVID-19 pandemic					
	2019 Weeks 10–23 (March 3–June 8)*		2020 Weeks 10–23 (March 1–June 6)*		% Reduction in stroke hospitalization†	P value‡
	No.	Percent (95% CI)	No.	Percent (95% CI)	Percent (95% CI)	
All-stroke						
Total	68 266		53 062		22.3 (21.4–23.1)	
Age, y (median, IQR)		79.1 (72.4–86.0)		78.9 (72.5–85.6)		0.08
Age group, n (%)						
65–74 y	23 349	34.2 (33.9–34.6)	18 469	34.8 (34.4–35.2)	20.9 (19.3–22.4)	
75–84 y	25 710	37.7 (37.3–38.0)	20 163	38.0 (37.6–38.4)	21.6 (20.1–23.0)	
≥85 y	19 207	28.1 (27.8–28.5)	14 430	27.2 (26.8–27.6)	24.9 (23.2–26.5)	0.003
Sex, n (%)						
Men	31 232	45.8 (45.4–46.1)	24 354	45.9 (45.5–46.3)	22.0 (20.7–23.4)	
Women	37 034	54.3 (53.9–54.6)	28 708	54.1 (53.7–54.5)	22.5 (21.3–23.6)	1.00
Race/ethnicity, n (%)						
Non-Hispanic White	54 602	80.0 (79.7–80.3)	42 463	80.0 (79.7–80.4)	22.2 (21.2–23.1)	
Non-Hispanic Black	7597	11.1 (10.9–11.4)	5865	11.1 (10.8–11.3)	22.8 (19.9–25.4)	
Hispanic	3365	4.9 (4.8–5.1)	2633	5.0 (4.8–5.2)	21.8 (17.6–25.6)	
Other	2702	4.0 (3.8–4.1)	2101	4.0 (3.8–4.1)	22.2 (17.7–26.3)	1.00
Length of stay in days (median, IQR)		3 (2–6)		3 (2–6)		0.001
In-hospital death, n (%)						
Yes	4140	6.1 (5.9–6.3)	3266	6.2 (6.0–6.4)	21.1 (17.4–24.5)	
No	64 126	93.9 (93.8–94.1)	49 796	93.8 (93.6–94.1)	22.3 (21.5–23.2)	1.00
Acute ischemic stroke						
Total	49 779		39 012		21.6 (20.6–22.6)	
Age, y (median, IQR)		79.4 (72.5–86.4)		79.2 (72.6–86.0)		0.10
Age group, n (%)						
65–74 y	16 575	33.3 (32.9–33.7)	13 229	33.9 (33.4–34.4)	20.2 (18.3–22.0)	
75–84 y	18 463	37.1 (36.7–37.5)	14 648	37.6 (37.1–38.0)	20.7 (18.8–22.3)	
≥85 y	14 741	29.6 (29.2–30.0)	11 135	28.5 (28.1–29.0)	24.5 (22.6–26.4)	0.006
Sex, n (%)						
Men	22 549	45.3 (44.9–45.7)	17 551	45.0 (44.5–45.5)	22.2 (20.6–23.7)	
Women	27 230	54.7 (54.3–55.1)	21 461	55.0 (54.5–55.5)	21.2 (19.7–22.5)	1.00
Race/ethnicity, n (%)						
Non-Hispanic White	40 157	80.7 (80.3–81.0)	31 453	80.6 (80.2–81.0)	21.7 (20.5–22.8)	
Non-Hispanic Black	5460	11.0 (10.7–11.3)	4255	10.9 (10.6–11.2)	22.1 (18.6–25.3)	
Hispanic	2336	4.7 (4.5–4.9)	1861	4.8 (4.6–5.0)	20.3 (15.3–25.4)	
Other	1826	3.7 (3.5–3.8)	1443	3.7 (3.5–3.9)	21.0 (15.1–26.4)	1.00
Length of stay in days (median, IQR)		3 (2–5)		3 (2–5)		0.001
In-hospital death, n (%)						
Yes	2076	4.2 (4.0–4.4)	1658	4.3 (4.1–4.5)	20.1 (14.7–25.3)	
No	47 703	95.8 (95.7–96.0)	37 354	95.8 (95.6–96.0)	21.7 (20.6–22.8)	1.00
Hemorrhagic stroke						
Total	7300		6032		17.4 (14.7–20.2)	
Age, y (median, IQR)		78.3 (72.2–85.0)		78.1 (72.1–84.8)		1.00
Age group, n (%)						
65–74 y	2666	36.5 (35.4–37.6)	2215	36.7 (35.5–38.0)	16.9 (12.2–21.7)	
75–84 y	2821	38.6 (37.5–39.8)	2359	39.1 (37.9–40.4)	16.4 (11.8–20.8)	

(Continued)

Table 2. Continued

After initial impact					
2019 Weeks 24–44 (June 9–November 2) [§]		2020 Weeks 24–44 (June 7–October 31) [§]		% Reduction in stroke hospitalization [†]	P value [‡]
No.	Percent (95% CI)	No.	Percent (95% CI)		
98 884		86 959		12.1 (11.2–12.9)	
	79.2 (72.6–86.1)		79.0 (72.6–85.7)		<0.001
33 147	33.5 (33.2–33.8)	29 881	34.4 (34.1–34.7)	9.9 (8.4–11.3)	
37 539	38.0 (37.7–38.3)	33 248	38.2 (37.9–38.6)	11.4 (10.2–12.7)	
28 198	28.5 (28.2–28.8)	23 830	27.4 (27.1–27.7)	15.5 (13.9–17.0)	<0.001
44 883	45.4 (45.1–45.7)	39 287	45.2 (44.9–45.5)	12.5 (11.2–13.7)	
54 001	54.6 (54.3–54.9)	47 672	54.8 (54.5–55.2)	11.7 (10.5–12.8)	1.00
79 242	80.1 (79.9–80.4)	70 016	80.5 (80.3–80.8)	11.6 (10.6–12.6)	
10 852	11.0 (10.8–11.2)	9 225	10.6 (10.4–10.8)	15.0 (12.6–17.2)	
4 850	4.9 (4.8–5.0)	4 273	4.9 (4.8–5.1)	11.9 (8.2–15.6)	
3 940	4.0 (3.9–4.1)	3 445	4.0 (3.8–4.1)	12.6 (8.6–16.5)	1.00
	3 (2–6)		3 (2–6)		<0.001
5 767	5.8 (5.7–6.0)	5 071	5.8 (5.7–6.0)	12.1 (8.5–15.5)	
93 117	94.2 (94.0–94.3)	81 888	94.2 (94.0–94.3)	12.1 (11.2–12.8)	1.00
72 599		63 758		12.2 (11.3–13.1)	
	79.6 (72.8–86.5)		79.2 (72.7–86.0)		<0.001
23 655	32.6 (32.2–32.9)	21 448	33.6 (33.3–34.0)	9.3 (7.6–10.9)	
27 159	37.4 (37.1–37.8)	24 085	37.8 (37.4–38.2)	11.3 (9.8–12.8)	
21 785	30.0 (29.7–30.3)	18 225	28.6 (28.2–28.9)	16.3 (14.7–18.1)	<0.001
32 407	44.6 (44.3–45.0)	28 212	44.3 (43.9–44.6)	12.9 (11.6–14.3)	
40 192	55.4 (55.0–55.7)	35 546	55.8 (55.4–56.1)	11.6 (10.3–12.8)	1.00
58 683	80.8 (80.5–81.1)	51 664	81.0 (80.7–81.3)	12.0 (11.0–13.0)	
7 755	10.7 (10.5–10.9)	6 658	10.4 (10.2–10.7)	14.1 (11.1–16.9)	
3 429	4.7 (4.6–4.9)	3 067	4.8 (4.7–5.0)	10.6 (6.4–15.0)	
2 732	3.8 (3.6–3.9)	2 369	3.7 (3.6–3.9)	13.3 (8.4–17.6)	1.00
	3 (2–5)		3 (2–5)		1.00
2 969	4.1 (4.0–4.2)	2 657	4.2 (4.0–4.3)	10.5 (5.6–15.1)	
69 630	95.9 (95.8–96.1)	61 101	95.8 (95.7–96.0)	12.2 (11.3–13.2)	1.00
10 275		9 203		10.4 (7.6–13.0)	
	78.8 (72.3–85.1)		78.5 (72.4–85.0)		1.00
3 599	35.0 (34.1–36.0)	3 286	35.7 (34.7–36.7)	8.7 (3.9–12.9)	
4 075	39.7 (38.7–40.6)	3 626	39.4 (38.4–40.4)	11.0 (6.9–15.5)	

(Continued)

Table 2. Continued

Characteristics	Initial impact of COVID-19 pandemic					
	2019 Weeks 10–23 (March 3–June 8)*		2020 Weeks 10–23 (March 1–June 6)*		% Reduction in stroke hospitalization†	P value‡
	No.	Percent (95% CI)	No.	Percent (95% CI)	Percent (95% CI)	
≥85 y	1813	24.8 (23.9–25.8)	1458	24.2 (23.1–25.3)	19.6 (14.1–25.4)	1.00
Sex, n (%)						
Men	3215	44.0 (42.9–45.2)	2782	46.1 (44.9–47.4)	13.5 (9.0–17.9)	
Women	4085	56.0 (54.8–57.1)	3250	53.9 (52.6–55.1)	20.4 (16.7–24.2)	0.50
Race/ethnicity, n (%)						
Non-Hispanic White	5738	78.6 (77.6–79.5)	4746	78.7 (77.6–79.7)	17.3 (14.2–20.6)	
Non-Hispanic Black	749	10.3 (9.6–11.0)	603	10.0 (9.3–10.8)	19.5 (9.7–27.8)	
Hispanic	397	5.4 (4.9–6.0)	350	5.8 (5.2–6.4)	11.8 (–1.7–23.5)	
Other	416	5.7 (5.2–6.3)	333	5.5 (5.0–6.1)	20.0 (7.7–30.9)	1.00
Length of stay (median, IQR) in days						
		4 (2–8)		4 (2–8)		1.00
In-hospital death, n (%)						
Yes	1663	22.8 (21.8–23.8)	1301	21.6 (20.5–22.6)	21.8 (16.2–26.9)	
No	5637	77.2 (76.2–78.2)	4731	78.4 (77.4–79.5)	16.1 (13.1–19.6)	1.00

(Continued)

and it is recommended that people who experience stroke symptoms during the COVID-19 pandemic seek immediate care to reduce serious outcomes or death.

ARTICLE INFORMATION

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Supplemental Materials

Online Figure I
Online Table I

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Table 2. Continued

After initial impact					
2019 Weeks 24–44 (June 9–November 2)§		2020 Weeks 24–44 (June 7–October 31)§		% Reduction in stroke hospitalization†	P value‡
No.	Percent (95% CI)	No.	Percent (95% CI)		
2601	25.3 (24.5–26.2)	2291	24.9 (24.0–25.8)	11.9 (6.7–16.7)	1.00
4623	45.0 (44.0–46.0)	4047	44.0 (43.0–45.0)	12.5 (8.6–16.3)	
5652	55.0 (54.0–56.0)	5156	56.0 (55.0–57.0)	8.8 (5.3–12.2)	1.00
8077	78.6 (77.8–79.4)	7279	79.1 (78.3–79.9)	9.9 (6.8–12.8)	
1024	10.0 (9.4–10.6)	894	9.7 (9.1–10.3)	12.7 (4.3–20.5)	
574	5.6 (5.2–6.1)	531	5.8 (5.3–6.3)	7.5 (–4.1–17.4)	
600	5.8 (5.4–6.3)	499	5.4 (5.0–5.9)	16.8 (5.9–26.1)	1.00
	4 (2–8)		4 (2–9)		1.00
2280	22.2 (21.4–23.0)	1932	21.0 (20.2–21.8)	15.3 (10.3–20.0)	
7995	77.8 (77.0–78.6)	7271	79.0 (78.2–79.8)	9.1 (6.1–12.0)	0.96

COVID-19 indicates coronavirus disease 2019; and IQR, interquartile range.

§Weeks 10 (March 3–9) through 23 (June 2–8) in 2019 serve as pre-COVID-19 pandemic period and weeks 10 (March 1–7) through 23 (May 3–June 6) in 2020 as initial impact of COVID-19 pandemic weeks.

†% reduction of stroke hospitalization between 2019 and 2020 is calculated as (2019–2020)/(2019)×100 and the bootstrap resamples were used to determine the 95% CI.

‡P value to test for difference in median age or length of stay between 2019 and 2010 and P value to test difference in distribution by age group, sex, race/ethnicity, and in-hospital death between 2019 and 2020 based on χ^2 test and presented adjusted P values by Holm method for multiple comparison.

§Weeks 24 (June 9–15) through 44 (October 27–November 2) in 2019 serve as pre-COVID-19 pandemic period and weeks 24 (June 7–13) through 44 (October 25–31) in 2020 as the period after initial impact on level of stroke hospitalizations.

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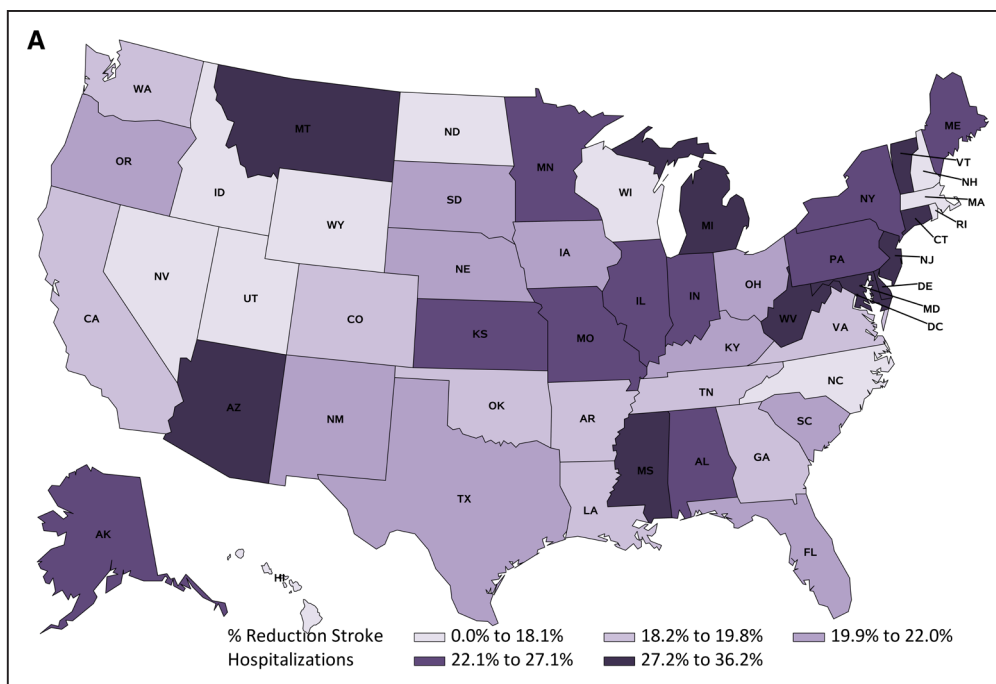


Figure 2. Percent reduction of stroke hospitalizations comparing weeks 10 through 23 in 2019 and 2020 among Medicare fee-for-service beneficiaries aged ≥65 y by stroke type and State, United States*.

A, All-stroke. **B**, AIS. **C**, hemorrhagic stroke. *Weeks 10 (March 3–9) through 23 (June 2–June 8) in 2019 serve as pre-coronavirus disease 2019 (COVID-19) pandemic period and weeks 10 (March 1–7) in 2020 through 23 (May 31–June 6) as the initial impact of the COVID-19 pandemic weeks. (Continued)

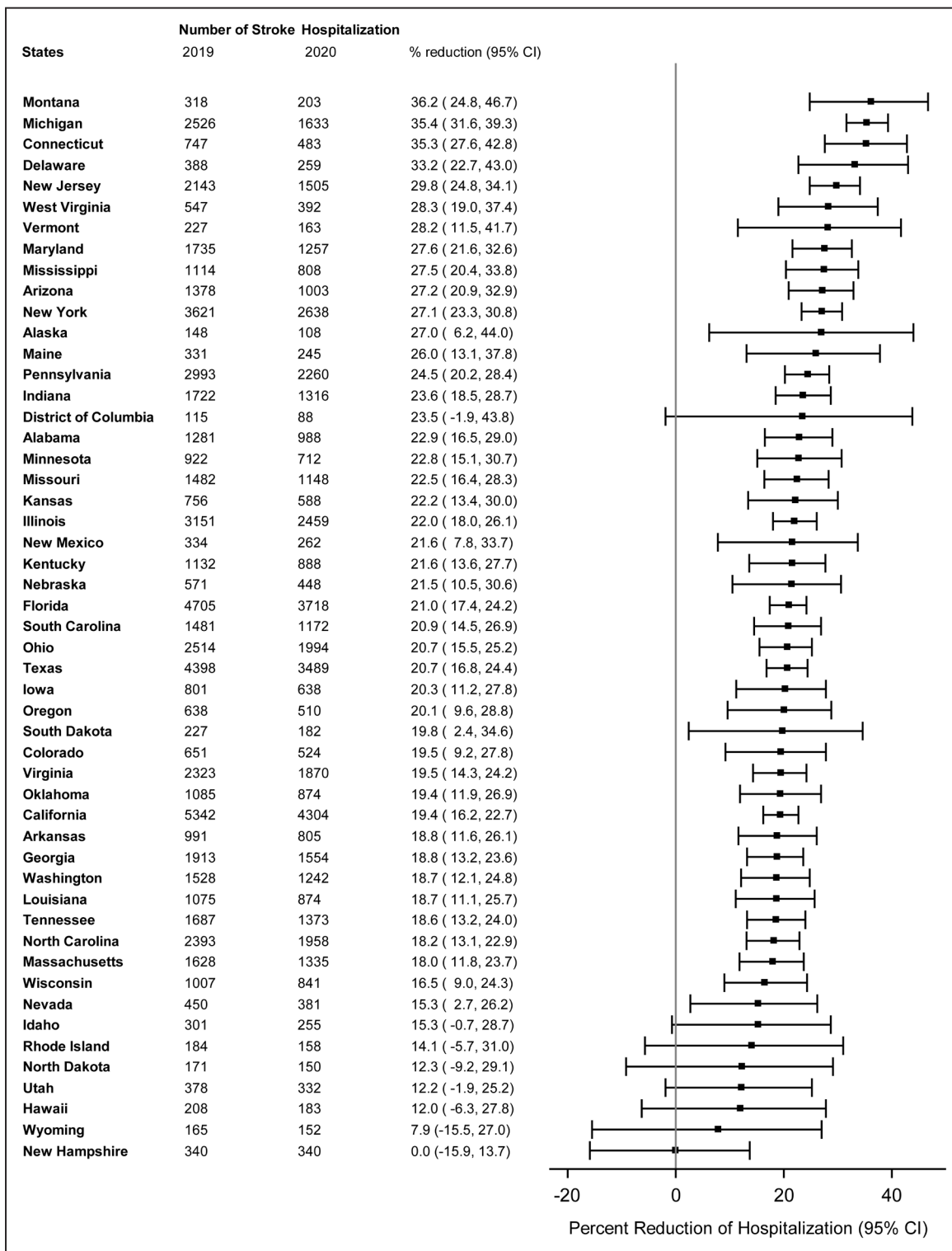


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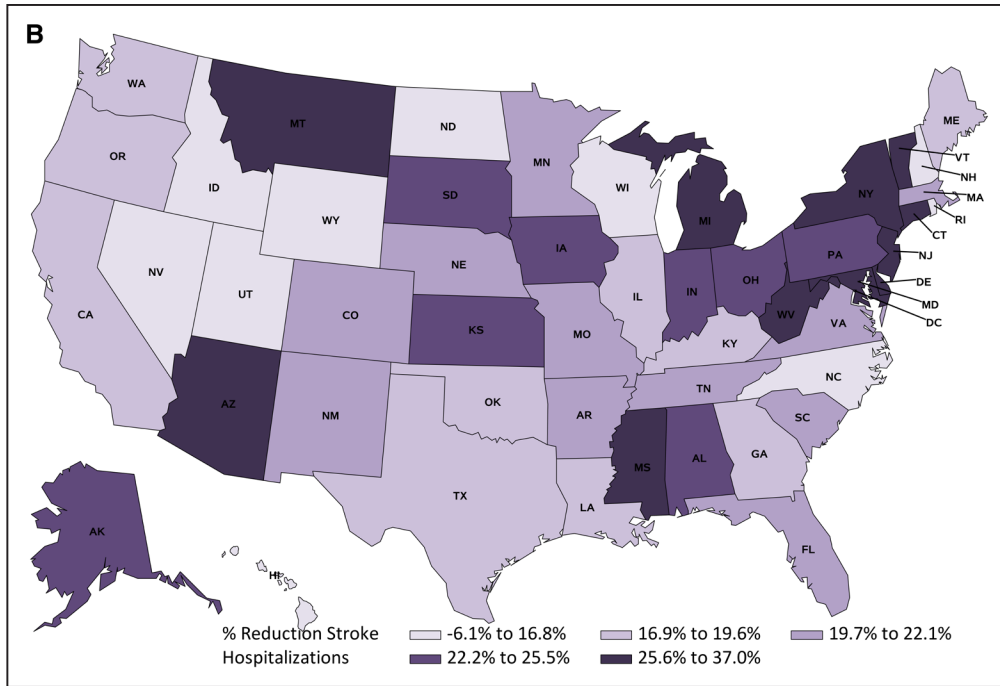


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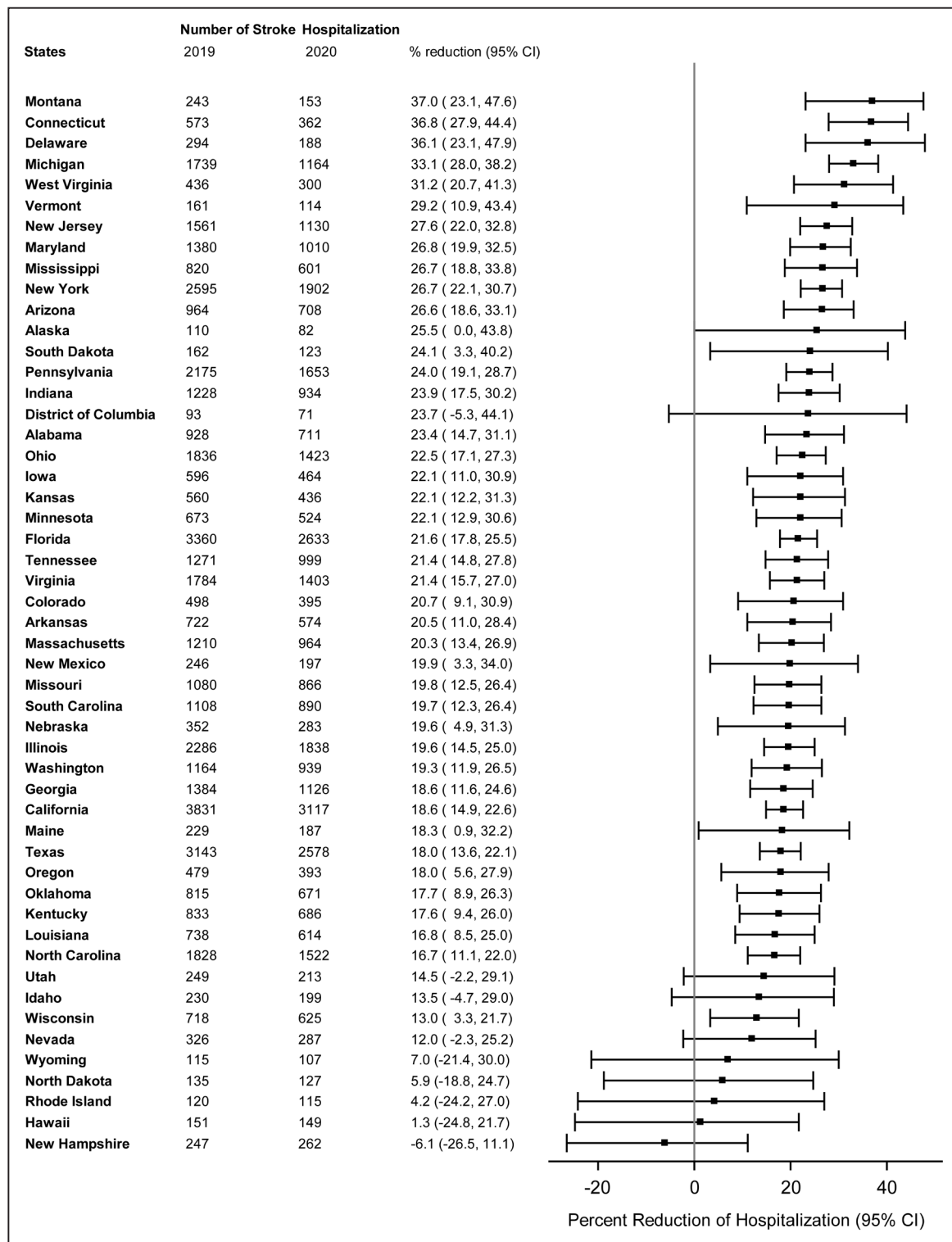


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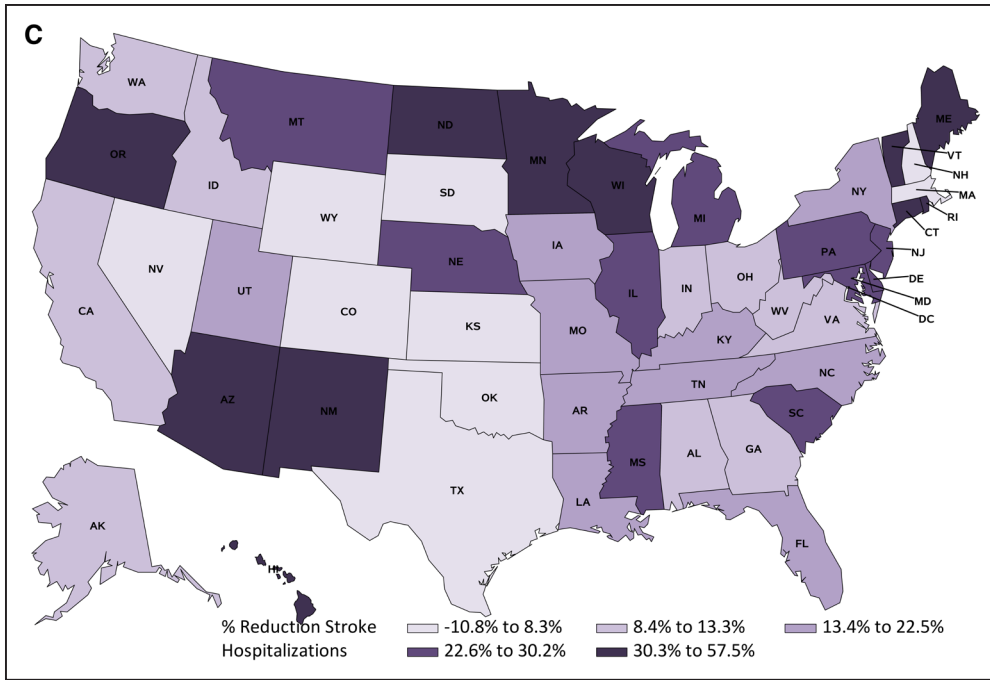


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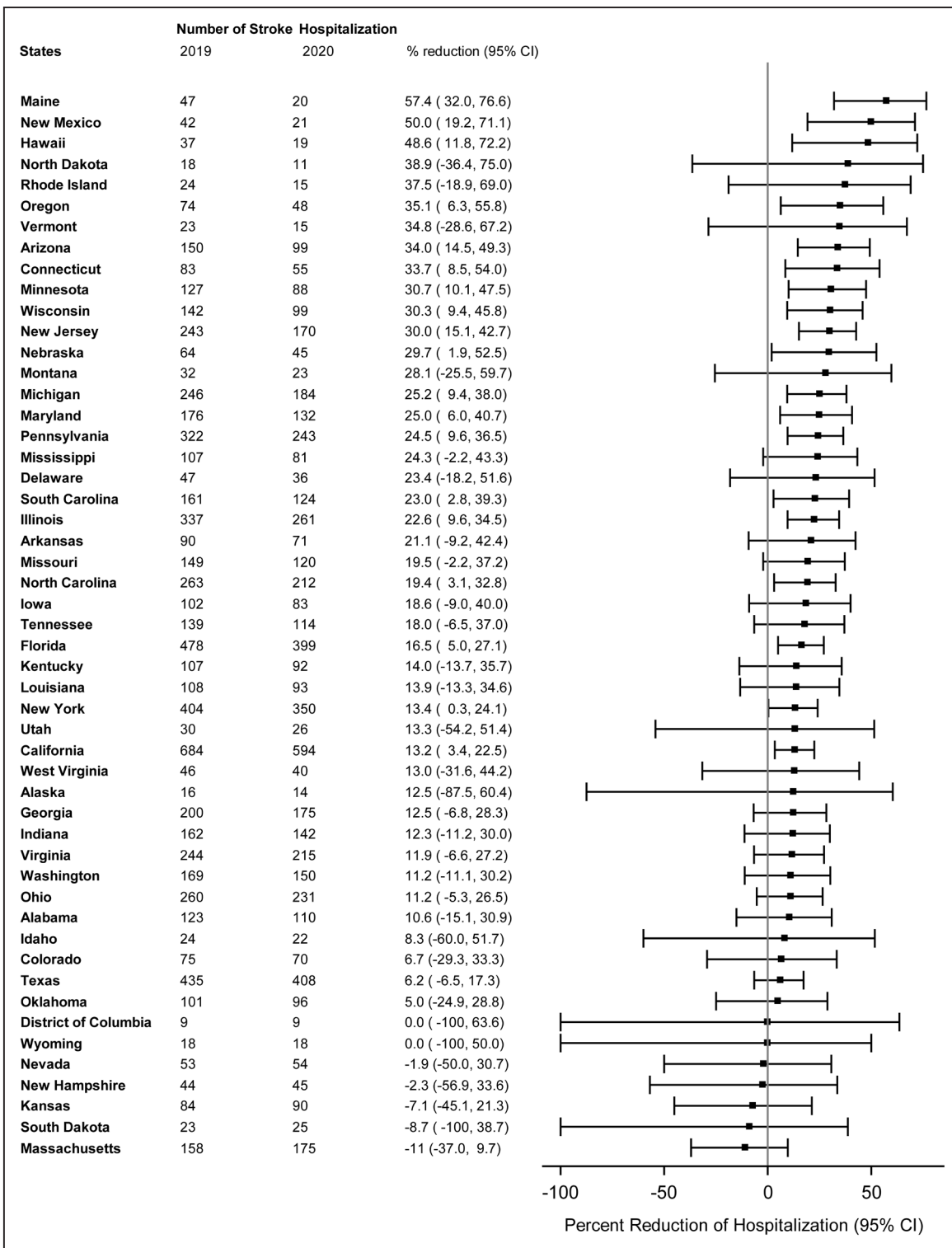


Figure 2 Continued.