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Quality of Care and Outcomes for Patients with Acute Ischemic Stroke and Transient Ischemic Attack During the COVID-19 Pandemic

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Background and Purpose: Hospitalizations for acute ischemic stroke (AIS) and transient ischemic attack (TIA) decreased during the COVID-19 pandemic. We compared the quality of care and outcomes for patients with AIS/TIA before vs. during the COVID-19 pandemic across the United States Department of Veterans Affairs healthcare system. *Methods:* This retrospective cohort study compared AIS/TIA care quality before (March−September 2019) vs. during (March-September 2020) the pandemic. Electronic health record data were used to identify patient characteristics, quality of care and outcomes. The without-fail rate was a composite measure summarizing whether an individual patient received all of the seven processes for which they were eligible. Mixed effects logistic regression modeling was used to assess differences between the two periods. *Results:* A decrease in presentations occurred during the pandemic (N = 4360 vs. N = 5636 patients; p = 0.003) and was greater for patients with TIA (-30.4%) than for AIS (-18.7%). The without-fail rate improved during the pandemic (56.2 vs. before 50.1%). The use of high/moderate potency statins increased among AIS patients (OR 1.26 [1.06−1.48]) and remained unchanged among those with TIA (OR 1.04 [0.83,1.29]). Blood pressure measurement within 90-days of discharge was less frequent during the pandemic (57.8 vs. 89.2%, $p < 0.001$). Hypertension control decreased among patients with AIS (OR 0.73 [0.60−0.90]) and TIA (OR 0.72 [0.54-0.96]). The average systolic and diastolic blood pressure was 1.9/1.4 mmHg higher during the pandemic than before ($p < 0.001$). Compared to before, during the pandemic fewer AIS patients had a primary care visit (52.5% vs. 79.8%; p = 0.0001) or a neurology visit (27.9 vs. 41.1%; p = 0.085). Both 30- and 90-day unadjusted all-cause mortality rates were higher in 2020 (3.6% and 6.7%) vs. 2019 (2.9, 5.4%; p = 0.041 and p = 0.006); but these differences were not statistically significant after risk adjustment. *Conclusions:* Overall quality of care for patients with AIS/TIA did not decline during the COVID-19 pandemic.

Abbreviations: AIS, acute ischemic stroke; CDW, corporate data warehouse; OR, odds ratio, PREVENT, protocol-guided rapid evaluation of veterans experiencing new transient neurological symptoms; TIA, transient ischemic attack; VA, department of veterans affairs

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Introduction

The number of hospitalizations for acute ischemic stroke (AIS) and transient ischemic attack (TIA) was lower during the COVID-19 pandemic and patients who sought care often did so with delays from symptom onset to presentation.[1–6] The reported effect of the pandemic on quality of care for patients with cerebrovascular disease has varied across studies.[7] For example, lower rates of thrombectomy have been reported[8] in some settings but not others.[9] One study demonstrated that well-established telestroke programs with existing protocols for timely treatment allowed for uninterrupted care during the COVID-19 pandemic despite hospital resource constraints (e.g., changes in clinical workflow and staffing shortages) which may result in reduced quality of care.[10] The objective of this study was to compare the quality of care and outcomes for patients with stroke and TIA before versus during the COVID-19 pandemic across the Department of Veterans Affairs (VA) healthcare system, the largest healthcare system in the United States. We hypothesized that the quality of care would be lower during the COVID-19 pandemic.

Methods

Data sharing statement

These data must remain on Department of Veterans Affairs servers. Investigators interested in using these data for analyses should email the corresponding author.

Cohort: patients with acute ischemic stroke or transient ischemic attack (2016–2020)

Patients at 128 VA hospitals with an Emergency Department (ED) visit or inpatient stay for AIS or TIA (2016–2020) were identified on the basis of admission diagnoses as described previously.[11–13] Each patient was included only once, using the first event in the study period. The primary analysis compared quality of care for patients in March-September 2019 vs. March-September 2020. In secondary analyses we examined quality of care over time during the periods March-September of each year from 2016 through 2018.

Data sources and outcomes

Data were obtained from VA corporate data warehouse (CDW) which included: inpatient and outpatient data files (with diagnostic and procedure codes) in the five-years pre-event to identify past medical history[14]; healthcare utilization; receipt of procedures (Current Procedural Terminology [CPT], Healthcare Common Procedures Coding System [HCPCS], and *ICD*-9 and *ICD*-10 procedure codes); vital signs; laboratory data; allergies; imaging; orders; medications; and clinical consults. Fee-Basis Data (which includes care that was provided at non-VA hospitals but that was paid for by the VA) were also used to identify inpatient and outpatient healthcare utilization and medical history. Therefore, recurrent vascular events[15–17] (defined as an ED visit or inpatient stay within 90-days of discharge for congestive heart failure, myocardial infarction/acute coronary syndrome, ischemic stroke, TIA, ventricular arrhythmia, or death) as well as all-cause hospital readmissions which occurred in community hospitals, but which were not paid for by the VA, were not included. All-cause mortality (defined as death from any cause within 30-days or 90-days of presentation for the index event) was obtained from the VA Vital Status File.[18] However, because the VA Vital Status File was last updated in May 2020, we also used information from the VA Master Patient Index (MPI), which is updated daily and is now considered the authoritative source for date of death within the VA.[19] More than 96% of deaths are captured in the MPI data within four-months; the remainder are captured in subsequent months.

Quality of care

Quality of care was assessed using validated electronic quality measures[11] using seven process of care that have been associated with improved outcomes, as described previously.[11–13,20] Each process of care was assessed among eligible patients. For six of the processes of care (brain imaging, carotid artery imaging, anticoagulation for atrial fibrillation, antithrombotics, receipt of high or moderate potency statins, and neurology consultation) patients could either pass or fail the quality measure. For the hypertension control measure, patients without a blood pressure measurement in the 90-days post-discharge period were considered to be ineligible for the measure. The definitions for the numerators and denominators of each process of care are provided in Supplemental Table A.

The without-fail rate (also known as defect-free[21] care) was an all-or-none composite measure of quality that evaluated whether an individual patient received all of the care for which they were eligible (yes vs. no).[22] We focused on an all-or-none measure of care quality (the without-fail rate) rather than on individual processes of care or a consolidated measure of quality (e.g., the

number of passes divided by the number of processes of care for which a patient is eligible) because all-or-none measures are considered to most closely reflect the interests of patients,[22] examine a whole continuum of care (e.g., not just processes in the Emergency Department),[22,23] and although they can be a relatively difficult outcome to change and even small improvements in the absolute rate may reflect substantial changes in practice at the facility level, they are sensitive to change.[12,22,24]

During the early phases of the COVID-19 pandemic, many in-person clinic visits were postponed or replaced by telehealth visits[25]; per VA policy, blood pressure measurements may only be entered into the electronic health record vital sign package if the blood pressure measurement was observed by VA clinical staff either during in-person visits or video visits. Thus, we expected the number of primary care and specialty care visits to be substantially lower during the COVID-19 pandemic, resulting in unavailability of blood pressure measurements. Therefore, as a sensitivity analysis, we also examined the without-fail rate based on 6 process measures (excluding the hypertension control measure) instead of 7 process measures.

Statistical analysis

The primary analysis compared the pass rates for each of the seven process of care measures and the mean without-fail rate in the COVID-19 period (March−September 2020) versus the pre-COVID-19 period (March−September 2019). Patient characteristics were compared using chi-square tests for categorical variables and t-test for continuous variables by period. We used a mixed effects logistic regression model to assess whether the without-fail rate and individual process measures differed by year while adjusting for patient characteristics. The model included a random effect for facility and patient characteristics identified from prior research.[12,20,26] All analyses were performed using SAS Enterprise Guide, version 7.11 (SAS Institute Inc.). Human subjects research approval was received from the Indiana University Institutional Review Board (IRB). The institutional review board waived the need for patient consent.

Results

The number of patients with acute cerebrovascular events who were cared for in a VA Emergency Department (ED) or inpatient setting was substantially lower in March−September 2020 as compared to the same time period in 2019: N = 5636 patients (N = 1916 [34.0%] TIA and N = 3720 [66.0%] patients with stroke) were seen in 2019 as compared to N = 4360 (patients (N = 1334 [30.6%] TIA and N = 3026 [69.4%] patients with stroke) in 2020 (p = 0.003). The decreases in cases was greater for patients with TIA ([1916-1334]/1916, 30.4% decrease) than for patients with stroke ([3720−3026]/3720, 18.7%). The proportion of patients who were admitted to the hospital (as opposed to being discharged from the ED) remained stable for TIA (68.1% in 2019 vs. 69.1% in 2020, p = 0.523) and increased slightly for stroke (80.7% vs. 83.2%, p = 0.008). Only 72/4360 (1.7%) of the TIA and patients with stroke in 2020 had COVID-19.

With few exceptions, patient characteristics were similar between 2019 (before COVID-19 pandemic) and 2020 (during COVID-19 pandemic, Table 1). Notably, more patients in 2019 than 2020 had a history of atrial fibrillation (18.2 vs. 16.3%, p = 0.016), peripheral artery disease (17.1 vs. 14.3% vs. $p < 0.001$), and smoking (34.6% vs. 29.8 vs. < 0.0001). As expected, substantially fewer patients had a blood pressure measurement in the 90-days following discharge in 2020 (57.8%) as compared to 2019 (89.2%, $p < 0.0001$). The average systolic and diastolic blood pressure was 1.9/1.4 mmHg higher in 2020 ($p < 0.001$).

Quality of care as measured by the without-fail rate improved from 50.1% in 2019 to 56.2% in 2020 overall (Table 2). The without-fail rate remained relatively stable for patients with TIA: 43.6% in 2019 vs. 44.3% in 2020 and increased for patients with stroke (53.6% in 2019 vs. 61.6% in 2020). The without-fail rate increased when the hypertension control measure was not included: 2019, 50.1% to 58.6%, absolute change of 8.5%; 2020, 56.2% to 61.4%, absolute change of 5.2%. Quality of care in both 2019 and 2020 was lower for patients with TIA than patients with AIS (Supplemental Table B and C). However, the without-fail rate has improved consistently each year since 2016, from a low of 41.9% in 2016 to a high of 56.2% in 2020 (Fig. 1). This trend is evident for both AIS and TIA.

The pass rates for five processes of care were similar between 2019 and 2020 (Tables 2 and 3). Overall, the pass rate for the high or moderate potency statin measure was higher in 2020 (76.0%) compared to 2019 (72.8%). The pass rate for the high or moderate potency statin process increased among patients with stroke (OR 1.26 [1.06−1.48], p = 0.008) but was unchanged among patients with TIA (OR 1.04 [0.83−1.29], p = 0.753). This increasing trajectory in high or moderate potency statin use has been evident since at least 2016 (Fig. 1). Hypertension control decreased among both stroke (OR 0.73 [0.60−0.90], p = 0.003) and patients with TIA (OR 0.72 [0.54−0.96], p = 0.027). Fewer patients were eligible for the hypertension control measure in 2020 than in prior years: 3541/5325 (66.5%) in 2016, 3492/5230 (66.8%) in 2017, 3375/5071 (66.6%) in 2018, 3298/4906 (67.2%) in 2019, 1188/3823 (31.1%) in 2020. This is likely explained by fewer patients having a primary care visit in the 90-days after discharge from the index event in 2020 (82.1 vs. 51.5% for patients with TIA [p = 0.045] and 79.8 vs. 52.5% for patients with stroke [$p < 0.0001$]). The number of patients with a neurology visit in the 90-days after discharge in 2020 was also lower than in 2019 (38.7% vs. 26.7% for patients with TIA [p = 0.412] and 41.1 vs. 27.9% for patients with stroke [p = 0.085]).

Table 1. *Baseline patient characteristics of patients with transient ischemic attack (TIA) and ischemic stroke.*

Characteristics*	Before Pandemic: March—September 2019 N = 5636				During pandemic: March—September 2020 N = 4360				P-value (2019 vs. 2020)
	Total N = 5636	TIA* N = 1916	Stroke N = 3720	P-value	Total N = 4360	TIA* N = 1334	Stroke N = 3026	P-value	
Index Event									
Admitted vs ED for Index Event				<0.001				<0.001	0.003
ED Only	1330 (23.6)	612 (31.9)	718 (19.3)		920 (21.0)	412 (30.9)	508 (16.8)		
Admitted to Hospital	4306 (76.4)	1304 (68.1)	3002 (80.7)		3440 (78.9)	922 (69.1)	2518 (83.2)		
Weekend Presentation	1117 (19.8)	398 (20.8)	719 (19.3)	0.198	848 (19.5)	261 (19.6)	587 (19.4)	0.898	0.645
Left Against Medical Advice	240 (4.3)	113 (5.9)	127 (3.4)	<0.001	174 (4.0)	90 (6.8)	84 (2.8)	<0.001	0.506
Length of Stay									
Mean (SD)	3.9 (8.1)	1.6 (2.4)	5.1 (9.6)	<0.001	4.1 (8.7)	1.8 (5.0)	5.1 (9.7)	<0.001	0.352
Median (IQR)	2 (1-4)	1 (0-2)	3 (1-5)		2 (1-4)	1 (0-2)	3 (1-5)		
Demographic Characteristics									
Age (years)									
Mean (SD)	70.6 (11.0)	71.0 (11.2)	70.4 (10.9)	0.049	70.7 (11.1)	70.7 (12.0)	70.7 (10.7)	0.911	0.719
Median (IQR)	71 (64-77)	71 (64-78)	71 (63-77)		71 (64-77)	71 (63-77)	71 (64-77)		
Male Sex	5391 (95.7)	1811 (94.5)	3580 (96.2)	0.003	4162 (95.5)	1250 (93.7)	2912 (96.2)	0.000	0.640
Race				<0.001				<0.001	0.039
White	3849 (68.3)	1396 (72.9)	2453 (65.9)		2940 (67.4)	988 (74.1)	1952 (64.5)		
Black	1521 (27.0)	437 (22.8)	1084 (29.1)		1163 (26.7)	285 (21.4)	878 (29.0)		
Asian	27 (0.5)	3 (0.2)	24 (0.7)		34 (0.8)	11 (0.8)	23 (0.8)		
Other	73 (1.3)	34 (1.8)	39 (1.1)		55 (1.3)	21 (1.6)	34 (1.1)		
Unknown	166 (3.0)	46 (2.4)	120 (3.2)		168 (3.9)	29 (2.2)	139 (4.6)		
Medical Comorbidity									
COVID-19 within ± 30-days Before/After Presentation/Discharge	0	0	0		72 (1.7)	19 (1.4)	53 (1.8)	0.435	
Diabetes	2531 (44.9)	783 (40.9)	1748 (47.0)	<0.001	2010 (46.1)	558 (41.8)	1452 (48.0)	0.000	0.235
Atrial Fibrillation	1023 (18.2)	320 (16.7)	703 (18.9)	0.043	711 (16.3)	189 (14.2)	522 (17.3)	0.011	0.016
Myocardial Infarction	519 (9.2)	153 (8.0)	366 (9.8)	0.023	412 (9.5)	103 (7.7)	309 (10.2)	0.010	0.681
Congestive Heart Failure	1069 (19.0)	336 (17.5)	733 (19.7)	0.049	768 (17.6)	209 (15.7)	559 (18.5)	0.025	0.083
Chronic Obstructive Pulmonary Disease	1260 (22.4)	420 (21.9)	840 (22.6)	0.573	932 (21.4)	282 (21.1)	650 (21.5)	0.800	0.240
Peripheral Arterial Disease	961 (17.1)	311 (16.2)	650 (17.5)	0.241	625 (14.3)	181 (13.6)	444 (14.7)	0.338	<0.001
Dementia	527 (9.4)	146 (7.6)	381 (10.2)	0.001	390 (8.9)	101 (7.6)	289 (9.6)	0.035	0.486
Chronic Kidney Disease	1274 (22.6)	374 (19.5)	900 (24.2)	<0.001	975 (22.4)	250 (18.7)	725 (24.0)	0.000	0.774
Dialysis	93 (1.7)	21 (1.1)	72 (1.9)	0.019	71 (1.6)	16 (1.2)	55 (1.8)	0.137	0.933
Cancer	726 (12.9)	241 (12.6)	485 (13.0)	0.626	528 (12.1)	141 (10.6)	387 (12.8)	0.039	0.248
Hypertension	4587 (81.4)	1493 (77.9)	3094 (83.2)	<0.001	3516 (80.6)	1001 (75.0)	2515 (83.1)	<0.001	0.346
Hyperlipidemia	3655 (64.9)	1222 (63.8)	2433 (65.4)	0.226	2885 (66.2)	835 (62.6)	2050 (67.8)	0.001	0.169
Depression	1454 (25.8)	503 (26.3)	951 (25.6)	0.576	1140 (26.2)	349 (26.2)	791 (26.1)	0.988	0.694

Table 1 (*Continued*)

Characteristics*	Before Pandemic: March—September 2019 N = 5636				During pandemic: March—September 2020 N = 4360				P-value (2019 vs. 2020)
	Total N = 5636	TIA* N = 1916	Stroke N = 3720	P-value	Total N = 4360	TIA* N = 1334	Stroke N = 3026	P-value	
Venous Thromboembolism	242 (4.3)	60 (3.1)	182 (4.9)	0.002	184 (4.2)	55 (4.1)	129 (4.3)	0.832	0.857
Major Bleeding Event	28 (0.5)	11 (0.6)	17 (0.5)	0.554	17 (0.4)	6 (0.5)	11 (0.4)	0.674	0.429
Intracranial Bleeding	394 (7.0)	78 (4.1)	316 (8.5)	<0.001	295 (6.8)	51 (3.8)	244 (8.1)	<0.001	0.660
Current Smoker	1950 (34.6)	576 (30.1)	1374 (36.9)	<0.001	1300 (29.8)	322 (24.1)	978 (32.3)	<0.001	<0.001
Hospice/Palliative Care	349 (6.2)	54 (2.8)	295 (7.9)	<0.001	305 (7.0)	40 (3.0)	265 (8.8)	<0.001	0.107
Charlson Comorbidity Index Score									
Mean (SD)	3.0 (2.9)	2.9 (2.9)	3.1 (2.9)	0.072	2.9 (2.9)	2.8 (2.7)	3.0 (2.9)	0.008	0.161
Median (IQR)	2 (1-4)	2 (1-4)	2(1-5)		2 (1-4)	2 (1-4)	2 (1-5)		
CHA_2DS_2-VASc									
Mean (SD)	3.3 (1.4)	3.2 (1.5)	3.4 (1.4)	<0.001	3.3 (1.4)	3.2 (1.5)	3.4 (1.4)	<0.001	0.574
Median (IQR)	3 (2-4)	3 (2-4)	3 (3-4)		3 (2-4)	3 (2-4)	3 (3-4)		
HAS-BLED									
Mean (SD)	2.6 (1.1)	2.2 (1.0)	2.8 (1.1)	<0.001	2.6 (1.1)	2.1 (1.0)	2.9 (1.1)	<0.001	0.563
Median (IQR)	3 (2-3)	2 (2-3)	3 (2-4)		3 (2-3)	2 (1-3)	3 (2-4)		
Laboratory and Vital Signs									
APACHE III score									
Mean (SD)	10.8 (7.2)	10.0 (6.6)	11.2 (7.4)	<0.001	10.5 (6.7)	9.6 (6.2)	10.9 (6.9)	<0.001	0.044
Median (IQR)	10 (6-15)	9 (5-14)	10 (6-15)		10 (6-14)	9 (4-14)	10 (6-15)		
Average Systolic Blood Pressure 90-Days After Discharge									
Mean (SD)	129.4 (15.4)	128.6 (14.8)	129.7 (15.7)	0.021	131.3 (17.6)	131.0 (17.8)	131.5 (17.6)	0.530	<0.001
Median (IQR)	129.0 (119.7-138.0)	128.5 (119-137)	129.0 (120-138)		130 (120-141)	130.0 (119-140.4)	130.5 (120-141)		
Average Diastolic Blood Pressure 90-Days After Discharge									
Mean (SD)	74.2 (9.4)	73.8 (9.1)	74.5 (9.5)	0.018	75.6 (10.3)	75.3 (9.9)	75.7 (10.5)	0.497	<0.001
Median (IQR)	74 (68.3-80.0)	73.6 (68-79.7)	74.5 (68.5-80.0)		76 (69-82)	76 (69-82)	76 (69-82)		
No Blood Pressure Measurement within 90-Days After Discharge	608 (10.8)	225 (11.7)	383 (10.3)	0.097	1841 (42.2)	619 (46.4)	1222 (40.4)	0.000	<0.001
Healthcare Utilization									
Any Inpatient Admission in 1-Year prior to Index Event	1542 (27.4)	531 (27.7)	1011 (27.2)	0.669	1104 (25.3)	342 (25.6)	762 (25.2)	0.750	0.022
Any ED Visit in 1-Year prior to Index Event	3143 (55.8)	1130 (59.0)	2013 (54.1)	0.001	2360 (54.1)	784 (58.8)	1576 (52.1)	<0.001	0.103
Primary Care Visit within 90-days of Discharge	4541 (80.6)	1572 (82.1)	2969 (79.8)	0.045	2275 (52.2)	687 (51.5)	1588 (52.5)	0.551	<0.001
Neurology Visit within 90-days of Discharge	2268 (40.2)	741 (38.7)	1527 (41.1)	0.085	1200 (27.5)	356 (26.7)	844 (27.9)	0.412	<0.001

*TIA refers to transient ischemic attack; SD to the standard deviation; ED to the Emergency Department; IQR to interquartile range; the CHA_2DS_2-VASc score is a measure of thromboembolic risk among patients with atrial fibrillation; the HASBLED score is a measure of risk of major bleeding; and the modified APACHE III score is a measure of physiological disease severity.

Table 2. *Guideline-recommended processes of care before vs. during COVID-19.*

Quality of Care Metric	Before Pandemic: March−September 2020						During pandemic: March−September 2020					
	Total $N = 5636$		TIA* $N = 1916$		Stroke $N = 3720$		Total $N = 4360$		TIA* $N = 1334$		Stroke $N = 3026$	
	Eligible *N* (%)	Pass *N* (%)	Eligible *N* (%)	Pass *N* (%)	Eligible *N* (%)	Pass *N* (%)	Eligible *N* (%)	Pass *N* (%)	Eligible *N* (%)	Pass *N* (%)	Eligible *N* (%)	Pass *N* (%)
Anticoagulation for Atrial Fibrillation	709 (12.6)	607 (85.6)	255 (13.3)	215 (84.3)	454 (12.2)	392 (86.3)	493 (11.3)	409 (83.0)	168 (12.6)	133 (79.2)	325 (10.7)	276 (84.9)
Antithrombotic Use	4286 (76.0)	4135 (96.5)	1554 (81.1)	1479 (95.2)	2732 (73.4)	2656 (97.2)	3336 (76.5)	3225 (96.7)	1094 (82.0)	1034 (94.5)	2242 (74.1)	2191 (97.7)
Brain Imaging	4736 (84.0)	4498 (95.0)	1667 (87.0)	1590 (95.4)	3069 (82.5)	2908 (94.8)	3652 (83.8)	3446 (94.4)	1151 (86.3)	1090 (94.7)	2501 (82.7)	2356 (94.2)
Carotid Artery Imaging	4563 (81.0)	3797 (83.2)	1650 (86.1)	1319 (79.9)	2913 (78.3)	2478 (85.1)	3520 (80.7)	2933 (83.3)	1148 (86.1)	901 (78.5)	2372 (78.4)	2032 (85.7)
High- or Moderate-Potency Statin Therapy	3898 (69.2)	2838 (72.8)	1434 (74.8)	1016 (70.9)	2464 (66.2)	1822 (73.9)	2999 (68.8)	2280 (76.0)	985 (73.8)	694 (70.5)	2014 (66.6)	1586 (78.8)
Hypertension Control	3298 (58.5)	2585 (78.4)	1245 (65.0)	997 (80.1)	2053 (55.2)	1588 (77.4)	1188 (25.7)	858 (72.2)	400 (30.0)	298 (74.5)	788 (26.0)	560 (71.1)
Neurological Consultation	4610 (81.8)	3872 (84.0)	1660 (86.6)	1297 (78.1)	2950 (79.3)	2575 (87.3)	3565 (81.8)	3001 (84.2)	1155 (86.6)	891 (77.1)	2410 (79.6)	2110 (87.6)
Without-Fail Rate	4906 (87.0)	2458 (50.1)	1706 (89.0)	743 (43.6)	3200 (86.0)	1715 (53.6)	3823 (87.7)	2149 (56.2)	1187 (89.0)	526 (44.3)	2636 (87.1)	1623 (61.6)
Without-Fail Rate excluding Blood Pressure Control		2876 (58.6)		877 (51.4)		1999 (62.5)		2346 (61.4)		576 (48.5)		1770 (67.2)

*TIA refers to transient ischemic attack.

Table 3. *Odds ratios for guideline-recommended processes of care in March−September 2020 (During pandemic) vs. 2019 (Before).*

Quality Measure	Overall		TIA		Stroke	
	OR* (95% CI)	*P*-value	OR* (95% CI)	*P*-value	OR* (95% CI)	*P*-value
Anticoagulation for Atrial Fibrillation	0.88 (0.62−1.24)	0.453	0.72 (0.41−1.27)	0.253	0.96 (0.62−1.49)	0.860
Antithrombotic Use	1.04 (0.78−1.37)	0.802	0.95 (0.62−1.45)	0.794	1.17 (0.80−1.71)	0.423
Brain Imaging	0.92 (0.76−1.13)	0.433	0.84 (0.57−1.22)	0.348	0.92 (0.73−1.18)	0.515
Carotid Artery Imaging	0.96 (0.84−1.09)	0.479	0.89 (0.72−1.10)	0.271	0.99 (0.84−1.17)	0.937
High/Moderate Potency Statin	1.17 (1.03−1.34)	0.020	1.04 (0.83−1.29)	0.753	1.26 (1.06−1.48)	0.008
Hypertension Control	0.73 (0.62−0.86)	<0.001	0.72 (0.54−0.96)	0.027	0.73 (0.60−0.90)	0.003
Neurology Consultation	1.01 (0.88−1.16)	0.902	1.02 (0.82−1.28)	0.853	1.01 (0.84−1.22)	0.881
Without-Fail Rate	1.29 (1.17, 1.42)	<0.001	1.07 (0.90, 1.28)	0.424	1.40 (1.24, 1.57)	<0.001
Without-Fail Rate excluding Blood Pressure Control	1.08 (0.97, 1.20)	0.139	0.87 (0.73, 1.05)	0.145	1.20 (1.05, 1.36)	0.006

*TIA refers to transient ischemic attack; OR refers to odds ratios which represents the odds of passing each individual process measure in 2020 compared to 2019.

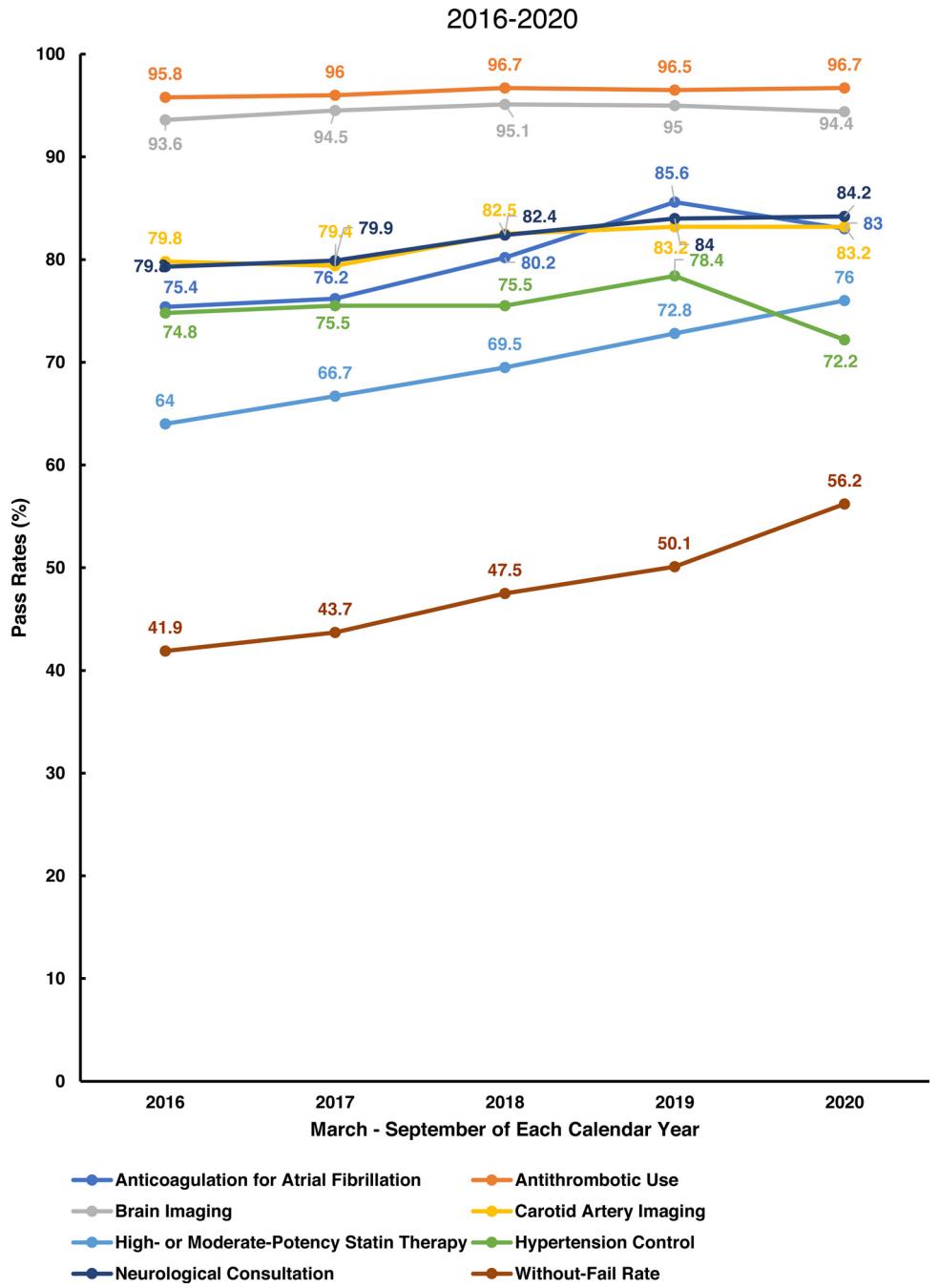

Fig. 1. *Displays the quality of care for seven processes of care plus the without-fail rate for the period March to September (2016 through 2020).*

Unadjusted all-cause readmission and vascular recurrent events were nearly identical between 2019 and 2020 (Table 4). Both 30- and 90-day unadjusted all-cause mortality rates were higher in 2020 (3.6% and 6.7%) as compared to 2019 (2.9%, 5.4%; p = 0.041 and p = 0.006; Table 4). However, after risk adjustment, the differences in the mortality between the two time periods were not statistically different: adjusted OR 0.85 (95%CI 0.70-1.03; p = 0.094) for 90-day mortality in 2019 vs. 2020; and adjusted OR 0.86 (95%CI 0.66-1.11; p = 0.241) for 30-day mortality in 2019 vs. 2020 (Table 5 provides the variables that were included in the risk-adjustment models).

Discussion

These results demonstrate that, in contrast to our *a priori* hypothesis, overall quality of care did not diminish among patients with stroke and TIA cared for in VA facilities during the COVID-19 pandemic. The without-fail rate has been improving consistently over the last five years.

Table 4. *Unadjusted death, hospital readmission and vascular event rates among patients with TIA/stroke.*

Outcome	Before Pandemic: September–March 2019				During pandemic: September–March 2020				*P*-value (2019 vs. 2020)
	Total *N* = 5636 *N* (%)	TIA *N* = 1916 *N* (%)	Stroke *N* = 3720 *N* (%)	*P*-Value	Total *N* = 4360 *N* (%)	TIA *N* = 1334 *N* (%)	Stroke *N* = 3026 *N* (%)	*P*-Value	
All-Cause Death within 30-days of Presentation	161 (2.9)	7 (0.4)	154 (4.1)	<0.001	156 (3.6)	10 (0.8)	146 (4.8)	<0.001	0.041
All-Cause Death within 90-days of Presentation	305 (5.4)	32 (1.7)	273 (7.3)	<0.001	293 (6.7)	26 (2.0)	267 (8.8)	<0.001	0.006
All-Cause Hospital Readmission within 90-days of Discharge	1029 (18.3)	296 (15.5)	733 (19.7)	<0.001	801 (18.4)	198 (14.8)	603 (19.3)	<0.001	0.884
Vascular Recurrent Event within 90-days of Discharge	725 (12.9)	171 (8.9)	554 (14.9)	<0.001	565 (13.0)	102 (7.7)	463 (15.3)	<0.001	0.888

The use of high or moderate potency statins continued to increase—especially among patients with stroke—a trajectory that has been evident for the past several years. However, not only did stroke and patients with TIA have far fewer visits with primary care during the pandemic,[27] their blood pressure, when measured, was not as well controlled as during the pre-pandemic period. Given the robust relationship between blood pressure and stroke risk,[28] it is imperative that primary care clinicians prioritize hypertension management among patients with stroke and TIA as they seek to address care that was delayed or deferred during the pandemic.[29]

Many studies have described the clinical presentation of SARS-CoV-2-related stroke, the observation that ischemic stroke and transient ischemic attack (TIA) hospitalizations have been much less frequent during the COVID-19 pandemic, and delays in presentation time for stroke patients who do seek care.[1–3,30–33] Our finding that fewer patients with stroke and TIA presented during the pandemic are in alignment with those other studies. Many hypotheses have been offered to explain the decreased caseload (e.g., patients fearful of contracting COVID-19 may avoid healthcare settings; competing mortality from COVID-19). Given that our cohort included both patients in the Emergency Department and inpatient settings, the changes in prevalence observed in this study cannot be attributed to decreased hospital admissions for patients who present for care (e.g., due potentially to constraints on inpatient care).

The reports about changes in quality of care during the pandemic have been mixed. A study from France reported lower rates of mechanical thrombectomy.[8] A study from Hungary demonstrated that both intravenous thrombolysis and endovascular therapy rates declined, but that the specific temporal pattern in these stroke therapies fluctuated over surges in the pandemic.[34] A study from the United Kingdom indicated that quality of care was preserved during the pandemic.[32] Our results are similar to those from a study of stroke care quality in Taiwan that also reported higher quality rates during the COVID-19 pandemic as compared to the pre-COVID-19 period.[35] The majority of studies about pandemic-associated changes in quality have focused on acute stroke therapies (e.g., thrombolysis); the current study adds to the literature by describing changes in risk factor management.

Although the observed mortality rates were higher for stroke and patients with TIA during the COVID-19 pandemic period, after adjustment for baseline characteristics, the differences in mortality were not statistically significant. Patients whose index event was stroke rather than TIA had a 6-fold increased odds of 30-day mortality and a 4-fold increased odds of 90-day mortality (Table 5). During the pandemic period, a slightly greater proportion of patients had a stroke as the index event rather than a TIA (69.4 vs. 66.0%), consistent with the hypothesis that

Table 5. *Risk adjusted models for all-cause 30-day and 90-day mortality.*

Baseline Characteristic	30-Day Mortality Model		90-Day Mortality Model	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Female sex	0.81 (0.32−2.05)	0.658	0.71 (0.36−1.40)	0.323
Age(years)	1.06 (1.05−1.07)	<0.001	1.05 (1.04−1.06)	<0.001
Race				
Asian	0.06 (0.00−22.21)	0.343	1.47 (0.46−4.72)	0.520
Black	0.99 (0.71−1.38)	0.956	1.04 (0.82−1.31)	0.753
Other	1.71 (0.58−5.03)	0.326	1.13 (0.47−2.73)	0.785
Unknown	2.16 (1.22−3.82)	0.008	1.64 (1.04−2.59)	0.033
White (reference)	1.00		1.00	
Admitted (versus discharged from Emergency Department)	1.04 (0.70−1.55)	0.841	1.02 (0.78−1.35)	0.860
Charlson Comorbidity Index	1.08 (1.04−1.12)	<0.001	1.09 (1.06−1.12)	<0.001
Hemiplegia	1.21 (0.92−1.59)	0.171	1.27 (1.05−1.55)	0.017
History of Atrial Fibrillation	1.18 (0.88−1.57)	0.262	1.23 (0.99−1.52)	0.063
Hospice/Palliative Care	15.65 (11.77−20.81)	<0.001	9.91 (7.98−12.30)	<0.001
Syncope	0.81 (0.59−1.09)	0.168	0.93 (0.75−1.16)	0.536
COVID-19*	1.55 (0.53−4.54)	0.420	3.06 (1.49−6.30)	0.002
Index Cerebrovascular Event				
Stroke	5.84 (3.53−9.69)	<0.001	3.89 (2.88−5.25)	<0.001
TIA (reference)	1.00		1.00	
Mean systolic Blood Pressure in the 90-days post-discharge (mmHg)				
Missing	5.70 (2.60−12.52)	<0.001	3.28 (1.67−6.45)	0.001
<110	3.75 (2.11−6.67)	<0.001	3.11 (2.01−4.82)	<0.001
110−139	1.50 (0.94−2.41)	0.092	1.80 (1.28−2.54)	0.001
140−159	1.22 (0.75−1.99)	0.426	1.51 (1.06−2.14)	0.022
160−179	1.07 (0.63−1.82)	0.800	1.14 (0.78−1.68)	0.502
≥ 180 (reference)	1.00		1.00	
2019 (versus 2020)	0.86 (0.66−1.11)	0.241	0.85 (0.70−1.03)	0.094

*COVID-19 refers to patients with a history of COVID-19 within 30-days prior to admission, during admission, or 30-days post-admission.

patients with transient symptoms may have hesitated to present for medical attention during the pandemic.

Limitations

The national scope of this study is a strength, but several limitations must be acknowledged. The cohort is drawn from the US Department of Veterans Affairs and should not be generalized to other healthcare systems. We examined quality of care using validated electronic quality measures[11]; some processes of care (e.g., thrombolysis, endovascular therapy) which require chart review for valid measurement were not evaluated. The study focused on the all-or-none measure of quality (the without-fail rate); alternative quality measurement approaches could have been used. The study evaluated care for stroke/patients with TIA from typical causes; we did not include patients who were admitted for COVID-19 who had concomitant stroke/TIA or developed an index event during an admission for COVID-19. Stroke severity is a predictor of post-stroke outcomes, however a measure of stroke severity (e.g., the NIH Stroke Scale) was not available.

Conclusions

These data demonstrate that overall quality of care for patients with AIS/TIA did not decline during the COVID-19 pandemic in US Department of Veterans Affairs hospitals. Clinicians and hospital administrators should ensure that patients who have had a AIS/TIA receive priority as health care systems address deferred primary care, including hypertension management, which is a cornerstone of stroke prevention. Future research should also examine facility-specific trends in quality of care to understand if the facility's inpatient COVID-19 burden was associated with quality of care.

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Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jstrokecerebrovasdis.2022.106455.

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