Real-World Assessment of Healthcare Resource Utilization and Expenditures Following Initial Ischemic Stroke or Transient Ischemic Attack of Non-Cardioembolic Origin

P020

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Objective

- This study evaluated the real-world clinical and economic burden experienced by patients following a primary ischemic stroke (IS) or transient ischemic attack (TIA) of non-cardioembolic origin, stratified by the occurrence of a secondary IS.

Methods

- The study population (**Table 1**) included US adults in the Healthcare Integrated Research Database (HIRD®) with:
  - A hospitalization or emergency department (ED) visit with an International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis of IS or TIA between January 1, 2016, and June 30, 2024. The first stroke event identified during the intake period was defined as the index event.
  - No evidence of atrial fibrillation/flutter, left ventricular thrombus, or a mechanical valve during the 365 days prior to, and inclusive of, the index date, and no evidence of IS or TIA at any time prior to the index start date.
  - At least 1-year continuous health plan enrollment prior to, and 1 day after, the index IS or TIA.
- Patients were stratified based on the presence of a secondary IS over a variable follow-up period.
  - The follow-up period extended from the day following their index event (discharge from the inpatient [IP] stay or the ED visit) through either their end of continuous enrollment, end of study period, or their death date, whichever occurred first.
- Stroke-related use or expenditures required a stroke ICD-10-CM diagnosis code in any position, except for IP, which requires a primary diagnosis code indicating stroke. Stroke-related pharmacy was defined as prescriptions for antiplatelets.
- Costs represent the sum of payor- and patient-paid amounts and are presented in 2024 US dollars ($) adjusted using the Consumer Price Index for medical care.

Table 1. Study population

Step	Criteria	N	% from previous step
1	Adult patients (≥18 years of age) with evidence of an IS or TIA in the IP or ED during the intake period, with ≥1 year of continuous medical and pharmacy coverage in a Commercial or Medicare Advantage plan prior to the index date	133,606	–
2	Patients without evidence of a NCIS or TIA diagnosis at any time prior to the index start date	99,739	74.7
3	Patients without evidence of left ventricular thrombus, mechanical valve, or atrial flutter during the 365 days prior to, and inclusive of, the index end date	97,568	97.8
4	Patients without evidence of atrial fibrillation during the 365 days prior to and through 30 days following the index end date	83,212	85.3
5	Excluded patients with evidence for any oral anticoagulants during the 90 days prior to, and inclusive of, the index start date, who had no evidence of a pulmonary embolism, deep vein thrombosis, hip surgery, or knee surgery during the 365 days prior to, and inclusive of, the index end date	82,454	99.1
6	Patients with ≥1 day of continuous enrollment following the index end date	80,864	98.1
Number of secondary strokes during the follow-up period			
A	Patients with no secondary strokes	75,149	92.9
B	Patients with one or more secondary strokes	5,715	7.1

The first stroke event identified during the intake period was defined as the index event. The follow-up period extends from the day following the index event, defined as either the day following discharge of the IP stay or the day following the service date of the ED event, through the patients end of data, which is defined as the end of continuous enrollment, end of the study period, or their death date, whichever occurs first.
Study period: June 1, 2014–September 30, 2024; intake period: January 1, 2016–June 30, 2024.
ED, emergency department; IP, inpatient; IS, ischemic stroke; NCIS, non-cardioembolic ischemic stroke; TIA, transient ischemic attack.

Results

- The study included 80,864 individuals with a mean (standard deviation [SD]) age of 62.4 (13.7) years, 51.4% were male, 75.9% were non-Hispanic white, and 5,715 (7.1%) had a subsequent IS over a mean (SD) follow-up of 2.3 (2.1) years (**Table 2**).

Table 2. Baseline demographics and clinical characteristics

	Total	No secondary strokes	≥1 secondary strokes
N (%)	80,864 (100)	75,149 (92.9)	5,715 (7.1)
Age, mean (SD), years	62.4 (13.7)	62.3 (13.7)	64.7 (13.5)
Sex, male, n (%)	41,535 (51.4)	38,512 (51.2)	3,023 (52.9)
White non-Hispanic, n (%)	61,361 (75.9)	57,068 (75.9)	4,293 (75.1)
US geographic region, n (%)			
Northeast	11,256 (13.9)	10,473 (13.9)	783 (13.7)
Midwest	25,414 (31.4)	23,456 (31.2)	1,958 (34.3)
South	29,773 (36.8)	27,779 (37.0)	1,994 (34.9)
West	13,991 (17.3)	13,033 (17.3)	958 (16.8)
Unknown	430 (0.5)	408 (0.5)	22 (0.4)
Urbanicity of residence, n (%)			
Urban	41,748 (51.6)	38,754 (51.6)	2,994 (52.4)
Suburban	21,153 (26.2)	19,780 (26.3)	1,373 (24.0)
Rural	16,262 (20.1)	15,002 (20.0)	1,260 (22.0)
Unknown	1,701 (2.1)	1,613 (2.1)	88 (1.5)
Plan type, n (%)			
HMO	24,659 (30.5)	22,728 (30.2)	1,931 (33.8)
PPO	>43,960†	40,874 (54.4)	>3,085†
CDHP	12,225 (15.1)	11,531 (15.3)	694 (12.1)
Other	>15†	16 (0.0)	<5†
Payor, n (%)			
Commercial	59,627 (73.7)	55,941 (74.4)	3,686 (64.5)
Medicare Advantage	21,237 (26.3)	19,208 (25.6)	2,029 (35.5)
Quartiles of SES index score, n (%)‡			
Patients with available data	76,923 (95.1)	71,477 (95.1)	5,446 (95.3)
1 Lowest SES quartile (worst)	15,602 (20.3)	14,388 (20.1)	1,214 (22.3)
2	20,370 (26.5)	18,821 (26.3)	1,549 (28.4)
3	21,421 (27.8)	19,937 (27.9)	1,484 (27.2)
4 Highest SES quartile	19,530 (25.4)	18,331 (25.6)	1,199 (22.0)
Quan–Charlson Comorbidity Index			
Mean (SD)	1.0 (1.7)	1.0 (1.7)	1.2 (1.8)
Median (IQR)	0.0 (0–1)	0.0 (0–1)	0.0 (0–2)
Presence of evidence of diagnosis during the baseline period, n (%)			
Chronic kidney disease	8,356 (10.3)	7,556 (10.1)	800 (14.0)
Congestive heart failure	4,232 (5.2)	3,862 (5.1)	370 (6.5)
Coronary artery disease	11,910 (14.7)	10,803 (14.4)	1,107 (19.4)
Diabetes	22,060 (27.3)	19,837 (26.4)	2,223 (38.9)
Hyperlipidemia	39,764 (49.2)	36,643 (48.8)	3,121 (54.6)
Hypertension	47,053 (58.2)	43,184 (57.5)	3,869 (67.7)
Intracranial bleeding	379 (0.5)	342 (0.5)	37 (0.6)
Myocardial infarction	3,200 (4.0)	2,883 (3.8)	317 (5.5)
Venous thromboembolism	2,743 (3.4)	2,536 (3.4)	207 (3.6)

†Cells with values of 1–4, or cells in which values 1–4 can be derived, have been masked per Carelon Research privacy policies.
‡The SES index is a composite social drivers of health measure based on seven factors from the American Community Survey 2016–2020 based on patient Census block group.
CDHP, consumer-driven health plan; HMO, health maintenance organization; IQR, interquartile range; PPO, preferred provider organization; SD, standard deviation; SES, socioeconomic status; US, United States.

- During the variable follow-up period, 2,722 (3.4%) patients in the study population had ≥1 TIA and 4,674 (5.8%) had evidence of major bleeding. Prevalence of these conditions was lower among patients with no subsequent IS (**Table 3**).
- During follow-up, 22,328 (27.6%) patients had evidence of disability, defined as IP or outpatient (OP) rehabilitation or skilled nursing facility visit. More than half (57.4%) of patients with a subsequent IS had evidence of disability.
- Mean (SD) total all-cause healthcare expenditures for the study population were $3,366 ($9,306) per patient per month (PPPM) and total stroke-related healthcare expenditures were $544 ($4,182) PPPM. Total costs PPPM were twice as high for patients with evidence of subsequent IS compared with those with no evidence of strokes following the index event.

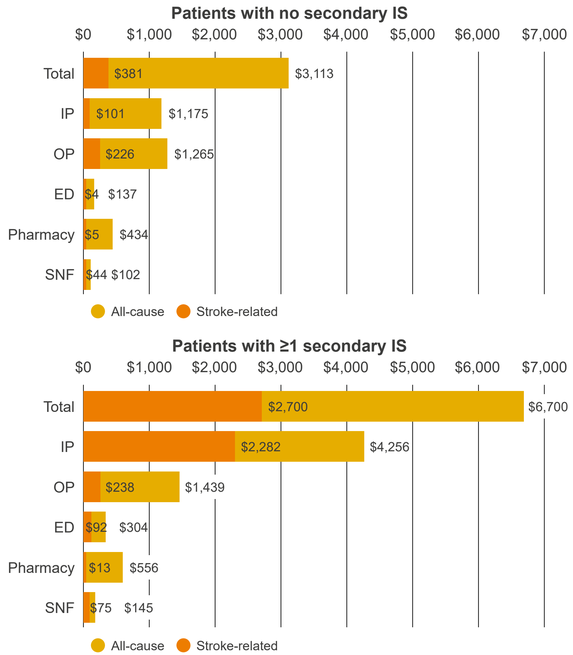
Table 3. Clinical burden of patients during the follow-up period, by presence of secondary strokes

Metric	Total	No secondary strokes	≥1 secondary strokes
N (%)	80,864 (100)	75,149 (92.9)	5,715 (7.1)
Length of post-index observation period, continuous years, n (%)†			
Mean (SD)	2.3 (2.1)	2.3 (2.1)	3.0 (2.3)
Median (IQR)	1.7 (0.7–3.4)	1.6 (0.7–3.3)	2.5 (1.1–4.6)
Presence of encounters during the follow-up period, n (%)			
Transient ischemic attack	2,722 (3.4)	1,367 (1.8)	1,355 (23.7)
Atrial fibrillation	9,527 (11.8)	8,033 (10.7)	1,494 (26.1)
Major bleeding	4,674 (5.8)	3,966 (5.3)	708 (12.4)
Myocardial infarction or ischemic stroke	7,108 (8.8)	1,393 (1.9)	5,715 (100)
Rivaroxaban 2.5 mg	186 (0.2)	158 (0.2)	28 (0.5)
Disability	22,328 (27.6)	19,049 (25.3)	3,279 (57.4)
Carotid endarterectomy	1,253 (1.5)	1,028 (1.4)	225 (3.9)
Thrombectomy	258 (0.3)	67 (0.1)	191 (3.3)
Carotid stenting or angioplasty	632 (0.8)	492 (0.7)	140 (2.4)
Tissue plasminogen activator	967 (1.2)	445 (0.6)	522 (9.1)
All-cause utilization during the follow-up period, n (%)			
≥1 OP encounters	79,112 (97.8)	73,410 (97.7)	5,702 (99.8)
≥1 IP admission	29,126 (36.0)	24,095 (32.1)	5,031 (88.0)
≥1 ED encounter	35,777 (44.2)	31,645 (42.1)	4,132 (72.3)
≥1 pharmacy prescription fills	74,021 (91.5)	68,643 (91.3)	5,378 (94.1)
Stroke-related utilization during the follow-up period, n (%)			
≥1 OP encounters	64,740 (80.1)	59,310 (78.9)	5,430 (95.0)
≥1 IP admission	10,776 (13.3)	6,127 (8.2)	4,649 (81.3)
≥1 ED encounter	6,097 (7.5)	3,961 (5.3)	2,136 (37.4)
≥1 pharmacy prescription fills	35,323 (43.7)	31,264 (41.6)	4,059 (71.0)

Cells with values of 1–4, or cells in which 1–4 can be derived, have been masked per Carelon Research privacy policies.
†Individuals with secondary strokes were found to have longer mean and median post-index observation periods, meaning they had greater opportunities for clinical events to be observed.
ED, emergency department; IP, inpatient; IQR, interquartile range; OP, outpatient; SD, standard deviation.

- Mean (SD) IP all-cause expenses for patients with no recurrent strokes were $1,175 ($7,157) PPPM, with $101 ($2,503) of that amount being stroke-related. By contrast, patients with a recurrent stroke had mean (SD) all-cause IP expenditures nearly four times higher ($4,256 [$12,976]), with a substantially larger share attributed to stroke-related healthcare needs ($2,282 [$10,445]) (**Figure 1**).

Figure 1. Mean all-cause and stroke-related costs PPPM during the follow-up period, by presence of a secondary IS



Stroke-related cost required a stroke ICD-10 diagnosis code in any position, except for inpatient, which required a primary diagnosis code indicating stroke. Stroke-related pharmacy was defined as prescriptions for antiplatelets. All values are in 2024 US$.
ED, emergency department; ICD-10, International Classification of Diseases, Tenth Revision; IP, inpatient; IS, ischemic stroke; OP, outpatient; PPPM, per patient per month; SNF, skilled nursing facility; US, United States.

Conclusions

- Individuals with secondary IS had considerable disability and utilization of all-cause and stroke-related healthcare services, as well as more than twice the total all-cause costs of those without a secondary IS.
- Improved secondary stroke prevention may provide an opportunity to increase quality of life and reduce healthcare costs.

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Conflicts of Interest/Disclosures

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