Incidence and Mortality Rates of Secondary Ischemic Strokes Among Medicare Fee-For-Service Beneficiaries in the United States

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Aim

- To assess the incidence of secondary ischemic strokes and associated mortality rates, among Medicare beneficiaries with non-cardioembolic ischemic stroke (NCIS) or transient ischemic attack (TIA).

Introduction

- In the United States (US), more than 795,000 individuals have a stroke every year, among which approximately 23% are secondary strokes.[1]
  - About 87% of all strokes are ischemic strokes. NCIS accounts for >70% of ischemic strokes.[2-3]
- After the initial occurrence of a stroke, patients have a high risk of experiencing secondary strokes, ranging from 7%−20% at 1 year to 16%−35% at 5 years,[4, 5] which are often more likely to be fatal, disabling, and more costly.[6]
- TIA is brief stroke-like episode where blood flow to the brain is blocked for a short time. Individuals who experience TIA are also at elevated risk of secondary stroke.[1]
- While previous studies have evaluated the incidence of secondary strokes in general, there remains a lack of evidence on the incidence and mortality associated with each subsequent secondary stroke following an initial NCIS or TIA.

Methods

- This US-based, retrospective study used Medicare fee-for-service (FFS) data for the period January 2007 through September 2024, and included adults ≥65 years of age with a primary diagnosis of ischemic stroke or TIA during an inpatient stay or emergency room visit, and without prior history of stroke (full selection criteria shown in **Figure 1**).
  - To identify patients with NCIS, patients with history of atrial fibrillation, atrial flutter, left ventricular thrombus, mechanic valve replacement, left atrial appendage occlusion, and rheumatic heart disease prior to the index date or up to 30 days after the index date were excluded.
- The index date was defined as the date of the first observed NCIS or TIA event.
- Baseline characteristics were assessed during the 12 months prior to the index date.
- Incidence rates of the primary NCIS or TIA during the entire study period and each secondary ischemic stroke following the previous stroke were estimated within the population at risk.
- All-cause mortality rates following the primary and each secondary stroke were also assessed.
- Kaplan-Meier (KM) analysis was used to estimate incidence and mortality at landmark time points.

Results

- A total of 1,291,897 patients with NCIS or TIA were included (**Figure 1**). The mean age was 77.8 years and 56.3% were female (**Table 1**).
- Among patients with NCIS or TIA, 62.0% had NCIS and 38.0% had TIA at index. Baseline demographic and clinical characteristics are summarized in **Table 1**.
- Incidence rates of primary NCIS or TIA and second, third, fourth, and fifth ischemic stroke were 0.3, 3.0, 6.7, 10.0, and 13.6 per 100 person-years (PYs), respectively (**Figure 2**).
  - The incidence rate of any stroke (primary NCIS or TIA, or secondary ischemic stroke) was 0.4 per 100 PYs.
- Rates of second stroke at 30 days, 90 days, 1 year, and 5 years were 2.6%, 3.8%, 6.1%, and 13.9%; third: 4.2%, 6.7%, 12.0%, and 25.6%; fourth: 5.0%, 8.5%, 16.6%, and 33.8%; fifth: 5.8%, 10.4%, 20.4%, and 40.0% (**Table 2**).
- The 1-year all-cause mortality rate was 15.0% following the primary NCIS or TIA, 27.4% following the second stroke, 32.8% following the third, 36.8% following the fourth, and 36.5% following the fifth (**Figure 3**).
- Compared to patients with TIA, those with NCIS had higher rates of second stroke (NCIS: 3.9 per 100 PYs; TIA: 2.0 per 100 PYs; **Figure 2**) and higher 1-year mortality following the index event (19.8% vs 7.2%); however, rates were similar for subsequent secondary strokes.

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Figure 1. Selection of patients with primary NCIS or TIA

Patients with ≥1 primary diagnosis of ischemic stroke or TIA in the IP or ED setting during January 2007 − September 2024
***Index date** is defined as the date of the first eligible event*
N = 5,133,219

↓

Patients aged ≥65 years at the index date
N = 4,659,369 (90.8%)

↓

Patients with ≥12 months of continuous enrollment in Medicare Part A and B plans before the index date
N = 4,142,637 (88.9%)

↓

Patients without diagnosis of any type of stroke in any position at any time prior to the index date
N = 2,509,649 (60.6%)

↓

Patients with primary NCIS or TIA[1]
N = 1,291,897 (51.5%)

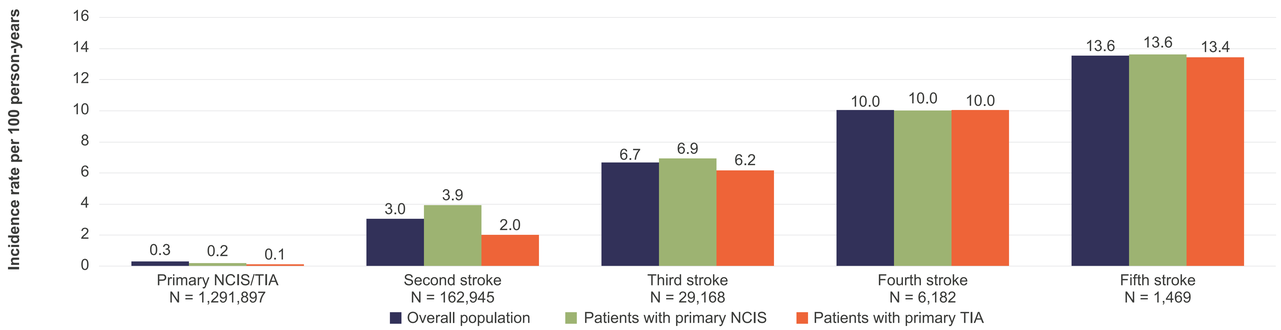
Abbreviations: ED, emergency department; IP, inpatient; NCIS, non-cardioembolic ischemic stroke; TIA, transient ischemic attack.
Note:
[1] To exclude patients with cardioembolic ischemic strokes, patients with history of atrial fibrillation, atrial flutter, left ventricular thrombus, mechanic valve replacement, left atrial appendage occlusion, and rheumatic heart disease prior to the index date or up to 30 days after the index date were excluded. Further, patients with oral anticoagulant use during the 90 days prior to the index date were excluded (except for those who had deep vein thrombosis/pulmonary embolism or hip/knee surgery).

Table 1. Patient characteristics

Characteristics	Overall N = 1,291,897
Age as of index (years), mean ± SD [median]	77.8 ± 8.0 [76.8]
Female, n (%)	727,671 (56.3)
Race/ethnicity, n (%)	
White	1,052,963 (81.5)
Black	126,635 (9.8)
Hispanic	63,062 (4.9)
Asian	25,616 (2.0)
Other/unknown	23,621 (1.8)
Geographic region, n (%)	
South	526,740 (40.8)
Midwest	322,503 (25.0)
West	230,264 (17.8)
Northeast	207,922 (16.1)
Other/unknown	4,468 (0.3)
Year of index date, n (%)	
2007-2010	411,149 (31.8)
2011-2014	292,502 (22.6)
2015-2018	265,888 (20.6)
2019-2022	233,574 (18.1)
2023-2024	88,784 (6.9)
NCIS at index date, n (%)	801,176 (62.0)
TIA at index date, n (%)	490,721 (38.0)
NIHSS at index, n (%)	178,337 (13.8)
Minor (score of 0–7)	141,198 (79.2)
Moderate (score of 8–13)	18,246 (10.2)
Moderate-to-severe (score of 14–21)	11,783 (6.6)
Severe (score of 22–42)	7,110 (4.0)
Comorbidities, n (%)	
Hypertension	929,655 (72.0)
Hyperlipidemia	764,224 (59.2)
Diabetes	416,522 (32.2)
Atherosclerosis	356,291 (27.6)
Peripheral vascular disease	228,087 (17.7)
Coronary artery disease	95,358 (7.4)
Myocardial infarction	61,441 (4.8)

Abbreviations: NIHSS, National Institutes of Health Stroke Scale; NCIS, non-cardioembolic ischemic stroke; SD, standard deviation; TIA, transient ischemic attack.

Figure 2. Incidence rates of strokes



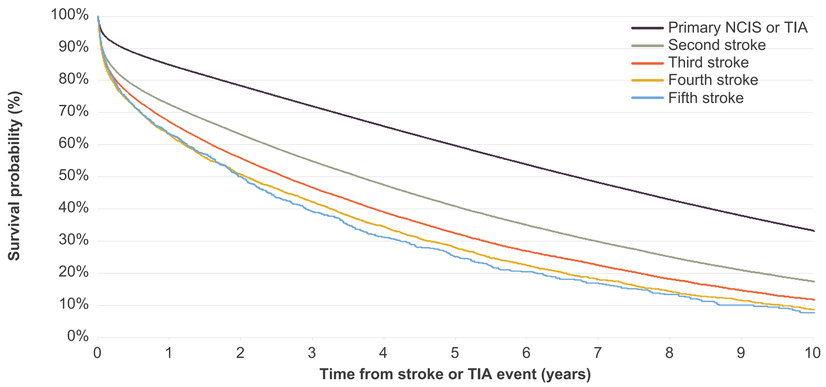
Abbreviations: NCIS, non-cardioembolic ischemic stroke; TIA, transient ischemic attack.
Note:
[1] The stroke or TIA event was identified based on the primary diagnosis in an inpatient admission or an emergency department visit. TIA was only considered for the primary event. All secondary events (second through fifth) represent ischemic strokes only.
[2] The incidence rates were calculated as the total number of events divided by the sum of patient time at risk for experiencing the event.

Table 2. KM estimates for cumulative incidence rates of strokes

		Incidence rates, % (95% CI)			
Outcome	**Population**	**30 days**	**90 days**	**1 year**	**5 years**
Second stroke	Overall	2.6 (2.6, 2.6)	3.8 (3.7, 3.8)	6.1 (6.1, 6.2)	13.9 (13.8, 14.0)
	Patients with primary NCIS	3.4 (3.4, 3.4)	4.9 (4.9, 5.0)	8.0 (7.9, 8.0)	17.0 (16.9, 17.1)
	Patients with primary TIA	1.4 (1.4, 1.5)	2.0 (1.9, 2.0)	3.4 (3.4, 3.5)	9.6 (9.5, 9.7)
Third stroke	Overall	4.2 (4.1, 4.3)	6.7 (6.6, 6.9)	12.0 (11.8, 12.1)	25.6 (25.3, 25.9)
	Patients with primary NCIS	4.4 (4.3, 4.5)	7.0 (6.9, 7.2)	12.5 (12.3, 12.7)	26.2 (25.8, 26.5)
	Patients with primary TIA	3.9 (3.7, 4.1)	6.1 (5.8, 6.3)	10.8 (10.5, 11.1)	24.5 (24.0, 25.0)
Fourth stroke	Overall	5.0 (4.7, 5.2)	8.5 (8.2, 8.9)	16.6 (16.2, 17.1)	33.8 (33.0, 34.6)
	Patients with primary NCIS	5.0 (4.7, 5.3)	8.7 (8.3, 9.1)	16.7 (16.1, 17.3)	33.7 (32.7, 34.6)
	Patients with primary TIA	4.9 (4.5, 5.4)	8.1 (7.5, 8.7)	16.4 (15.6, 17.3)	34.1 (32.6, 35.5)
Fifth stroke	Overall	5.8 (5.2, 6.4)	10.4 (9.5, 11.2)	20.4 (19.2, 21.6)	40.0 (38.0, 41.9)
	Patients with primary NCIS	5.8 (5.0, 6.5)	10.7 (9.7, 11.8)	20.5 (19.1, 21.9)	40.6 (38.2, 42.9)
	Patients with primary TIA	5.8 (4.7, 6.9)	9.5 (8.1, 11.0)	20.1 (18.0, 22.2)	38.4 (34.9, 42.0)

Abbreviations: CI, confidence interval; NCIS, non-cardioembolic ischemic stroke; TIA, transient ischemic attack.
Note:
[1] The stroke or TIA event was identified based on the primary diagnosis in an inpatient admission or an emergency department visit. TIA was only considered for the primary event. All secondary events (second through fifth) represent ischemic strokes only.

Figure 3. All-cause mortality



Population	Median time to death (95% CI), years
Primary NCIS or TIA	6.7 (6.7, 6.7)
Second stroke	3.7 (3.6, 3.7)
Third stroke	2.6 (2.6, 2.7)
Fourth stroke	2.1 (1.9, 2.2)
Fifth stroke	2.0 (1.8, 2.2)

Abbreviations: CI, confidence interval; NCIS, non-cardioembolic ischemic stroke; TIA, transient ischemic attack.
Note:
[1] The stroke or TIA event was identified based on the primary diagnosis in an inpatient admission or an emergency department visit. TIA was only considered for the primary event. All secondary events (second through fifth) represent ischemic strokes only.

Limitations

- Results may not be generalizable to other patient populations, including patients covered by commercial or Medicaid insurance, and patients who are uninsured.
  - Nevertheless, understanding the burden of secondary stroke among our study population is important given that approximately three-quarters of all strokes occur in individuals aged 65 or older and Medicare FFS beneficiaries represent around 45% of this demographic.
- Strokes that occurred before patients enrolled in the Medicare FFS plan were not captured in our data, which may result in misclassification of some secondary strokes as primary events.
- The cumulative incidence estimates for secondary strokes were derived using KM method which does not account for competing risks such as death. Prior research has shown that, in elderly patients, KM-based estimates tended to overestimate stroke incidence relative to competing risk approaches.

Conclusion

- **The risk of secondary ischemic stroke and associated mortality increases progressively with each subsequent event, highlighting the need for effective secondary stroke prevention strategies.**
- **Patients with NCIS have nearly twice the incidence of second ischemic stroke compared to those with primary TIA; however, the risk of subsequent secondary strokes is similarly elevated regardless of index event type.**

References

1. Centers for Disease Control and Prevention. Stroke Facts.
2. Tsao CW, et al. *Circulation.* 2023;147(8):e93-e621.
3. Hoshino T, et al. *European Stroke Journal.* 2019;4(1):65-74.
4. Mohan KM, et al. *Stroke.* 2011;42(5):1489-94.
5. Boulanger M, et al. *Journal of the American Heart Association.* 2018;7(2):e007267.
6. Caso V, et al. *European Stroke Journal.* 2026;11(1):aakaf012.

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