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ORIGINAL ARTICLE

US Surveillance of Acute Ischemic Stroke Patient Characteristics, Care Quality, and Outcomes for 2019

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BACKGROUND: The United States lacks a timely and accurate nationwide surveillance system for acute ischemic stroke (AIS). We use the Get With The Guidelines-Stroke registry to apply poststratification survey weights to generate national assessment of AIS epidemiology, hospital care quality, and in-hospital outcomes.

METHODS: Clinical data from the Get With The Guidelines-Stroke registry were weighted using a Bayesian interpolation method anchored to observations from the national inpatient sample. To generate a US stroke forecast for 2019, we linearized time trend estimates from the national inpatient sample to project anticipated AIS hospital volume, distribution, and race/ethnicity characteristics for the year 2019. Primary measures of AIS epidemiology and clinical care included patient and hospital characteristics, stroke severity, vital and laboratory measures, treatment interventions, performance measures, disposition, and clinical outcomes at discharge.

RESULTS: We estimate 552 476 patients with AIS were admitted in 2019 to US hospitals. Median age was 71 (interquartile range, 60–81), 48.8% female. Atrial fibrillation was diagnosed in 22.6%, 30.2% had prior stroke/transient ischemic attack, and 36.4% had diabetes. At baseline, 46.4% of patients with AIS were taking antiplatelet agents, 19.2% anticoagulants, and 46.3% cholesterol-reducers. Mortality was 4.4%, and only 52.3% were able to ambulate independently at discharge. Performance nationally on AIS achievement measures were generally higher than 95% for all measures but the use of thrombolytics within 3 hours of early stroke presentations (81.9%). Additional quality measures had lower rates of receipt: dysphagia screening (84.9%), early thrombolytics by 4.5 hours (79.7%), and statin therapy (80.6%).

CONCLUSIONS: We provide timely, reliable, and actionable US national AIS surveillance using Bayesian interpolation poststratification weights. These data may facilitate more targeted quality improvement efforts, resource allocation, and national policies to improve AIS care and outcomes.

GRAPHIC ABSTRACT: A graphic abstract is available for this article.

Key Words: Bayesian analysis ■ epidemiology ■ health services ■ ischemic stroke ■ quality and outcomes

Timely and accurate national surveillance of stroke and cardiovascular disease remains an immense challenge in the United States due to the lack of integration of various paper and electronic health record systems.[1,2] Acute ischemic stroke (AIS) remains a leading cause of death and disability and may be prevented and treated with delivery of evidence-based AIS care.[3–5] In 2018, 3.4% of Americans reported a history of stroke.[6] Developing a national AIS surveillance system would allow for monitoring and responding to AIS burden, health equity, and quality of care.

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ORIGINAL ARTICLE

Nonstandard Abbreviations and Acronyms

AIS	acute ischemic stroke
GWTG	Get With The Guidelines
NIHSS	National Institutes of Health Stroke Scale
NIS	national inpatient sample

The American Heart Association sponsored The Get With The Guidelines (GWTG) registry program includes reliable abstracted AIS clinical data for quality improvement and research analyses.[7] Registry data are a convenience sample and not directly representative of a specific population of interest.[8,9] Nonrepresentative samples may be transformed into a representative ones using statistical methods such as poststratification weights that rebalance over and under-represented segments of the target population of interest.[10,11] A few community cohort and case-control studies are currently featured in the annual American Heart Association statistical update on heart disease and stroke statistics but are not nationally representative and inadequate to measure AIS burden and quality of care nationally.[12–14] For this study, we use Bayesian interpolation to estimate post-stratification survey weights for the GWTG-Stroke registry to quantify the 2019 AIS burden, hospital quality of care, and clinical outcomes.

METHODS

Data Source

Because of the sensitive nature of the data collected for this study, requests to access the dataset from qualified researchers trained in human subject confidentiality protocols may be sent to the Get With The Guidelines - Stroke program to QualityResearch@heart.org. We used the GWTG-Stroke registry data from 2019 to model AIS epidemiology, clinical characteristics, hospital quality of care, and outcomes at discharge. 2019 was the most recent year not impacted by COVID-19 and the disruption of hospital services. GWTG-Stroke uses trained personnel to abstract reliable demographic, clinical, and event information from participating hospitals using an internet-based patient management tool.[7] Identification of AIS is accurately identified and clinical variables such as admission and discharge stroke severity are systematically included, alongside detailed clinical data not available in administrative claims data alone. GWTG-Stroke includes 1300 to 1500 hospitals per year (out of approximately 5300 US community or federal hospitals nationally) and details are previously described.[15–17] Hospitals participating in the GWTG program do so on a voluntary basis. Although the GWTG program contains many small, rural, and nonacademic hospitals, these hospital types are under-represented compared with the overall US hospitalized population.[8,11] Therefore, the sampling strategy does not directly estimate national AIS clinical characteristics as currently structured.

To determine the total number of AIS hospitalizations for 2019 in the United States, marginal counts stratified by population characteristics are used to anchor poststratification weights for GWTG-stroke. These estimates were derived from 2012 to 2018 from national inpatient sample (NIS) sponsored by the Agency for Healthcare Research and Quality. NIS is a structured random sample of US hospitalizations that is then weighted to represent national hospital utilization. There are 4550 community hospitals included in the NIS.[18] However, the database does not include detailed clinical data such as stroke severity, laboratory data, medical treatments received, and patient reported outcomes. NIS samples 20% of the administrative discharge records from all participating hospitals (approximately 4300 hospitals) covering 95% of the US population and 94% of all community hospital discharges.[19] While the NIS may be used to estimate the total number of AIS hospitalization, basic demographics, procedure performed, and hospitalization costs, the database lacks detailed clinical and outcomes data important for AIS quality of care and outcomes assessment.

Data Definitions

In the NIS, AIS is defined using the primary discharge diagnosis from the first listed *International Classification of Diseases, Ninth Revision (ICD-9)* code or the beta Clinical Classifications Software code "CIR020" (Tables S1 and S2).[20,21] AIS is defined in GWTG-Stroke based on abstracted discharge diagnoses. GWTG-Stroke uses electronic case report form-based data extraction from clinical chart review to document patient-specific comorbid conditions, care quality, and clinical outcomes. Performance and quality metric definitions are provided (Tables S3 and S4). Only records with complete variables of interest were included, no imputation was performed.

Statistical Analysis

Annual AIS population counts stratified by patient (age group, sex, and race/ethnicity) and hospital factors (size, rurality, ownership, teaching status) were obtained between 2012 and 2018. Annual stratified population counts were linearized, and predictions made for the 2019 AIS population in the United States. The derived 2019 NIS population counts were used to generate poststratification weights for 2019 GWTG-Stroke observations using Bayesian population interpolation method previously validated.[11] GWTG-Stroke observations (Bayesian prior) are fit to the marginal distributions of the 2019 NIS anchoring counts to estimate poststratification weights for each hospitalization. Weighted GWTG-Stroke data is used to estimate national AIS clinical characteristics, laboratory values, and quality metrics. Findings followed the STROBE cohort study reporting guideline.[22] Anchoring population counts from the NIS were analyzed in Stata 17.0 (StataCorp LLC, College Station, TX). All Bayesian analyses are performed in R 3.6.1 (R Foundation, Vienna Austria). Each participating hospital received either human research approval to enroll patients without individual consent under the Common Rule or a waiver of authorization and exemption from subsequent review by their institutional review board. IQVIA, Inc. serves as the data collection and coordination center. Duke Clinical Research Institute serves as the data analysis center and has an agreement to

Table 1. Baseline Characteristics in Patients With Ischemic Stroke: The 2019 GWTG-Stroke Sample and the Entire US Based on the Bayesian Weighted Sample

Variable	GWTG-Stroke N=414 628	US 2019 (Bayesian weighted) N=552 476 N (proportion, 95% CI)
Patient demographics		
Age, y; median (IQR)	71 (61–81)	71 (60–81)
Female	203 249 (49.0%)	269 840 (48.8% [95% CI, 48.5%–49.2%])
Race/ethnicity		
White	278 602 (67.2%)	348 457 (63.1% [95% CI, 62.7%–63.5%])
Black	74 227 (17.9%)	92 875 (16.8% [95% CI, 16.5%–17.1%])
Hispanic	31 109 (7.5%)	51 788 (9.4% [95% CI, 9.0%–9.7%])
Asian and Pacific Islander	13 871 (3.4%)	24 302 (4.4% [95% CI, 4.2%–4.6%])
Other	16 819 (4.1%)	35 053 (6.3% [95% CI, 6.1%–6.6%])
Insurance		
Private/VA/champus/other insurance	76 349 (22.5%)	104 231 (23.0% [95% CI, 22.7%–23.3%])
Medicaid	28 448 (8.4%)	37 277 (8.2% [95% CI, 8.0%–8.5%])
Medicare	218 893 (64.4%)	286 934 (63.3% [95% CI, 62.9%–63.7%])
Self pay/no insurance	15 983 (4.7%)	25 120 (5.5% [95% CI, 5.3%–5.8%])
Medical history		
Atrial fibrillation/flutter history/new diagnosis	95 507 (23.1%)	124 192 (22.6% [95% CI, 22.3%–22.8%])
Previous stroke/TIA	125 649 (30.5%)	165 355 (30.2% [95% CI, 29.8%–30.5%])
CAD/prior myocardial infarction	92 743 (22.5%)	121 403 (22.1% [95% CI, 22.9%–22.4%])
Carotid stenosis	14 934 (3.6%)	19 187 (3.5% [95% CI, 3.4%–3.6%])
Diabetes	147 794 (35.9%)	199 675 (36.4% [95% CI, 36.1%–36.8%])
Peripheral vascular disease	16 784 (4.1%)	22 390 (4.1% [95% CI, 4.0%–4.2%])
Hypertension	315 574 (76.7%)	419 251 (76.5% [95% CI, 76.2%–76.8%])
Smoker	77 756 (18.9%)	105 826 (19.3% [95% CI, 19.1%–19.6%])
Dyslipidemia	200 575 (48.7%)	262 999 (48.0% [95% CI, 47.6%–48.3%])
Heart failure	41 726 (10.1%)	54 609 (10.0% [95% CI, 9.8%–10.2%])
Obesity/overweight	123 112 (29.9%)	163 125 (29.8% [95% CI, 29.4%–30.1%])
Chronic renal insufficiency	43 135 (10.5%)	56 779 (10.4% [95% CI, 10.2%–10.6%])
Medications before admission		
Antiplatelets	177 052 (47.6%)	230 322 (46.4% [95% CI, 46.1%–46.8%])
Anticoagulants	51 139 (20.0%)	66 364 (19.2% [95% CI, 18.9%–19.6%])
Antihypertensives	227 286 (66.6%)	304 648 (66.2% [95% CI, 65.8%–66.6%])
Cholesterol-reducers	194 326 (47.2%)	253 731 (46.3% [95% CI, 45.9%–46.6%])
Diabetic medications	96 998 (28.8%)	131 446 (29.0% [95% CI, 28.7%–29.4%])
Stroke presentation severity		
NIHSS score categories		
0–4	226 953 (58.6%)	299 827 (58.7% [95% CI, 58.3%–59.0%])
5–9	74 321 (19.2%)	97 680 (19.1% [95% CI, 18.9%–19.4%])
10–14	32 530 (8.4%)	42 466 (8.3% [95% CI, 8.1%–8.5%])
15–20	26 827 (6.9%)	35 634 (7.0% [95% CI, 6.8%–7.2%])
>20	26 884 (6.9%)	35 406 (6.9% [95% CI, 6.8%–7.1%])
Initial NIHSS score (0–42), median (IQR)	3 (1–8)	3 (1–8)
Hospital characteristics		
Census divisions		
Division 1 New England	17 640 (4.3%)	23 847 (4.3% [95% CI, 4.2%–4.5%])

(*Continued*)

Table 1. Continued

Variable	GWTG-Stroke N=414 628	US 2019 (Bayesian weighted) N=552 476 N (proportion, 95% CI)
Division 2 Mid-Atlantic	63 949 (15.4%)	71 472 (12.9% [95% CI, 12.7%–13.1%])
Division 3 East North Central	58 373 (14.1%)	82 502 (14.9% [95% CI, 14.7%–15.2%])
Division 4 West North Central	28 034 (6.8%)	35 975 (6.5% [95% CI, 6.3%–6.7%])
Division 5 South Atlantic	97 670 (23.6%)	124 143 (22.5% [95% CI, 22.2%–22.8%])
Division 6 East South Central	27 333 (6.6%)	44 053 (8.0% [95% CI, 7.7%–8.2%])
Division 7 West South Central	43 504 (10.5%)	68 336 (12.4% [95% CI, 12.1%–12.6%])
Division 8 Mountain	21 446 (5.2%)	30 018 (5.4% [95% CI, 5.3%–5.6%])
Division 9 Pacific	56 679 (13.7%)	72 132 (13.1% [95% CI, 12.8%–13.3%])
Hospital ownership		
Government	47 351 (11.4%)	61 607 (11.2% [95% CI, 10.8%–11.5%])
Private, nonprofit	319 389 (77.0%)	413 545 (74.9% [95% CI, 74.4%–75.3%])
Private, investment	47 888 (11.6%)	77 324 (14.0% [95% CI, 13.7%–14.3%])
Rural/teaching status		
Rural	19 371 (4.7%)	32 793 (5.9% [95% CI, 5.5%–6.3%])
Urban nonteaching	89 200 (21.5%)	90 735 (16.4% [95% CI, 16.1%–16.8%])
Urban teaching	306 057 (73.8%)	428 948 (77.6% [95% CI, 77.2%–78.1%])
Bed size categories*		
Small	53 558 (12.9%)	96 760 (17.5% [95% CI, 17.1%–17.9%])
Medium	112 109 (27.0%)	167 345 (30.3% [95% CI, 30.0%–30.6%])
Large	248 961 (60.0%)	288 372 (52.2% [95% CI, 51.8%–52.6%])
GWTG hospital characteristics		
Primary stroke center	302 198 (72.9%)	397 705 (72.0% [95% CI, 71.6%–72.4%])
Comprehensive stroke center	97 461 (23.5%)	126 893 (23.0% [95% CI, 22.8%–23.2%])
Academic hospital	312 615 (75.4%)	436 212 (79.0% [95% CI, 78.5%–79.4%])

CAD indicates coronary artery disease; GWTG, Get With The Guidelines; NIHSS, National Institutes of Health Stroke Scale; and TIA, transient ischemic attack.

*Defined by health care cost and utilization project definitions.

analyze the aggregate de-identified data for research purposes. This study was approved by the institutional review board of Duke University.

RESULTS

In 2019, there were an estimated 552 476 AIS hospitalizations in the United States with a median age of 71 years (IQR, 60–81), 48.8% (95% CI, 48.5%–49.2%) female, and 63.1% (95% CI, 62.7%–63.5%) White (Table 1). With respect to comorbid conditions, 22.6% (95% CI, 22.3%–22.8%) had an atrial fibrillation history or new diagnosis, prior stroke 30.2% (95% CI, 29.8%–30.5%), diabetes 36.4% (95% CI, 36.1%–36.8%), hypertension 76.5% (95% CI, 76.2%–76.8%), and smoking 19.3% (95% CI, 19.1%–19.6%). Only 46.4% (46.1%–46.8%) of patients were taking antiplatelets at baseline, 19.2% (95% CI, 18.9%–19.6%) anticoagulants, 46.3% (95% CI, 45.9%–46.6%) on cholesterol-reducing medications, and 29.0% (95% CI, 28.7%–29.4%) on diabetic medications. Nationally, 74.9% (95% CI, 74.4%–75.3%) were treated in private, nonprofit hospitals. The distribution of stroke severity using the National Institutes of Health Stroke Scale score was 58.7% (95% CI, 58.3%–59.0%) for the 0 to 4 category, 19.1% (95% CI, 18.9%–19.4%) for 5 to 9, 8.3% (95% CI, 8.1%–8.5%) for 10 to 14, 7.0% (95% CI, 6.8%–7.2%) for 15 to 20, and 6.9% [95% CI, 6.8%–7.1%) for NIHSS score >20.

In terms of outcomes, the median hospital stay was 4 days (IQR, 2–6 days; Table 2). Disposition at discharge included 275 033 (49.8% [95% CI, 49.4%–50.1%) to home, 208 289 (37.7% [95% CI, 37.4%–38.0%]) to another health care facility primarily for skilled nursing or inpatient rehabilitation, 21 908 (4.0% [95% CI, 3.8%–4.1%]) died, and 16 987 (3.1% [95% CI, 3.0%–3.2%]) were discharged to hospice facilities. Among patients with documented ambulatory status, 62 652 (12.5% [95% CI, 12.3%–12.8%]) were unable to ambulate and 154 188 (30.8% [95% CI, 30.5%–31.2%]) need assistance with ambulation.

For early onset AIS presenting within 2 hours, 38 980 (81.9% [95% CI, 80.7%–83.1%]) of eligible patients

Table 2. Short-Term Outcomes and Stroke Performance Metrics in Patients With Ischemic Stroke: The 2019 GWTG-Stroke Sample and the Entire US Based on the Bayesian-Weighted Sample

Variable	GWTG-stroke N=414 628	US 2019 (Bayesian weighted) N=552 476 N (proportion, 95% CI)
Short-term outcomes		
Length of stay, days, median (IQR)	4 (2–6)	4 (2–6)
Discharge disposition		
Home	204 586 (49.3%)	275 033 (49.8% [95% CI, 49.4%–50.1%])
Home hospice	6568 (1.6%)	8526 (1.5% [95% CI, 1.4%–1.7%])
Hospice facility	12 727 (3.1%)	16 987 (3.1% [95% CI, 3.0%–3.2%])
Acute care facility	9758 (2.4%)	15 009 (2.7% [95% CI, 2.5%–2.9%])
Other health care facility	159 492 (38.5%)	208 289 (37.7% [95% CI, 37.4%–38.0%])
Expired	16 530 (4.0%)	21 908 (4.0% [95% CI, 3.8%–4.1%])
Left against medical advice	4292 (1.0%)	5650 (1.0% [95% CI, 1.0%–1.1%])
If "other health care facility"		
Skilled nursing facility	70 714 (44.4%)	91 998 (44.3% [95% CI, 43.7%–44.8%])
Inpatient rehabilitation facility	82 889 (52.1%)	107 735 (51.9% [95% CI, 51.3%–52.4%])
Long-term care hospital	3274 (2.1%)	4624 (2.2% [95% CI, 2.1%–2.4%])
Intermediate care facility	952 (0.6%)	1370 (0.7% [95% CI, 0.6%–0.8%])
Other	1316 (0.8%)	2067 (1.0% [95% CI, 0.9%–1.1%])
Thrombolytic complications–symptomatic intracranial hemorrhage <36 h	3316 (3.8%)	4263 (3.7% [95% CI, 3.6%–3.9%])
Discharge ambulatory status		
Unable to ambulate	46 481 (12.3%)	62 652 (12.5% [95% CI, 12.3%–12.8%])
With assistance from person	118 271 (31.2%)	154 188 (30.8% [95% CI, 30.5%–31.2%])
Able to ambulate independently	197 933 (52.2%)	261 561 (52.3% [95% CI, 51.9%–52.7%])
modified Rankin Scale at discharge total, median (IQR)	3 (1–4)	3 (1–4)
Achievement measures		
Acute–IV thrombolytics arrive by 2 h, treat by 3 h	30 584 (83.8%)	38 980 (81.9% [95% CI, 80.7%–83.1%])
Acute–early antithrombotics	238 022 (97.0%)	315 212 (96.9% [95% CI, 96.7%–97.0%])
Acute–VTE prophylaxis	302 435 (99.2%)	398 744 (99.2% [95% CI, 99.1%–99.3%])
At or by discharge–antithrombotics	340 563 (99.2%)	450 912 (98.9% [95% CI, 98.7–99.0%])
At or by discharge–anticoagulation for atrial fibrillation/flutter	55 552 (97.2%)	71 710 (96.9% [95% CI, 96.5%–97.4%])
At or by discharge–smoking cessation	65 657 (97.9%)	88 352 (97.2% [95% CI, 96.6%–97.8%])
At or by discharge–statin prescribed at discharge	250 031 (98.9%)	328 842 (98.7% [95% CI, 98.7%–98.9%)
GWTG/PAA defect-free measure	363 743 (94.3%)	480 112 (93.7% [95% CI, 93.4–93.9%])
Quality measures		
Acute–dysphagia screen	316 185 (85.8%)	415 863 (84.9% [95% CI, 84.5%–85.2%])
Acute–time to intravenous thrombolytic therapy–60 min	30 131 (86.3%)	38 045 (85.0% [95% CI, 83.8%–86.1%])
Acute–IV thrombolytics arrive by 3.5 h, treat by 4.5 h	40 715 (81.3%)	52 199 (79.7% [95% CI, 78.8%–80.7%])
Acute–NIHSS reported	353 181 (93.8%)	466 975 (92.9% [95% CI, 92.5–93.2%])
At or by discharge–stroke education	192 279 (95.8%)	256 626 (95.2% [95% CI, 94.8%–95.5%])
At or by discharge–rehabilitation considered	347 797 (99.0%)	460 709 (98.8% [95% CI, 98.7%–98.9%])
At or by discharge–LDL documented	325 527 (93.5%)	429 722 (93.1% [95% CI, 92.8%–93.3%)
At or by discharge–intensive statin therapy	130 069 (81.2%)	173 858 (80.6% [95% CI, 80.1%–81.0%])
Additional metrics		
Door to CT time, min, median (IQR)	33 (13–87)	32 (13–86)
IV Thrombolytic use	47 292 (11.4%)	60 510 (11.0% [95% CI, 10.8%–11.1%])
Door to IV thrombolytic time, min, median (IQR)	49 (35–68)	49 (35–69)
Endovascular treatment use	29 939 (7.2%)	39 008 (7.1% [95% CI, 6.9%–7.2%])
Door to endovascular treatment time, min, median (IQR)	87 (53–128)	86 (53–127)

CT indicates computed tomography; GWTG/PAA, Get With The Guideline/Performance Achievement Award; IQR, interquartile range; NIHSS, National Institutes of Health Stroke Scale; and VTE, venous thromboembolism.

with AIS received thrombolytics IV within 3 hours of presentation. Receipt of early antithrombotics, and venous thromboembolic prophylaxis were > 95%. Indicated therapies at discharge were provided at a high rate (>95%) for antithrombotics, anticoagulation for atrial flutter or fibrillation, smoking cessation recommendations, and statin therapy. Defect-free care was received by 480 112 (93.7% [95% CI, 93.4%–93.9%), defined has no deficiencies across all 7 AIS performance measures. However, some quality measures had lower rates of receipt. Dysphagia screening occurred in 415 863 (84.9% [95% CI, 84.5%–85.2%]) of patients with AIS, time to thrombolysis within 60 minutes for eligible patients occurred for 38 045 (85.0% [95% CI, 83.8%–86.1%]) of indicated patients, and intensive statin therapy was only received for 173 858 (80.6% [95% CI, 80.1%–81.0%]) of patients.

DISCUSSION

There remains an immense challenge in monitoring AIS epidemiology, clinical care, and outcomes using existing data structures. This study used a novel method to apply poststratification weights to an existing large GWTG-Stroke registry to describe national stroke epidemiology, clinical care, and outcomes for the year 2019. NIS is typically released with a 2 to 3 lag and consists of administrative data, while GWTG data are verified by chart review by train personnel with accuracy checks and the data are mostly complete and analyzable within 6 months. We used the NIS to select reliable anchoring variables to generate poststratification survey weights for the GWTG-Stroke registry. We think our approach provides accurate and near real-time estimates of AIS burden and clinical outcomes.

Currently, the American Heart Association stroke prevalence estimates are based on self-report from the National Health and Nutrition Examination Survey and Behavioral Risk Factor Surveillance System, which is a limited sample of community participants with a risk of health selection bias.[6,23] Smaller cohort studies sponsored from the National Institutes of Health are featured for characterizing stroke incidence and etiology with nonrepresentative national populations.[14,24] The National Heart, Lung, and Blood Institute estimates 795 000 incident new or recurrent strokes per year using these cohorts and unpublished methods.[25] Our study improves the reliability of these estimates by applying Bayesian interpolation to a large stroke patient registry anchored to nationally representative hospital claims data to characterize the US AIS population.

Nationally, we observe a large AIS burden suggesting large gaps in care prehospitalization that would likely reduce the risk of both primary and secondary AIS events. Less than half of patients presenting with AIS receive antiplatelet or cholesterol reducing medications before hospital presentation. Overall, patients seen in participating GWTG-Stroke hospitals receive excellent and timely care but areas for quality improvement remain. The early recognition, treatment, and appropriate screening during hospitalization remain critical areas for care improvement.

Clinical outcomes remain severe at discharge with large proportions of patients post-AIS events requiring rehabilitation or extended inpatient care. This highlights the importance of population health to prevent both primary and secondary stroke attack rates. Strategies that encourage population-wide hypertension control, atherosclerotic risk reduction with use of cholesterol-lowering therapies, anticoagulation for atrial fibrillation/flutter, and antiplatelet agents for indicated patients will reduce the incidence of AIS.

In terms of limitations, this study's methods may not accurately forecast large shifts in cardiovascular disease related to events such as the COVID-19 pandemic. We applied these methods to 2019 data to avoid issues related to delayed AIS presentation and shifts in cardiovascular health related to the COVID-19 pandemic and large behavioral changes. GWTG-Stroke includes over 1500 hospitals that primarily provide stroke services and voluntarily participate in the GWTG-Stroke quality improvement program. Participating hospitals may provide higher quality care relative to hospitals not participating in the GWTG-Stroke program.[26,27] Nonparticipating hospitals likely treat a smaller portion of patients with AIS. Nevertheless, our estimates for care quality might be on the higher end of true national performance. The Bayesian interpolation method is not able to adjust for unknown confounders. However, we think that by balancing hospital characteristics related to size and rurality, we closely approximate national AIS care quality of care.

CONCLUSIONS

This study provides an overview of the burden of AIS and delivers more timely representative reports of the national population health. The post-stratification Bayesian survey weights and forecasting approach allows for more timely evaluation of trends in AIS hospital presentations and quality of care assessments. By leveraging clinically valuable data from a high-quality national stroke registry program to make national estimates, we provide a broad overview of epidemiological clinical and hospital factors underlying the stroke epidemic that can be sustained for the future.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S4

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