

2020

TEXAS STROKE SYSTEM OF CARE REPORT



TEXAS
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I. EXECUTIVE SUMMARY

In 2017, stroke was the third leading cause of death among Texans, causing 42.3 deaths per 100,000 people. (1) Stroke mortality varied by race/ethnicity. Deaths due to stroke were more common among blacks (58.4 deaths per 100,000 people) compared with whites (41.8 deaths per 100,000 people) or Hispanics (36.9 deaths per 100,000). In 2019, the prevalence of stroke among Texans ages 18 years and older was 3.7%. (2)

In 2018, about 25 hospitalizations occurred due to stroke for every 10,000 Texans. (3) The total charges for stroke hospitalizations in 2018 were more than \$5.9 billion. Medicaid beneficiaries accounted for over \$336 million of the total charges. (3)

In order to advance stroke reduction efforts, it is important to analyze the system of care by collecting and analyzing data. During the 83rd Regular Texas Legislative Session, funds were appropriated to advance heart attack and stroke reduction efforts throughout Texas. To inform such efforts, the Texas Department of State Health Services (DSHS) launched a heart attack and stroke data collection initiative.

To evaluate the care of patients diagnosed with a stroke, DSHS assessed elements within the stroke system of care for timeliness and appropriateness. DSHS analyzed data collected from the hospitals that agreed to participate in this data collection initiative. The data are collected in the "Get With The Guidelines®"-Stroke database using the IQVIA PMT® system, and reflect hospital care from the first quarter of 2008 through the fourth quarter of 2019, unless otherwise stated.

Substantial stroke system of care findings, 2008-2019:

- From 2008-2019, the number of hospitals providing data on individual episodes of stroke has ranged from 21-50 hospitals, with 47 located in urban counties and 4 in rural counties (Pg. 10). Note: One hospital system reports four hospitals in aggregate; these cases cannot be analyzed individually by hospital, so these four hospitals are counted as a single hospital.
- For 2019, 46 hospitals/hospital systems participated in the data collection.
- In total, 149,778 episodes of care have been reported. Out of these, 143,199 episodes of stroke care were considered eligible for analyses in this report (Pg. 10 - Pg. 13).
- Overall, about four out of 10 stroke cases (39.5%) arrived at the hospital by private vehicle (Pg. 15). For the most recent 6 years (2014-2019), the arrival methods of stroke cases have remained similar (Pg. 17).
 - Among rural hospitals, 46.7% cases arrived to the hospital by private vehicle, vs. 39.1% among urban hospitals (Pg. 15);
 - Females were more likely than males to arrive via ambulance (46.2% vs. 43.4%), while males were more likely than females to arrive via private vehicle (40.3% vs. 38.7%) (Pg. 15).

- Overall, Emergency Medical Services (EMS) gave advance notification to the receiving hospital for 52.8% of stroke cases transported by EMS from home or scene (Pg. 18).
 - Advance notification occurred for 71.8% of adult stroke cases in rural hospitals, as compared with 56.1% in urban hospitals (Pg. 18);
 - In 2019, EMS provided advance notification for over half (52.1%) of the transported adult stroke cases (Pg. 19).
- For the most recent 6 years (2014-2019), the National Institutes of Health Stroke Scale (NIHSS) score was reported for over 91% of adult ischemic stroke and stroke not otherwise specified (NOS) cases (Pg. 21).
 - For the last 8 years (2012-2019), the median NIHSS score has remained the same: NIHSS score of 4 - Minor stroke.
- Overall, almost half of all adult stroke cases (49.1%) received initial brain imaging within 15 minutes of hospital arrival. The median door-to-imaging time was 16 minutes (Pg. 22).
 - The median door-to-imaging time was 14 minutes for arrival by EMS and 20 minutes for arrival by private vehicle (Pg. 22);
 - Having a door-to-imaging \leq 25 minutes varied by arrival method: 74.6% for EMS arrivals and 62.0% for private vehicle arrivals (Pg. 22).
- Overall, three out of 10 stroke cases (34.2%) received Tissue plasminogen activator (tPA) within 45 minutes of hospital arrival, and almost seven out of 10 (57.2%) received tPA within 60 minutes of hospital arrival (Pg. 24).
- The door-to-tPA times and percentage of cases treated varied by method of arrival (Pg. 24 - 26).
 - 67.1% of EMS arrivals vs. 63.1% of private vehicle arrivals had a door-to-tPA time \leq 60 minutes (Pg. 24);
 - Over time, the median door-to-tPA time has decreased by half, from 90 minutes in 2008 to 45 minutes in 2019 (Pg. 26).
- In 2019, roughly four in 100 (3.5%) adult stroke cases treated with any type of thrombolytic therapy experienced bleeding complications post thrombolytic therapy (Pg. 34).
- Of the eligible adult ischemic stroke and Transient Ischemic Attack (TIA) cases, two-thirds (68.9%) were prescribed a qualifying high-intensity statin at hospital discharge (Pg. 35).
- For the last 9 years, 98.0% or more of adult ischemic stroke and TIA cases were prescribed an antithrombotic at hospital discharge (Pg. 38).
- From 2008-2019, 98.3% of eligible adult stroke cases were assessed for rehabilitative services (Pg. 40).
- The percentage of eligible adult stroke cases receiving all of the stroke education materials has increased, from a low of 50.3% in 2008 to a high of 90.2% in 2014, and has remained above 85.0% since (Pg. 43).
- From 2011-2019, almost four in 10 (38.5%) adult stroke cases had a Modified Rankin Scale score (mRS) documented at discharge (Pg. 44).

II. INTRODUCTION

A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is blocked by a clot or ruptures, leading to death of brain cells. (4) The two most common types of stroke are ischemic stroke and hemorrhagic stroke. An ischemic stroke is caused by a clot in a brain blood vessel which prevents blood and oxygen flow to the area. A hemorrhagic stroke is caused when a brain blood vessel ruptures, leaking blood into the surrounding brain area. An additional type of stroke, transient ischemic attack (TIA), also called a "mini stroke", is caused by a temporary clot in a brain blood vessel and may indicate increased risk for a future stroke. (4)

III. BACKGROUND

In order to advance stroke reduction efforts, it is important to assess the system of care by collecting and analyzing data. During the 83rd Regular Texas Legislative Session, funds were appropriated to advance heart attack and stroke reduction efforts throughout Texas. To inform such efforts, the Texas Department of State Health Services (DSHS) launched a Heart Attack and Stroke Data Collection initiative. The data collection initiative focuses on pre-hospital and hospital data elements. This report includes de-identified, aggregate data for hospitals who have agreed to share "Get With The Guidelines®" (GWTG) Stroke data with DSHS. All data is protected under Health Insurance Portability Accountability Act (HIPAA) guidelines. No hospital level data will be distributed, nor will any hospital name be identified in the report. This aggregate data is intended to inform stakeholders about opportunities for collaboration and system improvement.

The objectives of the data collection are: 1) to gain an understanding of the stroke systems of care in Texas; and 2) to evaluate pre-hospital and hospital care components, and treatment of stroke patients. The findings will be used to assess the practices regarding delivery of care across the state and identify areas of opportunity for quality improvement.

IV. STROKE IN TEXAS

In 2019, the prevalence of stroke among Texans 18 years of age and older was 3.7% (95% CI: 3.1-4.3). (2) The unadjusted prevalence of stroke for each year (2011-2019), overall and by race-ethnicity, is displayed in Table 1.

TABLE 1. ESTIMATED NUMBER AND UNADJUSTED PREVALENCE OF STROKE, ADULTS AGES 18 YEARS AND OLDER, BY RACE/ETHNICITY, 2011-2019

| Year | Number | % (95% CI) | Race/Ethnicity | | | |
|------|---------|---------------|--------------------------|--------------------------|------------------------|---------------------|
| | | | % White only (95% CI) | % Black only (95% CI) | % Hispanic (95% CI) | % Other (95% CI) |
| 2011 | 487,039 | 2.7 (2.3-3.0) | 2.7 (2.2-3.1) | 5.2 (3.2-7.2) | 1.8 (1.1-2.4) | -- |
| 2012 | 513,211 | 2.7 (2.3-3.1) | 3.2 (2.6-3.8) | 4.2 (2.6-5.8) | 1.5 (0.9-2.0) | -- |
| 2013 | 487,955 | 2.5 (2.1-2.9) | 3.0 (2.5-3.6) | 3.7 (2.1-5.3) | 1.6 (1.0-2.2) | -- |
| 2014 | 587,304 | 3.0 (2.5-3.4) | 3.1 (2.6-3.7) | 5.8 (3.9-8.6) | 1.9 (1.4-2.6) | -- |
| 2015 | 608,538 | 3.0 (2.5-3.5) | 3.1 (2.6-3.5) | 4.7 (2.6-6.9) | 2.3 (1.5-3.2) | -- |
| 2016 | 532,088 | 2.6 (2.1-3.1) | 2.9 (2.3-3.7) | 2.7 (1.6-4.4) | 2.0 (1.2-3.3) | -- |
| 2017 | 732,484 | 3.5 (2.8-4.2) | 4.2 (3.2-5.4) | 5.8 (3.6-9.4) | 2.1 (1.5-3.1) | -- |
| 2018 | 791,643 | 3.7 (3.0-4.6) | 4.0 (3.1-5.1) | 4.6 (2.8-7.4) | -- | 5.3 (2.9-9.4) |
| 2019 | 800,388 | 3.7 (3.1-4.3) | 4.1 (3.4-4.9) | 5.3 (3.6-7.7) | 2,4 (1.7-3.4) | -- |

Abbreviations: CI = confidence interval.

-- indicates data is not reportable due to small sample size.

According to the 2013 Texas Behavioral Risk Factor Surveillance System (BRFSS) survey, an estimated 86.9% of adults in Texas said they would call 911 if they thought someone was having a heart attack or stroke. The remaining 13.1% of adults said they would take other action, such as take the person to the hospital, tell the person to call their doctor, call a spouse or family member, or do something else.

HOSPITALIZATIONS

Table 2 displays annual (2010-2018) age-adjusted hospitalization rates (per 10,000 individuals) for stroke among Texans of all ages. In 2018, for every 10,000 people, about 25 hospitalizations occurred due to stroke (24.5%; 95% Confidence Interval [CI]: 24.3-24.7). (3) The annual age-adjusted hospitalization rate for stroke (per 10,000) increased by 12.9% from 2010 to 2018.

TABLE 2. AGE-ADJUSTED STROKE HOSPITALIZATION RATES PER 10,000 INDIVIDUALS, ALL AGES, BY RACE/ETHNICITY, TEXAS, 2010-2018

| Year | Number | Age-Adjusted Hospitalization Rate (95% CI) | Race/Ethnicity | | | |
|------|--------|---|------------------------|------------------------|---------------------------|---------------------|
| | | | White only (95% CI) | Black only (95% CI) | Hispanic only (95% CI) | Other (95% CI) |
| 2010 | 47,588 | 21.7 (21.5-21.9) | 20.6 (20.3-20.8) | 28.9 (28.1-29.6) | 19.0 (18.6-19.4) | 38.4 (36.9-39.9) |
| 2011 | 49,224 | 21.7 (21.5-21.9) | 20.4 (20.2-20.7) | 30.7 (29.9-31.4) | 17.9 (17.6-18.3) | 32.7 (31.5-33.8) |
| 2012 | 49,738 | 21.1 (20.9-21.2) | 18.8 (18.6-19.0) | 26.4 (25.8-27.1) | 16.8 (16.4-17.1) | 56.3 (54.8-57.8) |
| 2013 | 50,500 | 20.7 (20.5-20.9) | 19.4 (19.2-19.6) | 27.5 (26.9-28.2) | 17.0 (16.6-17.3) | 34.9 (33.8-36.1) |
| 2014 | 50,933 | 20.3 (20.1-20.4) | 19.1 (18.9-19.3) | 27.4 (26.7-28.0) | 17.3 (17.0-17.7) | 32.9 (31.7-34.0) |
| 2015 | 57,113 | 22.0 (21.8-22.1) | 20.9 (20.6-21.1) | 30.2 (29.5-30.9) | 19.3 (18.9-19.6) | 30.0 (29.0-31.1) |
| 2016 | 68,327 | 25.3 (25.1-25.5) | 23.4 (23.2-23.7) | 33.4 (32.7-34.1) | 21.7 (21.3-22.1) | 48.1 (46.8-49.4) |
| 2017 | 69,764 | 25.0 (24.8-25.2) | 22.1 (21.9-22.3) | 32.5 (31.8-33.2) | 24.8 (24.4-25.2) | 43.7 (42.5-44.9) |
| 2018 | 71,880 | 24.5 (24.3-24.7) | 30.8 (30.5-31.1) | 25.9 (25.3-26.4) | 17.4 (17.2-17.7) | 26.2 (25.5-26.9) |

Abbreviations: CI = confidence interval.

In 2018, the total charges for hospitalizations due to stroke approached \$6 billion (Table 3). (3) Medicare beneficiaries accounted for 63% percent of hospital discharges and roughly \$3.5 billion in total charges. Total charges for Medicaid beneficiaries were over \$300 million.

TABLE 3. STROKE HOSPITAL DISCHARGES AND TOTAL CHARGES BY PRIMARY PAYMENT SOURCE, TEXAS, 2018

| Payer Source | Hospital Discharges | | Total Charges |
|-------------------|---------------------|------|-----------------|
| | N=71,880 | % | |
| Total | | | \$5,977,451,145 |
| Medicaid | 2,628 | 3.7 | \$336,127,406 |
| Medicare | 44,894 | 62.5 | \$3,457,122,029 |
| Private Insurance | 16,584 | 23.1 | \$1,398,448,560 |
| Uninsured | 6,567 | 9.1 | \$672,505,311 |
| Other | 1,207 | 1.7 | \$113,247,839 |

MORTALITY

In 2017, stroke was the third leading cause of death among Texans of all ages, accounting for 42.3 deaths per 100,000 people. (1) When stratified by race/ethnicity, the age-adjusted stroke mortality was significantly higher among blacks (58.4 per 100,000) than among whites (41.8 per 100,000) or Hispanics (36.9 per 100,000).

From 2013-2017, the average age-adjusted stroke mortality rate was 43.0 deaths per 100,000 Texans of all ages. Among race-ethnicity groups, deaths due to stroke were more common among blacks (60.6 per 100,000) than among whites (42.9 per 100,000) or Hispanics (36.9 per 100,000).

The map below displays the geographic distribution of the 5-year (2013-2017) age-adjusted stroke mortality rate per 100,000 Texans. The highest mortality rates emerge across north, east, and central Texas.

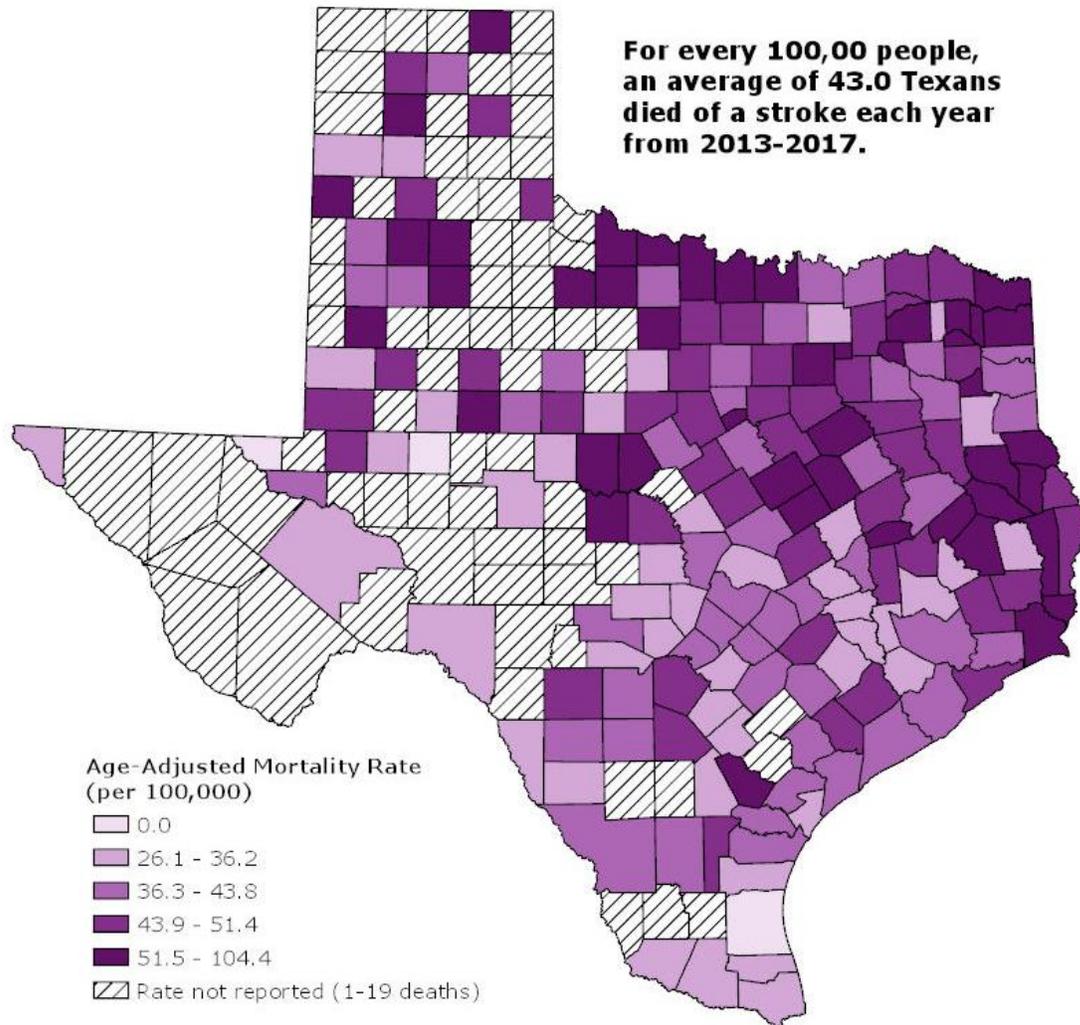


FIGURE 1. AGE-ADJUSTED STROKE MORTALITY RATE, PER 100,000 PEOPLE, ALL AGES, BY COUNTY, TEXAS, 2013-2017

V. EVALUATING HOSPITAL CARE FOR STROKE IN TEXAS

In an ideal system of care, all patients should receive proper care with minimal delays to treatment. To evaluate the care of patients diagnosed with a stroke, elements of care were assessed for timeliness and appropriateness.

DSHS analyzed data collected from a group of hospitals that voluntarily agreed to participate in this data collection initiative. The data are collected in the GWTG®-Stroke database using the IQVIA PMT® system. This report reflects hospital care from January 1, 2008 through December 31, 2019.

HOSPITAL PARTICIPATION

A total of 149,778 stroke-related or suspected stroke visits were reported from 2008 through 2019. Over this time, 51 different hospitals have participated after accounting for hospitals' participation and withdrawal over time. Of 46* hospitals participating in 2019, 43 were located in urban settings, and 3 in a rural setting.

The number of patient beds among participating hospitals ranged from 43 to 817 beds per hospital. About one-third of the participating hospitals (n=26; 34.3%) had 100 to 299 bed capacity. Roughly eight in 100 stroke cases (8.1%) were treated at hospitals with less than 100 beds and about 32 in 100 (31.8%) at hospitals with 500 or more beds.

TABLE 4. NUMBER OF CASES AND HOSPITAL PARTICIPATION, BY YEAR, PATIENT BEDS, AND SETTING, 2008-2019

| | Total Reported Cases | Participating Hospitals * |
|---------------------|-----------------------------|----------------------------------|
| | N=149,778 (%) | N |
| Year | | |
| 2008 | 4,857 (3.2) | 21 |
| 2009 | 6,336 (4.2) | 27 |
| 2010 | 8,313 (5.6) | 33 |
| 2011 | 9,350 (6.2) | 36 |
| 2012 | 10,481 (7.0) | 40 |
| 2013 | 12,699 (8.5) | 44 |
| 2014 | 14,226 (9.5) | 49 |
| 2015 | 16,900 (11.3) | 49 |
| 2016 | 16,864 (11.3) | 50 |
| 2017 | 16,897 (11.3) | 49 |
| 2018 | 16,124 (10.8) | 46 |
| 2019 | 16,741 (11.2) | 46 |
| Patient Beds | | |
| <100 | 12,057 (8.1) | 8 |
| 100-299 | 51,326 (34.3) | 26 |
| 300-499 | 38,771 (25.9) | 11 |
| ≥500 | 47,634 (31.8) | 6 |
| Setting | | |
| Urban | 142,149 (94.9) | 43 |
| Rural | 7,639 (5.1) | 3 |

* One hospital presents aggregate data for four of their hospitals; since data from these four hospitals cannot be analyzed by individual hospital, they are counted as a single hospital in this report.

FINAL STROKE DIAGNOSIS

Table 5 and Figure 2 display the descriptive characteristics of each type of the final stroke diagnoses, 2008 through 2019.

From 2008-2019, ischemic stroke accounted for 67.0% of all reported cases. Among the other stroke subtypes reported, 12.6% were transient ischemic attack (TIA), 11.0% were intracerebral hemorrhage (ICH), 3.7% were subarachnoid hemorrhage (SAH), and 1.3% were stroke not otherwise specified (NOS). No stroke-related diagnosis, elective carotid intervention, or no stroke diagnosis provided (missing) accounted for the remaining 4.4%

TABLE 5. STROKE TYPE, BY DEMOGRAPHIC AND OTHER SELECT FACTORS, 2008-2019

| Final Stroke Diagnosis | Total Reported Cases | % | LOS (days) | Gender (Female) | Age (years) | Race (White) | Insurance (yes) | County (Rural) |
|------------------------------------|-----------------------------|----------|-------------------|------------------------|--------------------|---------------------|------------------------|-----------------------|
| | N=149,778 | % | Median | % | Median | % | % | % |
| Ischemic Stroke | 100,334 | 67.0 | 4 | 49.6 | 68 | 74.0 | 84.8 | 4.1 |
| TIA (<24hrs) | 18,848 | 12.6 | 2 | 56.8 | 69 | 80.0 | 90.5 | 10.6 |
| Intracerebral Hemorrhage | 16,459 | 11.0 | 5 | 45.2 | 65 | 70.9 | 78.6 | 3.4 |
| Subarachnoid Hemorrhage | 5,546 | 3.7 | 8 | 61.7 | 58 | 72.1 | 73.7 | 1.8 |
| Stroke NOS | 2,012 | 1.3 | 4 | 50.6 | 69 | 69.3 | 88.5 | 20.2 |
| Elective Carotid Intervention only | 3,773 | 2.5 | 1 | 42.7 | 71 | 88.9 | 95.4 | 7.6 |
| No stroke related diagnosis | 2,248 | 1.5 | 2 | 54.0 | 65 | 72.3 | 89.0 | 9.4 |
| Missing | 568 | 0.4 | 3 | -- | -- | -- | -- | -- |

Abbreviations: LOS=Length of Stay

From 2008-2019, the overall median length of hospital stay (LOS) for all stroke patients was 4 days. LOS varied by final stroke diagnosis. Of stroke patients, those with TIA had the shortest LOS (median 2 days) while hemorrhagic stroke patients had the longest: median 5 days for intracerebral, median 8 days for subarachnoid. The median LOS for Elective Carotid Intervention was 1 day. Figure 2 shows the 2019 median LOS by stroke type.

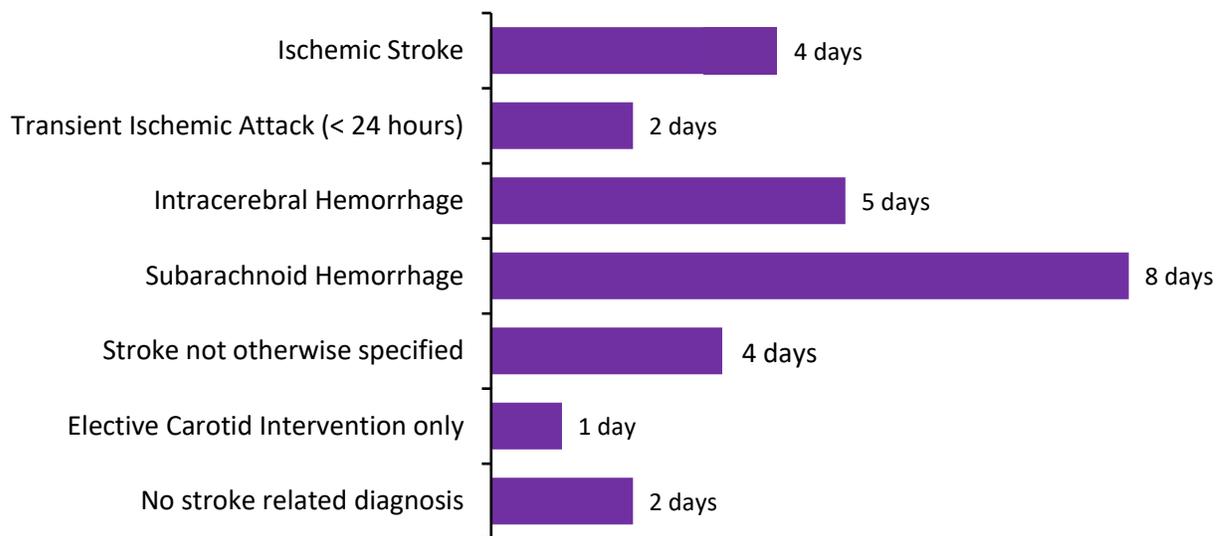


FIGURE 2. MEDIAN LENGTH OF STAY, BY FINAL STROKE DIAGNOSIS, 2019

Note: While Table 5 and Figure 2 include cases of “elective carotid intervention only” and “no stroke related diagnosis”, these cases are not included in any further analyses unless otherwise stated.

PATIENT DEMOGRAPHICS

Table 6 displays the demographic characteristics of the 143,199 stroke cases reported from 2008 to 2019.

TABLE 6. DEMOGRAPHIC CHARACTERISTICS AMONG REPORTED STROKE CASES, 2008-2019

| Demographics | Total reported stroke cases | | LOS (days)* |
|----------------------------------|-----------------------------|------|-------------|
| | N=143,199* | % | Median |
| Gender | | | |
| Female | 72,217 | 50.5 | 4 |
| Male | 70,921 | 49.5 | 4 |
| Unknown | 17 | <0.1 | 4 |
| Age (years) | | | |
| < 18 | 47 | <0.1 | 5 |
| 18 – 30 | 1,401 | 1.0 | 4 |
| 31 – 45 | 9,565 | 6.7 | 4 |
| 46 – 65 | 53,329 | 37.2 | 4 |
| 66 – 85 | 62,832 | 43.9 | 4 |
| > 85 | 16,025 | 11.2 | 4 |
| Race | | | |
| White | 106,111 | 74.3 | 3 |
| Black or African American | 25,033 | 17.5 | 4 |
| Asian | 2,005 | 1.4 | 4 |
| American Indian/Alaskan Native | 266 | 0.2 | 3 |
| Native Hawaiian/Pacific Islander | 149 | 0.1 | 4 |
| Unable to determine (UTD) | 9,325 | 6.5 | 4 |
| Ethnicity | | | |
| Hispanic | 34,033 | 23.8 | 4 |
| Non-Hispanic | 109,023 | 76.2 | 3 |
| Health Insurance Status | | | |
| Health insurance | 96,415 | 67.3 | 4 |
| Without health insurance | 17,680 | 12.3 | 4 |
| Missing | 29,104 | 20.3 | 3 |

* Totals for each grouping may not add up to table total due to missing data.

Note: While Table 6 includes stroke cases of all ages, the remaining tables and figures report only on patients ages 18 years and older.

Females accounted for half (50.6%) of the patient population. The median age was 68 years, with patients aged 66 to 85 years accounting for 43.7% of the total patients. About three out of four patients were white (74.4%) and non-Hispanic (76.1%). More than two-thirds (76.1%) of patients had some form of health insurance. The median LOS among the demographic categories rarely deviated from the overall, 4 days, except for patients age < 18 years (median 5 days).

VI. HOSPITAL STROKE PERFORMANCE MEASURES

The following tables and figures display the data for specific reporting, quality, and achievement measures for effective care of stroke patients. Annual percent trends for the period of 2008 – 2019 are also included for each of the measures of effective care for stroke patients. Additional information, including data sources, can be found in the Appendix. Because the measures listed here have different inclusion/exclusion criteria, the number of cases reported for measures differ, and totals for the measures may not add up to the total number of cases reported in Table 6.

This report includes the following hospital performance measures for stroke:

1. Hospital Arrival Method
2. Advance Notification
3. National Institutes of Health Stroke Scale (NIHSS) Reported
4. Time to Initial Brain Imaging
5. Time to Intravenous Thrombolytic Therapy – 45 Minutes
6. Time to Intravenous Thrombolytic Therapy – 60 Minutes
7. IV tPA Arrive by 2 Hours, Treat by 3 Hours
8. IV tPA Arrive by 3.5 Hours, Treat by 4.5 Hours
9. Drip-and-Ship
10. Early Antithrombotics
11. Thrombolytic Therapies
12. Thrombolytic Complications
13. Intensive Statin Therapy
14. Antithrombotic Prescribed at Discharge
15. Anti-hypertensives Prescribed at Discharge
16. Rehabilitation Considered
17. Stroke Education
18. Modified Rankin Scale at Discharge
19. Discharge Disposition

HOSPITAL ARRIVAL METHOD

Time to treatment can have a significant effect on stroke patient survival rate and potential disability. For this reason, it is important to evaluate the method of arrival for stroke patients. Transport protocols should be in place for Emergency Medical Services (EMS) transport to take suspected stroke patients to the hospital with the

appropriate level of stroke care, whereas patients who arrive by private vehicle may be taken to a hospital that does not meet their medical and treatment needs. (5)

Figure 3, below, displays the percentage of stroke patients' mode of hospital arrival overall, and by setting (rural and urban hospitals).

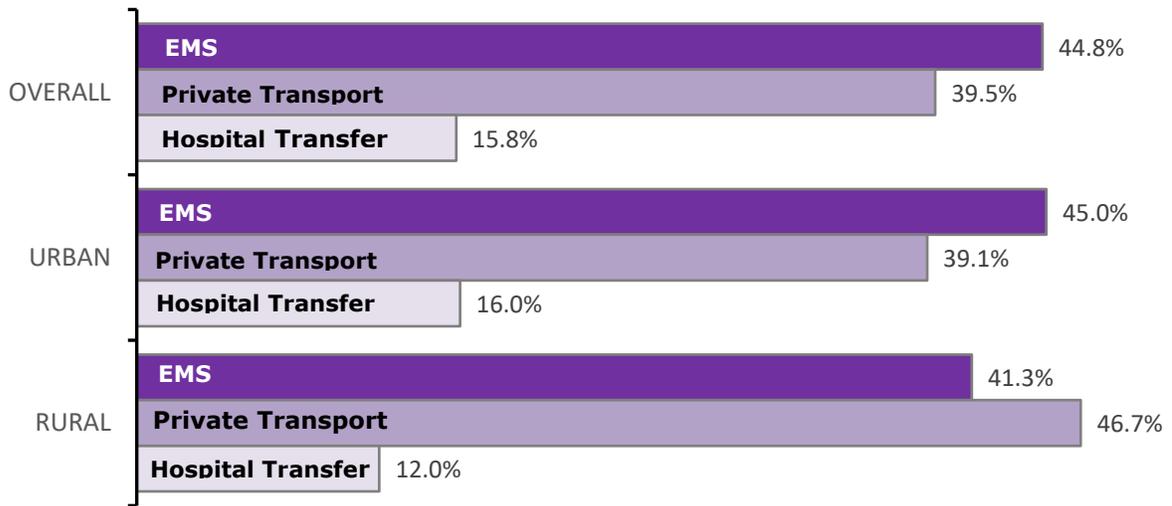


FIGURE 3. STROKE CASES BY METHOD OF HOSPITAL ARRIVAL: OVERALL, AND SETTING URBAN/RURAL, 2008-2019

Note: Missing and unknown categories are not included in Figure 3 percentages.

From 2008-2019, the most common mode of hospital arrival among stroke cases was EMS from home or scene (44.8%, n=58,937), followed by private transport from home or scene (39.5%, n=51,997), and transfers from other hospitals (15.8%, n=20,733).

Forty-seven out of 100 stroke cases treated at rural hospitals (46.7%, n=3,261) arrived via private transport, compared with 39 out of 100 stroke cases treated at urban hospitals (39.1%; n=48,736).

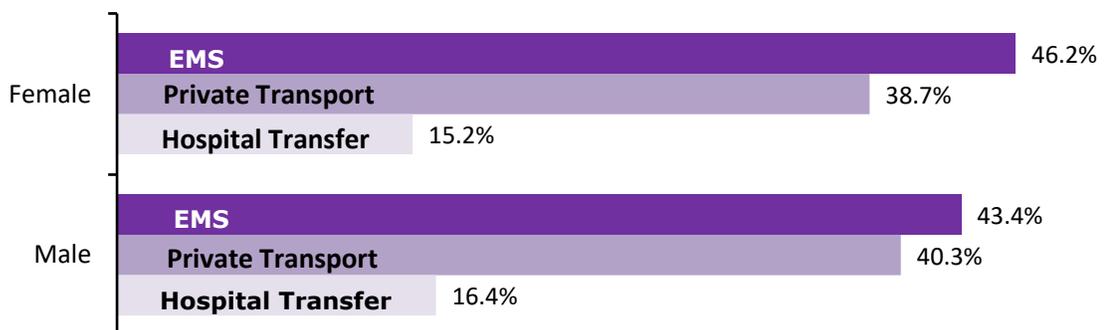


FIGURE 4. STROKE CASES BY METHOD OF HOSPITAL ARRIVAL, BY SEX, 2008-2019

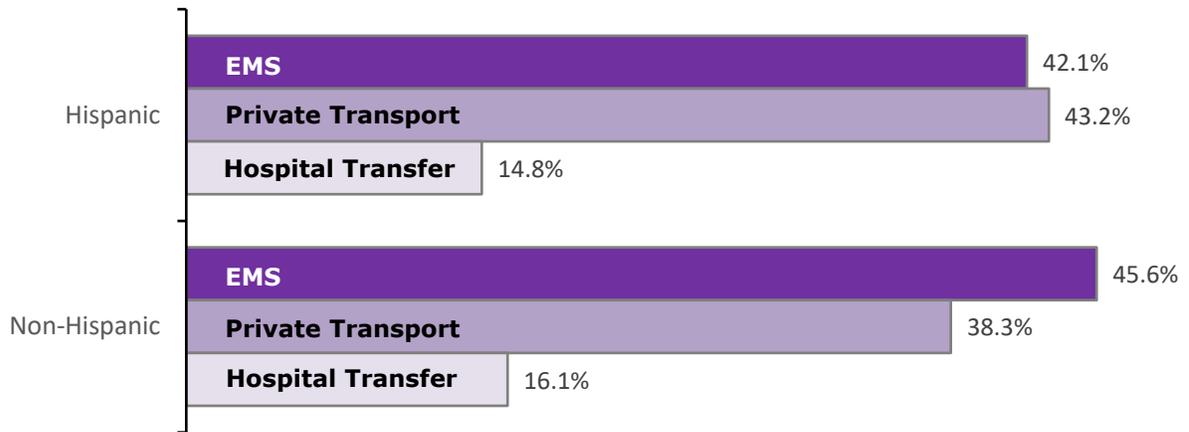


FIGURE 5. STROKE CASES BY METHOD OF HOSPITAL ARRIVAL, BY ETHNICITY, 2008-2019

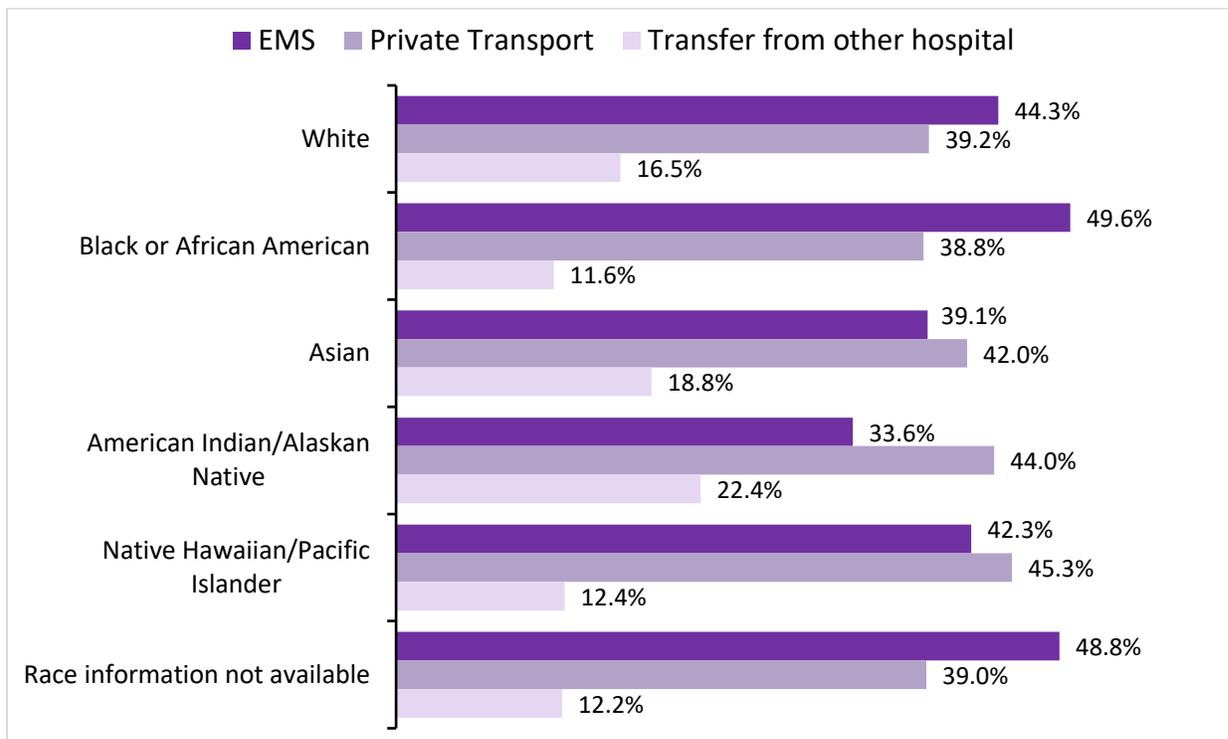


FIGURE 6. STROKE CASES BY METHOD OF HOSPITAL ARRIVAL, BY RACE, 2008-2019

The arrival method patterns were similar between females and males, and Hispanic and Non-Hispanic cases during 2008-2019 (Figures 4 and 5). White, Black or African American, and cases with no race available used EMS more frequently than private transportation and hospital transfer, while private transportation was used more frequently than EMS among other races (Figure 6).

Arrival Method, by Year

Figure 7 and Table 7 provide information regarding hospital arrival methods among stroke cases by reporting year.

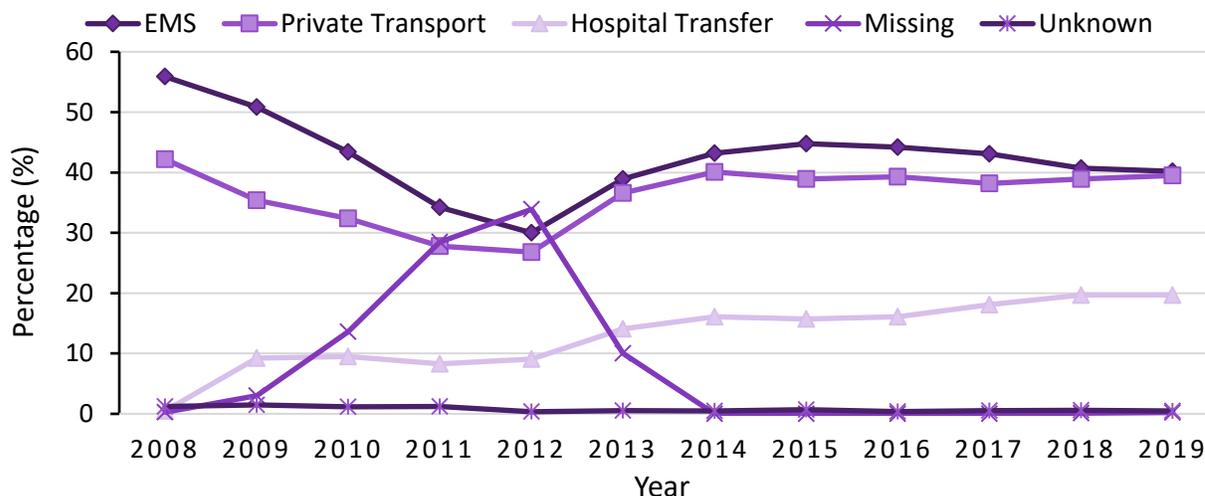


FIGURE 7. PERCENTAGE OF STROKE CASES, BY HOSPITAL ARRIVAL MODE, BY YEAR, 2008-2019

TABLE 7. STROKE CASES, BY HOSPITAL ARRIVAL MODE, BY YEAR, 2008-2019

| Year | Stroke cases N=141,112 | EMS from home/scene n=58,937 (41.8%) | Private Transportation n=51,197 (36.9%) | Hospital Transfer n=20,733 (14.7%) | Missing n=8,505 (6.0%) | Unknown n=940 (0.7%) | Reporting Hospitals N |
|------|---------------------------|--|---|--|------------------------------|----------------------------|--------------------------|
| 2008 | 4,814 | 2,692 (55.9) | 2,029 (42.2) | 23 (0.5) | 12 (0.3) | 58 (1.2) | 21 |
| 2009 | 6,255 | 3,179 (50.8) | 2,215 (35.4) | 577 (9.2) | 190 (3.0) | 94 (1.5) | 27 |
| 2010 | 8,106 | 3,517 (43.4) | 2,623 (32.4) | 767 (9.5) | 1,105 (13.6) | 94 (1.2) | 33 |
| 2011 | 9,081 | 3,105 (34.2) | 2,525 (27.8) | 749 (8.3) | 2,591 (28.5) | 112 (1.2) | 35 |
| 2012 | 10,094 | 3,024 (30.0) | 2,700 (26.8) | 916 (9.1) | 3,418 (33.9) | 36 (0.4) | 40 |
| 2013 | 11,472 | 4,463 (38.9) | 4,193 (36.6) | 1,614 (14.1) | 1,142 (10.0) | 60 (0.5) | 44 |
| 2014 | 12,830 | 5,550 (43.3) | 5,146 (40.1) | 2,064 (16.1) | 3 (<0.1) | 67 (0.5) | 49 |
| 2015 | 15,224 | 6,816 (44.8) | 5,922 (38.9) | 2,383 (15.7) | 2 (<0.1) | 101 (0.7) | 49 |
| 2016 | 15,773 | 6,971 (44.2) | 6,203 (39.3) | 2,533 (16.1) | 3 (<0.1) | 63 (0.4) | 50 |
| 2017 | 16,206 | 6,986 (43.1) | 6,197 (38.2) | 2,937 (18.1) | 5 (<0.1) | 81 (0.5) | 49 |
| 2018 | 15,605 | 6,350 (40.7) | 6,065 (38.9) | 3,081 (19.7) | 11 (0.1) | 98 (0.6) | 46 |
| 2019 | 15,652 | 6,284 (40.2) | 6,179 (39.5) | 3,089 (19.7) | 24 (0.2) | 76 (0.5) | 46 |

The annual percentage of stroke cases arriving by EMS ranged from a high of 55.9% in 2008 to a low of 30.0% in 2012. This rose to 44.8% in 2015, and has slowly declined, dropping to 40.2% in 2019.

Arrival by private transportation had a similar trend as EMS, ranging from 42.2% in 2008 to 26.8% in 2012. This rose to 40.1% in 2014 and has remained relatively stable since.

Percentage of cases transferred from another hospital has increased gradually and substantially, from 0.5% in 2008, to 19.7% in 2019.

Between 2008 and 2019, the number of participating hospitals reporting on arrival method increased each year, from 21 in 2008 to 46-50 in 2016-2019.

An opportunity exists to explore why Texans continue to rely heavily on private transportation (see Table 7).

ADVANCE NOTIFICATION

A stroke alert protocol should be in place that requires EMS technicians to alert the receiving hospital of suspected stroke patients. EMS act as the point of first contact, providing critical time information, such as symptom onset and time last known well (LKW), potentially improving time from hospital arrival to treatment

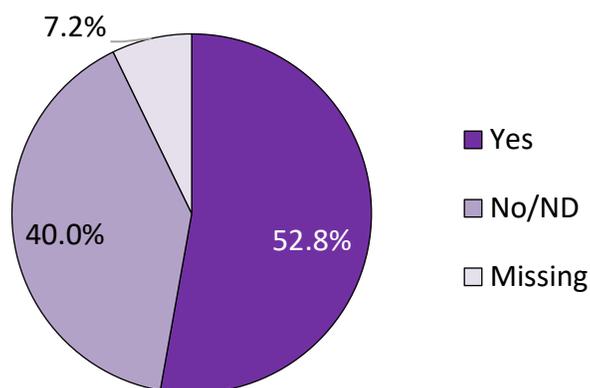


FIGURE 8. EMS ADVANCE NOTIFICATION TO HOSPITAL, 2008-2019

From 2008-2019, 58,937 stroke patients were transported by EMS from home or scene. Advance notification occurred in 52.8% of these arrivals while 40.0% had no advance notification or had no documentation (ND), and for 7.2% cases, data were missing (Figure 8).

Among rural hospitals' eligible stroke cases (n=2,667), advance notification occurred for 71.8% (n=1,9164) of cases. Among urban hospitals' eligible stroke cases (n=52,022), advance notification occurred for 56.1% (n=29,188) of cases. This excludes missing data.

Advance notification varied by stroke diagnosis. The highest percentage was seen among stroke NOS patients (64.8%, n=496) and the lowest percentage was seen among hemorrhagic stroke patients (Subarachnoid 50.4%, n=857; Intracerebral 55.3%, n=4,174).

Advance Notification by EMS, by Year

Figure 9 and Table 8 display percentages of advance notification provided prior to Emergency Department (ED) arrival among adult stroke cases arriving by EMS from home/scene.

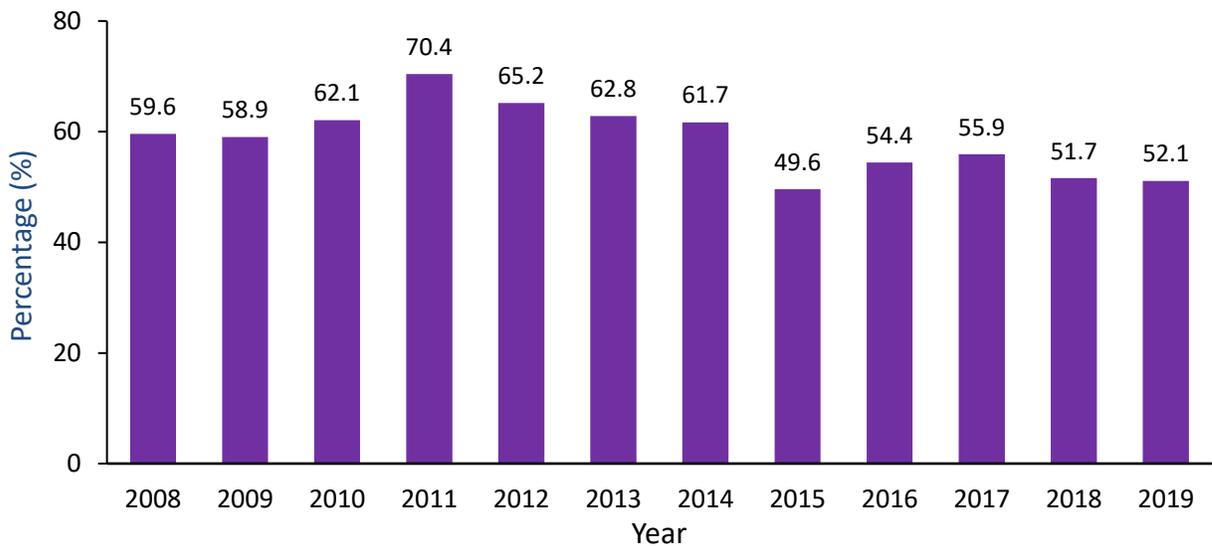


FIGURE 9. ADVANCE NOTIFICATION BY EMS, BY YEAR, 2008-2019

TABLE 8. ADVANCE NOTIFICATION BY EMS, BY YEAR, 2008-2019

| Year | Eligible cases | Advance | | Reporting |
|------|------------------|--------------|-------|-----------|
| | arriving via EMS | Notification | | Hospitals |
| | N=54,689 | n=31,102 | 56.9% | N |
| 2008 | 2,318 | 1,382 | 59.6 | 19 |
| 2009 | 2,784 | 1,641 | 59.0 | 27 |
| 2010 | 3,133 | 1,944 | 62.1 | 32 |
| 2011 | 2,827 | 1,990 | 70.4 | 29 |
| 2012 | 2,652 | 1,729 | 65.2 | 34 |
| 2013 | 3,216 | 2,021 | 62.8 | 44 |
| 2014 | 5,106 | 3,150 | 61.7 | 49 |
| 2015 | 6,373 | 3,162 | 49.6 | 49 |
| 2016 | 6,853 | 3,726 | 54.4 | 50 |
| 2017 | 6,956 | 3,890 | 55.9 | 49 |
| 2018 | 6,221 | 3,213 | 51.7 | 46 |
| 2019 | 6,250 | 3,254 | 52.1 | 46 |

The yearly percentage of advance notification varied, ranging from a low of 49.6% in 2015 to a high of 70.4% in 2011. In 2019, EMS provided advance notification for just over half (52.1%, n=3,254) of their transported patients.

Over time, the number of participating hospitals reporting on this measure has increased, from the low of 19 in 2008 to 46-50 since 2014.

The lack of advance notification by EMS prior to hospital arrival is a missed opportunity and indicates a gap in the stroke system of care, regardless of geographic differences. Identifying the cause of under-utilization and potential barriers to use of pre-notification by EMS is needed. An opportunity exists to standardize the use of EMS stroke alert protocol across all hospital systems.

NATIONAL INSTITUTES OF HEALTH STROKE SCALE (NIHSS) REPORTED

When a suspected stroke patient arrives at a hospital, an initial neurological examination should be conducted as a component of determining diagnosis of stroke and further care. The NIHSS is a standardized neurologic examination tool used to evaluate and document a patient’s status. The NIHSS allows healthcare providers to easily quantify the degree and severity of neurological deficits, and to identify the most appropriate treatment and level of care. (5)

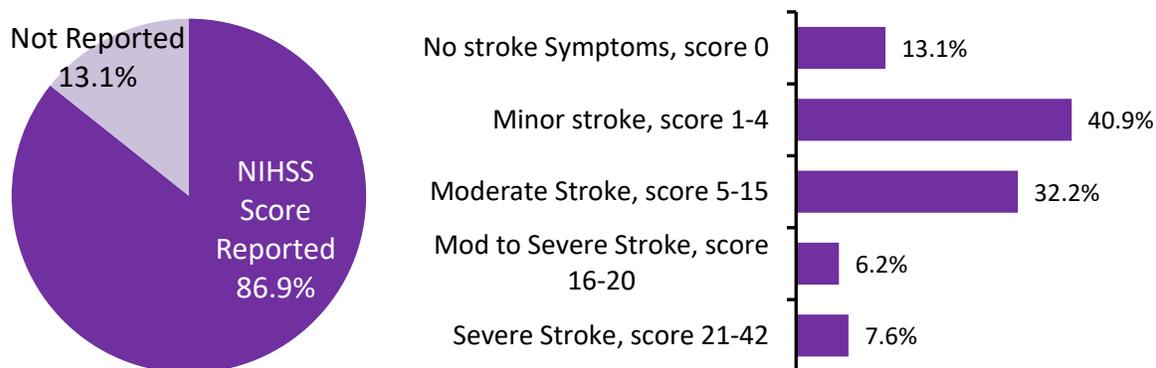


FIGURE 10. INITIAL NATIONAL INSTITUTES OF HEALTH STROKE (NIHSS) SCORES AMONG ADULT ISCHEMIC STROKE OR STROKE NOT OTHERWISE SPECIFIED CASES, 2008-2019

From 2008-2019, the NIHSS was performed as part of the initial examination in 86.9% (n=81,996) of eligible cases (n=94,379). Alternatively, 13.1% (n=12,383) of cases with a diagnosis of ischemic stroke or stroke NOS did not have an NIHSS evaluation performed and/or initial score reported (Figure 10). Data on this measure were missing for n=361 (0.4%) cases.

- Of the 81,996 cases listed as having an NIHSS performed, actual NIHSS scores were available for 81,769 cases (99.7%). From 2008-2019, four in 10 cases had a NIHSS score of 1-4, qualifying as a minor stroke (40.9%, n=33,429), and three in 10 (32.2%, n=26,328) had a score of 5-15, qualifying as a moderate stroke. Over all reporting years, the overall median NIHSS score was 4.

NIHSS Reported, by Year

Figure 11 and Table 9 display the percentages of eligible adult ischemic and stroke NOS cases with an NIHSS score reported, by year.

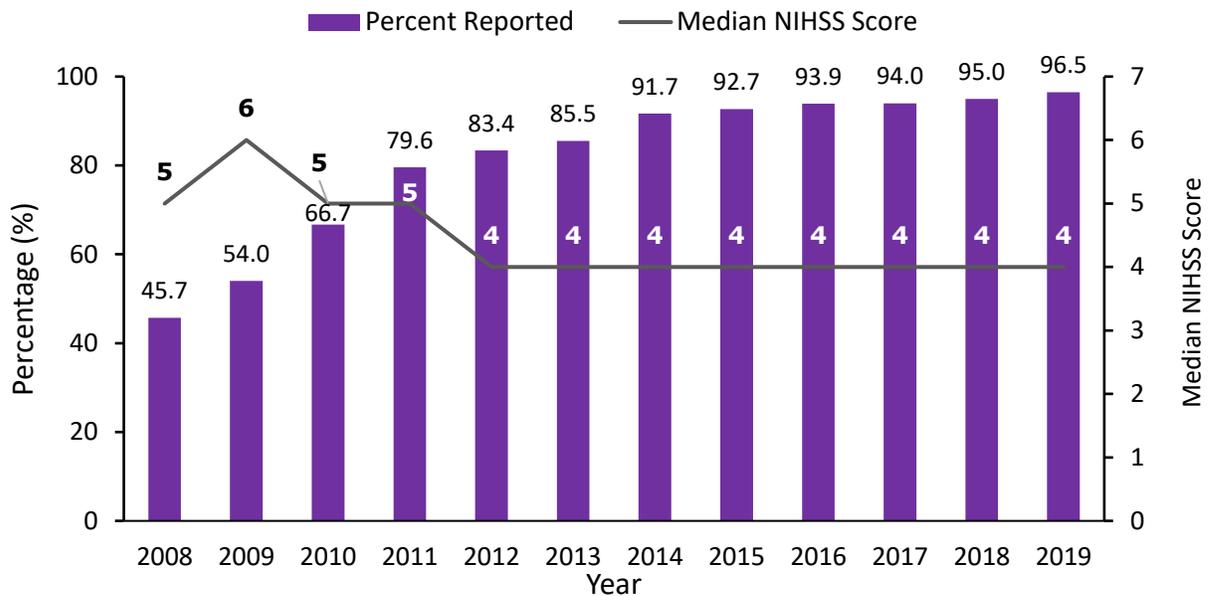


FIGURE 11. ADULT ISCHEMIC AND STROKE NOT OTHERWISE SPECIFIED CASES WITH AN INITIAL NIHSS SCORE, BY YEAR, 2008-2019

TABLE 9. ADULT ISCHEMIC AND STROKE NOT OTHERWISE SPECIFIED CASES WITH AN INITIAL NIHSS SCORE, BY YEAR, 2008-2019

| Year | Ischemic & Stroke NOS cases | NIHSS score reported | | Reporting Hospitals |
|------|-----------------------------|----------------------|-------|---------------------|
| | N=94,379 | n=81,996 | 86.9% | N |
| 2008 | 3,100 | 1,418 | 45.7 | 20 |
| 2009 | 3,816 | 2,062 | 54.0 | 27 |
| 2010 | 5,485 | 3,658 | 66.7 | 33 |
| 2011 | 6,268 | 4,989 | 79.6 | 35 |
| 2012 | 6,703 | 5,587 | 83.4 | 40 |
| 2013 | 7,428 | 6,350 | 85.5 | 42 |
| 2014 | 8,557 | 7,846 | 91.7 | 49 |
| 2015 | 9,998 | 9,268 | 92.7 | 49 |
| 2016 | 10,527 | 9,886 | 93.9 | 50 |
| 2017 | 10,764 | 10,121 | 94.0 | 49 |
| 2018 | 10,811 | 10,268 | 95.0 | 46 |
| 2019 | 10,922 | 10,543 | 96.5 | 46 |

The percentage of eligible cases receiving an initial NIHSS evaluation has more than doubled over time, from 45.7% in 2008 to 96.5% in 2019. For the 5 most recent years (2015-2019), the NIHSS score was reported in over 90% of eligible ischemic stroke and stroke NOS cases. For the last 8 years (2012-2019), the median NIHSS score has remained the same (minor stroke, score 4).

Between 2008 and 2016, the number of participating hospitals reporting on this measure increased from 20 to 50, with a small decline since; a total of 46 hospitals reported on this measure in 2019. Opportunities exist for improving the standardization of NIHSS use and score reporting across all hospital systems.

TIME TO INITIAL BRAIN IMAGING

Brain imaging, or computerized tomography (CT) scan, is used to identify the type and acuity of a stroke, and to locate the blockage or clot. (4) A timely initial CT scan is vital to providing effective treatment for a stroke patient. A CT scan should be performed within 25 minutes of hospital arrival and interpreted within 45 minutes of arrival. (5)

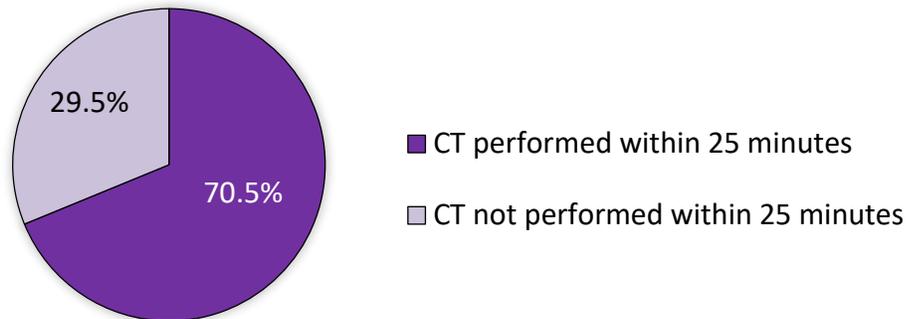


FIGURE 12. ADULT STROKE CASES ARRIVING AT HOSPITAL WITHIN 3 HOURS OF TIME LAST KNOWN WELL, WITH DOOR-TO-CT TIME WITHIN 25 MINUTES OF HOSPITAL ARRIVAL, 2008-2019

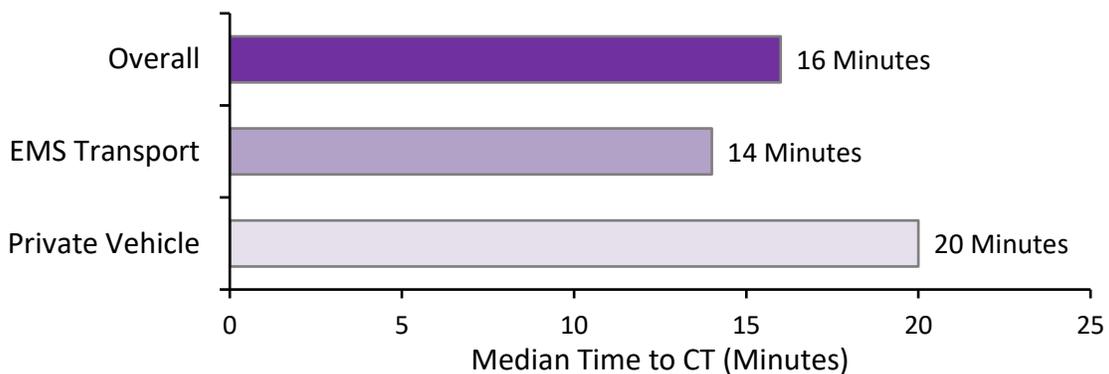


FIGURE 13. MEDIAN DOOR-TO-CT TIMES OF ADULT STROKE CASES ARRIVING AT HOSPITAL WITHIN 3 HOURS OF TIME LAST KNOWN WELL, OVERALL AND BY MODE OF TRANSPORT, 2008-2019

Among eligible stroke cases arriving to the hospital within 3 hours of time LKW (n=25,770), almost seven in 10 cases (69.8%, n=17,978) received an initial CT scan within 25 minutes of hospital arrival (Figure 12). Almost half of eligible cases (49.1%, n=12,658) had an initial CT performed within 15 minutes of hospital arrival. Overall, the median door-to-initial CT time was 16 minutes.

The median door-to-CT imaging time was 14 minutes for patients arriving by EMS and 20 minutes for those arriving by private vehicle (Figure 13). Door-to-CT imaging performed within 25 minutes varied by arrival method: 74.6% of patients who arrived by EMS vs. 62.0% who arrived by private vehicle.

Door-to-CT Imaging ≤ 25 Minutes

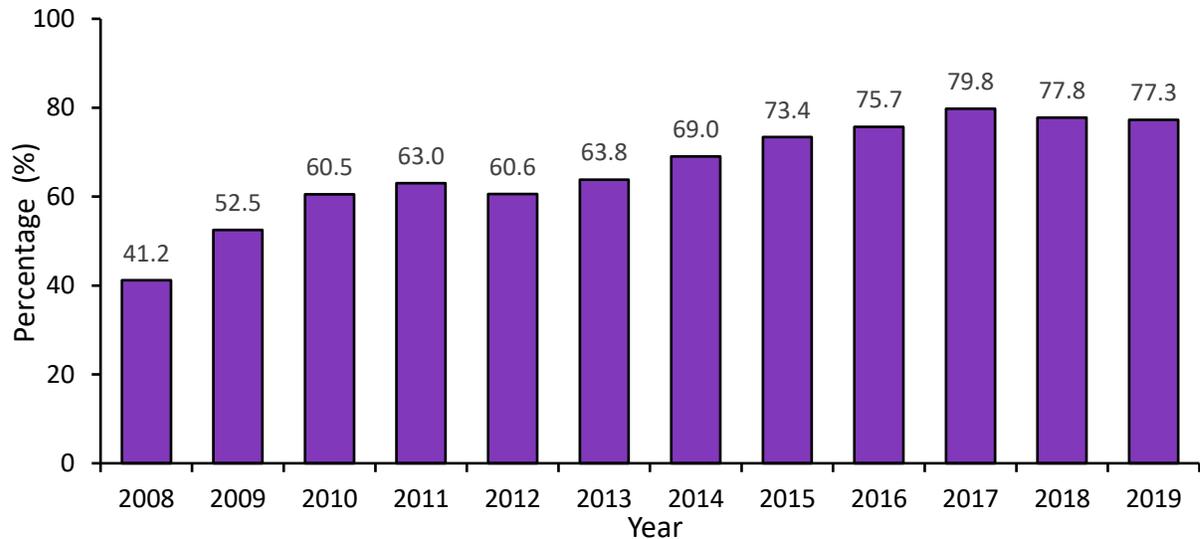


FIGURE 14. ADULT STROKE CASES ARRIVING WITHIN 3 HOURS OF TIME LAST KNOWN WELL AND HAVING AN INITIAL CT SCAN WITHIN 25 MINUTES OF HOSPITAL ARRIVAL, 2008-2019

TABLE 10. ADULT STROKE CASES ARRIVING WITHIN 3 HOURS OF TIME LAST KNOWN WELL AND HAVING AN INITIAL CT SCAN WITHIN 25 MINUTES OF HOSPITAL ARRIVAL, 2008-2019

| Year | Stroke cases N=22,570 | CT scan ≤ 25 minutes of hospital arrival | | Reporting Hospitals N |
|------|--------------------------|---|-------|--------------------------|
| | | n=17,978 | 69.8% | |
| 2008 | 881 | 363 | 41.2 | 17 |
| 2009 | 1,203 | 632 | 52.5 | 25 |
| 2010 | 1,621 | 981 | 60.5 | 33 |
| 2011 | 1,748 | 1,102 | 63.0 | 34 |
| 2012 | 1,870 | 1,133 | 60.6 | 39 |
| 2013 | 1,999 | 1,275 | 63.8 | 43 |
| 2014 | 2,041 | 1,409 | 69.0 | 47 |
| 2015 | 2,617 | 1,922 | 73.4 | 49 |
| 2016 | 2,824 | 2,139 | 75.7 | 50 |
| 2017 | 3,061 | 2,444 | 79.8 | 49 |
| 2018 | 2,991 | 2,327 | 77.8 | 46 |
| 2019 | 2,914 | 2,251 | 77.3 | 46 |

The percentage of eligible cases who arrived to the hospital within 3 hours of time LKW and had an initial CT scan performed within 25 minutes of arrival ranged from a low of 40.8% in 2008 to a high of 77.8% in 2018.

- In 2019, almost eight in 10 cases (77.3%) received their initial CT scan within 25 minutes of hospital arrival. The median door-to-CT time was 13 minutes.

Between 2008 and 2015, the number of participating hospitals reporting on this measure increased, from 17 in 2008, to 46-50 in 2015-2019.

While there has been improvement in door to CT time, opportunities exist for hospitals to reduce the time from ED arrival to initial brain imaging to promote timely and effective stroke treatment.

TIME TO INTRAVENOUS THROMBOLYTIC THERAPY - 45 MINUTES and 60 MINUTES

Thrombolytic therapy using IV t-PA is the preferred reperfusion strategy for eligible patients with acute ischemic stroke caused by a clot blocking a brain blood vessel. (5) Time to IV t-PA therapy, often referred to as door-to-needle time, is a key measure of hospitals' quality that encompasses multiple elements of the stroke system of care: time of symptom onset; first medical contact; hospital arrival; initial CT scan; and interpretation of CT scan. IV t-PA therapy should be administered within 60 minutes of hospital arrival for eligible acute ischemic stroke patients. (5)

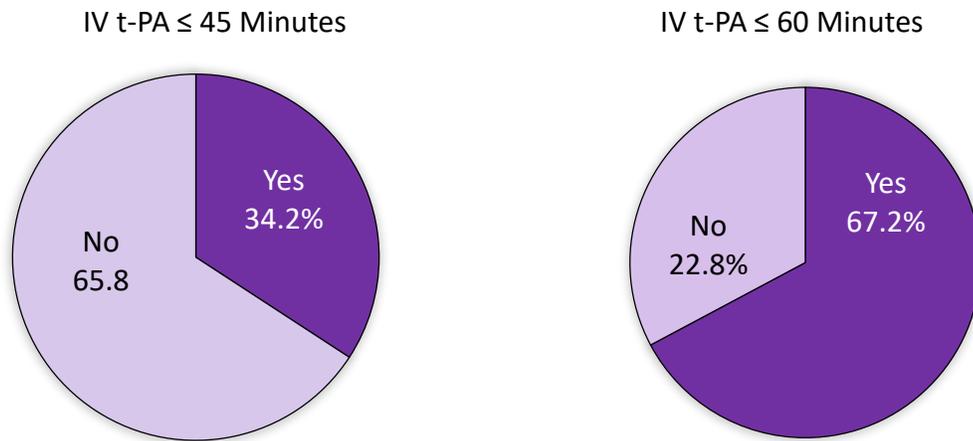


FIGURE 15. ADULT ACUTE ISCHEMIC STROKE CASES WHO RECEIVED IV TPA ≤45 MINUTES OR ≤60 MINUTES OF HOSPITAL ARRIVAL, 2008-2019

Among eligible ischemic stroke cases treated with IV t-PA from 2008-2019, just over one in three, 34.2% (n=2,784), received IV t-PA within 45 minutes of arrival, while over two in three, 67.2% (n=5,464), received it within 60 minutes of hospital arrival. The median door to tPA time was 53 minutes.

More cases arriving to the hospital by EMS had a door-to-tPA time within 45 or 60 minutes (37.0% and 69.7%, respectively), than those arriving by private transport (27.9% and 63.1%, respectively).

IV tPA ≤45 and ≤60 Minutes, by Year

Figure 16 and Table 11 display the percentage of eligible adult ischemic stroke cases who received IV tPA within 45 minutes and within 60 minutes of hospital arrival, by year, from 2008-2019.

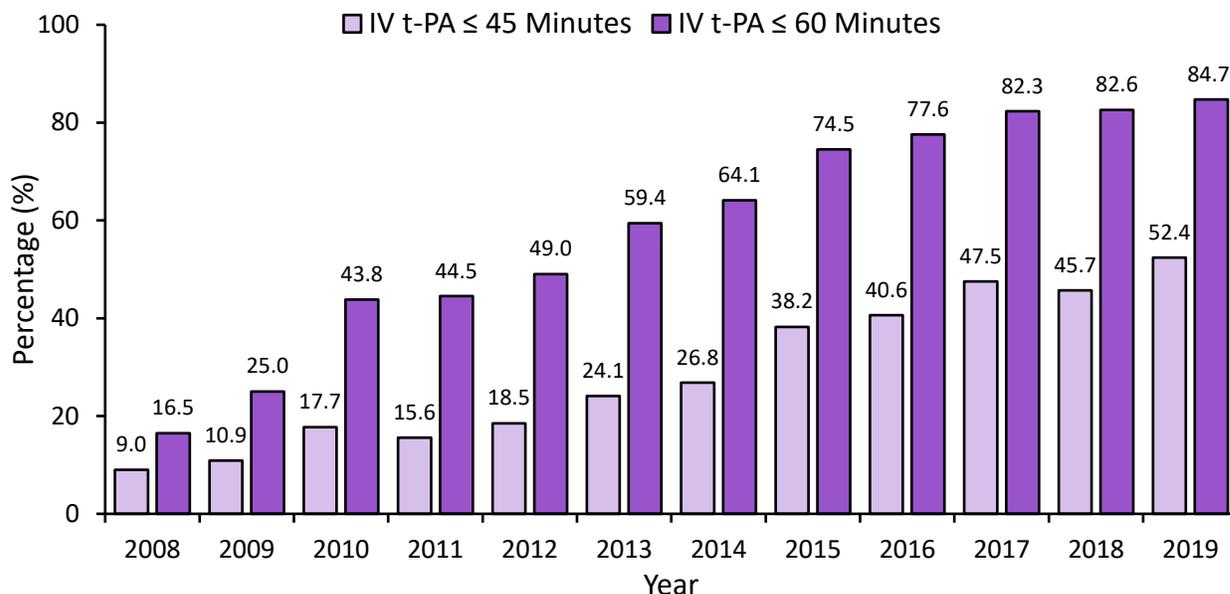


FIGURE 16. TREATMENT WITH IV T-PA WITHIN 45 MINUTES AND WITHIN 60 MINUTES OF HOSPITAL ARRIVAL AMONG ADULT ISCHEMIC STROKE CASES, BY YEAR, 2008-2019

TABLE 11. ADULT ISCHEMIC STROKE CASES TREATED WITH IV T-PA WITHIN 45 MINUTES AND 60 MINUTES OF HOSPITAL ARRIVAL, BY YEAR, 2008-2019

| Adult Ischemic Stroke Cases Treated with IV tPA, 2008-2019 | | | | | | |
|--|---------|----------------|-------|----------------|-------|---------------------|
| | All | IV tPA ≤45 min | | IV tPA ≤60 min | | Reporting Hospitals |
| Year | N=8,135 | n=2,784 | 34.2% | n=5,464 | 67.2% | N |
| 2008 | 133 | 12 | 9.0 | 22 | 16.5 | 12 |
| 2009 | 284 | 31 | 10.9 | 71 | 25.0 | 20 |
| 2010 | 491 | 87 | 17.7 | 215 | 43.8 | 30 |
| 2011 | 623 | 97 | 15.6 | 277 | 44.5 | 33 |
| 2012 | 600 | 111 | 18.5 | 294 | 49.0 | 35 |
| 2013 | 626 | 151 | 24.1 | 372 | 59.4 | 40 |
| 2014 | 710 | 190 | 26.8 | 455 | 64.1 | 44 |
| 2015 | 857 | 327 | 38.2 | 638 | 74.5 | 46 |
| 2016 | 902 | 366 | 40.6 | 700 | 77.6 | 48 |
| 2017 | 992 | 471 | 47.5 | 816 | 82.3 | 48 |
| 2018 | 944 | 431 | 45.7 | 780 | 82.5 | 46 |
| 2019 | 973 | 510 | 52.4 | 824 | 84.7 | 45 |

The percentage of cases treated with IV tPA within 45 minutes and within 60 minutes of hospital arrival has increased annually. IV tPA within 45 minutes ranged from a low of 9.0% (2008) to a high of 52.4% (2019). IV t-PA within 60 minutes of hospital

arrival ranged from a low of 16.5% (2008) to a high of 84.7% (2019). The median door-to-tPA times decreased by half, from 90 minutes in 2008 to 45 minutes in 2019.

For the last 7 years (2013-2019), the median door-to-tPA time has remained less than 60 minutes: 57 minutes in 2013; 55 minutes in 2014; 51 minutes in 2015; 50 minutes in 2016; 47 minutes in 2017 and 2018; and 45 minutes in 2019.

The number of participating hospitals reporting on this measure increased annually, from a low of 12 in 2008 to a high of 46 - 48 in 2015-2019.

A gradual increase in the percentage of ischemic stroke cases receiving IV tPA within 60 minutes was observed over the past few years. However, there is still need for standardization of protocols and implementation of best practices for the care of acute ischemic stroke patients across hospital systems.

IV tPA ARRIVE BY 2 HOURS, TREAT BY 3 HOURS

A critical component when evaluating a stroke patient is identifying the time last known well (LKW), or the time at which a patient was last known to be without signs and symptoms of a stroke. Acute ischemic stroke patients who arrive at the hospital within 2 hours of time LKW should be treated within 3 hours of time LKW. (5)

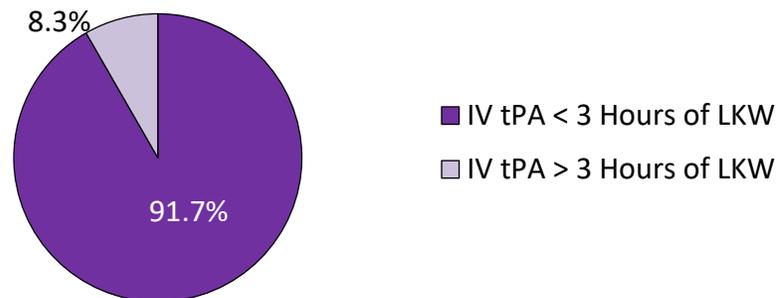


FIGURE 17. ADULT ACUTE ISCHEMIC STROKE CASES TREATED WITHIN 3 HOURS OF TIME LAST KNOWN WELL (LKW), 2008-2019

Among eligible adult ischemic stroke cases who arrived at the hospital within 2 hours of time LKW, almost all (91.7%; n=7,783) received IV tPA within 3 hours of time LKW. Only 8 in 100 cases (8.3%; n=703) received IV tPA outside of this time (Figure 17).

Arrive by 2 Hours, Treat by 3 Hours, by Year

Figure 18 and Table 12 show eligible adult ischemic stroke cases who arrived at the hospital within 2 hours of time LKW and were treated with IV tPA within 3 hours of time LKW, by year.

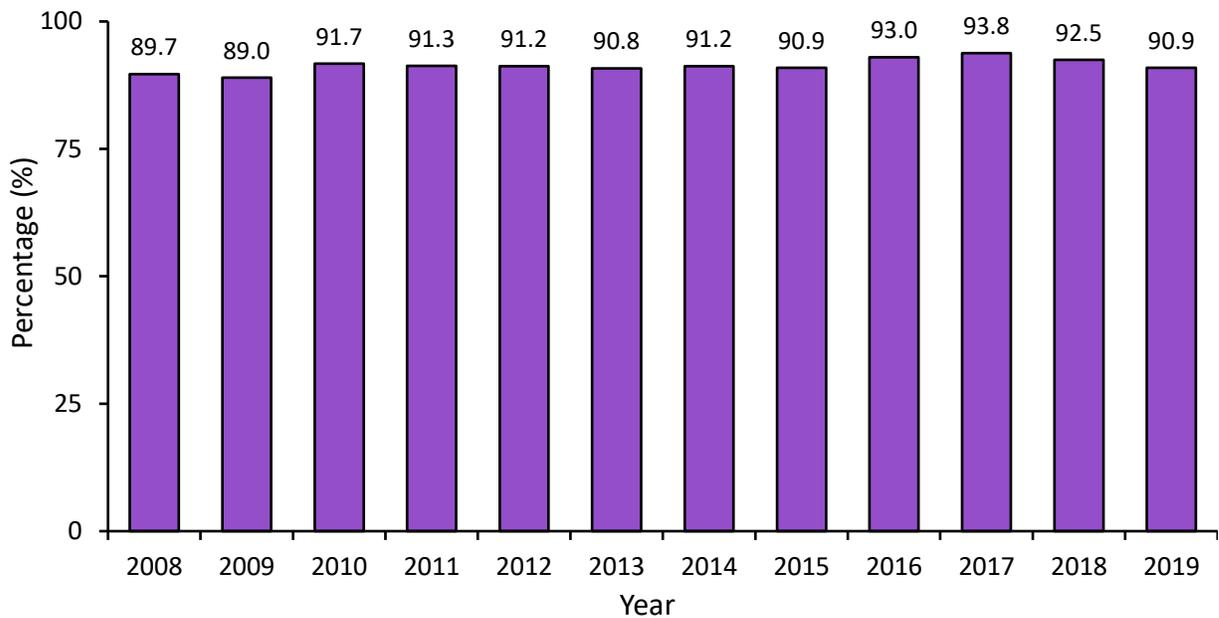


FIGURE 18. ADULT ISCHEMIC STROKE CASES ARRIVING TO THE HOSPITAL WITHIN TWO HOURS OF TIME LAST KNOWN WELL (LKW) AND TREATED WITH IV TPA WITHIN 3 HOURS OF TIME LKW, 2008-2019

TABLE 12. ADULT ISCHEMIC STROKE CASES ARRIVING TO THE HOSPITAL WITHIN TWO HOURS OF TIME LAST KNOWN WELL (LKW) AND TREATED WITH IV TPA WITHIN 3 HOURS OF TIME LKW, 2008-2019

| Adult Ischemic Stroke Cases Arriving at the Hospital within 2 hours of Time Last Known Well and Treated with IV tPA | | | | |
|--|------------|-------------------------|-------|----------------------------|
| | All | IV tPA ≤ 3 hours | | Reporting Hospitals |
| Year | n=8,486 | n=7,783 | 91.7% | N |
| 2008 | 136 | 122 | 89.7 | 13 |
| 2009 | 272 | 242 | 89.0 | 20 |
| 2010 | 467 | 428 | 91.7 | 30 |
| 2011 | 575 | 525 | 91.3 | 33 |
| 2012 | 610 | 556 | 91.2 | 37 |
| 2013 | 682 | 619 | 90.8 | 40 |
| 2014 | 798 | 728 | 91.2 | 46 |
| 2015 | 910 | 827 | 90.9 | 46 |
| 2016 | 958 | 891 | 93.0 | 48 |
| 2017 | 1,036 | 972 | 93.8 | 48 |
| 2018 | 1,027 | 950 | 92.5 | 46 |
| 2019 | 1,015 | 923 | 90.9 | 44 |

Between 2008 and 2019, the percentage of eligible cases who arrived at the hospital within 2 hours of time LKW and were treated with IV tPA within 3 hours of time LKW varied but overall remained high, increasing from 89-90% in 2008-2009 to a high of 93-94% in 2017-2018.

The number of participating hospitals reporting on this measure has increased from 13 in 2008 to 46-48 in 2016-2019.

IV tPA ARRIVE BY 3.5 HOURS, TREAT BY 4.5 HOURS

Eligible ischemic stroke patients who arrive at the hospital within 3.5 hours since time LKW should be treated with IV tPA within 4.5 hours since time LKW. (5)

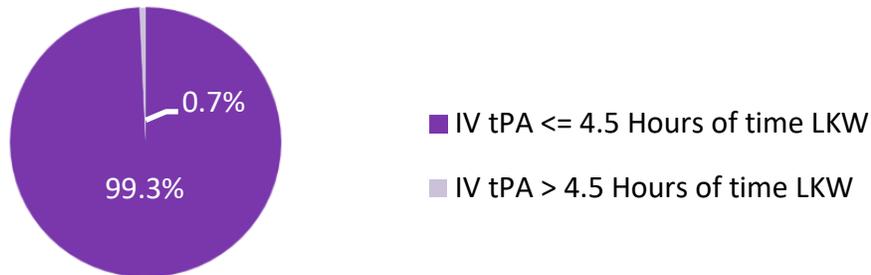


FIGURE 19. ADULT ISCHEMIC STROKE CASES WITH HOSPITAL ARRIVAL WITHIN 3.5 HOURS OF TIME LAST KNOWN WELL (LKW) AND TREATED WITH IV tPA WITHIN 4.5 HOURS OF TIME LKW, 2008-2019

Among the 9,897 eligible adult ischemic stroke cases who arrived at the hospital within 3.5 hours since time LKW, 99.3% (n=9,824) received IV tPA treatment within 4.5 hours since time LKW, while 0.7% (n=73) received IV tPA treatment outside this time window (Figure 19).

Arrive by 3.5 Hours, Treat by 4.5 Hours, by Year

Figure 20 and Table 13 show the adult ischemic stroke cases who arrived at the hospital within 3.5 hours of time LKW and were treated with IV tPA within 4.5 hours of time LKW, by year.

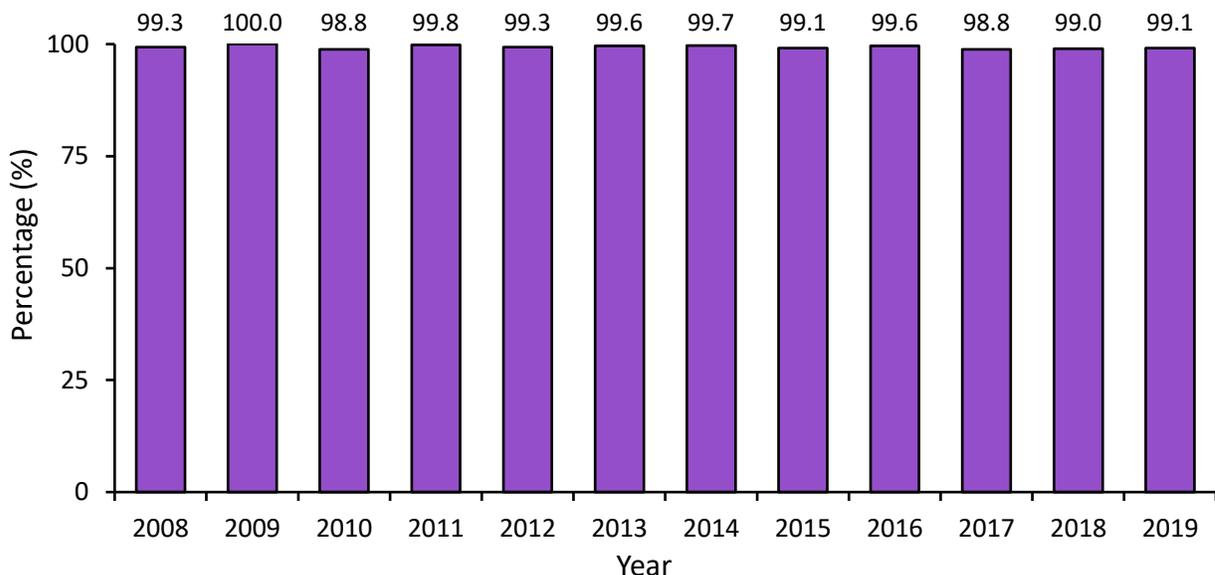


FIGURE 20. ADULT ISCHEMIC STROKE CASES WITH HOSPITAL ARRIVAL WITHIN 3.5 HOURS OF TIME LAST KNOWN WELL (LKW) AND TREATED WITH IV tPA WITHIN 4.5 HOURS OF TIME LKW, 2008-2019

TABLE 13. ADULT ISCHEMIC STROKE CASES WITH HOSPITAL ARRIVAL WITHIN 3.5 HOURS OF TIME LAST KNOWN WELL (LKW) AND TREATED WITH IV tPA WITHIN 4.5 HOURS OF TIME LKW, 2008-2019

| Adult ischemic stroke cases arriving to the hospital ≤3.5 hours since time LKW and treated with IV tPA≤4.5 hours since time LKW | | | | |
|--|------------|--------------------------|-------|----------------------------|
| | All | IV tPA ≤4.5 hours | | Reporting Hospitals |
| Year | N=9,897 | n=9,824 | 99.3% | N |
| 2008 | 140 | 39 | 99.3 | 13 |
| 2009 | 291 | 291 | 100.0 | 20 |
| 2010 | 503 | 497 | 98.8 | 31 |
| 2011 | 619 | 618 | 99.8 | 33 |
| 2012 | 666 | 661 | 99.3 | 37 |
| 2013 | 756 | 753 | 99.6 | 41 |
| 2014 | 895 | 892 | 99.7 | 46 |
| 2015 | 1,051 | 1,041 | 99.1 | 46 |
| 2016 | 1,178 | 1,173 | 99.6 | 48 |
| 2017 | 1,277 | 1,262 | 98.8 | 49 |
| 2018 | 1,252 | 1,239 | 99.0 | 46 |
| 2019 | 1,269 | 1,258 | 99.1 | 45 |

The annual percentage of cases meeting this measure is consistently above 98% (2008-2019). Compared to the previous measure (time to initiation of IV tPA treatment of cases who arrive by 2 hours of time LKW), a greater percentage of cases who arrive within 3.5 hours of time LKW receive IV tPA within one hour of hospital arrival (91.8% vs. 99.3%, respectively).

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased, from 13 in 2008, to 49 in 2017; a total of 45 hospitals reported on this measure in 2019.

Improving the process of care, including decreased arrival to treatment times, can potentially increase the odds of favorable health outcomes among a patient population that is already at an increased risk of poor health outcomes.

DRIP-AND-SHIP THERAPY

Drip-and-ship is a term applied to ischemic stroke patients who receive IV tPA at the ED of a local hospital and are then transferred to a comprehensive stroke facility.

TABLE 14. ADULT DRIP-AND-SHIP ISCHEMIC STROKE CASES, 2008-2019

| | N (%) |
|---|----------------|
| Adult ischemic stroke cases without contraindication for IV tPA | 36,218 (100.0) |
| Adult ischemic stroke cases where IV tPA was initiated at community hospital prior to patient transfer to comprehensive stroke facility | 1,101 (3.0) |

Among the eligible adult ischemic stroke cases without contraindication for IV tPA seen between 2008-2019 (n=36,218), three in 100 (3.0%; n=1,101) had initiation of IV tPA therapy at a community hospital ED and were then transferred to a comprehensive stroke facility (Table 14).

Drip-and-Ship Therapy, by Year

A slight, but consistent, increase in the practice of drip-and-ship therapy is noted over time. In 2008, only 0.2% of eligible cases received IV tPA in the ED of a local hospital prior to being transferred to a stroke center. This increased to 10-12% in less than 8 years, with 4.6% of eligible cases receiving this therapy in 2019.

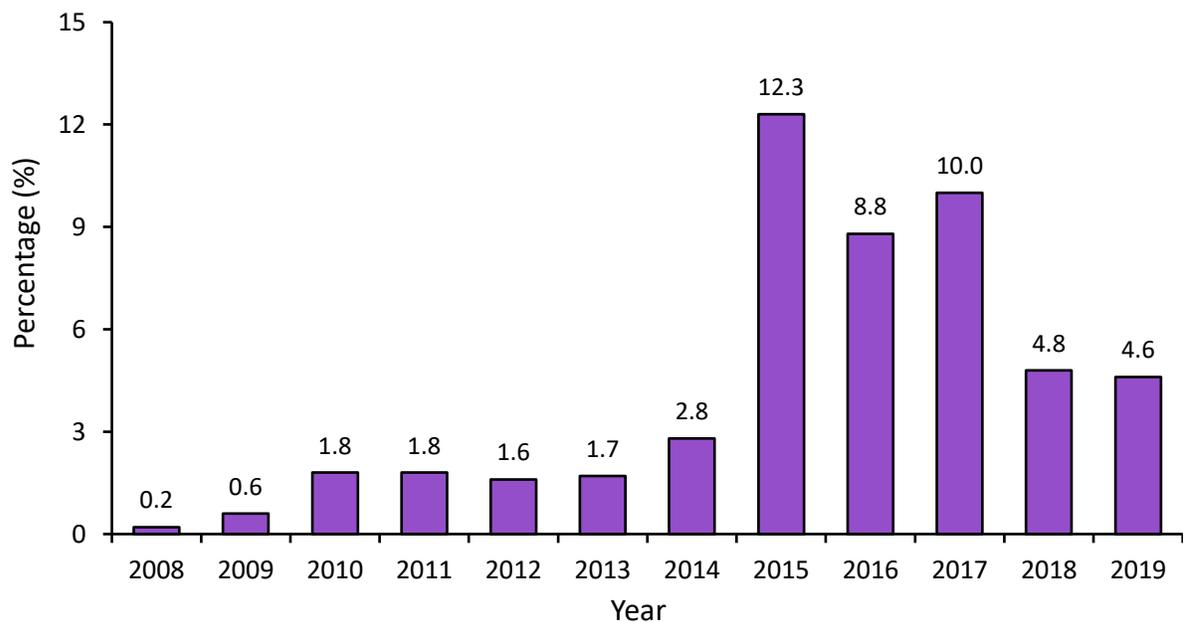


FIGURE 21. PERCENTAGE OF DRIP-AND-SHIP THERAPY AMONG ADULT ISCHEMIC STROKE CASES, 2008-2019

TABLE 15. DRIP-AND-SHIP THERAPY AMONG ADULT ISCHEMIC STROKE CASES, 2008-2019

| Adult Ischemic Stroke Patients without Contraindication for IV tPA | | | | |
|---|--------------|----------------------------|------|----------------------------|
| | Cases | Drip and Ship cases | | Reporting Hospitals |
| Year | N=36,218 | n=1,101 | % | N |
| 2008 | 2,350 | 4 | 0.2 | 20 |
| 2009 | 2,854 | 18 | 0.6 | 27 |
| 2010 | 3,554 | 63 | 1.8 | 33 |
| 2011 | 3,966 | 73 | 1.8 | 36 |
| 2012 | 4,261 | 68 | 1.6 | 40 |
| 2013 | 4,907 | 84 | 1.7 | 42 |
| 2014 | 4,194 | 119 | 2.8 | 48 |
| 2015 | 1,145 | 141 | 12.3 | 49 |
| 2016 | 1,095 | 96 | 8.8 | 50 |
| 2017 | 1,245 | 124 | 10.0 | 49 |
| 2018 | 2,997 | 145 | 4.8 | 46 |
| 2019 | 3,650 | 166 | 4.6 | 44 |

Between 2008 and 2016, the number of participating hospitals reporting on this measure increased annually, from 20 in 2008, to 46-50 in 2014-2018, and 44 in 2019.

Early Antithrombotics

TABLE 16. ADULT ISCHEMIC STROKE AND TIA CASES RECEIVING ANTITHROMBOTIC THERAPY BY THE END OF HOSPITAL DAY TWO, 2008-2019

| | N (%) |
|--|----------------|
| Eligible Adult ischemic stroke and TIA cases | 82,099 (100.0) |
| Adult ischemic stroke and TIA cases received antithrombotic therapy by the end of hospital day two | 79,748 (97.1) |

Among all eligible adult ischemic stroke and TIA cases seen between 2008-2019 (N=82,099), almost all (97.1%; n=79,748) had initiation of antithrombotic therapy by the end of day two stay in the hospital (Table 16).

Early Antithrombotics, by Year

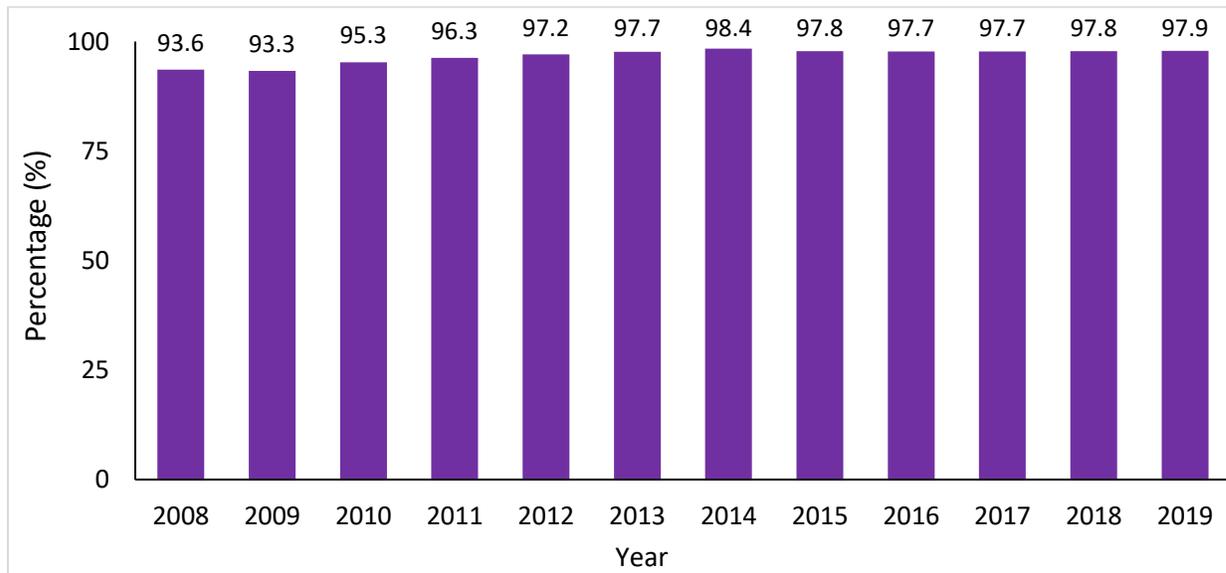


FIGURE 22. PERCENTAGE OF EARLY ANTITHROMBOTIC THERAPY AMONG ADULT ISCHEMIC STROKE AND TIA CASES, 2008-2019

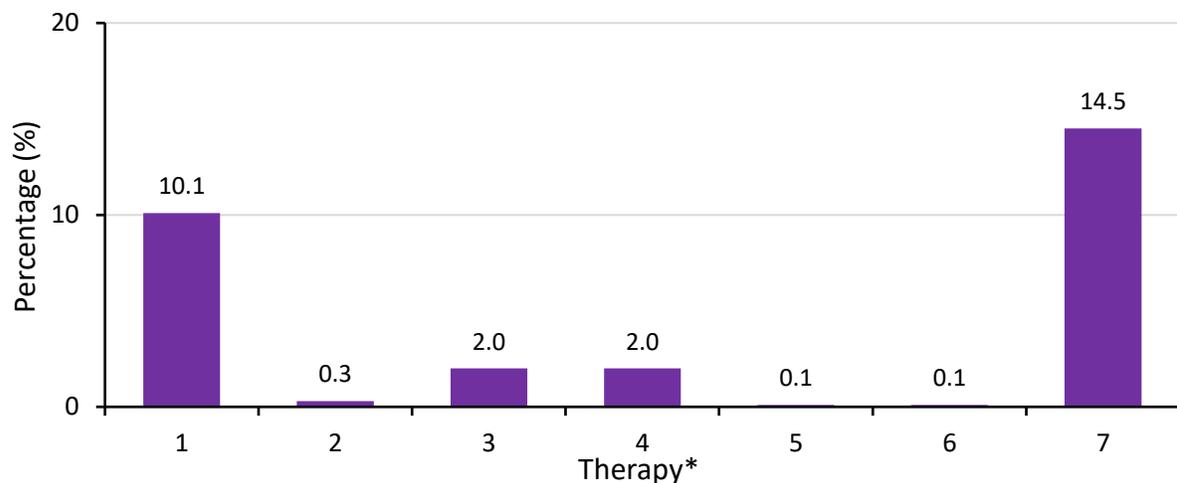
TABLE 17. EARLY ANTITHROMBOTIC THERAPY AMONG ADULT ISCHEMIC STROKE AND TIA CASES, 2008-2019

| Adult Ischemic Stroke and TIA Cases Given Early Antithrombotics | | | | |
|---|-------------------|--------------------------------------|-------|--------------------------|
| Year | Cases N=82,099 | Cases Given Early Antithrombotics | | Reporting Hospitals N |
| | | n=79,748 | 97.1% | |
| 2008 | 3,367 | 3,152 | 93.6 | 20 |
| 2009 | 4,043 | 3,772 | 93.3 | 27 |
| 2010 | 5,075 | 4,835 | 95.3 | 33 |
| 2011 | 5,719 | 5,508 | 96.3 | 35 |
| 2012 | 6,245 | 6,067 | 97.2 | 40 |
| 2013 | 6,923 | 6,762 | 97.7 | 42 |
| 2014 | 7,398 | 7,277 | 98.4 | 49 |
| 2015 | 8,672 | 8,483 | 97.8 | 48 |
| 2016 | 8,707 | 8,507 | 97.7 | 49 |
| 2017 | 8,952 | 8,747 | 97.7 | 49 |
| 2018 | 8,452 | 8,269 | 97.8 | 46 |
| 2019 | 8,546 | 8,360 | 97.9 | 46 |

Over time, the percentage of cases meeting this treatment goal has improved, from 93-94% in 2008-2009 to an average of 98% since 2013.

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased annually, from 20 in 2008, to 46-50 in 2014-2019.

Thrombolytic Therapies



- *Therapy 1: IV alteplase initiated at hospitals for ED patients
- Therapy 2: IV alteplase initiated at hospitals for Inpatients
- Therapy 3: IV alteplase initiated at outside hospitals
- Therapy 4: IA catheter-based treatment at hospitals for ED patients
- Therapy 5: IA catheter-based treatment at hospitals for Inpatients
- Therapy 6: IA catheter-based treatment at outside hospitals
- Therapy 7: Any thrombolytic therapy

FIGURE 23. TYPES OF THROMBOLYTIC THERAPY AMONG ADULT ISCHEMIC STROKE CASES, 2008-2019

Thrombolytic Therapies, by Year

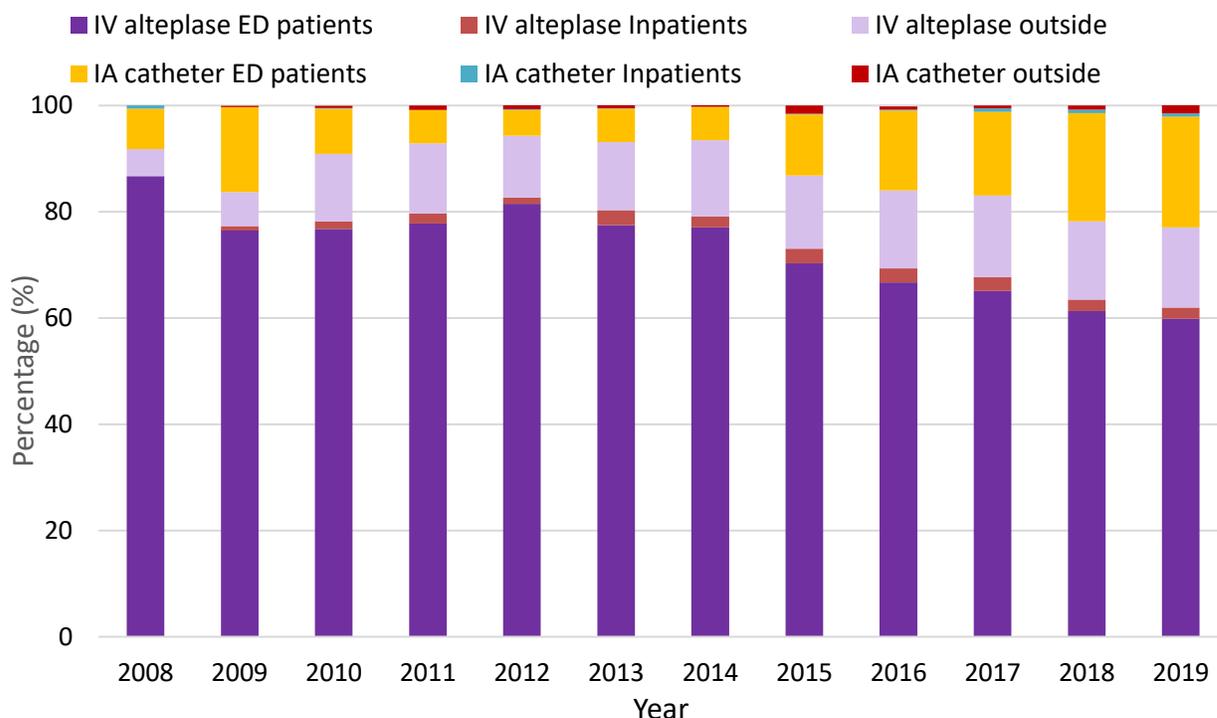


FIGURE 24. TYPES OF THROMBOLYTIC THERAPIES AMONG ADULT ISCHEMIC STROKE CASES WHO RECEIVED ANY THROMBOLYTIC THERAPY, BY YEAR, 2008-2019

TABLE 18. PERCENTAGE OF THROMBOLYTIC THERAPIES AMONG ADULT ISCHEMIC STROKE CASES, 2008-2019

| | Ischemic Stroke Cases | IV alteplase at home hospital | IV alteplase at other hospital | IA catheter at home hospital | IA catheter at other hospital | Reporting hospitals |
|------|-----------------------|-------------------------------|--------------------------------|------------------------------|-------------------------------|---------------------|
| Year | N=99,735 | n=10,049 (10.1%) | n=2,012 (2.0%) | n=1,942 (2.0%) | n=121 (0.1%) | N |
| 2008 | 3,048 | 137 (4.5) | 8 (0.3) | 12 (0.4) | 0 (-) | 20 |
| 2009 | 3,936 | 287 (7.3) | 24 (0.6) | 60 (1.5) | 1 (<0.1) | 27 |
| 2010 | 5,661 | 533 (9.4) | 88 (1.6) | 59 (1.0) | 3 (0.1) | 33 |
| 2011 | 6,375 | 644 (10.1) | 109 (1.7) | 52 (0.8) | 7 (0.1) | 35 |
| 2012 | 7,132 | 704 (9.9) | 100 (1.4) | 42 (0.6) | 7 (0.1) | 40 |
| 2013 | 7,973 | 815 (10.2) | 135 (1.7) | 66 (0.8) | 6 (0.1) | 42 |
| 2014 | 9,043 | 977 (10.8) | 182 (2.0) | 80 (0.9) | 4 (<0.1) | 49 |
| 2015 | 10,744 | 1,118 (10.4) | 219 (2.0) | 183 (1.7) | 25 (0.2) | 49 |
| 2016 | 11,057 | 1,168 (10.6) | 258 (2.3) | 264 (2.4) | 11 (0.1) | 50 |
| 2017 | 11,575 | 1,237 (10.7) | 292 (2.5) | 299 (2.6) | 10 (0.1) | 49 |
| 2018 | 11,464 | 1,195 (10.4) | 287 (2.5) | 397 (3.5) | 15 (0.1) | 46 |
| 2019 | 11,727 | 1,234 (10.5) | 310 (2.6) | 428 (3.7) | 32 (0.3) | 46 |

Of the 99,735 eligible ischemic stroke cases reported from 2008-2019, 14.5% (n=14,487) received some type of thrombolytic therapy. Of those receiving

thrombolytic therapy, the most common type was IV-alteplase, accounting for 85.5% of therapies, while IA catheter-based treatment accounted for the remaining 14.5%. The frequency of IA catheter-based treatment, however, appears to be increasing; in 2008, IA catheter-based treatment accounted for 8.3% of thrombolytic therapies, compared to 22.9% in 2019.

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased, from 20 in 2008 to 46-50 since 2014.

THROMBOLYTIC COMPLICATIONS

Thrombolytic complications occur when patients with a diagnosis of acute ischemic stroke experience bleeding complications after thrombolytic therapy was administered.

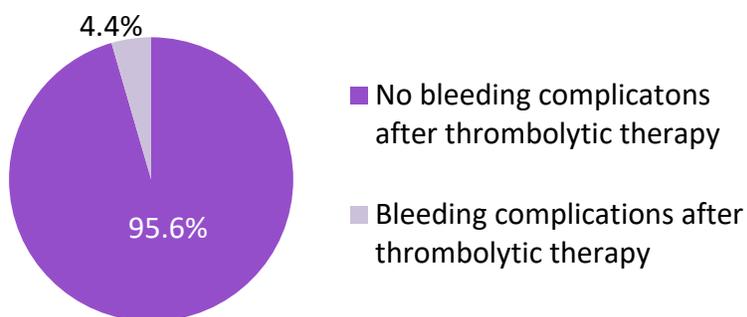


FIGURE 25. ADULT ISCHEMIC STROKE CASES WITH BLEEDING COMPLICATIONS AFTER THROMBOLYTIC THERAPY, 2008-2019

Of the 14,487 ischemic stroke cases seen between 2008-2019 who received thrombolytic treatment, 4.4% (n=636) experienced a serious bleeding complication after IV tPA or IA catheter-based treatment was administered (Figure 25). In 2019, a total of 73 cases (3.5%) experienced a bleeding complication.

Thrombolytic Complications, by Year

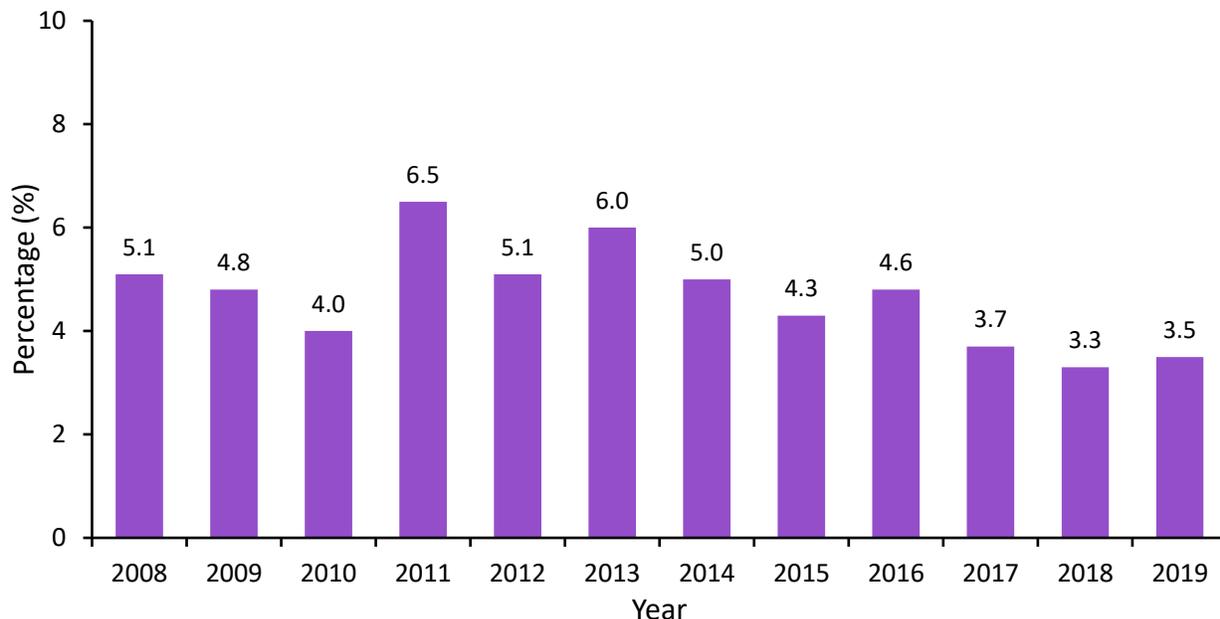


FIGURE 26. ADULT ISCHEMIC STROKE CASES WITH BLEEDING COMPLICATIONS AFTER THROMBOLYTIC THERAPY, BY YEAR, 2008-2019

TABLE 19. ADULT ISCHEMIC STROKE CASES WITH BLEEDING COMPLICATIONS AFTER THROMBOLYTIC THERAPY, BY YEAR, 2008-2019

| Thrombolytic therapy-treated cases | | | | |
|------------------------------------|----------|------------------------|-----|---------------------|
| | Total | Bleeding complications | | Reporting Hospitals |
| Year | n=14,487 | n=636 | % | N |
| 2008 | 158 | 8 | 5.1 | 20 |
| 2009 | 375 | 18 | 4.8 | 27 |
| 2010 | 694 | 28 | 4.0 | 33 |
| 2011 | 828 | 54 | 6.5 | 35 |
| 2012 | 864 | 44 | 5.1 | 40 |
| 2013 | 1,052 | 63 | 6.0 | 42 |
| 2014 | 1,268 | 63 | 5.0 | 49 |
| 2015 | 1,591 | 69 | 4.3 | 49 |
| 2016 | 1,750 | 81 | 4.6 | 50 |
| 2017 | 1,899 | 71 | 3.7 | 49 |
| 2018 | 1,948 | 64 | 3.3 | 46 |
| 2019 | 2,060 | 73 | 3.5 | 46 |

The percentage of eligible adult ischemic stroke cases who experienced bleeding complications post-thrombolytic therapy ranged from a high of 6.5% in 2011 to a low of 3.3% in 2018, with 3.5% of cases experiencing bleeding complications in 2019.

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased, from 20 in 2008 to 46-50 in 2014-2019.

INTENSIVE STATIN THERAPY

Of the 41,821 eligible adult ischemic stroke and TIA cases, two-thirds (68.9%; n=28,830) received a qualifying high-intensity statin prescription upon hospital discharge, while almost one-third (31.1%; n=12,991) did not (Figure 27). This does not include 17,935 cases with a documented contraindication against high-intensity statin therapy.

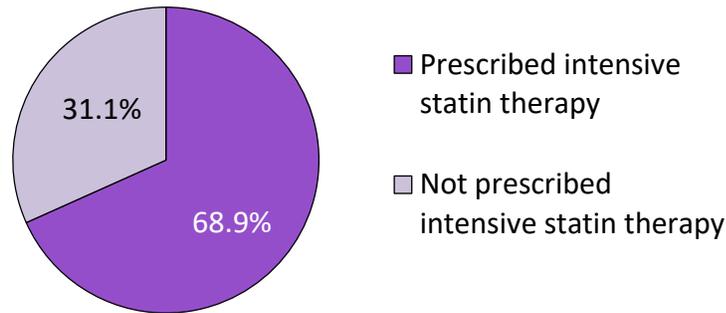


FIGURE 27. INTENSIVE STATIN THERAPY PRESCRIBED UPON HOSPITAL DISCHARGE AMONG ADULT ISCHEMIC STROKE AND TIA CASES, 2008-2019

Intensive Statin Therapy, by Year

Figure 26 and Table 19 display the percentage of eligible adult ischemic stroke and TIA cases who were prescribed a qualifying high-intensity statin upon hospital discharge, by year.

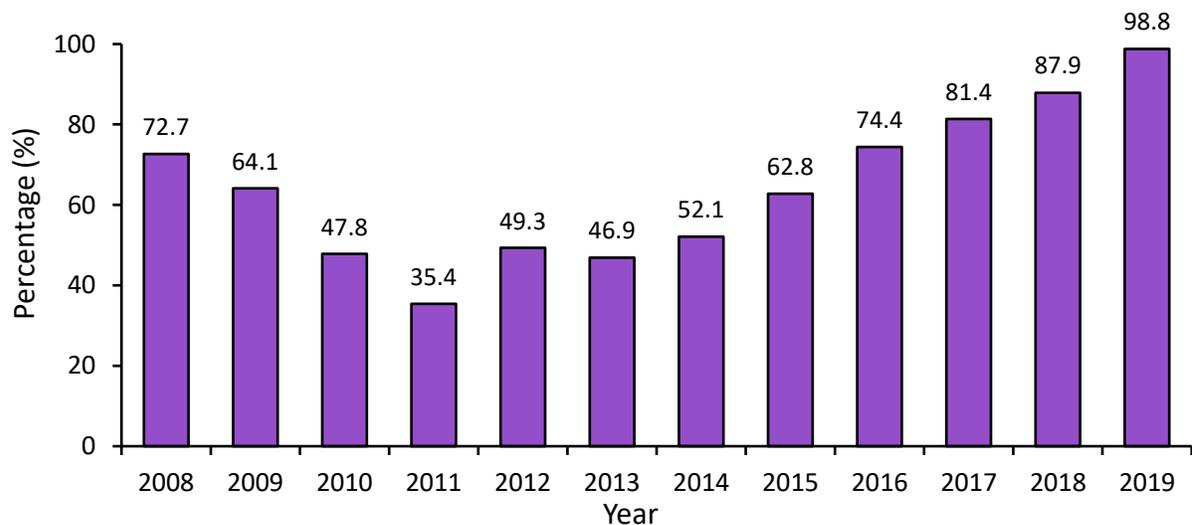


FIGURE 28. PERCENTAGE OF ADULT ISCHEMIC STROKE AND TIA CASES DISCHARGED WITH INTENSIVE STATIN THERAPY, BY YEAR, 2008-2019

TABLE 20. ADULT ISCHEMIC STROKE AND TIA CASES DISCHARGED WITH INTENSIVE STATIN THERAPY, BY YEAR, 2008-2019

| Adult Ischemic Stroke & TIA Cases | | | | |
|-----------------------------------|----------|--|-------|---------------------|
| | Total | Intensive Statin Therapy at Hospital Discharge | | Reporting Hospitals |
| Year | N=41,821 | n=28,830 | 68.9% | N |
| 2008 | 55 | 40 | 72.7 | 18 |
| 2009 | 1,412 | 905 | 64.1 | 27 |
| 2010 | 2,661 | 1,273 | 47.8 | 33 |
| 2011 | 2,298 | 814 | 35.4 | 35 |
| 2012 | 2,228 | 1,099 | 49.3 | 40 |
| 2013 | 3,240 | 1,519 | 46.9 | 43 |
| 2014 | 3,918 | 2,041 | 52.1 | 48 |
| 2015 | 4,865 | 3,054 | 62.8 | 48 |
| 2016 | 5,038 | 3,746 | 74.4 | 49 |
| 2017 | 5,570 | 4,531 | 81.4 | 48 |
| 2018 | 5,493 | 4,828 | 87.9 | 45 |
| 2019 | 5,043 | 4,980 | 98.8 | 45 |

The percentage of eligible ischemic stroke and TIA cases prescribed qualifying high-intensity statin therapy upon hospital discharge has risen steadily over the past 8 years, from 35.4% in 2011 to 98.8% in 2019. Prior to this, the percentage decreased from 72.7% in 2008.

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased, from 18 in 2008 to 45-49 in 2014-2019.

ANTITHROMBOTIC PRESCRIBED AT HOSPITAL DISCHARGE



FIGURE 29. PERCENTAGE OF ADULT STROKE CASES DISCHARGED WITH ANTITHROMBOTIC MEDICATION, 2008-2019

Of the eligible 55,596 ischemic stroke and TIA cases, almost all (98.2%, n=65,398) received prescription antithrombotic therapy upon hospital discharge (Figure 29). This does not include 10,651 cases with a documented contraindication against antithrombotic therapy.

Antithrombotic Prescribed at Discharge, by Year

Figure 30 and Table 21 display the percentage of eligible ischemic stroke and TIA cases who were prescribed antithrombotic medication at hospital discharge, by year.

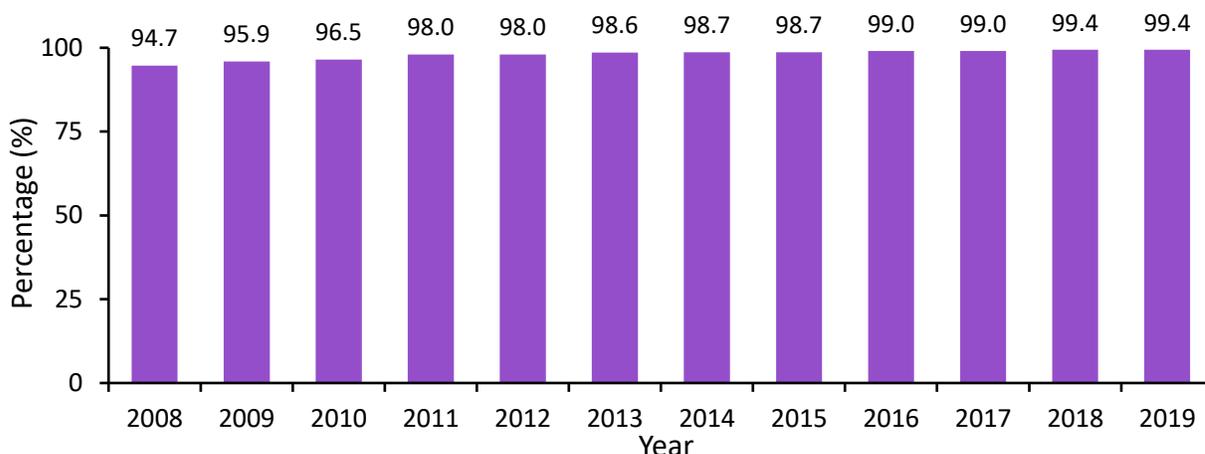


FIGURE 30. PERCENTAGE OF ISCHEMIC STROKE AND TIA CASES DISCHARGED WITH ANTITHROMBOTIC MEDICATION BY YEAR, 2008-2019

TABLE 21. ISCHEMIC STROKE AND TIA CASES DISCHARGED WITH ANTITHROMBOTIC MEDICATION BY YEAR, 2008-2019

| Adult Ischemic Stroke and TIA Cases | | | | |
|--|-----------------|---|----------|----------------------------|
| | Total | Antithrombotic prescribed at discharge | | Reporting Hospitals |
| Year | N=66,596 | n=65,398 | % | N |
| 2008 | 3,596 | 3,407 | 94.7 | 20 |
| 2009 | 4,485 | 4,300 | 95.9 | 27 |
| 2010 | 5,719 | 5,516 | 96.5 | 33 |
| 2011 | 4,711 | 4,615 | 98.0 | 35 |
| 2012 | 4,675 | 4,581 | 98.0 | 40 |
| 2013 | 5,258 | 5,186 | 98.6 | 43 |
| 2014 | 5,422 | 5,353 | 98.7 | 49 |
| 2015 | 6,293 | 6,212 | 98.7 | 48 |
| 2016 | 6,434 | 6,372 | 99.0 | 49 |
| 2017 | 6,860 | 6,793 | 99.0 | 48 |
| 2018 | 6,534 | 6,494 | 99.4 | 45 |
| 2019 | 6,609 | 6,569 | 99.4 | 46 |

The percentage of eligible ischemic stroke and TIA cases discharged with antithrombotic therapy increased slightly, from a low of 94.7% in 2008 to a high of 99.4% in 2018 and 2019.

Between 2008 and 2019, the number of participating hospitals reporting on this measure has increased, from 20 in 2008, to 45-49 in 2014-2019.

ANTI-HYPERTENSIVES PRESCRIBED AT HOSPITAL DISCHARGE

Of the 43,973 eligible ischemic stroke and TIA cases seen between 2008 and 2019, three-fourths (76.4%, n=32,849) had documented high blood pressure (SBP \geq 140 mmHg and/or DBP \geq 90 mmHg). This does not include 8,820 cases with documented contraindications against anti-hypertensive medication therapy.

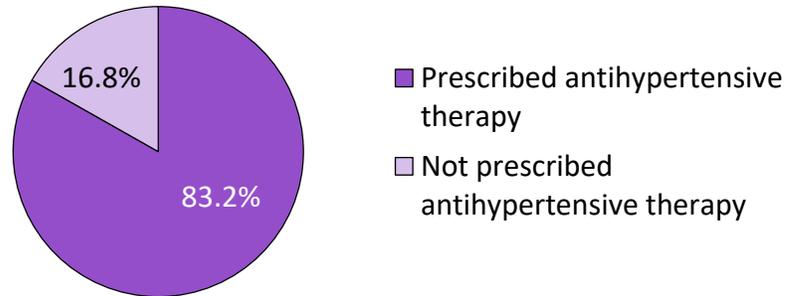


FIGURE 31. PERCENTAGE OF ADULT ISCHEMIC STROKE AND TIA CASES DISCHARGED WITH ANTIHYPERTENSIVE MEDICATION, 2008-2019

Among the eligible cases with high blood pressure, roughly 83 in 100 (83.2%; n=27,342) were prescribed some type of anti-hypertensive medication at hospital discharge.

Types of Anti-Hypertensives Prescribed at Discharge, by Year

Figure 32 displays the different types of anti-hypertensive medications prescribed at time of hospital discharge for eligible adult ischemic stroke and TIA patients, 2019. Percentage total may exceed 100% as patients may be prescribed multiple agents.

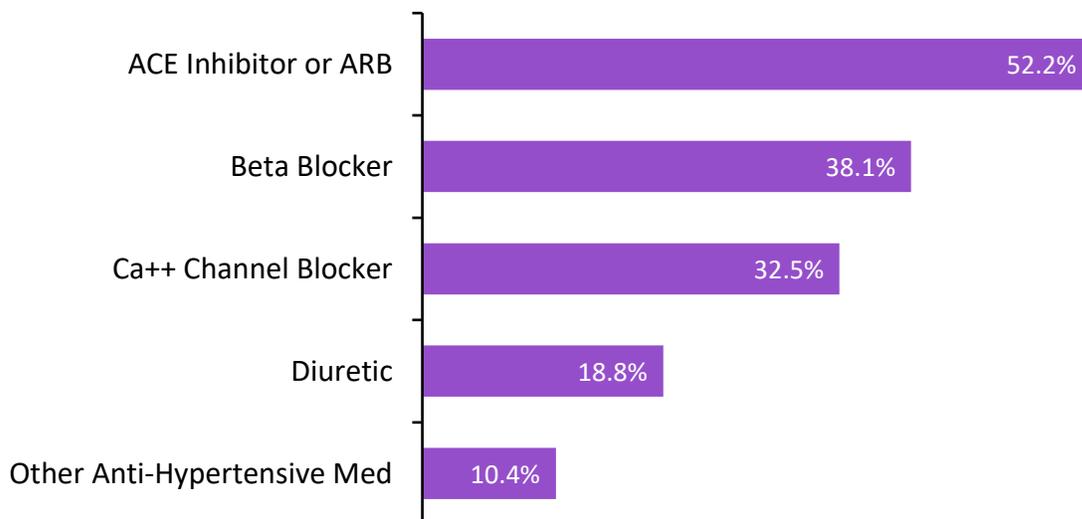


FIGURE 32. TYPES OF ANTIHYPERTENSIVE MEDICATIONS PRESCRIBED AT HOSPITAL DISCHARGE TO ELIGIBLE ADULT ISCHEMIC STROKE AND TIA CASES, 2019

TABLE 22. PERCENTAGE OF ANTIHYPERTENSIVE MEDICATIONS PRESCRIBED FOR ELIGIBLE ISCHEMIC STROKE AND TIA CASES AT DISCHARGE, BY YEAR, 2008-2019

| Adult Ischemic Stroke and TIA Cases Prescribed Anti-Hypertensives at Hospital Discharge | | | | | | | | | | | | |
|--|-------------------|---------------------------|------|-----------------|------|----------------------------|------|----------|------|-------|------|-----------------------------|
| Year | Cases N=27,342 | Type of Anti-Hypertensive | | | | | | | | | | Reporting Hospitals N |
| | | ACE Inhibitor/ ARB | | Beta Blocker | | Ca++ Channel Blocker | | Diuretic | | Other | | |
| | | N | % | N | % | N | % | N | % | N | % | |
| 2008 | 97 | 71 | 73.2 | 44 | 45.4 | 26 | 26.8 | 18 | 18.6 | 6 | 6.2 | 13 |
| 2009 | 2,761 | 1,802 | 65.3 | 1,472 | 53.3 | 790 | 28.6 | 641 | 23.2 | 457 | 16.6 | 27 |
| 2010 | 3,205 | 2,207 | 68.9 | 1,701 | 53.1 | 952 | 29.7 | 634 | 19.8 | 519 | 16.2 | 30 |
| 2011 | 1,865 | 1,355 | 72.7 | 974 | 52.2 | 552 | 29.6 | 353 | 18.9 | 234 | 12.5 | 27 |
| 2012 | 1,584 | 1,106 | 70.7 | 761 | 48.7 | 489 | 31.3 | 374 | 23.9 | 200 | 12.8 | 33 |
| 2013 | 1,735 | 1,214 | 70.0 | 877 | 50.5 | 537 | 31.0 | 435 | 25.1 | 220 | 12.7 | 39 |
| 2014 | 2,053 | 1,453 | 70.8 | 1,018 | 49.6 | 611 | 29.8 | 517 | 25.2 | 250 | 12.2 | 47 |
| 2015 | 2,697 | 1,798 | 66.7 | 1,360 | 50.4 | 970 | 36.0 | 647 | 24.0 | 387 | 14.3 | 46 |
| 2016 | 2,541 | 1,697 | 66.8 | 1,219 | 48.0 | 872 | 34.3 | 588 | 23.1 | 292 | 11.5 | 46 |
| 2017 | 3,102 | 2,046 | 66.0 | 1,520 | 49.0 | 1,165 | 37.6 | 788 | 25.4 | 336 | 10.8 | 46 |
| 2018 | 2,860 | 1,887 | 66.0 | 1,369 | 47.9 | 1,127 | 39.4 | 714 | 25.0 | 285 | 10.0 | 41 |
| 2019 | 2,842 | 1,821 | 64.1 | 1,329 | 46.8 | 1,134 | 39.9 | 655 | 23.0 | 363 | 12.8 | 41 |

The pattern of anti-hypertensive medications prescribed each year (2008-2019) remained similar: each year, ACE Inhibitors / ARBs were the most commonly prescribed, followed by Beta Blockers, then by Ca++ Channel Blockers. Note: Patients could be prescribed more than one type of medication.

From 2008 to 2019, the number of participating hospitals reporting on this measure increased, from 13 in 2008, to 46-47 in 2014-2017. For 2018 and 2019, the number fell to 41. The number of hospitals reporting on this measure could be improved upon.

REHABILITATION CONSIDERED

Both stroke severity and timely treatment of the stroke affect health outcomes and patient recovery, including the stroke survivor’s functionality in terms of speech, language, and physical ability. (5) In order to achieve the best results, physicians should assess all stroke patients for rehabilitative services. (7)

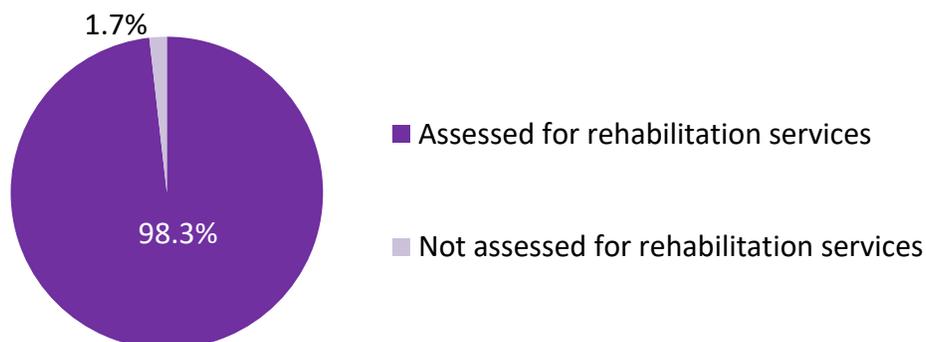


FIGURE 33. ADULT STROKE CASES ASSESSED FOR REHABILITATIVE SERVICES PRIOR TO DISCHARGE, 2008-2019

From 2008-2019, almost all ischemic, hemorrhagic, and stroke NOS cases (98.3%, n=97,602) were assessed for rehabilitative services, while 1.7% (n=1,674) were not considered for rehabilitative services (Figure 33).

Rehabilitation Considered, by Year

Figure 34 and Table 23 display the percentage of stroke cases who were assessed for rehabilitative services prior to hospital discharge, by year.

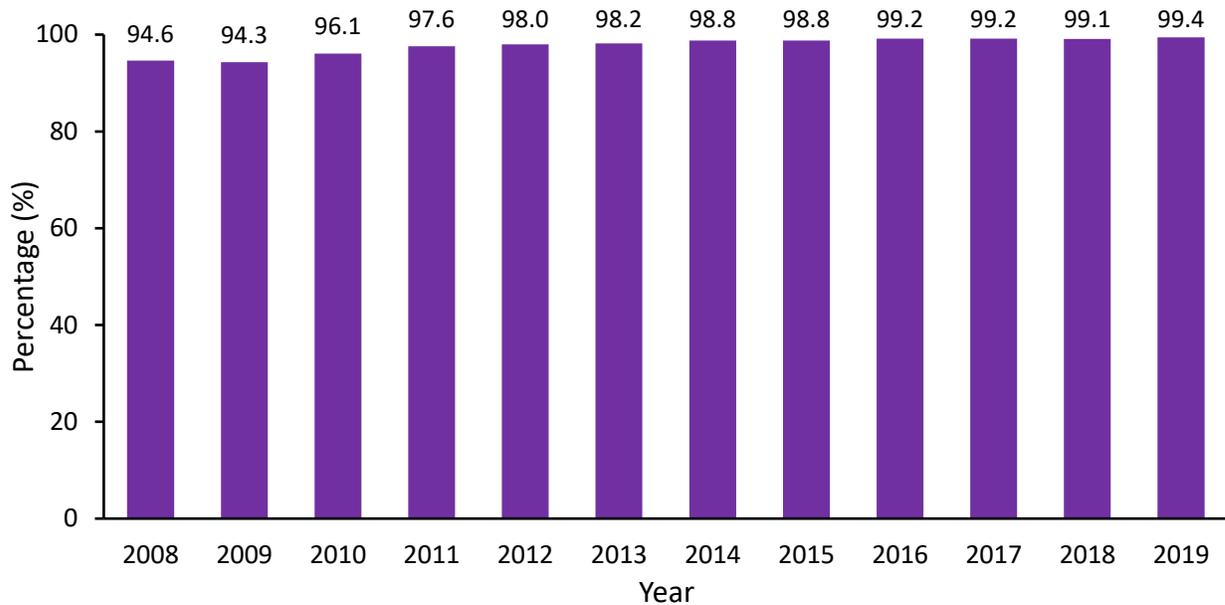


FIGURE 34. ADULT STROKE CASES ASSESSED FOR REHABILITATIVE SERVICES PRIOR TO DISCHARGE, BY YEAR, 2008-2019

TABLE 23. ADULT STROKE AND TIA CASES ASSESSED FOR REHABILITATIVE SERVICES PRIOR TO DISCHARGE, BY YEAR, 2008-2019

| Year | Cases | Assessed for rehabilitation | | Reporting Hospitals |
|------|----------|-----------------------------|-------|---------------------|
| | N=99,276 | n=97,602 | 98.3% | N |
| 2008 | 3,189 | 3,024 | 94.6 | 21 |
| 2009 | 4,252 | 4,017 | 94.3 | 27 |
| 2010 | 5,884 | 5,659 | 96.1 | 33 |
| 2011 | 6,469 | 6,338 | 97.6 | 34 |
| 2012 | 6,927 | 6,791 | 98.0 | 40 |
| 2013 | 7,744 | 7,604 | 98.2 | 43 |
| 2014 | 8,982 | 8,874 | 98.8 | 49 |
| 2015 | 10,582 | 10,456 | 98.8 | 49 |
| 2016 | 10,948 | 10,859 | 99.2 | 50 |
| 2017 | 11,438 | 11,350 | 99.2 | 49 |
| 2018 | 11,405 | 11,301 | 99.1 | 46 |
| 2019 | 11,455 | 11,380 | 99.4 | 46 |

The percentage of eligible stroke cases assessed for rehabilitative services ranged from a low of 94.3% in 2009 to a high of 99.4% in 2019.

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased, from 21 in 2008 to 46-50 in 2014-2019.

STROKE EDUCATION

In order for stroke survivors and their caregivers to be actively involved in decision making and management of the subsequent long-term effects of stroke, appropriate information delivered in a timely and effective format is necessary. (8) Education and/or educational materials must address the following: 1) activation of emergency medical system; 2) need for follow-up after hospital discharge; 3) medications prescribed; 4) personal risk factors for stroke; and 5) warning signs of stroke.

From 2008-2019, 84 of every 100 eligible stroke or TIA cases and/or their care givers (84.0%; n=95,393) received stroke educational materials prior to hospital discharge that addressed all five of these requirements (Figure 35).

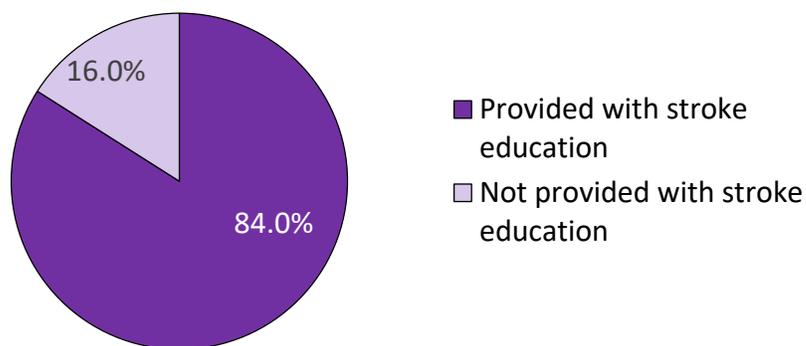


FIGURE 35. ADULT STROKE CASES AND CAREGIVERS PROVIDED WITH STROKE EDUCATION/MATERIALS, 2008-2018

Stroke Education, by Year

Figure 36 and Table 24 display the percentage of adult stroke patients and their caregivers who were provided with all five elements of stroke education and/or educational materials during the hospital stay, by year.

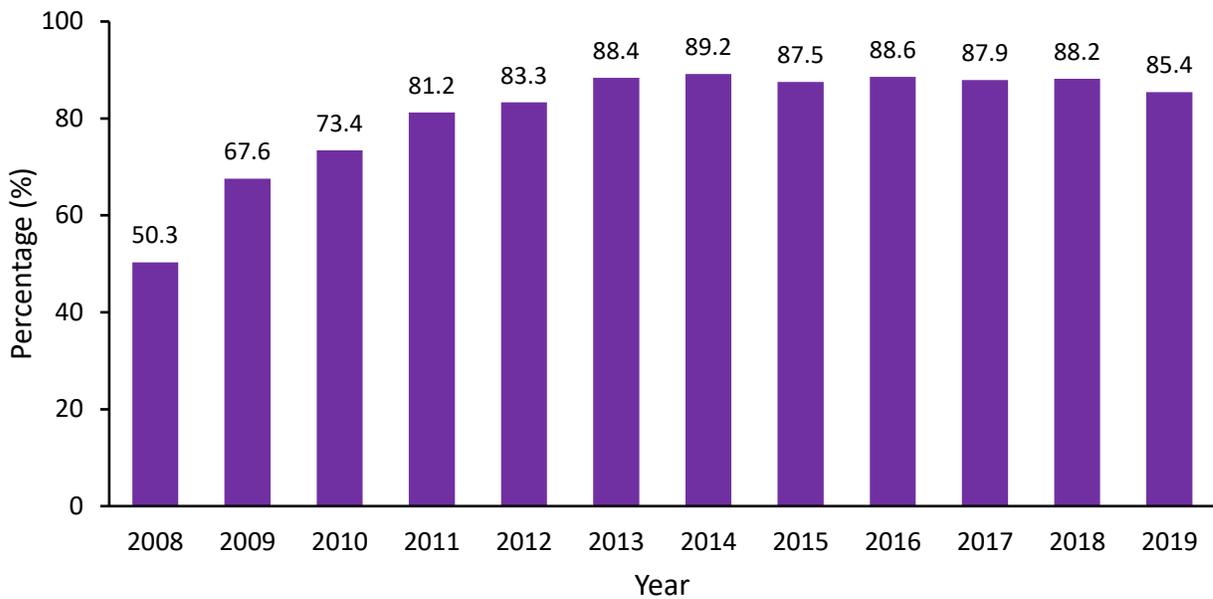


FIGURE 36. ADULT STROKE CASES AND CAREGIVERS PROVIDED WITH STROKE EDUCATION/MATERIAL DURING HOSPITAL STAY, BY YEAR, 2008-2019

TABLE 24. ADULT STROKE CASES AND CAREGIVERS PROVIDED WITH STROKE EDUCATION/MATERIAL DURING HOSPITAL STAY BY YEAR, 2008-2019

| Year | Cases | Stroke Education | | Reporting Hospitals |
|------|-----------|------------------|-------|---------------------|
| | N=113,611 | n=95,393 | 84.0% | N |
| 2008 | 4,104 | 2,065 | 50.3 | 21 |
| 2009 | 5,344 | 3,610 | 67.6 | 27 |
| 2010 | 6,822 | 5,010 | 73.4 | 33 |
| 2011 | 7,707 | 6,255 | 81.2 | 35 |
| 2012 | 8,333 | 6,939 | 83.3 | 40 |
| 2013 | 9,364 | 8,280 | 88.4 | 44 |
| 2014 | 10,201 | 9,201 | 90.2 | 49 |
| 2015 | 11,952 | 10,456 | 87.5 | 49 |
| 2016 | 12,289 | 10,891 | 88.6 | 50 |
| 2017 | 12,831 | 11,279 | 87.9 | 49 |
| 2018 | 12,347 | 10,894 | 88.2 | 46 |
| 2019 | 12,317 | 10,513 | 85.4 | 46 |

The percentage of stroke education provided increased rapidly for the first 7 reporting years, from 50.3% in 2008 to a high of 90.2% in 2014. Since then, it has varied slightly with a decreasing trend. In 2019, 85.4% of eligible patients / caregivers received all elements of stroke education prior to hospital discharge.

Between 2008 and 2019, the number of participating hospitals reporting on this measure increased annually, from 21 in 2008 to 46-50 in 2014-2019.

MODIFIED RANKIN SCALE AT DISCHARGE

The Modified Rankin Scale (mRS) is used to assess how severely a stroke has impacted the patients' ability to conduct daily activities of life. This measure became available in 2011. Out of 88,336 eligible stroke cases seen between 2011 and 2019, data on this measure were missing for n=16,801 (19.0%).

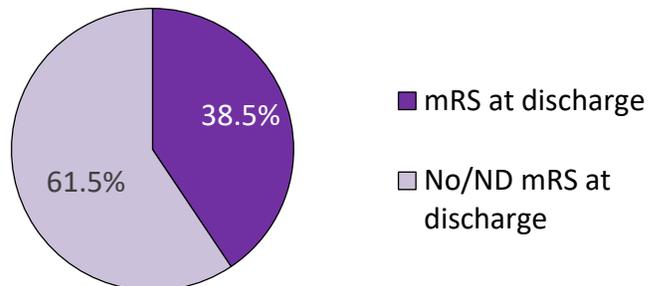


FIGURE 37. MODIFIED RANKIN SCALE PERFORMED AT HOSPITAL DISCHARGE, 2011-2018

Of the eligible adult ischemic, hemorrhagic, and stroke NOS cases seen from 2011-2019 with data on this measure (n=71,535), 39 out of 100 (38.5%; n=27,546) had an mRS at time of hospital discharge while more than half (61.5%; n=43,989) did not (Figure 37).

Modified Rankin Scale (mRS), by Year

Figure 38 and Table 25 display the percentage of eligible adult stroke cases with an mRS at hospital discharge, per year. Of the 27,654 eligible adult stroke cases who had mRS scores at hospital discharge, the median mRS score was 3, indicating slight disability.

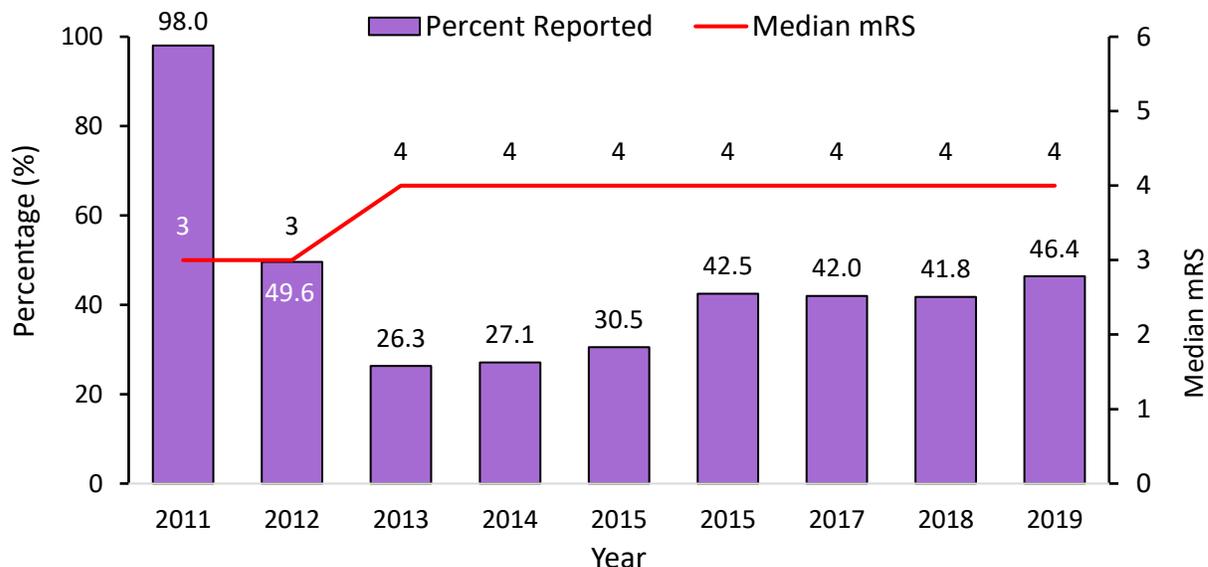


FIGURE 38. ADULT STROKE CASES WITH A MODIFIED RANKIN SCALE (MRS) SCORE AT HOSPITAL DISCHARGE, AND MEDIAN MRS SCORE, BY YEAR, 2011-2019

TABLE 25. ADULT STROKE CASES WITH A MODIFIED RANKIN SCALE (MRS) AT HOSPITAL DISCHARGE, AND MEDIAN MRS SCORE, BY YEAR, 2011-2019

| Adult Ischemic and Hemorrhagic Stroke Cases | | | | | |
|---|------------|------------------|-------|-----------|---------------------|
| | Cases | mRS at discharge | | mRS score | Reporting Hospitals |
| Year | N = 71,535 | n = 27,546 | 38.5% | Median | N |
| 2011 | 147 | 144 | 98.0 | 3 | 35 |
| 2012 | 3,761 | 1,872 | 49.8 | 3 | 40 |
| 2013 | 6,512 | 1,711 | 26.3 | 4 | 43 |
| 2014 | 7,985 | 2,153 | 27.0 | 4 | 49 |
| 2015 | 9,711 | 2,951 | 30.4 | 4 | 49 |
| 2016 | 11,374 | 4,430 | 42.4 | 4 | 50 |
| 2017 | 10,446 | 4,611 | 41.9 | 4 | 49 |
| 2018 | 10,905 | 4,550 | 41.7 | 4 | 46 |
| 2019 | 11,069 | 5,124 | 46.3 | 4 | 46 |

The percentage of adult ischemic, hemorrhagic, and stroke NOS cases with an mRS score at discharge varied annually, from a low of 26.3% in 2013 to a high of 46.3% in 2019. Note: Results for 2011 should be interpreted with caution; while 98.0% of eligible cases had an mRS at discharge in 2011, the measure was missing for 97.9% of eligible cases seen in this reporting year.

Between 2011 and 2019, the number of participating hospitals reporting on this measure increased from 35 in 2011 to 46-50 since 2014.

DISCHARGE DISPOSITION

The discharge disposition, or the plan for care of the stroke patient after discharge from the hospital, can provide an indication of the severity and extent of disability of a stroke patient. Of the eligible 123,224 cases seen from April 1, 2011 through December 2019, data on this measure were missing for 2,435 (2.0%) cases, and not documented for 34 cases (<0.1%).

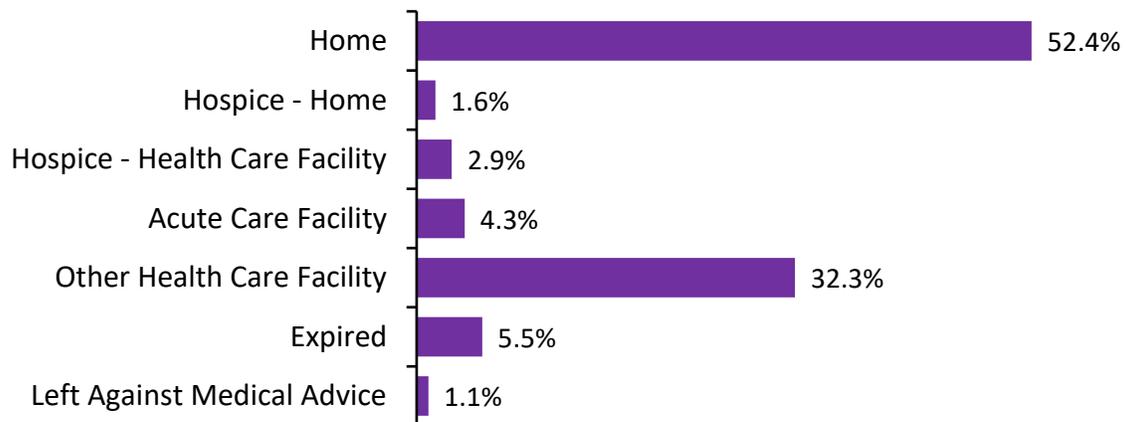


FIGURE 39A. DISCHARGE DISPOSITION OF ADULT STROKE CASES DISCHARGED ON OR AFTER APRIL 1, 2011 THROUGH DECEMBER 2019

Among stroke cases discharged on or after April 1, 2011 with data on this measure, more than half (n=63,290; 52.4%) were discharged to home. Another one third (n=38,994; 32.3%) were discharged to other health care facilities (Figure 39A). Of those discharged to other health care facilities, data on type of facility were missing for 1,314 cases (3.4%).

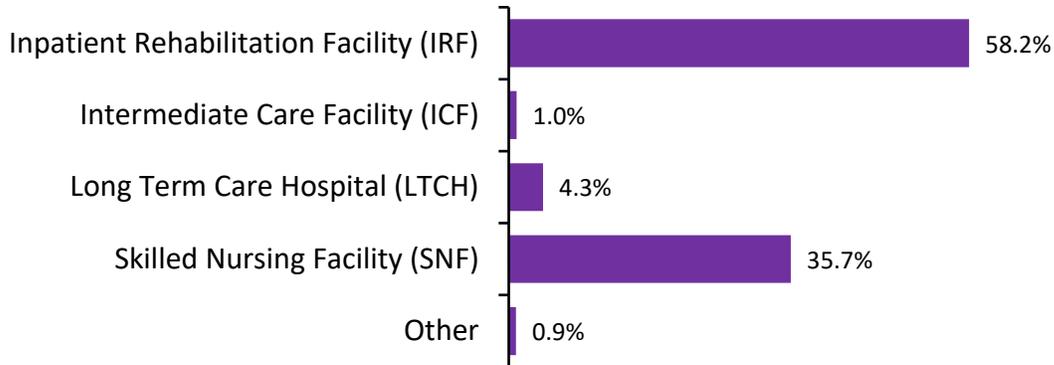


FIGURE 39B. DISCHARGE DISPOSITION AMONG ADULT STROKE CASES DISCHARGED TO OTHER HEALTHCARE FACILITIES, APRIL 2011 THROUGH DECEMBER 2019

Of the 37,680 adult cases discharged to other healthcare facilities, 58 in 100 (n=21,914; 58.2%) were discharged to an inpatient rehabilitation facility (IRF), and one-third (n=13,442; 35.7%) to a skilled nursing facility (SNF) (Figure 39B).

Discharge Disposition, by Year

Figures 40 and 41, below, display the discharge dispositions and types of healthcare facilities to which stroke patients were discharged, by year.

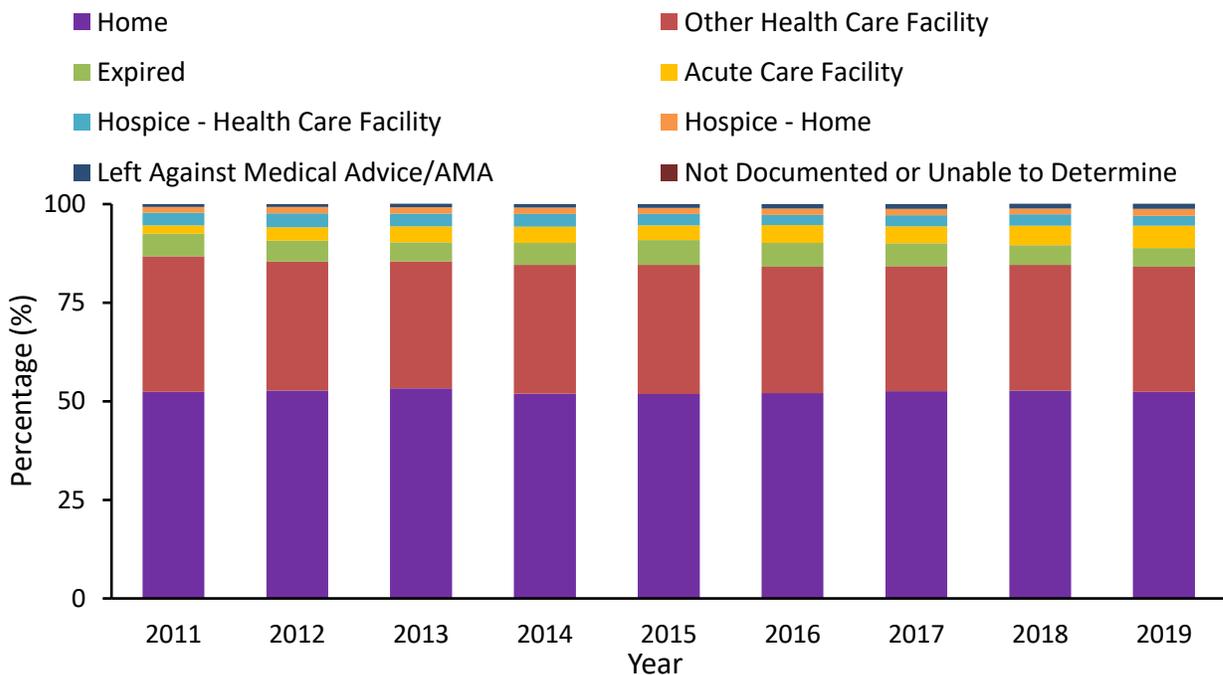


FIGURE 40. DISCHARGE DISPOSITION OF ADULT STROKE CASES, BY YEAR, 2011-2019

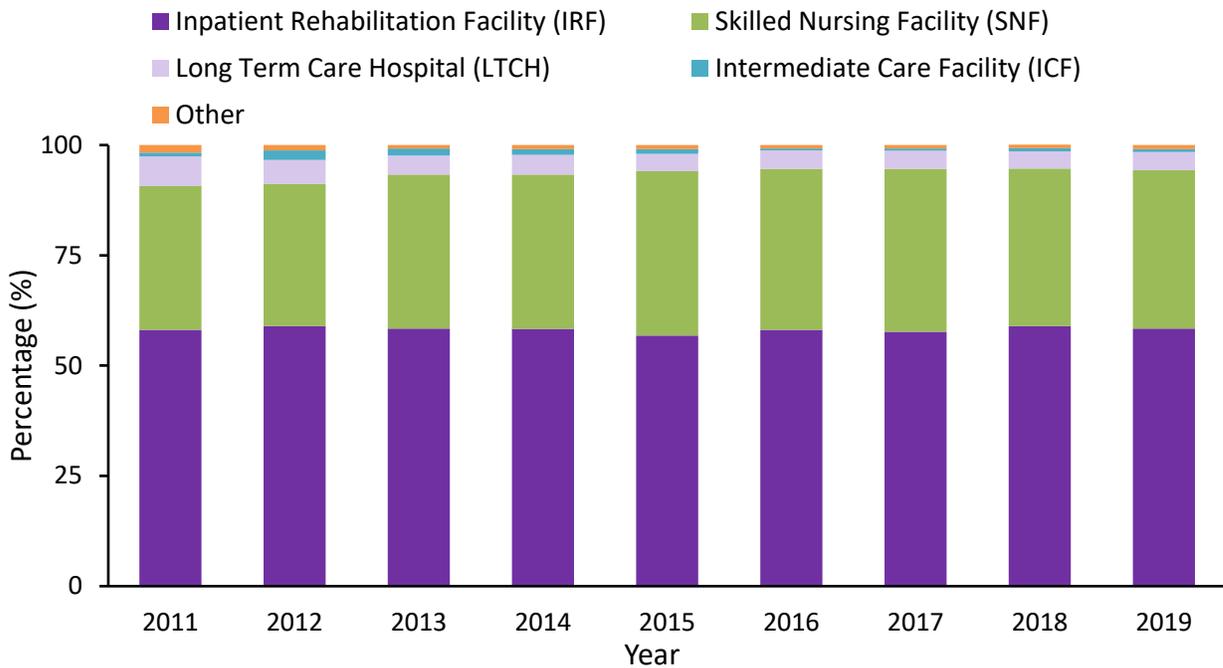


FIGURE 41. DISCHARGE DISPOSITION AMONG STROKE CASES DISCHARGED TO OTHER HEALTHCARE FACILITIES, BY YEAR, 2011-2019

Discharge disposition has remained stable since April 2011, with half of eligible cases discharged to home. Similarly, for those discharged to other healthcare facilities, more than half were discharged to an inpatient rehabilitation facility.

Between 2011 and 2019, the number of participating hospitals reporting on this measure increased annually, from 35 to 50 participating hospitals. In 2019, all 46 participating hospitals reported on this measure.

Opportunities may exist in determining if an association exists between patients discharge disposition, home vs. other healthcare facility, and the stroke survivors' utilization of rehabilitative services.

VII. COMORBIDITIES

The following section describes the prevalence of select risk factors and comorbid conditions among 142,470 adult patients seen between 2008-2019 with a diagnosis of Ischemic stroke, Transient Ischemic Attack (TIA), Intracerebral hemorrhage, Subarachnoid hemorrhage, or Stroke not otherwise specified (NOS). Two different methods are used to estimate the prevalence of the risk factors: 1) Documented medical history either self-reported by the patient or previously documented (missing for 6%, n=7,583 of cases); and 2) Documented clinical results measured during the stroke episode of care, if applicable.

The following comorbidities are included in the report:

1. Hypertension
2. Atrial Fibrillation
3. Diabetes Mellitus
4. Documentation of Lipid Profile
5. Lipid Measures – Total Cholesterol, LDL, HDL, and Triglycerides
6. Dyslipidemia
7. Smoking
8. Overweight and Obesity

HYPERTENSION

Treatment of hypertension is thought to be the most important intervention for secondary prevention of ischemic stroke. (7) Though the relationship between hypertension and stroke recurrence has been less well studied, its importance in preventing recurrent stroke is thought to be of equal importance. (7)



FIGURE 42. PERCENTAGE OF STROKE CASES WITH A MEDICAL HISTORY OF HYPERTENSION, 2008-2019

Hypertension reported as a previously known medical condition occurred among 74.6% (n=106,251) cases. That is, 75 in every 100 adult stroke patients seen between 2008 and 2019 had documented hypertension prior to their stroke (Figure 42).

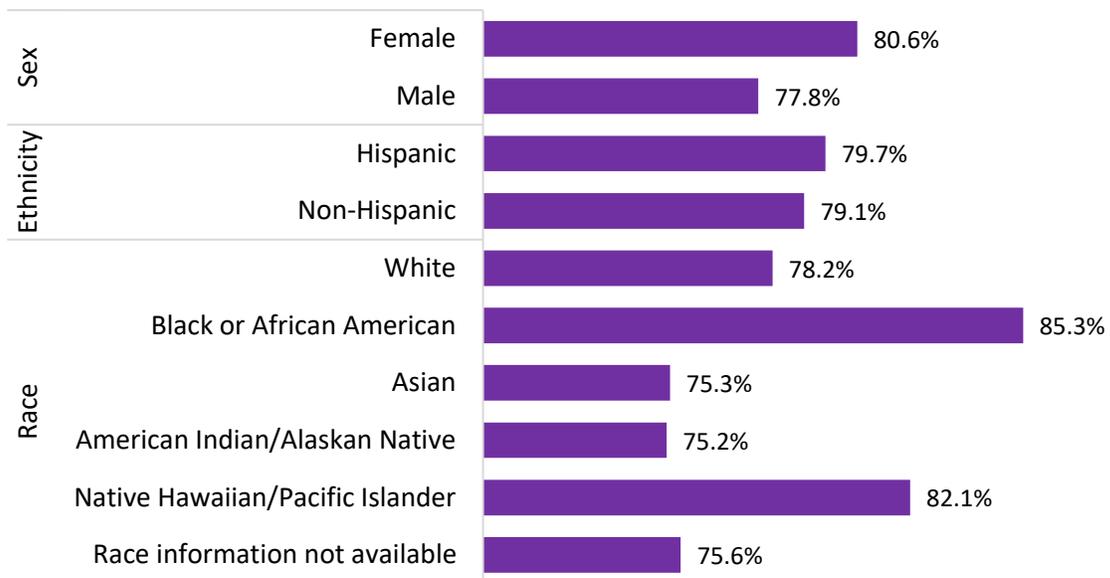


FIGURE 43. MEDICAL HISTORY OF HYPERTENSION AMONG ADULT STROKE CASES BY SEX, ETHNICITY, AND RACE, 2008-2019

A greater percentage of females than males reported a history of hypertension. Prevalence of pre-existing hypertension did not differ by Hispanic ethnicity. Black and Native Hawaiian/Pacific Islander cases has a higher prevalence of hypertension compared with other race groups (Figure 43).

Half of adult stroke cases had high blood pressure, documented as SBP \geq 140 mmHg and/or DBP \geq 90 mmHg, during the stroke episode of care (50.9% (n=72,467)). (Figure 44). Almost one-third of cases did not have their blood pressure recorded during their episode of care (n=46,160; 32.4%).

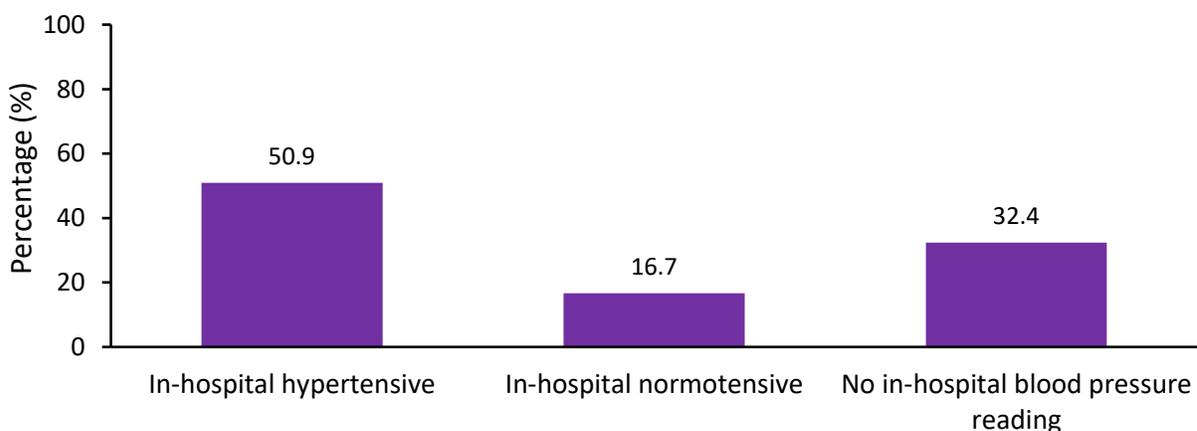


FIGURE 44. PREVALENCE OF HYPERTENSION DURING STROKE EPISODE OF CARE, 2008-2019

The difference between the prevalence of hypertension as a previously known medical condition (74.6%) vs. measured SBP/DBP at stroke episode of care (50.9%) may reflect differences in missingness of data, the management of hypertension during the stroke episode of care, and/or other factors.

ATRIAL FIBRILLATION

Atrial fibrillation (AF) is thought to cause approximately 10-12% of all ischemic stroke cases in the United States. (7) AF also increases the risk of stroke recurrence in patients with prior and/or recent ischemic stroke or TIA.

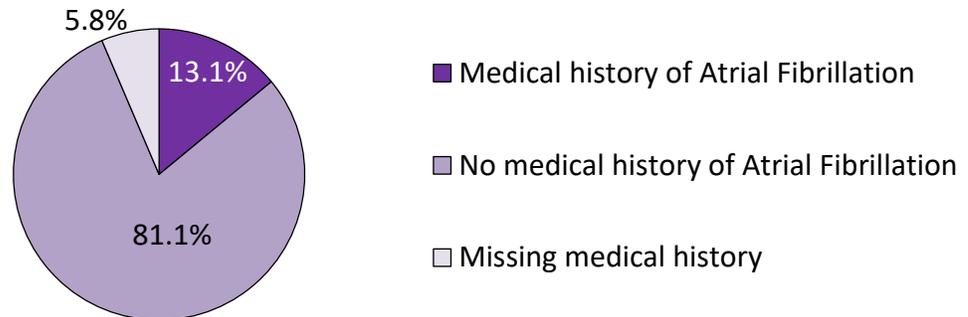


FIGURE 45. MEDICAL HISTORY OF ATRIAL FIBRILLATION AMONG ADULT STROKE CASES, 2008-2019

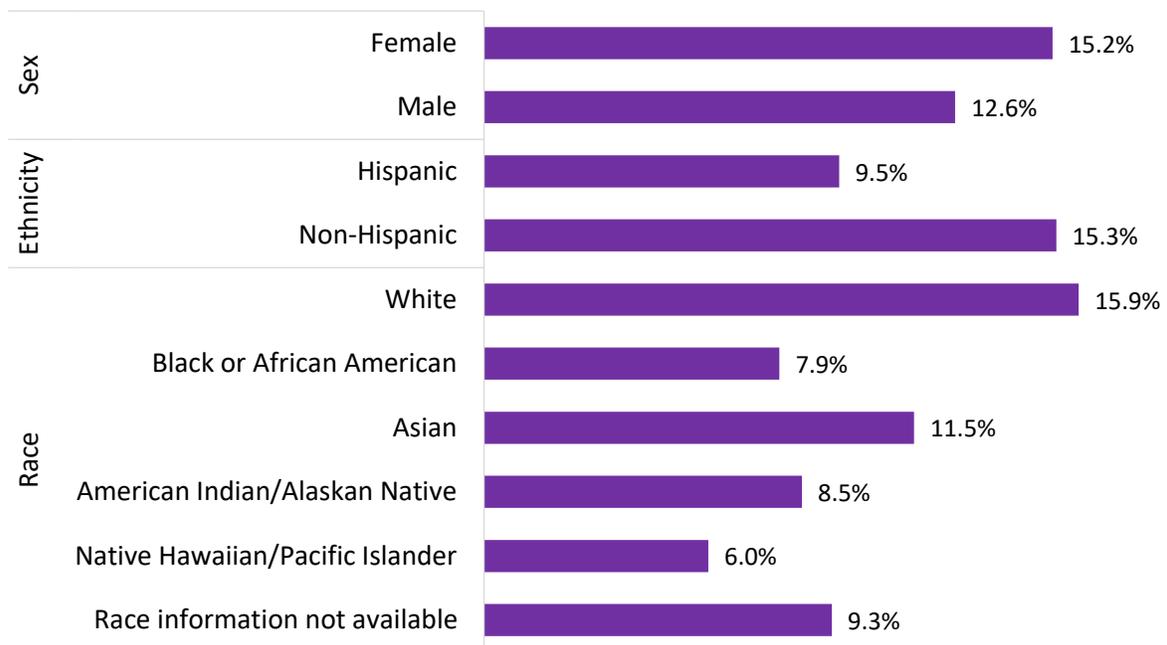


FIGURE 46. MEDICAL HISTORY OF ATRIAL FIBRILLATION AMONG ADULT STROKE CASES BY SEX, ETHNICITY, AND RACE, 2008-2019

The prevalence of AF reported as a previously known medical condition was 13.1% (n=18,677) (Figure 43). AF was more common among females than males, among non-Hispanics than Hispanics, and among Whites than other race groups (Figure 46).

DIABETES MELLITUS

Diabetes mellitus is associated with an increased risk of an initial ischemic stroke and it also increases the risk of stroke recurrence. (7)

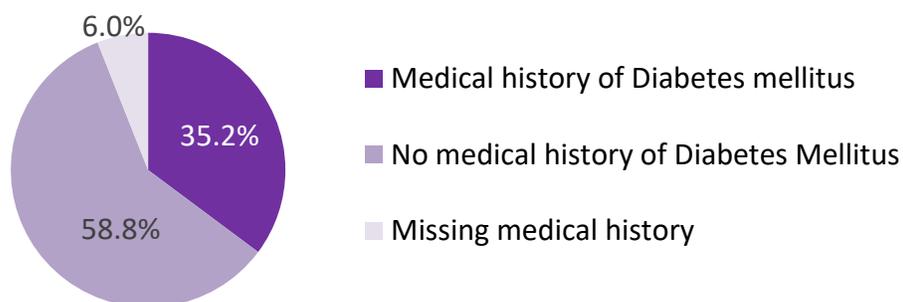


FIGURE 47. PERCENTAGE OF MEDICAL HISTORY OF DIABETES MELLITUS AMONG ADULT STROKE CASES, 2008-2019

The prevalence of diabetes mellitus reported as a previously known medical condition was 35.2% (n=44,404) (Figure 47).

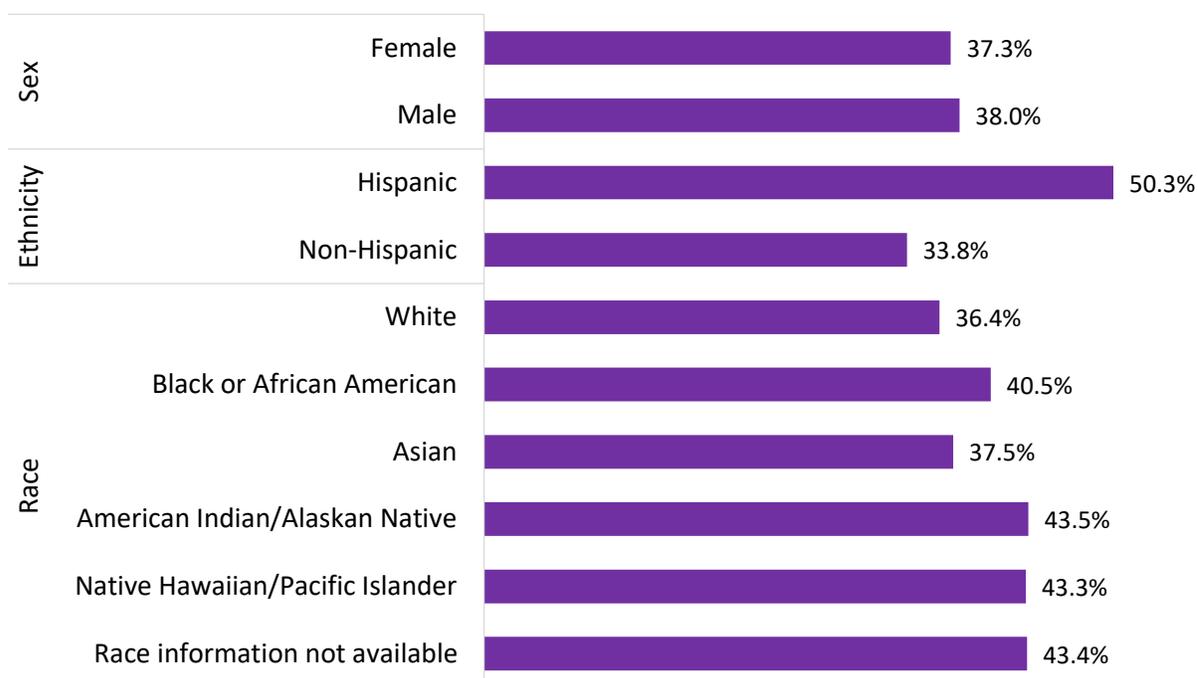


FIGURE 48. MEDICAL HISTORY OF DIABETES MELLITUS AMONG ADULT STROKE CASES BY SEX, ETHNICITY, AND RACE, 2008-2019

A similar number of males and females reported a history of diabetes mellitus. However, pre-existing diabetes was less common among non-Hispanics than Hispanics, and fewer Whites and Asians reported having diabetes as compared with other race groups.

DOCUMENTATION OF LIPID PROFILE

Patients diagnosed with ischemic stroke or TIA should have a lipid profile measurement performed within 24-48 hours of hospital admission, unless the patient's medical record contains documented lipid profile results performed within the past 30 days or indicates some contraindication for this measure. (7)

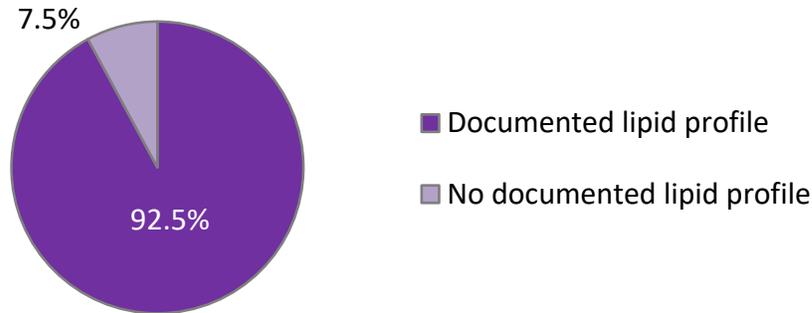


FIGURE 49. ADULT ISCHEMIC STROKE AND TIA CASES WITH A DOCUMENTED LIPID PROFILE, 2008-2019

Of the 98,191 eligible adult ischemic stroke and TIA cases, nine out of 10 cases (92.5%; n=90,844) had lipid results either performed and documented within 48 hours of hospital admission or previously performed and documented within 30 days prior to hospital admission (Figure 49).

This indicates a potential gap in the stroke system of care. Opportunity exists in requiring standardized documentation of lipid profiles across all Texas hospitals.

LIPID MEASURES – TOTAL CHOLESTEROL, LDL, HDL, TRIGLYCERIDES

Among the 90,844 eligible adult stroke cases with a documented lipid profile, 23.6% (n=16,117) had documented total cholesterol > 200 mg/dL, 20.6% (n=18,562) had documented LDL \geq 130 mg/dL, 45.9% (n=31,428) had documented HDL < 40 mg/dL, and 33.3% (n=22,814) had documented triglycerides \geq 150 mg/dL (Figure 48). The prevalence of these lipid measure categories are not mutually exclusive and may not add up to 100%.

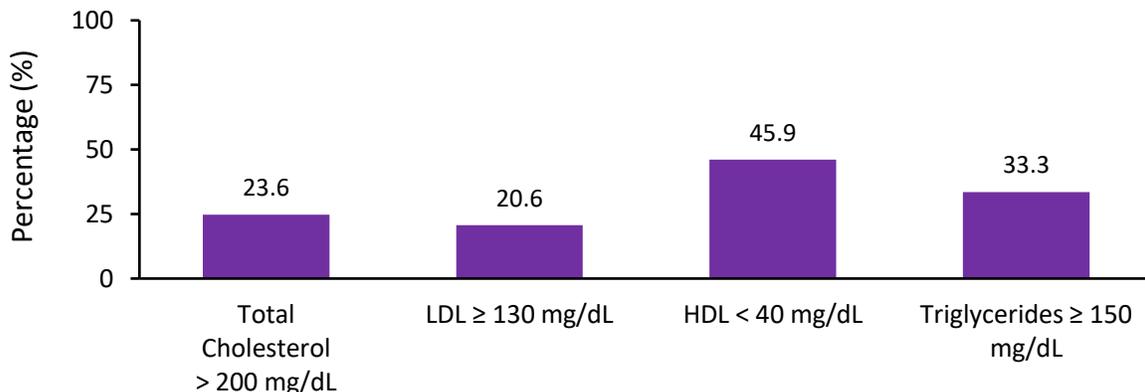


FIGURE 50. HIGH RISK LIPID LEVELS DURING STROKE EPISODE OF CARE, 2008-2019

DYSLIPIDEMIA

Certain serum lipid biomarkers (elevated triglycerides, low HDL, and high LDL) are associated with an increased risk of stroke and are primary targets for preventing stroke recurrence. (7) Having any or all these conditions is called dyslipidemia.



FIGURE 51. MEDICAL HISTORY OF DYSLIPIDEMIA AMONG ADULT STROKE CASES, 2008-2019

The prevalence of dyslipidemia, reported as a previously known medical condition prior to stroke occurrence, was 40.8% (n=58,163) (Figure 51).

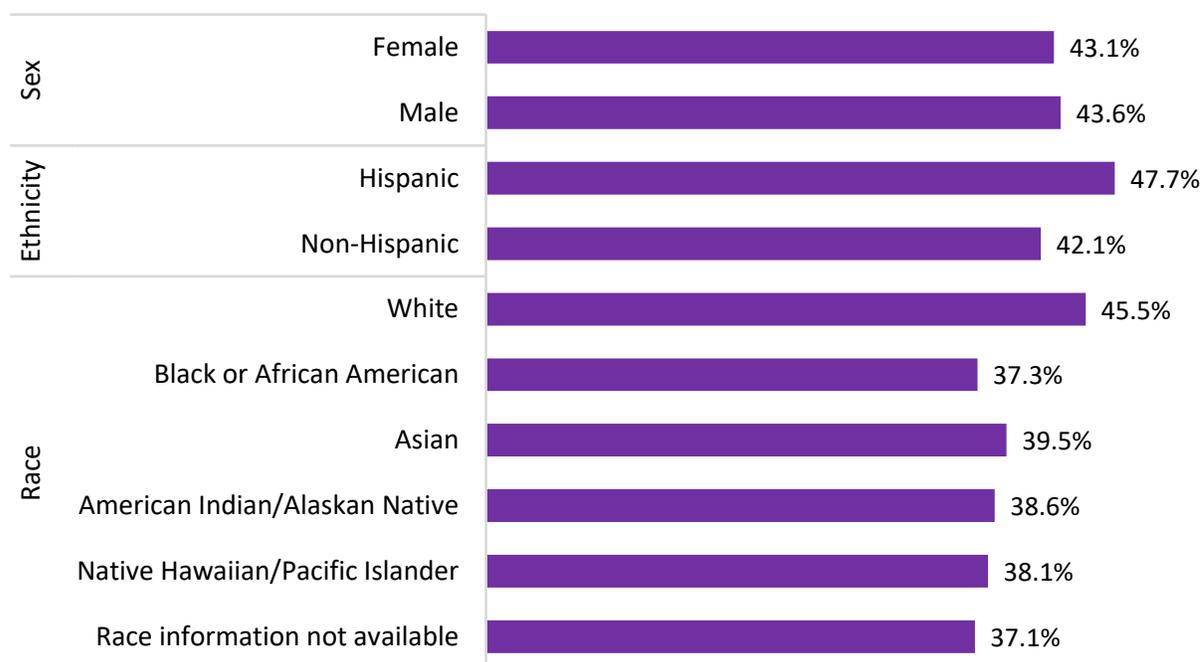


FIGURE 52. PERCENTAGE OF MEDICAL HISTORY OF DYSLIPIDEMIA AMONG ADULT STROKE CASES BY SEX, ETHNICITY, AND RACE, 2008-2019

The prevalence of dyslipidemia as a pre-existing condition was similar for males and females. It was more common among Hispanics than non-Hispanics, and among Whites than other race groups (Figure 52).

Figure 53 displays the prevalence of three indicators of dyslipidemia (total cholesterol > 200 mg/dL, LDL \geq 130 mg/dL, or HDL < 40 mg/dL) from lab tests performed within 48 hours of hospital admission or from existing documented results

of a lipid profile performed within 30 days prior to the onset of stroke signs and symptoms.

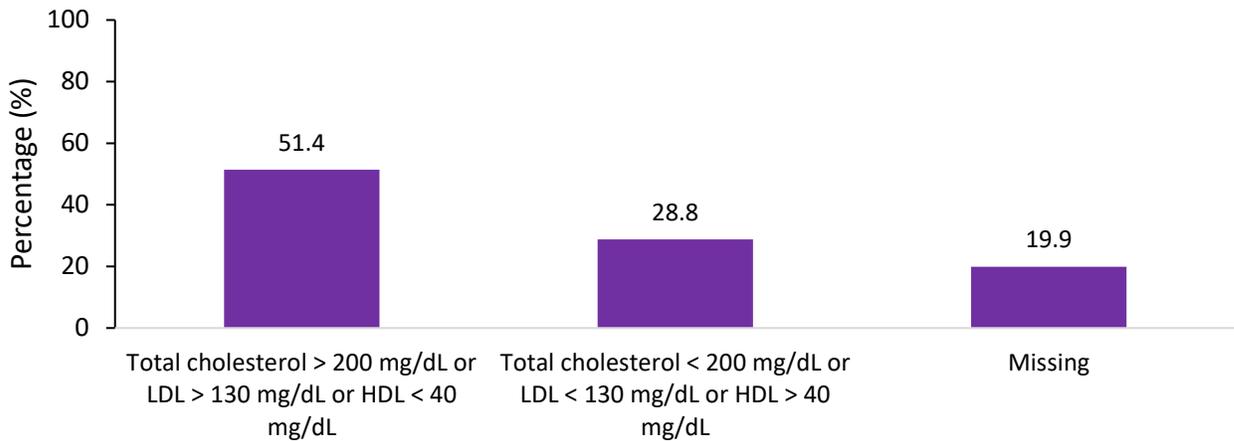


FIGURE 53. PREVALENCE OF DYSLIPIDEMIA AT TIME OF STROKE EPISODE OF CARE, 2008-2019

Dyslipidemia at time of stroke was documented from lab testing among 51.4% (n=46,651) of eligible adult ischemic stroke and TIA cases seen between 2008 and 2019 (Figure 51).

SMOKING

Tobacco use, a modifiable risk factor, is the greatest contributor to premature morbidity and mortality in Texas. Smoking cigarettes is an independent risk factor for a first ischemic stroke and appears to double the risk of stroke recurrence. (7)

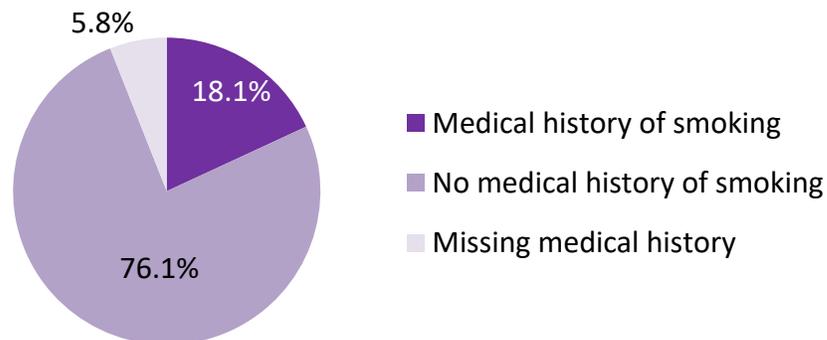


FIGURE 54. MEDICAL HISTORY OF SMOKING AMONG ADULT STROKE CASES, 2008-2019

The prevalence of smoking reported as a previously known medical condition among eligible adult stroke cases was 18.1% (n=25,745) (Figure 54).

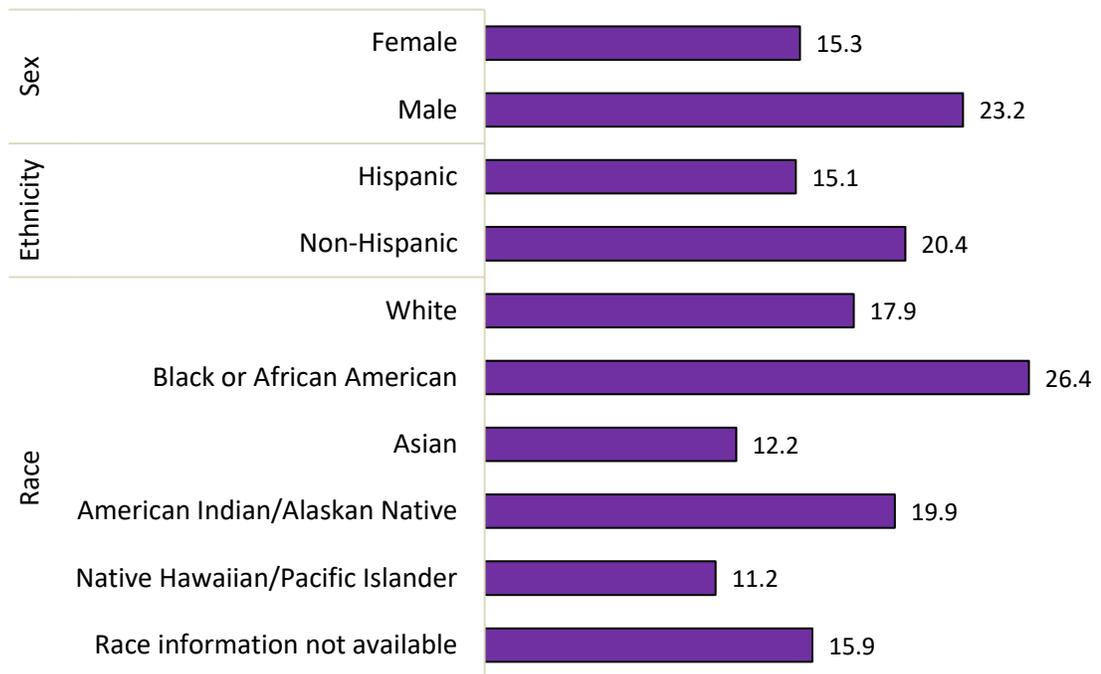


FIGURE 55. MEDICAL HISTORY OF SMOKING AMONG ADULT STROKE CASES BY SEX, ETHNICITY, AND RACE, 2008-2019

Among eligible adult stroke cases, a history of smoking was more common among males than females, among non-Hispanics than Hispanics, and among Blacks than other race groups (Figure 55).

Smoking Cessation

Healthcare providers should strongly advise every stroke patient who reports having smoked in the past year to quit smoking in an effort to decrease the risk of recurrent stroke.

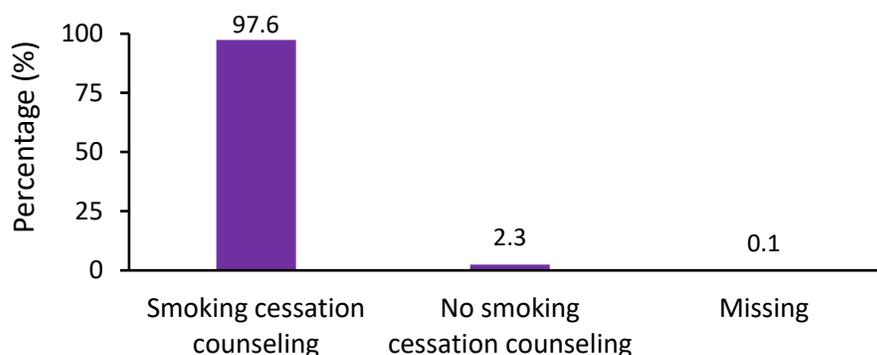


FIGURE 56. ADULT STROKE CASES WITH A HISTORY OF SMOKING, OR THEIR CAREGIVERS, WHO RECEIVED SMOKING CESSATION COUNSELING PRIOR TO HOSPITAL DISCHARGE, 2008-2019

Of the eligible adult stroke cases with a self-reported history of smoking, 98 out of 100 (97.6%; n=20,848) received (or caregiver received) smoking cessation counseling prior to hospital discharge (Figure 56).

Research suggests that stroke patients who receive even brief smoking cessation advice from their healthcare provider are more likely to quit smoking than those receiving no counseling at all. (8) Opportunities for improvement in smoking cessation counseling exist.

OVERWEIGHT AND OBESITY

Overweight/obesity are associated with an increased risk of stroke, and this relationship appears to be linear in nature. Each unit (kg/m²) increase in Body Mass Index (BMI) over 20 kg/m² increases the risk of stroke by 5%. (8)



FIGURE 57. MEDICAL HISTORY OF OVERWEIGHT/OBESITY AMONG ADULT STROKE CASES, 2008-2018

Of all eligible adult stroke patients, 19.2% (n=27,418) had overweight/obesity reported as a previously known medical condition (Figure 57).

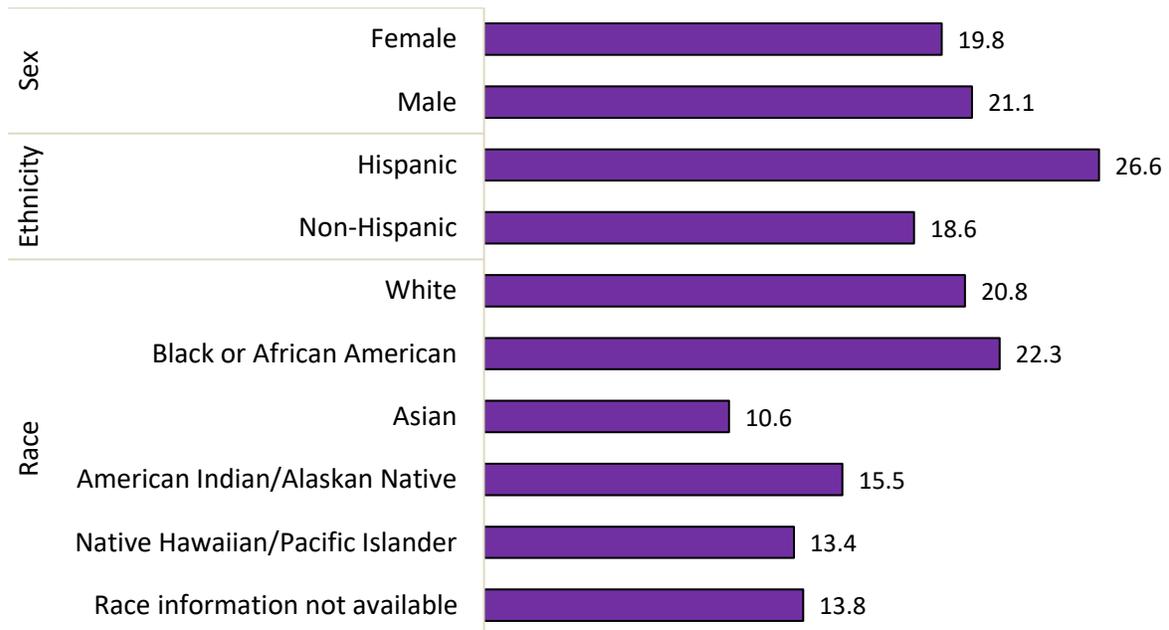


FIGURE 58. MEDICAL HISTORY OF OVERWEIGHT/OBESITY AMONG ADULT STROKE CASES BY SEX, ETHNICITY, AND RACE, 2008-2019

The prevalence of overweight/obesity as a pre-existing condition was similar for males and females. Overweight/obesity was more common among Hispanics than non-Hispanics, and among Blacks than other race groups (Figure 58).

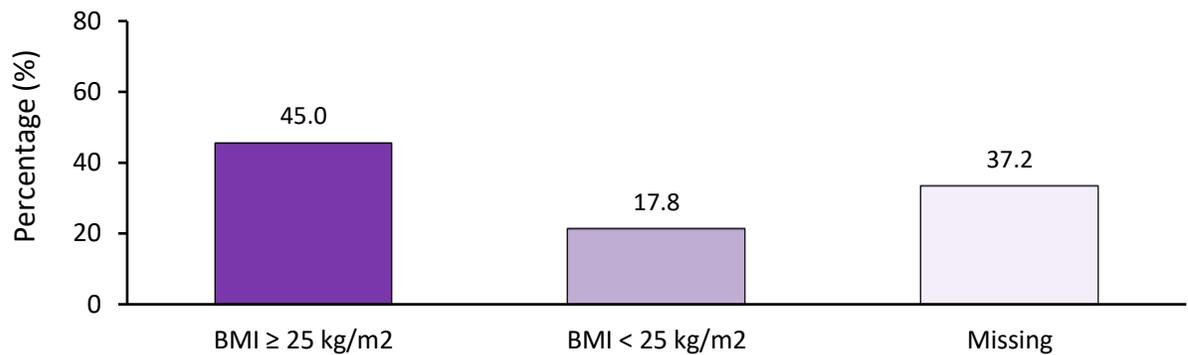


FIGURE 59. BODY MASS INDEX (BMI) CATEGORIES, KG/M², DURING STROKE EPISODE OF CARE, 2008-2019

In contrast, the prevalence of overweight/obesity, reported as a BMI \geq 25 kg/m² calculated from the patients' height and weight during the stroke episode of care, was 45.0% (n=64,255) (Figure 59).

The large difference between the prevalence of cases with self-reported medical history of overweight/obese (19.2%) and the actual measured prevalence of overweight/obese during the stroke episode of care (45.0%) indicates patients may underreport overweight/obesity, that doctors do not enter overweight/obesity as a medical condition in their patient's records, or that patients and their doctors do not discuss overweight/obesity and its negative health effects.

APPENDIX

URBAN-RURAL CLASSIFICATION FOR HOSPITAL CHARACTERISTICS AND MEASURES

The Texas Department of State Health Services (DSHS) follows the Metropolitan and Non-Metropolitan county designations defined by the U.S. Office of Budget and Management (OBM). In Texas, 82 counties are designated as Metropolitan and 172 are designated as Non-Metropolitan. The terms "Non-Metropolitan and Metropolitan" and interchangeable with "Urban and Rural."

Accessible at: <https://www.dshs.texas.gov/chs/hprc/counties.shtm>

The following are definitions used specifically for this report. The urban and rural categories used are defined based upon the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties. This includes six county-level categories: metropolitan (large central metro, large fringe metro, medium metro, and small metro) and nonmetropolitan (micropolitan and noncore).

URBAN COUNTY

- Large central metro—counties in metropolitan statistical areas (MSA) of 1 million or more population that: contain the entire population of the largest principal city of the MSA, or have their entire population contained in the largest principal city of the MSA, or contain at least 250,000 inhabitants of any principal city of the MSA.
- Large fringe metro—counties in MSAs of 1 million or more population that did not qualify as large central metro counties.
- Medium metro—counties in MSAs of populations of 250,000 to 999,999.
- Small metro—counties in MSAs of populations less than 250,000.

RURAL COUNTY

- Micropolitan—Counties in micropolitan statistical areas.
- Noncore—Nonmetropolitan counties that did not qualify as micropolitan.

TABLE DATA SOURCES

Table 1. Estimated number and unadjusted prevalence of adults, 18 years and older, that report ever having had a stroke in Texas, by race/ethnicity, 2011-2016. (Pg. 6) Data source: Texas Behavioral Risk Factor Surveillance System (2011-2016).

Table 2 (Pg. 7). Age-adjusted stroke hospitalization rate (per 10,000), all ages, in Texas, by race/ethnicity, 2010-2015. Data source: 2015 Texas Vital Statistics, Population Data; (2) 2015 Texas Vital Statistics, Mortality Data.

Table 3 (Pg. 7). Stroke hospital discharges and total charges by primary payment source, Texas, 2016. Data Source: Texas Health Care Information Collection (THCIC), Inpatient Hospital Discharge Public Use Data File, 2016.

Table 4–24 (Pgs. 9-53). EVALUATING HOSPITAL CARE FOR STROKE IN TEXAS
Data Source: This Get With The Guidelines® Aggregate Data report was generated using the IQVIA PMT® system. Copy or distribution of the Get With The Guidelines® Aggregate Data is prohibited without the prior written consent of the American Heart Association and IQVIA.

FIGURE DATA SOURCES

Figure 1 (Pg. 8). The 2011-2015, average age-adjusted number of deaths due to stroke per 100,000 people, all ages, by county, in Texas. Data source: County-level mortality data, 2011-2015, and County-level population data, 2011-2015; Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Figure 2–57 (Pgs. 10-53). EVALUATING HOSPITAL CARE FOR STROKE IN TEXAS
Data Source: This Get With The Guidelines® Aggregate Data report was generated using the IQVIA PMT® system. Copy or distribution of the Get With The Guidelines® Aggregate Data is prohibited without the prior written consent of the American Heart Association and IQVIA.

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