Clinical Outcomes of Atrial Fibrillation in Acute Ischemic Stroke Patients

Analysis for RCOP NIS Cardio4

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## Preamble:

* **Reference Papers:**
  + [Sidhu et al. 2022](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9207776/pdf/main.pdf)
* **Study Objective**: Examine the impact of atrial fibrillation on in-hospital mortality, length of stay total charges, and stroke morbidity among inpatient admissions with a principal diagnosis of ischemic stroke.
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with a principal diagnosis of Stroke.
* **Ischemic Stroke + Atrial Fibrillation Categories**:
  + Ischemic Stroke with Atrial Fibrillation
  + Ischemic Stroke without Atrial Fibrillation
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
* **Secondary Outcomes**:
  + Stroke-related morbidity
  + - Intracranial Hemorrhage  
      
    - Sepsis
* **Statistical Analysis**: Multiple logistic and linear regression to determine the independent association of atrial fibrillation with in-hospital mortality, stroke mortality, length of stay and total charges (inflation adjusted), respectively, adjusted for:
  + Demographics: Age, sex, race, residential income, insurance, hospital region, hospital bedsize, hospital location, and teaching status.
  + Medical History: Hypertension, diabetes mellitus, hyperlipidemia, coronary artery disease, peripheral vascular disease, heart failure, chronic kidney disease, rheumatic valvular disease, chronic obstructive pulmonary disease, dementia, cirrhosis, obstructive sleep apnea, anemia, obesity, prior stroke, prior cardiac surgery, presence of pacemaker/defibrillator, alochol use disorder, tobacco use disorder, use of tissue plasminogen activator and use of thrombectomy.
  + Comorbidities: Charlson comorbidity index.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **Overall** N = 9,280*1* | **Ischemic Stroke with Atrial Fibrillation** N = 1,975*1* | **Ischemic Stroke without Atrial Fibrillation** N = 7,305*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 70 (14) | 77 (11) | 68 (14) | <0.001 |
| Sex |  |  |  | 0.53 |
| Female | 4,545 (49) | 995 (50) | 3,550 (49) |  |
| Male | 4,735 (51) | 980 (50) | 3,755 (51) |  |
| Race |  |  |  | 0.003 |
| White | 5,780 (63) | 1,365 (70) | 4,415 (61) |  |
| Asian or Pacific Islander | 355 (3.9) | 85 (4.4) | 270 (3.8) |  |
| Black | 1,585 (17) | 250 (13) | 1,335 (19) |  |
| Hispanic | 1,085 (12) | 150 (7.7) | 935 (13) |  |
| Native American | 40 (0.4) | 10 (0.5) | 30 (0.4) |  |
| Other | 280 (3.1) | 80 (4.1) | 200 (2.8) |  |
| Charlson comorbidity index | 3.92 (2.15) | 4.28 (2.35) | 3.82 (2.08) | <0.001 |
| Residential income |  |  |  | 0.006 |
| $1 - $51,999 | 2,875 (32) | 525 (27) | 2,350 (33) |  |
| $52,000 - $65,999 | 2,435 (27) | 495 (26) | 1,940 (27) |  |
| $66,000 - $87,999 | 2,080 (23) | 455 (23) | 1,625 (23) |  |
| $88,000 or more | 1,655 (18) | 465 (24) | 1,190 (17) |  |
| Expected primary payer |  |  |  | <0.001 |
| Private | 2,375 (26) | 300 (15) | 2,075 (28) |  |
| Medicaid | 865 (9.3) | 65 (3.3) | 800 (11) |  |
| Medicare | 5,760 (62) | 1,560 (79) | 4,200 (58) |  |
| Other | 265 (2.9) | 50 (2.5) | 215 (2.9) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 885 (9.5) | 175 (8.9) | 710 (9.7) |  |
| Northeast | 1,120 (12) | 335 (17) | 785 (11) |  |
| South | 4,785 (52) | 875 (44) | 3,910 (54) |  |
| West | 2,490 (27) | 590 (30) | 1,900 (26) |  |
| Hospital bedsize |  |  |  | 0.94 |
| Large | 5,140 (55) | 1,105 (56) | 4,035 (55) |  |
| Medium | 2,820 (30) | 585 (30) | 2,235 (31) |  |
| Small | 1,320 (14) | 285 (14) | 1,035 (14) |  |
| Hospital location and teaching status |  |  |  | 0.052 |
| Rural | 505 (5.4) | 105 (5.3) | 400 (5.5) |  |
| Urban, non-teaching | 1,835 (20) | 305 (15) | 1,530 (21) |  |
| Urban, teaching | 6,940 (75) | 1,565 (79) | 5,375 (74) |  |
| Hypertension | 7,930 (85) | 1,760 (89) | 6,170 (84) | 0.019 |
| Diabetes mellitus | 4,000 (43) | 785 (40) | 3,215 (44) | 0.14 |
| Hyperlipidemia | 5,705 (61) | 1,150 (58) | 4,555 (62) | 0.14 |
| Coronary artery disease | 2,295 (25) | 620 (31) | 1,675 (23) | 0.001 |
| Peripheral vascular disease | 790 (8.5) | 225 (11) | 565 (7.7) | 0.024 |
| Heart failure | 1,805 (19) | 680 (34) | 1,125 (15) | <0.001 |
| Chronic kidney disease | 1,730 (19) | 465 (24) | 1,265 (17) | 0.005 |
| Rheumatic valvular disease | 260 (2.8) | 75 (3.8) | 185 (2.5) | 0.18 |
| Chronic obstructive pulmonary disease | 1,450 (16) | 365 (18) | 1,085 (15) | 0.074 |
| Dementia | 1,030 (11) | 325 (16) | 705 (9.7) | <0.001 |
| Cirrhosis | 90 (1.0) | 10 (0.5) | 80 (1.1) | 0.29 |
| Obstructive sleep apnea | 630 (6.8) | 155 (7.8) | 475 (6.5) | 0.32 |
| Anemia | 320 (3.4) | 95 (4.8) | 225 (3.1) | 0.10 |
| Obesity | 1,530 (16) | 280 (14) | 1,250 (17) | 0.15 |
| Prior stroke | 1,485 (16) | 375 (19) | 1,110 (15) | 0.077 |
| Prior cardiac surgery | 655 (7.1) | 215 (11) | 440 (6.0) | 0.001 |
| Pacemaker/ICD | 450 (4.8) | 240 (12) | 210 (2.9) | <0.001 |
| Alcohol use disorder | 3,595 (39) | 840 (43) | 2,755 (38) | 0.087 |
| Tobbacco use disorder | 80 (0.9) | 5 (0.3) | 75 (1.0) | 0.14 |
| Tissue plasminogen activator | 845 (9.1) | 195 (9.9) | 650 (8.9) | 0.54 |
| Thrombectomy use | 385 (4.1) | 120 (6.1) | 265 (3.6) | 0.039 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Outcomes Table:

| **Characteristic** | **Overall** N = 9,280*1* | **Ischemic Stroke with Atrial Fibrillation** N = 1,975*1* | **Ischemic Stroke without Atrial Fibrillation** N = 7,305*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 335 (3.6) | 90 (4.6) | 245 (3.4) | 0.25 |
| Length of stay (days) | 5.4 (6.9) | 6.0 (6.1) | 5.2 (7.1) | <0.001 |
| Inflation-adjusted total charge ($) | 78,028 (98,927) | 86,453 (102,066) | 75,750 (97,973) | 0.014 |
| Stroke-related morbidity | 630 (6.8) | 225 (11) | 405 (5.5) | <0.001 |
| Intracranial Hemorrhage | 545 (5.9) | 200 (10) | 345 (4.7) | <0.001 |
| Sepsis | 105 (1.1) | 30 (1.5) | 75 (1.0) | 0.39 |
| *1*n (%); Mean (SD) | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Atrial fibrillation categories |  |  |
| Ischemic Stroke with Atrial Fibrillation | — |  |
| Ischemic Stroke without Atrial Fibrillation | 1.05 (0.53 to 2.10) | 0.88 |
| Age, y | 1.03 (1.00 to 1.05) | 0.052 |
| Sex |  |  |
| Female | — |  |
| Male | 1.26 (0.73 to 2.16) | 0.40 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 0.73 (0.10 to 5.48) | 0.76 |
| Black | 0.58 (0.23 to 1.46) | 0.25 |
| Hispanic | 1.32 (0.57 to 3.06) | 0.52 |
| Native American | 0.00 (0.00 to 0.00) | <0.001 |
| Other | 1.57 (0.34 to 7.20) | 0.56 |
| Charlson comorbidity index | 1.15 (0.98 to 1.35) | 0.079 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.97 (0.49 to 1.91) | 0.92 |
| $66,000 - $87,999 | 0.44 (0.17 to 1.13) | 0.087 |
| $88,000 or more | 1.14 (0.56 to 2.32) | 0.73 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.71 (0.17 to 3.06) | 0.65 |
| Medicare | 0.78 (0.40 to 1.50) | 0.46 |
| Other | 1.95 (0.64 to 5.92) | 0.24 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.76 (0.27 to 2.16) | 0.61 |
| South | 0.50 (0.21 to 1.19) | 0.12 |
| West | 0.32 (0.12 to 0.90) | 0.031 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 0.68 (0.36 to 1.29) | 0.24 |
| Small | 0.64 (0.24 to 1.65) | 0.35 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 0.51 (0.15 to 1.72) | 0.28 |
| Urban, teaching | 0.78 (0.27 to 2.26) | 0.64 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.69 (0.32 to 1.47) | 0.34 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.89 (0.44 to 1.79) | 0.74 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | 0.46 (0.25 to 0.87) | 0.017 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 0.56 (0.27 to 1.14) | 0.11 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.67 (0.21 to 2.08) | 0.48 |
| Heart failure |  |  |
| No | — |  |
| Yes | 2.57 (1.25 to 5.27) | 0.010 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 1.00 (0.44 to 2.29) | >0.99 |
| Chronic obstructive pulmonary disease |  |  |
| No | — |  |
| Yes | 1.09 (0.51 to 2.31) | 0.82 |
| Dementia |  |  |
| No | — |  |
| Yes | 1.34 (0.64 to 2.80) | 0.43 |
| Cirrhosis |  |  |
| No | — |  |
| Yes | 4.69 (1.01 to 21.9) | 0.049 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 0.53 (0.11 to 2.62) | 0.43 |
| Anemia |  |  |
| No | — |  |
| Yes | 1.24 (0.28 to 5.41) | 0.78 |
| Alcohol use disorder |  |  |
| No | — |  |
| Yes | 0.82 (0.46 to 1.46) | 0.50 |
| Obesity |  |  |
| No | — |  |
| Yes | 0.84 (0.34 to 2.05) | 0.70 |
| Rheumatic valvular disease |  |  |
| No | — |  |
| Yes | 0.46 (0.06 to 3.70) | 0.47 |
| Prior stroke |  |  |
| No | — |  |
| Yes | 0.18 (0.04 to 0.74) | 0.018 |
| Prior cardiac surgery |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Pacemaker/ICD |  |  |
| No | — |  |
| Yes | 1.47 (0.52 to 4.10) | 0.46 |
| Tobbacco use disorder |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Tissue plasminogen activator |  |  |
| No | — |  |
| Yes | 0.48 (0.10 to 2.16) | 0.34 |
| Thrombectomy use |  |  |
| No | — |  |
| Yes | 3.74 (1.57 to 8.89) | 0.003 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

### Stroke Morbidity (ICH and Sepsis):

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Atrial fibrillation categories |  |  |
| Ischemic Stroke with Atrial Fibrillation | — |  |
| Ischemic Stroke without Atrial Fibrillation | 0.45 (0.28 to 0.72) | 0.001 |
| Age, y | 1.00 (0.98 to 1.02) | 0.92 |
| Sex |  |  |
| Female | — |  |
| Male | 1.44 (0.94 to 2.18) | 0.090 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 1.02 (0.34 to 3.05) | 0.98 |
| Black | 0.66 (0.34 to 1.28) | 0.21 |
| Hispanic | 1.08 (0.56 to 2.07) | 0.82 |
| Native American | 0.00 (0.00 to 0.00) | <0.001 |
| Other | 0.90 (0.17 to 4.83) | 0.90 |
| Charlson comorbidity index | 1.07 (0.95 to 1.21) | 0.25 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 1.05 (0.63 to 1.75) | 0.85 |
| $66,000 - $87,999 | 0.72 (0.40 to 1.30) | 0.28 |
| $88,000 or more | 1.14 (0.61 to 2.15) | 0.68 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 1.06 (0.47 to 2.38) | 0.88 |
| Medicare | 1.07 (0.58 to 1.97) | 0.82 |
| Other | 0.82 (0.22 to 3.15) | 0.78 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.87 (0.38 to 1.98) | 0.74 |
| South | 0.82 (0.40 to 1.68) | 0.59 |
| West | 0.82 (0.36 to 1.87) | 0.64 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 0.71 (0.43 to 1.16) | 0.17 |
| Small | 0.39 (0.17 to 0.93) | 0.033 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 5,307,637 (2,816,055 to 10,003,715) | <0.001 |
| Urban, teaching | 7,170,497 (4,605,270 to 11,164,605) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.77 (0.44 to 1.37) | 0.37 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.95 (0.59 to 1.53) | 0.84 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | 1.00 (0.62 to 1.61) | >0.99 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 1.02 (0.63 to 1.65) | 0.95 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.67 (0.33 to 1.39) | 0.28 |
| Heart failure |  |  |
| No | — |  |
| Yes | 1.63 (0.93 to 2.88) | 0.091 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 0.87 (0.48 to 1.58) | 0.64 |
| Chronic obstructive pulmonary disease |  |  |
| No | — |  |
| Yes | 0.94 (0.52 to 1.72) | 0.85 |
| Dementia |  |  |
| No | — |  |
| Yes | 0.61 (0.29 to 1.31) | 0.21 |
| Cirrhosis |  |  |
| No | — |  |
| Yes | 3.90 (0.98 to 15.6) | 0.054 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 2.06 (1.07 to 3.94) | 0.030 |
| Anemia |  |  |
| No | — |  |
| Yes | 1.83 (0.76 to 4.43) | 0.18 |
| Alcohol use disorder |  |  |
| No | — |  |
| Yes | 0.76 (0.48 to 1.21) | 0.24 |
| Obesity |  |  |
| No | — |  |
| Yes | 0.69 (0.39 to 1.23) | 0.21 |
| Rheumatic valvular disease |  |  |
| No | — |  |
| Yes | 1.10 (0.33 to 3.72) | 0.88 |
| Prior stroke |  |  |
| No | — |  |
| Yes | 0.77 (0.42 to 1.43) | 0.41 |
| Prior cardiac surgery |  |  |
| No | — |  |
| Yes | 0.47 (0.14 to 1.53) | 0.21 |
| Pacemaker/ICD |  |  |
| No | — |  |
| Yes | 1.02 (0.41 to 2.57) | 0.97 |
| Tobbacco use disorder |  |  |
| No | — |  |
| Yes | 1.12 (0.17 to 7.23) | 0.91 |
| Tissue plasminogen activator |  |  |
| No | — |  |
| Yes | 0.79 (0.37 to 1.68) | 0.54 |
| Thrombectomy use |  |  |
| No | — |  |
| Yes | 5.84 (3.18 to 10.7) | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

### Intracranial Hemorrhage:

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Atrial fibrillation categories |  |  |
| Ischemic Stroke with Atrial Fibrillation | — |  |
| Ischemic Stroke without Atrial Fibrillation | 0.45 (0.27 to 0.77) | 0.003 |
| Age, y | 1.00 (0.98 to 1.02) | 0.85 |
| Sex |  |  |
| Female | — |  |
| Male | 1.22 (0.78 to 1.90) | 0.38 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 0.56 (0.11 to 2.76) | 0.47 |
| Black | 0.60 (0.29 to 1.22) | 0.16 |
| Hispanic | 0.95 (0.45 to 2.03) | 0.90 |
| Native American | 0.00 (0.00 to 0.00) | <0.001 |
| Other | 0.32 (0.04 to 2.73) | 0.30 |
| Charlson comorbidity index | 1.08 (0.95 to 1.22) | 0.24 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 1.27 (0.73 to 2.20) | 0.40 |
| $66,000 - $87,999 | 0.90 (0.48 to 1.67) | 0.73 |
| $88,000 or more | 1.24 (0.64 to 2.40) | 0.53 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.51 (0.18 to 1.48) | 0.21 |
| Medicare | 1.00 (0.53 to 1.89) | >0.99 |
| Other | 0.53 (0.12 to 2.40) | 0.41 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.85 (0.36 to 2.02) | 0.71 |
| South | 0.82 (0.39 to 1.74) | 0.61 |
| West | 0.85 (0.36 to 2.00) | 0.70 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 0.59 (0.35 to 0.99) | 0.045 |
| Small | 0.42 (0.18 to 1.00) | 0.049 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 3,855,513 (1,978,674 to 7,512,597) | <0.001 |
| Urban, teaching | 6,080,202 (3,896,952 to 9,486,609) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.68 (0.38 to 1.23) | 0.20 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.94 (0.57 to 1.56) | 0.82 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | 0.82 (0.49 to 1.35) | 0.43 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 1.29 (0.77 to 2.15) | 0.33 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.84 (0.41 to 1.72) | 0.64 |
| Heart failure |  |  |
| No | — |  |
| Yes | 1.54 (0.83 to 2.83) | 0.17 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 0.83 (0.44 to 1.58) | 0.57 |
| Chronic obstructive pulmonary disease |  |  |
| No | — |  |
| Yes | 0.91 (0.50 to 1.68) | 0.77 |
| Dementia |  |  |
| No | — |  |
| Yes | 0.52 (0.22 to 1.25) | 0.15 |
| Cirrhosis |  |  |
| No | — |  |
| Yes | 4.68 (1.11 to 19.6) | 0.035 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 1.67 (0.80 to 3.50) | 0.17 |
| Anemia |  |  |
| No | — |  |
| Yes | 1.84 (0.73 to 4.67) | 0.20 |
| Alcohol use disorder |  |  |
| No | — |  |
| Yes | 0.71 (0.43 to 1.18) | 0.19 |
| Obesity |  |  |
| No | — |  |
| Yes | 0.72 (0.40 to 1.31) | 0.29 |
| Rheumatic valvular disease |  |  |
| No | — |  |
| Yes | 0.78 (0.18 to 3.34) | 0.74 |
| Prior stroke |  |  |
| No | — |  |
| Yes | 0.92 (0.48 to 1.80) | 0.82 |
| Prior cardiac surgery |  |  |
| No | — |  |
| Yes | 0.46 (0.13 to 1.57) | 0.21 |
| Pacemaker/ICD |  |  |
| No | — |  |
| Yes | 0.97 (0.37 to 2.54) | 0.95 |
| Tobbacco use disorder |  |  |
| No | — |  |
| Yes | 1.48 (0.21 to 10.3) | 0.69 |
| Tissue plasminogen activator |  |  |
| No | — |  |
| Yes | 0.94 (0.44 to 2.04) | 0.89 |
| Thrombectomy use |  |  |
| No | — |  |
| Yes | 6.29 (3.45 to 11.5) | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

### Sepsis:

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Atrial fibrillation categories |  |  |
| Ischemic Stroke with Atrial Fibrillation | — |  |
| Ischemic Stroke without Atrial Fibrillation | 0.36 (0.11 to 1.18) | 0.092 |
| Age, y | 1.01 (0.95 to 1.06) | 0.85 |
| Sex |  |  |
| Female | — |  |
| Male | 8.00 (1.44 to 44.3) | 0.017 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 7.11 (1.24 to 40.8) | 0.028 |
| Black | 1.02 (0.20 to 5.13) | 0.98 |
| Hispanic | 1.72 (0.36 to 8.22) | 0.49 |
| Native American | 0.00 (0.00 to 0.00) | <0.001 |
| Other | 16.0 (2.03 to 127) | 0.009 |
| Charlson comorbidity index | 1.02 (0.77 to 1.34) | 0.89 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.29 (0.06 to 1.42) | 0.13 |
| $66,000 - $87,999 | 0.11 (0.02 to 0.69) | 0.018 |
| $88,000 or more | 1.13 (0.28 to 4.62) | 0.87 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 6.48 (0.77 to 54.4) | 0.085 |
| Medicare | 1.27 (0.14 to 11.4) | 0.83 |
| Other | 7.03 (1.16 to 42.5) | 0.034 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.52 (0.04 to 6.52) | 0.61 |
| South | 0.37 (0.05 to 2.78) | 0.33 |
| West | 0.31 (0.02 to 4.12) | 0.38 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 1.63 (0.54 to 4.89) | 0.38 |
| Small | 0.00 (0.00 to 0.00) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 103,239,714 (21,759,123 to 489,837,702) | <0.001 |
| Urban, teaching | 103,472,829 (23,283,378 to 459,839,911) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 1.61 (0.39 to 6.69) | 0.51 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.66 (0.18 to 2.46) | 0.53 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | 2.63 (0.74 to 9.40) | 0.14 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 6.34 (1.88 to 21.4) | 0.003 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 0.82 (0.17 to 4.12) | 0.81 |
| Chronic obstructive pulmonary disease |  |  |
| No | — |  |
| Yes | 1.03 (0.19 to 5.54) | 0.97 |
| Dementia |  |  |
| No | — |  |
| Yes | 1.33 (0.32 to 5.55) | 0.69 |
| Cirrhosis |  |  |
| No | — |  |
| Yes | 26.0 (2.96 to 228) | 0.003 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 4.36 (1.33 to 14.3) | 0.015 |
| Anemia |  |  |
| No | — |  |
| Yes | 4.17 (0.67 to 26.0) | 0.13 |
| Alcohol use disorder |  |  |
| No | — |  |
| Yes | 1.02 (0.34 to 3.03) | 0.97 |
| Obesity |  |  |
| No | — |  |
| Yes | 0.57 (0.18 to 1.78) | 0.34 |
| Rheumatic valvular disease |  |  |
| No | — |  |
| Yes | 2.59 (0.51 to 13.1) | 0.25 |
| Prior stroke |  |  |
| No | — |  |
| Yes | 0.12 (0.03 to 0.47) | 0.002 |
| Prior cardiac surgery |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Pacemaker/ICD |  |  |
| No | — |  |
| Yes | 2.20 (0.13 to 36.9) | 0.58 |
| Tobbacco use disorder |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Tissue plasminogen activator |  |  |
| No | — |  |
| Yes | 0.00 (0.00 to 0.00) | <0.001 |
| Thrombectomy use |  |  |
| No | — |  |
| Yes | 0.29 (0.01 to 7.34) | 0.45 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Atrial fibrillation categories |  |  |
| Ischemic Stroke with Atrial Fibrillation | — |  |
| Ischemic Stroke without Atrial Fibrillation | -0.65 (-1.4 to 0.10) | 0.088 |
| Age, y | -0.02 (-0.05 to 0.01) | 0.20 |
| Sex |  |  |
| Female | — |  |
| Male | 0.35 (-0.21 to 0.91) | 0.22 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 0.49 (-1.1 to 2.0) | 0.54 |
| Black | 0.92 (-0.01 to 1.9) | 0.053 |
| Hispanic | 0.38 (-0.87 to 1.6) | 0.55 |
| Native American | -1.5 (-4.2 to 1.1) | 0.26 |
| Other | 0.75 (-0.79 to 2.3) | 0.34 |
| Charlson comorbidity index | 0.24 (0.05 to 0.43) | 0.015 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.48 (-0.48 to 1.4) | 0.32 |
| $66,000 - $87,999 | -0.09 (-0.86 to 0.68) | 0.83 |
| $88,000 or more | 0.53 (-0.38 to 1.4) | 0.26 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 2.5 (0.47 to 4.5) | 0.016 |
| Medicare | 0.33 (-0.57 to 1.2) | 0.47 |
| Other | 1.2 (-0.46 to 2.9) | 0.16 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.89 (-0.56 to 2.3) | 0.23 |
| South | 0.74 (-0.63 to 2.1) | 0.29 |
| West | 0.11 (-1.3 to 1.6) | 0.88 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | -0.51 (-1.3 to 0.31) | 0.22 |
| Small | -1.5 (-2.4 to -0.65) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | -0.05 (-1.0 to 0.91) | 0.91 |
| Urban, teaching | 1.4 (0.47 to 2.4) | 0.003 |
| Hypertension |  |  |
| No | — |  |
| Yes | -0.17 (-1.4 to 1.0) | 0.78 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.15 (-0.54 to 0.83) | 0.67 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | -0.62 (-1.5 to 0.25) | 0.16 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | -0.15 (-0.96 to 0.65) | 0.71 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.06 (-1.2 to 1.3) | 0.93 |
| Heart failure |  |  |
| No | — |  |
| Yes | 2.2 (0.74 to 3.7) | 0.003 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 0.00 (-1.1 to 1.1) | >0.99 |
| Chronic obstructive pulmonary disease |  |  |
| No | — |  |
| Yes | -0.01 (-0.71 to 0.69) | 0.98 |
| Dementia |  |  |
| No | — |  |
| Yes | 0.48 (-0.36 to 1.3) | 0.26 |
| Cirrhosis |  |  |
| No | — |  |
| Yes | 2.6 (-2.9 to 8.2) | 0.35 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 0.12 (-0.89 to 1.1) | 0.81 |
| Anemia |  |  |
| No | — |  |
| Yes | 1.0 (-0.44 to 2.5) | 0.17 |
| Alcohol use disorder |  |  |
| No | — |  |
| Yes | -0.58 (-1.4 to 0.20) | 0.14 |
| Obesity |  |  |
| No | — |  |
| Yes | -0.91 (-1.6 to -0.24) | 0.007 |
| Rheumatic valvular disease |  |  |
| No | — |  |
| Yes | 0.29 (-1.8 to 2.3) | 0.78 |
| Prior stroke |  |  |
| No | — |  |
| Yes | -0.46 (-1.3 to 0.41) | 0.30 |
| Prior cardiac surgery |  |  |
| No | — |  |
| Yes | -1.2 (-2.3 to -0.06) | 0.038 |
| Pacemaker/ICD |  |  |
| No | — |  |
| Yes | -0.61 (-1.9 to 0.72) | 0.37 |
| Tobbacco use disorder |  |  |
| No | — |  |
| Yes | -0.46 (-2.8 to 1.9) | 0.70 |
| Tissue plasminogen activator |  |  |
| No | — |  |
| Yes | -0.22 (-1.0 to 0.60) | 0.59 |
| Thrombectomy use |  |  |
| No | — |  |
| Yes | 1.3 (-0.17 to 2.7) | 0.083 |
| *1*CI = Confidence Interval | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Atrial fibrillation categories |  |  |
| Ischemic Stroke with Atrial Fibrillation | — |  |
| Ischemic Stroke without Atrial Fibrillation | -8,289 (-19,967 to 3,389) | 0.16 |
| Age, y | -553 (-1,032 to -74) | 0.024 |
| Sex |  |  |
| Female | — |  |
| Male | 8,054 (-509 to 16,617) | 0.065 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 15,845 (-10,356 to 42,046) | 0.24 |
| Black | -1,049 (-12,650 to 10,552) | 0.86 |
| Hispanic | 9,519 (-8,129 to 27,167) | 0.29 |
| Native American | -28,510 (-60,964 to 3,943) | 0.085 |
| Other | 37,149 (-1,735 to 76,034) | 0.061 |
| Charlson comorbidity index | 2,718 (-916 to 6,351) | 0.14 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 2,806 (-10,718 to 16,330) | 0.68 |
| $66,000 - $87,999 | 1,077 (-11,691 to 13,845) | 0.87 |
| $88,000 or more | 3,861 (-11,554 to 19,276) | 0.62 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 25,881 (5,675 to 46,087) | 0.012 |
| Medicare | 9,518 (-1,161 to 20,197) | 0.081 |
| Other | 1,374 (-20,153 to 22,902) | 0.90 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 24,654 (7,916 to 41,393) | 0.004 |
| South | 22,857 (11,584 to 34,130) | <0.001 |
| West | 40,078 (24,158 to 55,997) | <0.001 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | -6,927 (-18,976 to 5,121) | 0.26 |
| Small | -22,612 (-33,541 to -11,683) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 19,595 (7,160 to 32,030) | 0.002 |
| Urban, teaching | 34,430 (22,920 to 45,939) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | -1,268 (-17,788 to 15,253) | 0.88 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 2,081 (-6,978 to 11,140) | 0.65 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | -11,093 (-21,413 to -774) | 0.035 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 3,074 (-8,888 to 15,035) | 0.61 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 151 (-15,676 to 15,978) | 0.99 |
| Heart failure |  |  |
| No | — |  |
| Yes | 22,938 (4,702 to 41,173) | 0.014 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 1,828 (-11,386 to 15,041) | 0.79 |
| Chronic obstructive pulmonary disease |  |  |
| No | — |  |
| Yes | -5,550 (-16,873 to 5,773) | 0.34 |
| Dementia |  |  |
| No | — |  |
| Yes | -4,541 (-16,988 to 7,906) | 0.47 |
| Cirrhosis |  |  |
| No | — |  |
| Yes | 83,037 (-102,849 to 268,923) | 0.38 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 5,681 (-13,995 to 25,356) | 0.57 |
| Anemia |  |  |
| No | — |  |
| Yes | 20,933 (-2,909 to 44,776) | 0.085 |
| Alcohol use disorder |  |  |
| No | — |  |
| Yes | -751 (-12,100 to 10,598) | 0.90 |
| Obesity |  |  |
| No | — |  |
| Yes | -9,052 (-18,275 to 171) | 0.054 |
| Rheumatic valvular disease |  |  |
| No | — |  |
| Yes | 12,176 (-11,238 to 35,590) | 0.31 |
| Prior stroke |  |  |
| No | — |  |
| Yes | -8,430 (-16,606 to -255) | 0.043 |
| Prior cardiac surgery |  |  |
| No | — |  |
| Yes | -20,961 (-38,052 to -3,870) | 0.016 |
| Pacemaker/ICD |  |  |
| No | — |  |
| Yes | -15,117 (-34,551 to 4,318) | 0.13 |
| Tobbacco use disorder |  |  |
| No | — |  |
| Yes | -1,326 (-31,032 to 28,381) | 0.93 |
| Tissue plasminogen activator |  |  |
| No | — |  |
| Yes | 39,082 (23,319 to 54,845) | <0.001 |
| Thrombectomy use |  |  |
| No | — |  |
| Yes | 97,324 (70,383 to 124,265) | <0.001 |
| *1*CI = Confidence Interval | | |