Impact of Body Mass Index on Hospitalization Outcomes in Patients With Acute Ischemic Stroke

Analysis for RCOP NIS Neuro2 group

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## Preamble:

* **Reference Papers:**
  + [Persaud et al.2019](https://www.ahajournals.org/doi/full/10.1161/STROKEAHA.119.024638)
  + [Sreenivasan et al. 2022](https://doi.org/10.1016/j.amjcard.2022.04.011)
* **Study Objective**: Examine the impact of body mass index (BMI) on outcomes among inpatient admissions with acute ischemic stroke (AIS).
* **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 AIS.
* **BMI Categories**:
  + Underweight: BMI ≤19.9 kg/m²
  + Normal Weight: BMI 20.0 to 24.9 kg/m²
  + Overweight: BMI 25.0 to 29.9 kg/m²
  + Class I Obesity: BMI 30.0 to 34.9 kg/m²
  + Class II Obesity: BMI 35.0 to 39.9 kg/m²
  + Class III Obesity: BMI ≥40.0 kg/m²
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
* **Statistical Analysis**: Multiple logistic and linear regression to determine the independent association of BMI categories with in-hospital mortality and length of stay, respectively, adjusted for:
  + Demographics: Age, gender, race
  + Medical History: Previous coronary artery bypass graft, myocardial infarction, percutaneous coronary intervention
  + Comorbidities: Charlson comorbidity index, atrial fibrillation, heart failure, peripheral vascular disease, dementia, tobacco use disorder, chronic obstructive pulmonary disease, valvular heart disease, liver disease, diabetes mellitus, hypertension, chronic kidney disease, hyperlipidemia, and any cancer.
  + Medical Interventions: Administration of IV tissue-type plasminogen activator and utilization of thrombectomy
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Characterstics:

| **Characteristic** | **Normal weight (BMI 20.0-24.9kg/m²)** N = 16,430*1* | **Overall** N = 267,650*1* | **Class I obesity (BMI 30.0-34.9kg/m²)** N = 68,770*1* | **Class II obesity (BMI 35.0-39.9kg/m²)** N = 52,820*1* | **Class III obesity (BMI ≥40.0kg/m²)** N = 72,700*1* | **Overweight (BMI 25.0-29.9kg/m²)** N = 25,820*1* | **Underweight (BMI ≤19.9kg/m²)** N = 31,110*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Age, y | 78 (68, 86) | 67 (57, 76) | 67 (57, 75) | 64 (54, 72) | 62 (52, 70) | 71 (61, 80) | 78 (67, 87) | <0.001 |
| Sex |  |  |  |  |  |  |  | <0.001 |
| Female | 8,425 (51%) | 144,495 (54%) | 31,365 (46%) | 28,105 (53%) | 45,480 (63%) | 12,135 (47%) | 18,985 (61%) |  |
| Male | 8,005 (49%) | 123,150 (46%) | 37,405 (54%) | 24,715 (47%) | 27,215 (37%) | 13,685 (53%) | 12,125 (39%) |  |
| Race |  |  |  |  |  |  |  | <0.001 |
| White | 10,505 (66%) | 170,820 (65%) | 45,020 (67%) | 33,650 (65%) | 45,145 (64%) | 15,765 (63%) | 20,735 (68%) |  |
| Asian or Pacific Islander | 650 (4.1%) | 5,100 (2.0%) | 1,025 (1.5%) | 725 (1.4%) | 515 (0.7%) | 700 (2.8%) | 1,485 (4.9%) |  |
| Black | 2,880 (18%) | 55,815 (21%) | 12,860 (19%) | 11,335 (22%) | 18,125 (26%) | 5,015 (20%) | 5,600 (18%) |  |
| Hispanic | 1,485 (9.3%) | 22,095 (8.5%) | 6,245 (9.3%) | 4,550 (8.8%) | 5,155 (7.3%) | 2,870 (11%) | 1,790 (5.9%) |  |
| Native American | 55 (0.3%) | 1,255 (0.5%) | 320 (0.5%) | 195 (0.4%) | 470 (0.7%) | 95 (0.4%) | 120 (0.4%) |  |
| Other | 405 (2.5%) | 5,900 (2.3%) | 1,545 (2.3%) | 1,090 (2.1%) | 1,410 (2.0%) | 750 (3.0%) | 700 (2.3%) |  |
| Residential income |  |  |  |  |  |  |  | <0.001 |
| $1 - $51,999 | 5,115 (31%) | 87,030 (33%) | 21,100 (31%) | 17,095 (33%) | 25,685 (36%) | 8,140 (32%) | 9,895 (32%) |  |
| $52,000 - $65,999 | 4,490 (28%) | 71,930 (27%) | 18,375 (27%) | 14,485 (28%) | 19,800 (28%) | 6,670 (26%) | 8,110 (26%) |  |
| $66,000 - $87,999 | 3,630 (22%) | 61,345 (23%) | 16,335 (24%) | 12,340 (24%) | 16,235 (23%) | 6,155 (24%) | 6,650 (22%) |  |
| $88,000 or more | 3,010 (19%) | 43,660 (17%) | 12,070 (18%) | 8,195 (16%) | 9,930 (14%) | 4,495 (18%) | 5,960 (19%) |  |
| Expected primary payer |  |  |  |  |  |  |  | <0.001 |
| Private | 2,220 (14%) | 76,275 (29%) | 21,625 (31%) | 18,200 (35%) | 24,105 (33%) | 6,345 (25%) | 3,780 (12%) |  |
| Medicaid | 1,310 (8.0%) | 31,095 (12%) | 6,920 (10%) | 6,685 (13%) | 11,105 (15%) | 2,490 (9.6%) | 2,585 (8.3%) |  |
| Medicare | 12,600 (77%) | 153,715 (57%) | 38,315 (56%) | 26,540 (50%) | 35,675 (49%) | 16,355 (63%) | 24,230 (78%) |  |
| Other | 295 (1.8%) | 6,260 (2.3%) | 1,825 (2.7%) | 1,305 (2.5%) | 1,720 (2.4%) | 620 (2.4%) | 495 (1.6%) |  |
| Hospital region |  |  |  |  |  |  |  | <0.001 |
| East North Central | 3,050 (19%) | 50,525 (19%) | 14,145 (21%) | 10,035 (19%) | 13,700 (19%) | 4,565 (18%) | 5,030 (16%) |  |
| East South Central | 870 (5.3%) | 21,330 (8.0%) | 5,110 (7.4%) | 4,210 (8.0%) | 6,795 (9.3%) | 1,710 (6.6%) | 2,635 (8.5%) |  |
| Middle Atlantic | 2,160 (13%) | 31,405 (12%) | 7,370 (11%) | 5,755 (11%) | 8,670 (12%) | 2,950 (11%) | 4,500 (14%) |  |
| Mountain | 790 (4.8%) | 11,805 (4.4%) | 2,910 (4.2%) | 2,415 (4.6%) | 3,210 (4.4%) | 1,175 (4.6%) | 1,305 (4.2%) |  |
| New England | 755 (4.6%) | 10,340 (3.9%) | 2,770 (4.0%) | 2,100 (4.0%) | 2,365 (3.3%) | 1,065 (4.1%) | 1,285 (4.1%) |  |
| Pacific | 2,280 (14%) | 32,930 (12%) | 8,405 (12%) | 6,785 (13%) | 7,705 (11%) | 3,375 (13%) | 4,380 (14%) |  |
| South Atlantic | 3,290 (20%) | 59,440 (22%) | 15,540 (23%) | 11,705 (22%) | 15,835 (22%) | 6,280 (24%) | 6,790 (22%) |  |
| West North Central | 1,125 (6.8%) | 17,460 (6.5%) | 4,780 (7.0%) | 3,475 (6.6%) | 4,885 (6.7%) | 1,410 (5.5%) | 1,785 (5.7%) |  |
| West South Central | 2,110 (13%) | 32,415 (12%) | 7,740 (11%) | 6,340 (12%) | 9,535 (13%) | 3,290 (13%) | 3,400 (11%) |  |
| Hospital bedsize |  |  |  |  |  |  |  | 0.3 |
| Large | 8,490 (52%) | 143,670 (54%) | 37,440 (54%) | 28,100 (53%) | 39,370 (54%) | 13,745 (53%) | 16,525 (53%) |  |
| Medium | 4,775 (29%) | 74,800 (28%) | 18,840 (27%) | 15,070 (29%) | 20,210 (28%) | 7,310 (28%) | 8,595 (28%) |  |
| Small | 3,165 (19%) | 49,180 (18%) | 12,490 (18%) | 9,650 (18%) | 13,120 (18%) | 4,765 (18%) | 5,990 (19%) |  |
| Hospital location and teaching status |  |  |  |  |  |  |  | <0.001 |
| Rural | 1,000 (6.1%) | 16,735 (6.3%) | 3,870 (5.6%) | 3,330 (6.3%) | 4,885 (6.7%) | 1,375 (5.3%) | 2,275 (7.3%) |  |
| Urban, non-teaching | 2,985 (18%) | 47,040 (18%) | 12,265 (18%) | 9,395 (18%) | 12,195 (17%) | 4,765 (18%) | 5,435 (17%) |  |
| Urban, teaching | 12,445 (76%) | 203,875 (76%) | 52,635 (77%) | 40,095 (76%) | 55,620 (77%) | 19,680 (76%) | 23,400 (75%) |  |
| Hypertension | 13,595 (83%) | 233,375 (87%) | 61,555 (90%) | 47,200 (89%) | 64,340 (89%) | 22,570 (87%) | 24,115 (78%) | <0.001 |
| Diabetes mellitus | 5,405 (33%) | 132,175 (49%) | 35,800 (52%) | 29,585 (56%) | 42,770 (59%) | 12,130 (47%) | 6,485 (21%) | <0.001 |
| Hyperlipidemia | 8,770 (53%) | 172,785 (65%) | 49,065 (71%) | 36,710 (70%) | 46,880 (64%) | 16,910 (65%) | 14,450 (46%) | <0.001 |
| Peripheral vascular disease | 1,860 (11%) | 22,695 (8.5%) | 5,790 (8.4%) | 4,090 (7.7%) | 4,485 (6.2%) | 2,470 (9.6%) | 4,000 (13%) | <0.001 |
| Coronary artery disease | 3,955 (24%) | 60,415 (23%) | 16,610 (24%) | 11,860 (22%) | 14,950 (21%) | 6,250 (24%) | 6,790 (22%) | <0.001 |
| Heart failure | 3,780 (23%) | 57,490 (21%) | 12,465 (18%) | 10,350 (20%) | 18,395 (25%) | 4,940 (19%) | 7,560 (24%) | <0.001 |
| COPD | 2,710 (16%) | 51,880 (19%) | 10,795 (16%) | 9,385 (18%) | 16,575 (23%) | 4,075 (16%) | 8,340 (27%) | <0.001 |
| Chronic kidney disease | 3,690 (22%) | 53,570 (20%) | 13,230 (19%) | 10,085 (19%) | 15,160 (21%) | 5,440 (21%) | 5,965 (19%) | <0.001 |
| Valvular Heart Disease | 2,115 (13%) | 24,015 (9.0%) | 6,090 (8.9%) | 4,020 (7.6%) | 5,210 (7.2%) | 2,810 (11%) | 3,770 (12%) | <0.001 |
| Liver Disease | 505 (3.1%) | 6,400 (2.4%) | 1,465 (2.1%) | 1,055 (2.0%) | 1,725 (2.4%) | 690 (2.7%) | 960 (3.1%) | <0.001 |
| Atrial Fibrillation | 4,220 (26%) | 53,975 (20%) | 12,645 (18%) | 9,125 (17%) | 14,665 (20%) | 5,360 (21%) | 7,960 (26%) | <0.001 |
| Cancer | 1,075 (6.5%) | 7,495 (2.8%) | 1,545 (2.2%) | 1,005 (1.9%) | 1,160 (1.6%) | 915 (3.5%) | 1,795 (5.8%) | <0.001 |
| Dementia | 4,040 (25%) | 22,640 (8.5%) | 3,830 (5.6%) | 2,140 (4.1%) | 1,910 (2.6%) | 3,000 (12%) | 7,720 (25%) | <0.001 |
| Charlson comorbidity index | 4.00 (3.00, 6.00) | 4.00 (3.00, 5.00) | 4.00 (2.00, 5.00) | 4.00 (2.00, 5.00) | 4.00 (3.00, 5.00) | 4.00 (3.00, 5.00) | 4.00 (3.00, 6.00) | <0.001 |
| Prior MI | 1,195 (7.3%) | 19,485 (7.3%) | 5,495 (8.0%) | 4,080 (7.7%) | 4,775 (6.6%) | 1,915 (7.4%) | 2,025 (6.5%) | <0.001 |
| Prior PCI | 955 (5.8%) | 16,920 (6.3%) | 5,220 (7.6%) | 3,725 (7.1%) | 3,885 (5.3%) | 1,835 (7.1%) | 1,300 (4.2%) | <0.001 |
| Prior CABG | 990 (6.0%) | 13,045 (4.9%) | 4,120 (6.0%) | 2,635 (5.0%) | 2,510 (3.5%) | 1,575 (6.1%) | 1,215 (3.9%) | <0.001 |
| Tobbacco use disorder | 145 (0.9%) | 2,450 (0.9%) | 700 (1.0%) | 510 (1.0%) | 585 (0.8%) | 240 (0.9%) | 270 (0.9%) | 0.6 |
| Alcohol Abuse | 5,350 (33%) | 86,170 (32%) | 22,845 (33%) | 16,385 (31%) | 22,555 (31%) | 8,505 (33%) | 10,530 (34%) | <0.001 |
| IV tissue-type plasminogen activator | 1,475 (9.0%) | 34,865 (13%) | 9,265 (13%) | 7,505 (14%) | 10,680 (15%) | 3,370 (13%) | 2,570 (8.3%) | <0.001 |
| Thrombectomy | 715 (4.4%) | 12,845 (4.8%) | 3,255 (4.7%) | 2,395 (4.5%) | 3,910 (5.4%) | 1,230 (4.8%) | 1,340 (4.3%) | 0.005 |
| *1*Median (Q1, Q3); n (%) | | | | | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | | | | | |

## Outcomes Table:

| **Characteristic** | **Normal weight (BMI 20.0-24.9kg/m²)** N = 16,430*1* | **Overall** N = 267,650*1* | **Class I obesity (BMI 30.0-34.9kg/m²)** N = 68,770*1* | **Class II obesity (BMI 35.0-39.9kg/m²)** N = 52,820*1* | **Class III obesity (BMI ≥40.0kg/m²)** N = 72,700*1* | **Overweight (BMI 25.0-29.9kg/m²)** N = 25,820*1* | **Underweight (BMI ≤19.9kg/m²)** N = 31,110*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Died during hospitalization | 925 (5.6%) | 8,495 (3.2%) | 1,380 (2.0%) | 1,110 (2.1%) | 2,115 (2.9%) | 770 (3.0%) | 2,195 (7.1%) | <0.001 |
| Length of stay (days) | 5.0 (3.0, 9.0) | 4.0 (2.0, 6.0) | 3.0 (2.0, 6.0) | 3.0 (2.0, 6.0) | 4.0 (2.0, 6.0) | 4.0 (2.0, 7.0) | 5.0 (3.0, 9.0) | <0.001 |
| Inflation-adjusted total charge ($) | 58,790 (33,838, 107,794) | 48,685 (28,576, 88,709) | 45,731 (27,137, 82,839) | 45,642 (27,481, 81,700) | 48,046 (28,618, 87,611) | 53,344 (29,646, 98,523) | 53,886 (31,443, 100,114) | <0.001 |
| *1*n (%); Median (Q1, Q3) | | | | | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | | | | | |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR***1* | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| BMI |  |  |  |
| Normal weight (BMI 20.0-24.9kg/m²) | — | — |  |
| Class I obesity (BMI 30.0-34.9kg/m²) | 0.51 | 0.41, 0.63 | <0.001 |
| Class II obesity (BMI 35.0-39.9kg/m²) | 0.56 | 0.45, 0.71 | <0.001 |
| Class III obesity (BMI ≥40.0kg/m²) | 0.74 | 0.60, 0.92 | 0.006 |
| Overweight (BMI 25.0-29.9kg/m²) | 0.67 | 0.53, 0.85 | <0.001 |
| Underweight (BMI ≤19.9kg/m²) | 1.20 | 0.99, 1.45 | 0.065 |
| Age, y | 1.02 | 1.02, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.23 | 1.10, 1.36 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.21 | 0.88, 1.65 | 0.2 |
| Black | 0.94 | 0.81, 1.09 | 0.4 |
| Hispanic | 0.91 | 0.74, 1.12 | 0.4 |
| Native American | 0.63 | 0.26, 1.51 | 0.3 |
| Other | 1.10 | 0.79, 1.52 | 0.6 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.90 | 0.79, 1.03 | 0.13 |
| $66,000 - $87,999 | 0.86 | 0.74, 1.00 | 0.048 |
| $88,000 or more | 0.88 | 0.75, 1.04 | 0.15 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 0.99 | 0.80, 1.22 | >0.9 |
| Medicare | 0.98 | 0.84, 1.15 | 0.8 |
| Other | 1.32 | 0.93, 1.89 | 0.12 |
| Hospital region |  |  |  |
| East North Central | — | — |  |
| East South Central | 1.01 | 0.79, 1.29 | >0.9 |
| Middle Atlantic | 0.96 | 0.78, 1.17 | 0.7 |
| Mountain | 0.90 | 0.67, 1.21 | 0.5 |
| New England | 1.15 | 0.88, 1.49 | 0.3 |
| Pacific | 1.31 | 1.08, 1.58 | 0.005 |
| South Atlantic | 0.88 | 0.74, 1.05 | 0.2 |
| West North Central | 0.74 | 0.57, 0.96 | 0.025 |
| West South Central | 0.99 | 0.81, 1.22 | >0.9 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.84 | 0.74, 0.95 | 0.008 |
| Small | 0.68 | 0.57, 0.79 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.81 | 0.62, 1.06 | 0.12 |
| Urban, teaching | 1.14 | 0.91, 1.43 | 0.2 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.68 | 0.59, 0.78 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.86 | 0.75, 0.97 | 0.014 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.57 | 0.51, 0.64 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 1.16 | 1.00, 1.34 | 0.046 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 0.89 | 0.74, 1.06 | 0.2 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.47 | 1.30, 1.66 | <0.001 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 0.85 | 0.75, 0.97 | 0.018 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | 0.80 | 0.70, 0.93 | 0.003 |
| Valvular Heart Disease |  |  |  |
| No | — | — |  |
| Yes | 0.77 | 0.65, 0.92 | 0.004 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 1.60 | 1.23, 2.08 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.37 | 1.21, 1.54 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 0.89 | 0.69, 1.15 | 0.4 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.71, 0.99 | 0.034 |
| Charlson comorbidity index | 1.17 | 1.14, 1.21 | <0.001 |
| Prior MI |  |  |  |
| No | — | — |  |
| Yes | 0.64 | 0.51, 0.81 | <0.001 |
| Prior PCI |  |  |  |
| No | — | — |  |
| Yes | 0.72 | 0.56, 0.94 | 0.014 |
| Prior CABG |  |  |  |
| No | — | — |  |
| Yes | 0.77 | 0.59, 1.01 | 0.060 |
| Tobbacco use disorder |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.51, 1.71 | 0.8 |
| Alcohol Abuse |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.83, 1.05 | 0.3 |
| IV tissue-type plasminogen activator |  |  |  |
| No | — | — |  |
| Yes | 1.04 | 0.90, 1.21 | 0.6 |
| Thrombectomy |  |  |  |
| No | — | — |  |
| Yes | 2.68 | 2.25, 3.19 | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| BMI |  |  |  |
| Normal weight (BMI 20.0-24.9kg/m²) | — | — |  |
| Class I obesity (BMI 30.0-34.9kg/m²) | -2.4 | -2.7, -2.1 | <0.001 |
| Class II obesity (BMI 35.0-39.9kg/m²) | -2.4 | -2.8, -2.1 | <0.001 |
| Class III obesity (BMI ≥40.0kg/m²) | -2.0 | -2.3, -1.7 | <0.001 |
| Overweight (BMI 25.0-29.9kg/m²) | -1.4 | -1.8, -1.0 | <0.001 |
| Underweight (BMI ≤19.9kg/m²) | -0.36 | -0.72, 0.01 | 0.053 |
| Age, y | 0.00 | -0.01, 0.01 | 0.9 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.29 | 0.17, 0.42 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.83 | 0.29, 1.4 | 0.003 |
| Black | 0.81 | 0.63, 0.99 | <0.001 |
| Hispanic | 0.30 | 0.05, 0.54 | 0.017 |
| Native American | -0.43 | -1.2, 0.31 | 0.3 |
| Other | 1.1 | 0.51, 1.7 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -0.20 | -0.37, -0.04 | 0.015 |
| $66,000 - $87,999 | -0.25 | -0.43, -0.08 | 0.004 |
| $88,000 or more | -0.45 | -0.65, -0.24 | <0.001 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.7 | 1.4, 2.1 | <0.001 |
| Medicare | 0.10 | -0.07, 0.27 | 0.3 |
| Other | 0.32 | -0.06, 0.70 | 0.10 |
| Hospital region |  |  |  |
| East North Central | — | — |  |
| East South Central | 0.10 | -0.23, 0.43 | 0.5 |
| Middle Atlantic | 0.49 | 0.24, 0.75 | <0.001 |
| Mountain | -0.29 | -0.60, 0.03 | 0.072 |
| New England | 0.25 | -0.14, 0.63 | 0.2 |
| Pacific | -0.38 | -0.64, -0.13 | 0.003 |
| South Atlantic | 0.56 | 0.33, 0.79 | <0.001 |
| West North Central | -0.40 | -0.64, -0.16 | 0.001 |
| West South Central | 0.18 | -0.07, 0.42 | 0.2 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -0.74 | -0.91, -0.57 | <0.001 |
| Small | -1.3 | -1.4, -1.1 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.57 | 0.32, 0.83 | <0.001 |
| Urban, teaching | 1.5 | 1.2, 1.7 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -0.57 | -0.80, -0.34 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | -0.20 | -0.34, -0.05 | 0.007 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -0.76 | -0.90, -0.62 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 0.10 | -0.08, 0.28 | 0.3 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -0.31 | -0.52, -0.09 | 0.005 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 0.88 | 0.71, 1.1 | <0.001 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | -0.52 | -0.67, -0.38 | <0.001 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | -0.45 | -0.65, -0.26 | <0.001 |
| Valvular Heart Disease |  |  |  |
| No | — | — |  |
| Yes | 0.15 | -0.06, 0.36 | 0.2 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 0.55 | 0.07, 1.0 | 0.024 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 0.42 | 0.26, 0.57 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | -0.44 | -0.79, -0.09 | 0.014 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.68 | 0.42, 0.94 | <0.001 |
| Charlson comorbidity index | 0.40 | 0.35, 0.44 | <0.001 |
| Prior MI |  |  |  |
| No | — | — |  |
| Yes | -0.87 | -1.1, -0.65 | <0.001 |
| Prior PCI |  |  |  |
| No | — | — |  |
| Yes | -0.48 | -0.69, -0.26 | <0.001 |
| Prior CABG |  |  |  |
| No | — | — |  |
| Yes | -0.43 | -0.64, -0.21 | <0.001 |
| Tobbacco use disorder |  |  |  |
| No | — | — |  |
| Yes | 0.33 | -0.51, 1.2 | 0.4 |
| Alcohol Abuse |  |  |  |
| No | — | — |  |
| Yes | 0.25 | 0.09, 0.40 | 0.002 |
| IV tissue-type plasminogen activator |  |  |  |
| No | — | — |  |
| Yes | -0.33 | -0.49, -0.17 | <0.001 |
| Thrombectomy |  |  |  |
| No | — | — |  |
| Yes | 3.2 | 2.8, 3.6 | <0.001 |
| *1*CI = Confidence Interval | | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| BMI |  |  |  |
| Normal weight (BMI 20.0-24.9kg/m²) | — | — |  |
| Class I obesity (BMI 30.0-34.9kg/m²) | -21,429 | -25,370, -17,489 | <0.001 |
| Class II obesity (BMI 35.0-39.9kg/m²) | -23,013 | -27,071, -18,956 | <0.001 |
| Class III obesity (BMI ≥40.0kg/m²) | -17,983 | -22,219, -13,747 | <0.001 |
| Overweight (BMI 25.0-29.9kg/m²) | -9,227 | -13,962, -4,492 | <0.001 |
| Underweight (BMI ≤19.9kg/m²) | -5,095 | -9,482, -707 | 0.023 |
| Age, y | -364 | -458, -270 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 4,208 | 2,445, 5,970 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 12,630 | 4,444, 20,816 | 0.003 |
| Black | 5,183 | 2,503, 7,863 | <0.001 |
| Hispanic | 19,514 | 14,273, 24,755 | <0.001 |
| Native American | -21,870 | -29,157, -14,582 | <0.001 |
| Other | 24,574 | 15,941, 33,206 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -2,441 | -5,020, 138 | 0.064 |
| $66,000 - $87,999 | -3,096 | -5,858, -335 | 0.028 |
| $88,000 or more | -2,225 | -5,800, 1,351 | 0.2 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 13,630 | 9,715, 17,545 | <0.001 |
| Medicare | 4,714 | 2,344, 7,084 | <0.001 |
| Other | 3,725 | -2,911, 10,360 | 0.3 |
| Hospital region |  |  |  |
| East North Central | — | — |  |
| East South Central | 4,095 | -958, 9,148 | 0.11 |
| Middle Atlantic | 30,469 | 25,024, 35,915 | <0.001 |
| Mountain | 27,042 | 19,108, 34,975 | <0.001 |
| New England | -7,078 | -12,340, -1,816 | 0.008 |
| Pacific | 33,463 | 28,061, 38,865 | <0.001 |
| South Atlantic | 13,098 | 9,452, 16,743 | <0.001 |
| West North Central | -1,846 | -5,465, 1,773 | 0.3 |
| West South Central | 20,885 | 15,663, 26,107 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -5,900 | -9,439, -2,360 | 0.001 |
| Small | -14,656 | -17,709, -11,603 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 22,745 | 19,191, 26,299 | <0.001 |
| Urban, teaching | 29,576 | 26,929, 32,223 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -8,911 | -12,400, -5,422 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | -2,046 | -4,125, 33 | 0.054 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -6,777 | -8,689, -4,864 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 3,495 | 1,169, 5,821 | 0.003 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -1,544 | -4,613, 1,526 | 0.3 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 11,347 | 8,653, 14,041 | <0.001 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | -4,162 | -6,259, -2,065 | <0.001 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | -6,899 | -9,457, -4,341 | <0.001 |
| Valvular Heart Disease |  |  |  |
| No | — | — |  |
| Yes | -1,659 | -4,309, 990 | 0.2 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 12,560 | 1,668, 23,452 | 0.024 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 5,962 | 3,813, 8,110 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | -1,768 | -6,551, 3,015 | 0.5 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | -4,793 | -7,400, -2,186 | <0.001 |
| Charlson comorbidity index | 3,941 | 3,314, 4,567 | <0.001 |
| Prior MI |  |  |  |
| No | — | — |  |
| Yes | -13,215 | -16,043, -10,388 | <0.001 |
| Prior PCI |  |  |  |
| No | — | — |  |
| Yes | -5,784 | -8,711, -2,857 | <0.001 |
| Prior CABG |  |  |  |
| No | — | — |  |
| Yes | -3,839 | -7,195, -484 | 0.025 |
| Tobbacco use disorder |  |  |  |
| No | — | — |  |
| Yes | -491 | -9,038, 8,055 | >0.9 |
| Alcohol Abuse |  |  |  |
| No | — | — |  |
| Yes | 4,838 | 1,567, 8,108 | 0.004 |
| IV tissue-type plasminogen activator |  |  |  |
| No | — | — |  |
| Yes | 32,746 | 29,771, 35,721 | <0.001 |
| Thrombectomy |  |  |  |
| No | — | — |  |
| Yes | 129,795 | 120,074, 139,516 | <0.001 |
| *1*CI = Confidence Interval | | | |