Impact of Chronic Kidney Disease on In-Hospital Outcomes and Resource Utilization Among Patients Hospitalized for AMI

Analysis for RCOP NIS Cardio6

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## Preamble:

* **Reference Papers:**
  + [Smilowitz et al. 2017](https://doi.org/10.1016/j.ijcard.2016.11.026)
  + [Salman et al. 2025](https://doi.org/10.1097/MCA.0000000000001479)
* **Study Objective**: To examine the association between chronic kidney disease (CKD) and inpatient outcomes for acute myocardial infarction (AMI) in U.S. hospitals from 2018 to 2020, adjusting for demographic, socioeconomic, clinical, and hospital-related factors.
* **Data Source**: Cross-sectional analysis using the National Inpatient Sample (NIS) database from 2018 to 2020, a representative sample of all-payer inpatient hospitalizations in the U.S.
* **Patient Selection**: Included all inpatient admissions for AMI, identified using ICD-10 diagnosis codes. Patients were categorized into two groups: those with CKD and those without.
* **Outcomes of Interest:**
  + In-hospital Mortality
  + Length of Stay (days)
  + Inflation-adjusted Total Charge ($) [adjusted to 2020 dollars, using CPI data by the U.S. Bureau of Labor Statistics]
  + Any Complication of AMI (Includes hemopericardium, atrial septal defect, ventricular septal defect, rupture of cardiac wall, rupture of chordae tendineae, rupture of papillary muscle, thrombosis of atrium/auricular appendage/ventricle, postinfarction angina, other complications, and Dressler’s syndrome)
  + Coronary Artery Bypass Grafting (CABG) Procedure
  + Percutaneous Coronary Intervention (PCI) Procedure
  + Acute Kidney Injury (AKI)
  + Ischemic Stroke
* **Statistical Analysis**: Univariable and multivariable analyses were conducted to evaluate the association between race and outcomes:
  + **Univariable Analysis:**
    - Continuous variables: Design-based Kruskal-Wallis test.
    - Categorical variables: Pearson’s X² test with Rao & Scott adjustment to account for survey design.
  + **Multivariable Analysis:**
    - Logistic regression for binary outcomes (e.g., in-hospital mortality, AKI, ischemic stroke).
    - Linear regression for continuous outcomes (e.g., length of stay, total charges).
  + **Adjustments:** Models controlled for the following covariates:
    - **Demographics and Socioeconomic Factors**: Age, Sex, Race, Residential income, Expected primary payer.
    - **Clinical Factors:** Charlson comorbidity index, Hypertension, Obesity, Diabetes Mellitus, Chronic Pulmonary Disease, Liver Disease, Peripheral Vascular Disease, Hyperlipidemia, Previous Heart Failure, Atrial Fibrillation, Smoking, Previous Stroke/TIA, Previous PCI, Previous CABG.
    - **Hospital-Level Factors:** Hospital region, Hospital bedsize, Hospital location and teaching status.
* **Software:** All statistical analyses were performed using R Statistical Language (Version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria), incorporating survey-weighted procedures via the *survey* package to account for the complex sampling design of NIS.

## Baseline Table:

| **Characteristic** | **Overall** N = 1,894,160*1* | **AMI without CKD** N = 1,433,035*1* | **AMI with CKD** N = 461,125*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 67 (13) | 65 (13) | 72 (12) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 702,145 (37%) | 526,065 (37%) | 176,080 (38%) |  |
| Male | 1,191,940 (63%) | 906,910 (63%) | 285,030 (62%) |  |
| Race |  |  |  | <0.001 |
| Asian or Pacific Islander | 52,155 (2.8%) | 35,655 (2.6%) | 16,500 (3.7%) |  |
| Black | 210,205 (11%) | 139,850 (10%) | 70,355 (16%) |  |
| Hispanic | 165,065 (9.0%) | 121,320 (8.7%) | 43,745 (9.7%) |  |
| Native American | 11,255 (0.6%) | 8,225 (0.6%) | 3,030 (0.7%) |  |
| Other | 56,120 (3.1%) | 44,010 (3.2%) | 12,110 (2.7%) |  |
| White | 1,344,600 (73%) | 1,040,180 (75%) | 304,420 (68%) |  |
| Residential income |  |  |  | <0.001 |
| $1 - $51,999 | 571,040 (31%) | 425,545 (30%) | 145,495 (32%) |  |
| $52,000 - $65,999 | 515,875 (28%) | 390,375 (28%) | 125,500 (28%) |  |
| $66,000 - $87,999 | 435,135 (23%) | 331,000 (24%) | 104,135 (23%) |  |
| $88,000 or more | 338,645 (18%) | 260,000 (18%) | 78,645 (17%) |  |
| Expected primary payer |  |  |  | <0.001 |
| Medicaid | 182,120 (9.6%) | 150,500 (11%) | 31,620 (6.9%) |  |
| Medicare | 1,068,990 (57%) | 718,720 (50%) | 350,270 (76%) |  |
| Other | 156,150 (8.3%) | 135,695 (9.5%) | 20,455 (4.4%) |  |
| Private | 484,075 (26%) | 425,780 (30%) | 58,295 (13%) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 423,055 (22%) | 314,560 (22%) | 108,495 (24%) |  |
| Northeast | 321,135 (17%) | 246,235 (17%) | 74,900 (16%) |  |
| South | 785,340 (41%) | 600,715 (42%) | 184,625 (40%) |  |
| West | 364,630 (19%) | 271,525 (19%) | 93,105 (20%) |  |
| Hospital bedsize |  |  |  | 0.7 |
| Large | 953,780 (50%) | 721,050 (50%) | 232,730 (50%) |  |
| Medium | 574,065 (30%) | 435,025 (30%) | 139,040 (30%) |  |
| Small | 366,315 (19%) | 276,960 (19%) | 89,355 (19%) |  |
| Hospital location and teaching status |  |  |  | <0.001 |
| Rural | 143,995 (7.6%) | 109,840 (7.7%) | 34,155 (7.4%) |  |
| Urban, non-teaching | 371,575 (20%) | 283,550 (20%) | 88,025 (19%) |  |
| Urban, teaching | 1,378,590 (73%) | 1,039,645 (73%) | 338,945 (74%) |  |
| Charlson comorbidity index | 3.18 (2.03) | 2.36 (1.39) | 5.72 (1.56) | <0.001 |
| Chronic Kidney Disease Stage |  |  |  |  |
| CKD, Stage 1 | 2,360 (0.6%) | 0 (NA%) | 2,360 (0.6%) |  |
| CKD, Stage 2 | 25,125 (6.7%) | 0 (NA%) | 25,125 (6.7%) |  |
| CKD, Stage 3 | 205,455 (55%) | 0 (NA%) | 205,455 (55%) |  |
| CKD, Stage 4 | 52,400 (14%) | 0 (NA%) | 52,400 (14%) |  |
| CKD, Stage 5 | 6,325 (1.7%) | 0 (NA%) | 6,325 (1.7%) |  |
| ESRD | 81,195 (22%) | 0 (NA%) | 81,195 (22%) |  |
| Hypertension | 1,555,090 (82%) | 1,115,635 (78%) | 439,455 (95%) | <0.001 |
| Obesity | 404,395 (21%) | 302,975 (21%) | 101,420 (22%) | <0.001 |
| Diabetes Mellitus | 780,095 (41%) | 497,495 (35%) | 282,600 (61%) | <0.001 |
| Chronic Pulmonary Disease | 410,215 (22%) | 289,505 (20%) | 120,710 (26%) | <0.001 |
| Liver Disease | 78,840 (4.2%) | 55,145 (3.8%) | 23,695 (5.1%) | <0.001 |
| Peripheral Vascular Disease | 213,740 (11%) | 135,125 (9.4%) | 78,615 (17%) | <0.001 |
| Hyperlipidemia | 1,298,935 (69%) | 968,565 (68%) | 330,370 (72%) | <0.001 |
| Previous Heart Failure | 268,755 (14%) | 160,705 (11%) | 108,050 (23%) | <0.001 |
| Atrial Fibrillation | 381,615 (20%) | 245,950 (17%) | 135,665 (29%) | <0.001 |
| Smoking | 379,510 (20%) | 328,740 (23%) | 50,770 (11%) | <0.001 |
| Previous Stroke/TIA | 188,515 (10.0%) | 118,210 (8.2%) | 70,305 (15%) | <0.001 |
| Previous PCI | 330,160 (17%) | 230,405 (16%) | 99,755 (22%) | <0.001 |
| Previous CABG | 182,995 (9.7%) | 111,870 (7.8%) | 71,125 (15%) | <0.001 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Univariable Analysis:

| **Characteristic** | **Overall** N = 1,894,160*1* | **AMI without CKD** N = 1,433,035*1* | **AMI with CKD** N = 461,125*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 88,290 (4.7%) | 55,985 (3.9%) | 32,305 (7.0%) | <0.001 |
| Length of stay (days) | 3.0 (2.0, 5.0) | 2.0 (2.0, 4.0) | 4.0 (2.0, 7.0) | <0.001 |
| Inflation-adjusted total charge ($) | 72,340 (40,656, 126,134) | 72,552 (41,977, 123,296) | 71,592 (36,558, 136,576) | 0.4 |
| Any complication of AMI | 15,280 (0.8%) | 12,355 (0.9%) | 2,925 (0.6%) | <0.001 |
| CABG | 168,650 (8.9%) | 129,120 (9.0%) | 39,530 (8.6%) | <0.001 |
| PCI | 931,570 (49%) | 764,595 (53%) | 166,975 (36%) | <0.001 |
| Acute Kidney Injury | 392,175 (21%) | 181,175 (13%) | 211,000 (46%) | <0.001 |
| Ischemic Stroke | 23,795 (1.3%) | 16,735 (1.2%) | 7,060 (1.5%) | <0.001 |
| *1*n (%); Median (Q1, Q3) | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | |

## Multivariable Logistic Regression:

### In-hospital Mortality:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | 1.03 | 0.98, 1.08 | 0.3 |
| Age, y | 1.04 | 1.04, 1.04 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.97 | 0.93, 1.00 | 0.053 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | 0.84 | 0.75, 0.93 | <0.001 |
| Hispanic | 0.81 | 0.73, 0.90 | <0.001 |
| Native American | 0.94 | 0.75, 1.18 | 0.6 |
| Other | 1.03 | 0.91, 1.17 | 0.6 |
| White | 0.86 | 0.79, 0.94 | 0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.99 | 0.95, 1.04 | 0.7 |
| $66,000 - $87,999 | 0.96 | 0.91, 1.00 | 0.062 |
| $88,000 or more | 0.94 | 0.89, 0.99 | 0.018 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 0.94 | 0.87, 1.01 | 0.10 |
| Other | 1.18 | 1.08, 1.29 | <0.001 |
| Private | 0.85 | 0.79, 0.92 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.98 | 0.93, 1.03 | 0.5 |
| South | 1.06 | 1.02, 1.11 | 0.008 |
| West | 1.06 | 1.00, 1.12 | 0.034 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.91 | 0.88, 0.95 | <0.001 |
| Small | 0.79 | 0.75, 0.83 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.11 | 1.03, 1.20 | 0.005 |
| Urban, teaching | 1.30 | 1.22, 1.39 | <0.001 |
| Charlson comorbidity index | 1.15 | 1.13, 1.16 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.63 | 0.60, 0.66 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.77 | 0.73, 0.81 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.96 | 0.92, 1.00 | 0.081 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.88, 0.96 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 5.59 | 5.31, 5.89 | <0.001 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | 1.09 | 1.03, 1.14 | 0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.49 | 0.47, 0.51 | <0.001 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 0.84 | 0.80, 0.88 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.34 | 1.29, 1.39 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.75, 0.84 | <0.001 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.94, 1.05 | 0.8 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.72, 0.79 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.88, 0.99 | 0.017 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Any Complication of AMI:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | 0.61 | 0.54, 0.69 | <0.001 |
| Age, y | 0.99 | 0.99, 1.00 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.14 | 1.05, 1.23 | 0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | 0.95 | 0.72, 1.24 | 0.7 |
| Hispanic | 1.05 | 0.81, 1.37 | 0.7 |
| Native American | 1.13 | 0.68, 1.90 | 0.6 |
| Other | 1.12 | 0.83, 1.53 | 0.5 |
| White | 1.13 | 0.88, 1.44 | 0.3 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.11 | 1.00, 1.23 | 0.051 |
| $66,000 - $87,999 | 1.05 | 0.94, 1.17 | 0.4 |
| $88,000 or more | 1.15 | 1.02, 1.30 | 0.024 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 0.80 | 0.70, 0.93 | 0.003 |
| Other | 0.99 | 0.84, 1.16 | 0.9 |
| Private | 0.90 | 0.79, 1.03 | 0.13 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.96 | 0.84, 1.09 | 0.5 |
| South | 0.81 | 0.73, 0.91 | <0.001 |
| West | 0.93 | 0.82, 1.07 | 0.3 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.84 | 0.76, 0.92 | <0.001 |
| Small | 0.72 | 0.64, 0.82 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.04 | 0.86, 1.25 | 0.7 |
| Urban, teaching | 1.11 | 0.95, 1.31 | 0.2 |
| Charlson comorbidity index | 1.14 | 1.11, 1.17 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.72, 0.86 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.83, 1.01 | 0.074 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.88 | 0.80, 0.96 | 0.004 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | 0.73 | 0.65, 0.81 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 1.52 | 1.31, 1.77 | <0.001 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.81, 1.05 | 0.2 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.91, 1.07 | 0.7 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 0.82 | 0.73, 0.92 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.24 | 1.12, 1.36 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | 1.04 | 0.95, 1.15 | 0.4 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.72, 0.95 | 0.007 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.74, 0.93 | 0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.50 | 0.42, 0.60 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### CABG:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | 0.75 | 0.72, 0.79 | <0.001 |
| Age, y | 0.99 | 0.99, 0.99 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.76 | 1.72, 1.81 | <0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | 0.55 | 0.50, 0.60 | <0.001 |
| Hispanic | 0.78 | 0.71, 0.86 | <0.001 |
| Native American | 0.97 | 0.80, 1.17 | 0.7 |
| Other | 0.84 | 0.75, 0.94 | 0.002 |
| White | 0.85 | 0.78, 0.92 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.03 | 0.99, 1.07 | 0.2 |
| $66,000 - $87,999 | 0.95 | 0.90, 0.99 | 0.016 |
| $88,000 or more | 0.92 | 0.87, 0.98 | 0.006 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 1.06 | 1.00, 1.11 | 0.033 |
| Other | 1.05 | 0.99, 1.12 | 0.10 |
| Private | 1.12 | 1.07, 1.18 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.95 | 0.88, 1.03 | 0.2 |
| South | 1.25 | 1.16, 1.33 | <0.001 |
| West | 0.94 | 0.87, 1.02 | 0.13 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.66 | 0.62, 0.70 | <0.001 |
| Small | 0.44 | 0.41, 0.48 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 2.06 | 1.70, 2.50 | <0.001 |
| Urban, teaching | 3.82 | 3.20, 4.55 | <0.001 |
| Charlson comorbidity index | 1.06 | 1.04, 1.07 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 1.38 | 1.32, 1.44 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 1.46 | 1.42, 1.51 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 1.37 | 1.33, 1.42 | <0.001 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | 1.05 | 1.01, 1.09 | 0.008 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 0.96, 1.09 | 0.4 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | 1.22 | 1.17, 1.28 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 1.55 | 1.49, 1.61 | <0.001 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 0.66 | 0.63, 0.68 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 2.67 | 2.59, 2.75 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.96, 1.02 | 0.5 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | 0.77 | 0.73, 0.80 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 0.71 | 0.68, 0.74 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.16 | 0.15, 0.18 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### PCI:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | 1.09 | 1.06, 1.12 | <0.001 |
| Age, y | 0.99 | 0.99, 0.99 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.41 | 1.39, 1.43 | <0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | 0.80 | 0.76, 0.84 | <0.001 |
| Hispanic | 0.95 | 0.90, 1.01 | 0.083 |
| Native American | 1.19 | 1.07, 1.32 | 0.002 |
| Other | 1.22 | 1.15, 1.31 | <0.001 |
| White | 1.23 | 1.17, 1.29 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.04 | 1.01, 1.06 | 0.002 |
| $66,000 - $87,999 | 1.06 | 1.04, 1.09 | <0.001 |
| $88,000 or more | 1.06 | 1.03, 1.09 | <0.001 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 1.18 | 1.15, 1.22 | <0.001 |
| Other | 1.19 | 1.15, 1.23 | <0.001 |
| Private | 1.30 | 1.26, 1.34 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.74 | 0.71, 0.78 | <0.001 |
| South | 0.87 | 0.84, 0.90 | <0.001 |
| West | 0.83 | 0.80, 0.87 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.87 | 0.85, 0.90 | <0.001 |
| Small | 0.68 | 0.65, 0.71 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.36 | 1.27, 1.45 | <0.001 |
| Urban, teaching | 1.67 | 1.57, 1.77 | <0.001 |
| Charlson comorbidity index | 0.84 | 0.84, 0.85 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.90 | 0.89, 0.92 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.95 | 0.93, 0.97 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 1.21 | 1.19, 1.23 | <0.001 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | 0.88 | 0.87, 0.90 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.96, 1.03 | 0.9 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | 0.97 | 0.94, 0.99 | 0.010 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 1.44 | 1.41, 1.46 | <0.001 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 0.72 | 0.70, 0.73 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 0.62 | 0.60, 0.63 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | 1.27 | 1.24, 1.29 | <0.001 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | 0.84 | 0.82, 0.86 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.92, 0.96 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.72 | 0.70, 0.74 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Acute Kidney Injury:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | 3.00 | 2.91, 3.10 | <0.001 |
| Age, y | 1.02 | 1.02, 1.02 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.25 | 1.23, 1.28 | <0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | 1.14 | 1.07, 1.21 | <0.001 |
| Hispanic | 0.98 | 0.93, 1.05 | 0.6 |
| Native American | 0.85 | 0.75, 0.97 | 0.015 |
| Other | 1.07 | 1.00, 1.15 | 0.060 |
| White | 0.96 | 0.91, 1.01 | 0.12 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.98 | 0.96, 1.01 | 0.13 |
| $66,000 - $87,999 | 0.98 | 0.95, 1.00 | 0.086 |
| $88,000 or more | 0.99 | 0.95, 1.02 | 0.4 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 0.75 | 0.72, 0.78 | <0.001 |
| Other | 0.87 | 0.83, 0.91 | <0.001 |
| Private | 0.74 | 0.71, 0.77 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.97 | 0.93, 1.01 | 0.15 |
| South | 1.10 | 1.07, 1.14 | <0.001 |
| West | 0.99 | 0.95, 1.03 | 0.6 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.94 | 0.91, 0.96 | <0.001 |
| Small | 0.87 | 0.84, 0.90 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.23 | 1.16, 1.29 | <0.001 |
| Urban, teaching | 1.44 | 1.37, 1.51 | <0.001 |
| Charlson comorbidity index | 1.20 | 1.19, 1.21 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 1.04 | 1.02, 1.08 | 0.003 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 1.13 | 1.11, 1.16 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 1.01 | 0.99, 1.03 | 0.5 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.90, 0.95 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 3.15 | 3.01, 3.28 | <0.001 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.89, 0.95 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.73 | 0.72, 0.75 | <0.001 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 0.96 | 0.94, 0.99 | 0.006 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.38 | 1.35, 1.41 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | 0.88 | 0.86, 0.91 | <0.001 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.91, 0.96 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 0.81 | 0.79, 0.83 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.88 | 0.85, 0.90 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Ischemic Stroke:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | 0.23 | 0.21, 0.25 | <0.001 |
| Age, y | 1.00 | 1.00, 1.01 | 0.3 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.78 | 0.73, 0.83 | <0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | 0.73 | 0.60, 0.88 | 0.001 |
| Hispanic | 0.75 | 0.62, 0.91 | 0.004 |
| Native American | 0.44 | 0.26, 0.75 | 0.002 |
| Other | 0.93 | 0.73, 1.18 | 0.5 |
| White | 0.72 | 0.61, 0.85 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.96 | 0.89, 1.05 | 0.4 |
| $66,000 - $87,999 | 0.98 | 0.89, 1.07 | 0.6 |
| $88,000 or more | 0.93 | 0.84, 1.03 | 0.2 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 0.81 | 0.71, 0.92 | <0.001 |
| Other | 1.09 | 0.93, 1.27 | 0.3 |
| Private | 0.80 | 0.70, 0.90 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.90 | 0.81, 1.00 | 0.061 |
| South | 1.04 | 0.95, 1.13 | 0.4 |
| West | 0.97 | 0.87, 1.07 | 0.5 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.88 | 0.82, 0.95 | <0.001 |
| Small | 0.72 | 0.65, 0.79 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.26 | 1.07, 1.49 | 0.006 |
| Urban, teaching | 1.54 | 1.33, 1.79 | <0.001 |
| Charlson comorbidity index | 1.81 | 1.78, 1.83 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.97 | 0.89, 1.07 | 0.6 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.84 | 0.77, 0.92 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.56 | 0.52, 0.60 | <0.001 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | 0.40 | 0.37, 0.44 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 1.14 | 1.01, 1.29 | 0.029 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | 0.65 | 0.60, 0.72 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.74, 0.85 | <0.001 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.76, 0.90 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.56 | 1.45, 1.68 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.84, 1.02 | 0.12 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | 1.58 | 1.45, 1.72 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 0.66 | 0.60, 0.73 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.71 | 0.63, 0.81 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | -0.69 | -0.77, -0.61 | <0.001 |
| Age, y | 0.00 | 0.00, 0.01 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.17 | 0.13, 0.20 | <0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | -0.47 | -0.61, -0.32 | <0.001 |
| Hispanic | -0.27 | -0.42, -0.12 | <0.001 |
| Native American | -0.34 | -0.61, -0.07 | 0.013 |
| Other | -0.17 | -0.35, 0.01 | 0.071 |
| White | -0.52 | -0.66, -0.38 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -0.08 | -0.13, -0.03 | 0.003 |
| $66,000 - $87,999 | -0.17 | -0.23, -0.11 | <0.001 |
| $88,000 or more | -0.23 | -0.30, -0.16 | <0.001 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | -0.37 | -0.46, -0.29 | <0.001 |
| Other | -0.45 | -0.54, -0.37 | <0.001 |
| Private | -0.52 | -0.59, -0.44 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.39 | 0.29, 0.49 | <0.001 |
| South | 0.31 | 0.23, 0.39 | <0.001 |
| West | -0.36 | -0.45, -0.28 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -0.72 | -0.79, -0.65 | <0.001 |
| Small | -1.2 | -1.3, -1.1 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.82 | 0.71, 0.93 | <0.001 |
| Urban, teaching | 1.6 | 1.5, 1.7 | <0.001 |
| Charlson comorbidity index | 0.75 | 0.72, 0.77 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.07 | 0.02, 0.12 | 0.007 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.28 | 0.24, 0.32 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | -0.43 | -0.48, -0.38 | <0.001 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | -0.22 | -0.28, -0.17 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 2.2 | 2.0, 2.3 | <0.001 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | -0.34 | -0.41, -0.27 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -0.42 | -0.47, -0.37 | <0.001 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | -0.21 | -0.27, -0.15 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.8 | 1.7, 1.8 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | -0.33 | -0.37, -0.29 | <0.001 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | -0.25 | -0.31, -0.20 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | -0.64 | -0.68, -0.60 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | -1.0 | -1.1, -0.97 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |

### Inflation-adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease |  |  |  |
| AMI without CKD | — | — |  |
| AMI with CKD | -14,424 | -16,654, -12,195 | <0.001 |
| Age, y | -567 | -620, -514 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 15,319 | 14,356, 16,282 | <0.001 |
| Race |  |  |  |
| Asian or Pacific Islander | — | — |  |
| Black | -26,690 | -32,535, -20,846 | <0.001 |
| Hispanic | -2,132 | -8,450, 4,185 | 0.5 |
| Native American | -26,770 | -35,420, -18,120 | <0.001 |
| Other | 4,397 | -3,167, 11,961 | 0.3 |
| White | -17,155 | -22,932, -11,378 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -185 | -2,171, 1,801 | 0.9 |
| $66,000 - $87,999 | -1,112 | -3,487, 1,263 | 0.4 |
| $88,000 or more | 2,500 | -779, 5,779 | 0.14 |
| Expected primary payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 1,540 | -654, 3,733 | 0.2 |
| Other | 680 | -1,936, 3,296 | 0.6 |
| Private | 285 | -1,966, 2,535 | 0.8 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 10,008 | 5,334, 14,682 | <0.001 |
| South | 22,505 | 19,288, 25,721 | <0.001 |
| West | 37,775 | 32,601, 42,948 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -14,156 | -18,165, -10,147 | <0.001 |
| Small | -28,428 | -32,293, -24,564 | <0.001 |
| Hospital location and teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 34,756 | 30,423, 39,089 | <0.001 |
| Urban, teaching | 47,460 | 43,596, 51,324 | <0.001 |
| Charlson comorbidity index | 8,839 | 8,133, 9,545 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 1,603 | 160, 3,047 | 0.030 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 5,796 | 4,403, 7,189 | <0.001 |
| Diabetes Mellitus |  |  |  |
| No | — | — |  |
| Yes | 663 | -715, 2,040 | 0.3 |
| Chronic Pulmonary Disease |  |  |  |
| No | — | — |  |
| Yes | -4,704 | -6,107, -3,302 | <0.001 |
| Liver Disease |  |  |  |
| No | — | — |  |
| Yes | 80,884 | 75,203, 86,564 | <0.001 |
| Peripheral Vascular Disease |  |  |  |
| No | — | — |  |
| Yes | -1,183 | -3,100, 734 | 0.2 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -2,010 | -3,375, -645 | 0.004 |
| Previous Heart Failure |  |  |  |
| No | — | — |  |
| Yes | -10,795 | -12,330, -9,260 | <0.001 |
| Atrial Fibrillation |  |  |  |
| No | — | — |  |
| Yes | 30,568 | 28,879, 32,257 | <0.001 |
| Smoking |  |  |  |
| No | — | — |  |
| Yes | -8,818 | -10,151, -7,485 | <0.001 |
| Previous Stroke/TIA |  |  |  |
| No | — | — |  |
| Yes | -12,195 | -13,541, -10,850 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | -14,880 | -16,115, -13,644 | <0.001 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | -28,189 | -29,629, -26,750 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |