Impact of Chronic Kidney Disease on In-Hospital Outcomes in Patients with Sepsis

Analysis for RCOP NIS IM13

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## Preamble:

* **Reference Studies:**
  + [Panchal et al., 2021](https://doi.org/10.1016/j.amjcard.2021.03.057)
* **Study Objective:**
* To evaluate the impact of chronic kidney disease (CKD) on clinical and economic outcomes among adult patients hospitalized with sepsis in the United States. Specifically, this study assesses whether CKD status (no CKD, CKD without dialysis, and CKD with dialysis/ESRD) is associated with in-hospital mortality, length of stay (LOS), hospital charges, discharge disposition, and the occurrence of acute complications including acute kidney injury (AKI), mechanical ventilation, and vasopressor use.
* **Data Source:**
* A retrospective cohort study of the 2018–2020 Nationwide Inpatient Sample (NIS), developed by the Healthcare Cost and Utilization Project (HCUP). The NIS is the largest publicly available all-payer inpatient database in the United States, representing a 20% stratified sample of discharges from U.S. community hospitals and enabling generation of national estimates through survey-weighted analyses. NIS provides de-identified discharge-level records with rich information on patient demographics, hospital characteristics, diagnoses, procedures, and outcomes.
* **Cohort Definition:**
* Index hospitalizations were included if they met all of the following criteria:
  + Adults aged ≥18 years
  + Principal diagnosis of sepsis,identified using explicit ICD-10-CM codes for septicemia and systemic infection (A40*, A41*, R65.20, R65.21)
* **CKD Exposure Categories:**
  + No CKD (no N18 codes)
  + CKD without dialysis: ICD-10-CM N18.1–N18.5 and N18.9
  + CKD with dialysis (ESRD): ICD-10-CM N18.6
* **Outcomes of Interest:**
  + Primary Outcome:
    - In-hospital mortality
  + Secondary Outcomes:
    - Length of stay (LOS, days)
    - Inflation-adjusted total hospital charges (U.S. dollars, adjusted to 2020 using CPI)
    - Non-home discharge (e.g., SNF, hospice, other facilities, or death)
    - Mechanical ventilation
    - Vasopressor use
    - Acute kidney injury
* **Covariates and Variable Construction:**
  + Demographic & Socioeconomic Factors:
    - Age
    - Sex
    - Race/ethnicity
    - Primary expected payer (Medicare, Medicaid, Private, Other)
    - ZIP-based median income quartile (ZIPINC\_QRTL)
  + Clinical Characteristics:
    - Diabetes subtype (T1DM, T2DM, Other), derived from ICD-10 patterns
    - Comorbidities based on Elixhauser Comorbidity Index, using binary indicators:
    - Congestive heart failure
    - Chronic pulmonary disease
    - Renal failure
    - Liver disease
    - Obesity
    - Hypertension
    - Coagulopathy
    - Cancer (Lymphoma, Metastatic, Solid Tumor without metastasis)
    - Acute complications identified via ICD-10 code matching:
    - Acute Kidney Injury (AKI)
    - Acute Respiratory Failure (ARF)
    - Mechanical ventilation
    - Vasopressor use
  + Hospital Characteristics:
    - Hospital region (Northeast, Midwest, South, West)
    - Bed size (small, medium, large)
    - Urban/rural location and teaching status (rural, urban non-teaching, urban teaching)
  + Comorbidities and Severity:
    - Elixhauser Comorbidity Index (continuous sum score)
    - Selected comorbidities in descriptive baseline table: congestive heart failure, diabetes, hypertension, chronic pulmonary disease, liver disease, obesity, coagulopathy, metastatic cancer
* **Statistical Methods:**
  + Survey Design and Weighting:
    - Analyses incorporated NIS’s complex sampling design using discharge weights (DISCWT), strata (NIS\_STRATUM), and clustering (HOSPID). The survey package in R was used to generate nationally representative estimates.
  + Descriptive Statistics:
    - Baseline characteristics were summarized across CKD categories (no CKD, CKD without dialysis, CKD with dialysis).
    - P-values from design-based statistical tests (Rao–Scott adjusted chi-square for categorical variables; design-based Kruskal–Wallis test for continuous variables).
  + Multivariable Regression:
    - Survey-weighted logistic regression for binary outcomes (mortality, non-home discharge, mechanical ventilation, vasopressor use, AKI).
    - Survey-weighted linear regression for continuous outcomes (LOS, charges).
    - Models adjusted for age, sex, race/ethnicity, insurance, income quartile, hospital region, bed size, teaching status, and Elixhauser comorbidity index.
    - CKD exposure was the primary independent variable, with “no CKD” as the reference group.
    - Odds ratios (ORs) or beta coefficients with 95% confidence intervals were reported.
* **Software:**  
  All analyses were conducted in R Statistical Language (Version 4.5.1; R Foundation for Statistical Computing, Vienna, Austria).

## Baseline Table:

| **Characteristic** | **Overall** N = 6,800,081*1* | **No CKD** N = 5,083,065*1* | **CKD with Dialysis** N = 333,395*1* | **CKD without Dialysis** N = 1,383,620*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- |
| Age, y | 65 (17) | 63 (18) | 64 (14) | 73 (13) | <0.001 |
| Sex |  |  |  |  | <0.001 |
| Female | 3,365,265 (49%) | 2,582,580 (51%) | 145,950 (44%) | 636,735 (46%) |  |
| Male | 3,434,505 (51%) | 2,500,250 (49%) | 187,425 (56%) | 746,830 (54%) |  |
| Race/Ethnicity |  |  |  |  | <0.001 |
| White | 4,503,795 (68%) | 3,416,425 (69%) | 143,015 (44%) | 944,355 (70%) |  |
| Asian or Pacific Islander | 208,530 (3.1%) | 146,500 (2.9%) | 16,665 (5.1%) | 45,365 (3.4%) |  |
| Black | 920,060 (14%) | 624,875 (13%) | 95,845 (29%) | 199,340 (15%) |  |
| Hispanic | 779,450 (12%) | 598,850 (12%) | 57,105 (17%) | 123,495 (9.1%) |  |
| Other | 245,035 (3.7%) | 188,865 (3.8%) | 14,910 (4.6%) | 41,260 (3.0%) |  |
| Median Household Income Quartile (by ZIP) |  |  |  |  | <0.001 |
| 1st Quartile | 2,076,265 (31%) | 1,549,585 (31%) | 122,900 (38%) | 403,780 (30%) |  |
| 2nd Quartile | 1,770,080 (27%) | 1,321,635 (27%) | 84,390 (26%) | 364,055 (27%) |  |
| 3rd Quartile | 1,567,900 (24%) | 1,169,425 (24%) | 70,125 (21%) | 328,350 (24%) |  |
| 4th Quartile | 1,250,715 (19%) | 934,880 (19%) | 50,270 (15%) | 265,565 (20%) |  |
| Primary Expected Payer |  |  |  |  | <0.001 |
| Private | 1,232,735 (18%) | 1,039,515 (20%) | 34,425 (10%) | 158,795 (11%) |  |
| Medicaid | 994,195 (15%) | 848,880 (17%) | 37,380 (11%) | 107,935 (7.8%) |  |
| Medicare | 4,105,165 (60%) | 2,786,550 (55%) | 252,230 (76%) | 1,066,385 (77%) |  |
| Other | 460,550 (6.8%) | 402,035 (7.9%) | 9,070 (2.7%) | 49,445 (3.6%) |  |
| Hospital Region |  |  |  |  | <0.001 |
| Midwest | 1,381,100 (20%) | 989,530 (19%) | 61,775 (19%) | 329,795 (24%) |  |
| Northeast | 1,119,910 (16%) | 849,450 (17%) | 50,235 (15%) | 220,225 (16%) |  |
| South | 2,691,825 (40%) | 2,039,620 (40%) | 138,510 (42%) | 513,695 (37%) |  |
| West | 1,607,245 (24%) | 1,204,465 (24%) | 82,875 (25%) | 319,905 (23%) |  |
| Hospital Bed Size |  |  |  |  | <0.001 |
| Large | 3,170,165 (47%) | 2,361,795 (46%) | 168,875 (51%) | 639,495 (46%) |  |
| Medium | 2,076,385 (31%) | 1,548,120 (30%) | 101,290 (30%) | 426,975 (31%) |  |
| Small | 1,553,530 (23%) | 1,173,150 (23%) | 63,230 (19%) | 317,150 (23%) |  |
| Hospital Location & Teaching Status |  |  |  |  | <0.001 |
| Rural | 634,310 (9.3%) | 483,760 (9.5%) | 16,980 (5.1%) | 133,570 (9.7%) |  |
| Urban, non-teaching | 1,472,696 (22%) | 1,101,901 (22%) | 66,405 (20%) | 304,390 (22%) |  |
| Urban, teaching | 4,693,075 (69%) | 3,497,405 (69%) | 250,010 (75%) | 945,660 (68%) |  |
| Elixhauser Comorbidity Index | 5.03 (2.40) | 4.47 (2.22) | 6.91 (2.10) | 6.66 (2.11) | <0.001 |
| Congestive Heart Failure | 1,786,090 (26%) | 1,001,275 (20%) | 174,190 (52%) | 610,625 (44%) | <0.001 |
| Hypertension | 4,427,990 (65%) | 2,921,595 (57%) | 306,945 (92%) | 1,199,450 (87%) | <0.001 |
| Diabetes Mellitus | 2,593,730 (38%) | 1,638,720 (32%) | 220,575 (66%) | 734,435 (53%) | <0.001 |
| Obesity | 1,281,655 (19%) | 923,550 (18%) | 62,755 (19%) | 295,350 (21%) | <0.001 |
| Chronic Pulmonary Disease | 1,963,815 (29%) | 1,443,630 (28%) | 82,070 (25%) | 438,115 (32%) | <0.001 |
| Liver Disease | 692,895 (10%) | 520,565 (10%) | 45,420 (14%) | 126,910 (9.2%) | <0.001 |
| Metastatic Cancer | 331,400 (4.9%) | 268,455 (5.3%) | 7,355 (2.2%) | 55,590 (4.0%) | <0.001 |
| Coagulopathy | 937,595 (14%) | 660,375 (13%) | 67,520 (20%) | 209,700 (15%) | <0.001 |
| *1*Mean (SD); n (%) | | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | | |

## Univariable Analysis:

| **Characteristic** | **Overall** N = 6,800,081*1* | **No CKD** N = 5,083,065*1* | **CKD with Dialysis** N = 333,395*1* | **CKD without Dialysis** N = 1,383,620*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- |
| In-hospital Mortality | 669,145 (9.8%) | 451,660 (8.9%) | 56,725 (17%) | 160,760 (12%) | <0.001 |
| Length of Stay (days) | 5 (3, 9) | 5 (3, 8) | 7 (4, 13) | 6 (3, 9) | <0.001 |
| Inflation-Adjusted Total Charges ($) | 50,108 (27,410, 97,739) | 47,721 (26,248, 92,840) | 81,499 (42,419, 165,403) | 53,776 (29,806, 101,693) | <0.001 |
| Non-Home Discharge | 2,814,800 (41%) | 1,941,965 (38%) | 182,325 (55%) | 690,510 (50%) | <0.001 |
| Use of Mechanical Ventilation | 904,155 (13%) | 649,915 (13%) | 72,875 (22%) | 181,365 (13%) | <0.001 |
| Use of Vasopressors | 280,740 (4.1%) | 194,110 (3.8%) | 24,975 (7.5%) | 61,655 (4.5%) | <0.001 |
| Acute Kidney Injury | 2,793,620 (41%) | 1,721,590 (34%) | 71,795 (22%) | 1,000,235 (72%) | <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 Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 1.28 | 1.25, 1.32 | <0.001 |
| CKD without Dialysis | 0.71 | 0.70, 0.73 | <0.001 |
| Age, y | 1.03 | 1.03, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.12 | 1.11, 1.14 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.17 | 1.12, 1.22 | <0.001 |
| Black | 1.15 | 1.12, 1.18 | <0.001 |
| Hispanic | 1.08 | 1.05, 1.11 | <0.001 |
| Other | 1.29 | 1.24, 1.34 | <0.001 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | 0.94 | 0.92, 0.96 | <0.001 |
| 3rd Quartile | 0.86 | 0.84, 0.88 | <0.001 |
| 4th Quartile | 0.85 | 0.83, 0.88 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.07 | 1.04, 1.10 | <0.001 |
| Medicare | 0.83 | 0.81, 0.85 | <0.001 |
| Other | 1.23 | 1.18, 1.28 | <0.001 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.45 | 1.39, 1.51 | <0.001 |
| South | 1.06 | 1.03, 1.10 | <0.001 |
| West | 1.00 | 0.96, 1.03 | 0.9 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | 0.86 | 0.84, 0.89 | <0.001 |
| Small | 0.74 | 0.72, 0.77 | <0.001 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.21 | 1.16, 1.27 | <0.001 |
| Urban, teaching | 1.47 | 1.41, 1.53 | <0.001 |
| Elixhauser Comorbidity Index | 1.24 | 1.24, 1.24 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Mechanical Ventilation:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 0.93 | 0.91, 0.95 | <0.001 |
| CKD without Dialysis | 0.61 | 0.60, 0.62 | <0.001 |
| Age, y | 0.99 | 0.99, 0.99 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.23 | 1.22, 1.24 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.24 | 1.19, 1.30 | <0.001 |
| Black | 1.23 | 1.20, 1.26 | <0.001 |
| Hispanic | 1.09 | 1.06, 1.12 | <0.001 |
| Other | 1.34 | 1.29, 1.39 | <0.001 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | 0.93 | 0.91, 0.94 | <0.001 |
| 3rd Quartile | 0.86 | 0.84, 0.88 | <0.001 |
| 4th Quartile | 0.80 | 0.77, 0.82 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.16 | 1.13, 1.18 | <0.001 |
| Medicare | 1.05 | 1.03, 1.07 | <0.001 |
| Other | 0.98 | 0.95, 1.01 | 0.2 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.33 | 1.27, 1.38 | <0.001 |
| South | 1.04 | 1.00, 1.07 | 0.036 |
| West | 0.86 | 0.83, 0.90 | <0.001 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | 0.85 | 0.83, 0.88 | <0.001 |
| Small | 0.74 | 0.71, 0.76 | <0.001 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.53 | 1.46, 1.61 | <0.001 |
| Urban, teaching | 1.86 | 1.77, 1.95 | <0.001 |
| Elixhauser Comorbidity Index | 1.32 | 1.32, 1.33 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Vasopressor Use:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 1.14 | 1.09, 1.19 | <0.001 |
| CKD without Dialysis | 0.71 | 0.69, 0.74 | <0.001 |
| Age, y | 1.00 | 1.00, 1.00 | 0.088 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.12 | 1.10, 1.14 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.10 | 1.00, 1.20 | 0.058 |
| Black | 1.08 | 1.01, 1.15 | 0.022 |
| Hispanic | 1.01 | 0.94, 1.10 | 0.7 |
| Other | 1.21 | 1.10, 1.33 | <0.001 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | 1.00 | 0.95, 1.05 | >0.9 |
| 3rd Quartile | 1.02 | 0.96, 1.09 | 0.5 |
| 4th Quartile | 1.19 | 1.10, 1.28 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 0.94 | 0.90, 1.0 | 0.031 |
| Medicare | 0.86 | 0.83, 0.91 | <0.001 |
| Other | 0.90 | 0.84, 0.95 | <0.001 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.40 | 1.22, 1.61 | <0.001 |
| South | 0.90 | 0.79, 1.03 | 0.13 |
| West | 0.81 | 0.71, 0.93 | 0.004 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | 0.67 | 0.61, 0.75 | <0.001 |
| Small | 0.63 | 0.57, 0.70 | <0.001 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.87 | 1.58, 2.21 | <0.001 |
| Urban, teaching | 3.17 | 2.71, 3.72 | <0.001 |
| Elixhauser Comorbidity Index | 1.27 | 1.26, 1.28 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Acute Kidney Injury:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 0.31 | 0.30, 0.32 | <0.001 |
| CKD without Dialysis | 3.34 | 3.29, 3.39 | <0.001 |
| Age, y | 1.01 | 1.01, 1.01 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.25 | 1.24, 1.26 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.03 | 1.00, 1.06 | 0.024 |
| Black | 1.29 | 1.27, 1.31 | <0.001 |
| Hispanic | 0.97 | 0.95, 0.98 | <0.001 |
| Other | 1.12 | 1.09, 1.15 | <0.001 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | 0.99 | 0.97, 1.00 | 0.058 |
| 3rd Quartile | 0.95 | 0.93, 0.97 | <0.001 |
| 4th Quartile | 0.91 | 0.89, 0.93 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 0.98 | 0.97, 1.00 | 0.023 |
| Medicare | 0.91 | 0.89, 0.92 | <0.001 |
| Other | 0.96 | 0.94, 0.98 | <0.001 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.19 | 1.15, 1.22 | <0.001 |
| South | 1.11 | 1.08, 1.13 | <0.001 |
| West | 0.97 | 0.94, 0.99 | 0.013 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | 0.93 | 0.91, 0.95 | <0.001 |
| Small | 0.87 | 0.85, 0.89 | <0.001 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.20 | 1.17, 1.24 | <0.001 |
| Urban, teaching | 1.35 | 1.31, 1.39 | <0.001 |
| Elixhauser Comorbidity Index | 1.20 | 1.19, 1.20 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Non-Home Discharge:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 1.24 | 1.21, 1.26 | <0.001 |
| CKD without Dialysis | 0.83 | 0.82, 0.84 | <0.001 |
| Age, y | 1.03 | 1.03, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.11 | 1.10, 1.12 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.82 | 0.79, 0.85 | <0.001 |
| Black | 1.14 | 1.12, 1.16 | <0.001 |
| Hispanic | 0.76 | 0.75, 0.78 | <0.001 |
| Other | 1.01 | 0.99, 1.04 | 0.3 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | 0.96 | 0.94, 0.97 | <0.001 |
| 3rd Quartile | 0.90 | 0.88, 0.92 | <0.001 |
| 4th Quartile | 0.85 | 0.83, 0.87 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.72 | 1.69, 1.76 | <0.001 |
| Medicare | 1.56 | 1.54, 1.58 | <0.001 |
| Other | 1.19 | 1.17, 1.22 | <0.001 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.23 | 1.20, 1.27 | <0.001 |
| South | 0.90 | 0.88, 0.92 | <0.001 |
| West | 0.79 | 0.77, 0.82 | <0.001 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | 1.01 | 0.98, 1.03 | 0.6 |
| Small | 1.00 | 0.97, 1.02 | 0.8 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.99 | 0.96, 1.02 | 0.6 |
| Urban, teaching | 0.98 | 0.96, 1.01 | 0.3 |
| Elixhauser Comorbidity Index | 1.21 | 1.20, 1.21 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 1.3 | 1.1, 1.4 | <0.001 |
| CKD without Dialysis | -0.93 | -0.97, -0.89 | <0.001 |
| Age, y | -0.01 | -0.02, -0.01 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.67 | 0.64, 0.70 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.46 | 0.32, 0.60 | <0.001 |
| Black | 0.86 | 0.79, 0.93 | <0.001 |
| Hispanic | 0.27 | 0.19, 0.34 | <0.001 |
| Other | 0.59 | 0.48, 0.70 | <0.001 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | -0.13 | -0.18, -0.08 | <0.001 |
| 3rd Quartile | -0.22 | -0.28, -0.17 | <0.001 |
| 4th Quartile | -0.22 | -0.29, -0.14 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.0 | 0.96, 1.1 | <0.001 |
| Medicare | -0.09 | -0.14, -0.04 | <0.001 |
| Other | 0.11 | 0.03, 0.19 | 0.007 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.6 | 1.5, 1.7 | <0.001 |
| South | 0.64 | 0.56, 0.73 | <0.001 |
| West | -0.23 | -0.34, -0.13 | <0.001 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | -0.94 | -1.0, -0.86 | <0.001 |
| Small | -1.5 | -1.6, -1.4 | <0.001 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.2 | 1.1, 1.3 | <0.001 |
| Urban, teaching | 2.2 | 2.1, 2.2 | <0.001 |
| Elixhauser Comorbidity Index | 0.79 | 0.78, 0.80 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |

### Inflation-adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Chronic Kidney Disease Category |  |  |  |
| No CKD | — | — |  |
| CKD with Dialysis | 25,571 | 23,431, 27,710 | <0.001 |
| CKD without Dialysis | -19,698 | -20,699, -18,697 | <0.001 |
| Age, y | -433 | -460, -405 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 11,209 | 10,688, 11,731 | <0.001 |
| Race/Ethnicity |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 15,520 | 11,834, 19,207 | <0.001 |
| Black | 9,365 | 7,667, 11,064 | <0.001 |
| Hispanic | 20,178 | 17,586, 22,771 | <0.001 |
| Other | 18,783 | 15,363, 22,203 | <0.001 |
| Median Household Income Quartile (by ZIP) |  |  |  |
| 1st Quartile | — | — |  |
| 2nd Quartile | -1,153 | -2,545, 240 | 0.10 |
| 3rd Quartile | -2,562 | -4,291, -833 | 0.004 |
| 4th Quartile | 1,886 | -704, 4,476 | 0.2 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 3,671 | 2,067, 5,276 | <0.001 |
| Medicare | -5,843 | -6,984, -4,701 | <0.001 |
| Other | -2,701 | -4,363, -1,039 | 0.001 |
| Hospital Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 31,590 | 27,815, 35,364 | <0.001 |
| South | 18,155 | 15,961, 20,349 | <0.001 |
| West | 37,103 | 33,534, 40,672 | <0.001 |
| Hospital Bed Size |  |  |  |
| Large | — | — |  |
| Medium | -12,847 | -15,689, -10,006 | <0.001 |
| Small | -22,571 | -25,392, -19,750 | <0.001 |
| Hospital Location & Teaching Status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 31,029 | 28,569, 33,488 | <0.001 |
| Urban, teaching | 40,273 | 38,075, 42,471 | <0.001 |
| Elixhauser Comorbidity Index | 13,401 | 12,988, 13,814 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |