Impact of Obstructive Sleep Apnea on In-Hospital Outcomes in Patients with Renal Failure

National Inpatient Sample Analysis (2018–2020)

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## Preamble:

* **Study Objective**: Investigate the association between obstructive sleep apnea (OSA) and in-hospital outcomes in patients admitted with a diagnosis of renal failure across U.S. hospitals from 2018 to 2020, adjusting for demographic, clinical, and hospital factors.
* **Data Source**: Cross-sectional analysis using the National Inpatient Sample (NIS) from 2018 to 2020, a nationwide database that captures inpatient admissions in the U.S., and is weighted to provide nationally representative estimates.
* **Patient Selection**: Included all inpatient admissions with a diagnosis of renal failure, identified using ICD-10-CM codes N18.5xx (Stage 5 CKD) and N18.6xx (ESRD). Patients were categorized based on the presence or absence of obstructive sleep apnea, identified using ICD-10-CM code G47.33.
* **Outcomes of Interest:**
  + **Primary Outcomes**:
    - In-hospital all-cause mortality
    - Total hospital length of stay (days)
    - Total charge, inflation adjusted to 2020 ($)
  + **Secondary Outcomes:**
    - Cardiac arrest
    - Gastrointestinal hemorrhage
* **Adjustment Variables:**
  + **Demographics and Socioeconomic Factors:** Age, sex, race, residential income quartile.
  + **Hospital Characteristics:** Region, bed size, and teaching status.
  + **Clinical Factors:** Kidney transplant history, coronary artery disease, cerebrovascular disease, chronic obstructive pulmonary disease, diabetes mellitus, heart failure, hypertension, obesity, and Charlson Comorbidity Index.
* **Statistical Analysis**:
  + **Univariable Analysis:**
    - **Continuous Outcomes:** Design-based Kruskal-Wallis test for outcomes such as length of stay and total charges.
    - **Categorical Outcomes:** Rao & Scott-adjusted Pearson’s Chi-square test for outcomes like in-hospital mortality, gastrointestinal bleeding, and cardiac arrest.
  + **Multivariable Analysis:**
    - **Logistic Regression:** For binary outcomes (e.g., in-hospital mortality, gastrointestinal bleeding, cardiac arrest). Report adjusted odds ratios (ORs) with 95% confidence intervals (CIs).
    - **Linear Regression:** For continuous outcomes (e.g., length of stay, total charges). Report adjusted beta coefficients with 95% CIs.
  + **Model Adjustment:** All models adjusted for the demographic, clinical, and hospital factors listed above, as well as OSA status (yes/no).
  + **Survey Weights:** The NIS survey design and discharge weights were applied to account for the complex sampling methodology and ensure nationally representative estimates.
* **Software:** All analyses were conducted using the R Statistical Language (Version 4.4.1; R Foundation for Statistical Computing, Vienna, Austria), utilizing the *survey* package to account for complex sampling designs of the NIS.

## Baseline Table:

A total of 3,385,755 hospitalizations with a diagnosis of renal failure were identified, of which 362,855 (10.7%) involved patients with a concurrent diagnosis of obstructive sleep apnea (OSA). Patients with OSA were more likely to be older (mean age: 63 ± 12 vs. 62 ± 15 years; p < 0.001) and male (61% vs. 54%; p < 0.001) compared to those without OSA. The racial distribution differed significantly, with a higher proportion of White patients in the OSA group (52% vs. 40%) and lower representation among Asian/Pacific Islander, Hispanic, and Other racial categories (p < 0.001).

Socioeconomic indicators showed that patients with OSA were more likely to reside in higher-income quartiles (16% in the highest quartile vs. 14%; p < 0.001). Medicare was the predominant payer for patients with OSA (79% vs. 72%; p < 0.001). Geographically, OSA patients were more commonly hospitalized in the Midwest (30% vs. 19%) and less so in the South (39% vs. 44%; p < 0.001).

Comorbidity patterns revealed that patients with OSA had significantly higher rates of coronary artery disease (53% vs. 41%), diabetes mellitus (74% vs. 63%), heart failure (63% vs. 49%), hypertension (96% vs. 95%), and obesity (44% vs. 15%; all p < 0.001).

| **Characteristic** | **Overall** N = 3,385,755*1* | **Renal Failure without OSA** N = 3,022,900*1* | **Renal Failure with OSA** N = 362,855*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 62 (15) | 62 (15) | 63 (12) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 1,537,500 (45%) | 1,397,280 (46%) | 140,220 (39%) |  |
| Male | 1,848,165 (55%) | 1,625,530 (54%) | 222,635 (61%) |  |
| Race |  |  |  | <0.001 |
| White | 1,380,020 (42%) | 1,196,370 (40%) | 183,650 (52%) |  |
| Asian or Pacific Islander | 138,215 (4.2%) | 128,165 (4.3%) | 10,050 (2.8%) |  |
| Black | 1,105,220 (33%) | 989,245 (33%) | 115,975 (33%) |  |
| Hispanic | 558,465 (17%) | 522,820 (18%) | 35,645 (10%) |  |
| Other | 141,300 (4.3%) | 131,705 (4.4%) | 9,595 (2.7%) |  |
| Residential income |  |  |  | <0.001 |
| $1 - $51,999 | 1,297,295 (39%) | 1,171,690 (39%) | 125,605 (35%) |  |
| $52,000 - $65,999 | 858,270 (26%) | 762,255 (26%) | 96,015 (27%) |  |
| $66,000 - $87,999 | 692,500 (21%) | 612,270 (21%) | 80,230 (22%) |  |
| $88,000 or more | 482,110 (14%) | 425,735 (14%) | 56,375 (16%) |  |
| Insurance payer |  |  |  | <0.001 |
| Medicaid | 429,845 (13%) | 402,960 (13%) | 26,885 (7.4%) |  |
| Medicare | 2,471,650 (73%) | 2,186,840 (72%) | 284,810 (79%) |  |
| Other | 113,830 (3.4%) | 104,920 (3.5%) | 8,910 (2.5%) |  |
| Private | 367,220 (11%) | 325,285 (11%) | 41,935 (12%) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 673,010 (20%) | 564,770 (19%) | 108,240 (30%) |  |
| Northeast | 555,475 (16%) | 503,840 (17%) | 51,635 (14%) |  |
| South | 1,475,535 (44%) | 1,333,720 (44%) | 141,815 (39%) |  |
| West | 681,735 (20%) | 620,570 (21%) | 61,165 (17%) |  |
| Hospital bedsize |  |  |  | <0.001 |
| Large | 1,776,065 (52%) | 1,576,025 (52%) | 200,040 (55%) |  |
| Medium | 985,185 (29%) | 885,455 (29%) | 99,730 (27%) |  |
| Small | 624,505 (18%) | 561,420 (19%) | 63,085 (17%) |  |
| Hospital location/teaching status |  |  |  | <0.001 |
| Rural | 174,185 (5.1%) | 155,975 (5.2%) | 18,210 (5.0%) |  |
| Urban, non-teaching | 602,090 (18%) | 546,315 (18%) | 55,775 (15%) |  |
| Urban, teaching | 2,609,480 (77%) | 2,320,610 (77%) | 288,870 (80%) |  |
| Kidney transplant Hx | 71,600 (2.1%) | 63,945 (2.1%) | 7,655 (2.1%) | >0.9 |
| Coronary artery disease | 1,442,975 (43%) | 1,250,625 (41%) | 192,350 (53%) | <0.001 |
| Cerebrovascular disease | 301,515 (8.9%) | 272,070 (9.0%) | 29,445 (8.1%) | <0.001 |
| Chronic obstructive pulmonary disease | 821,050 (24%) | 680,090 (22%) | 140,960 (39%) | <0.001 |
| Diabetes mellitus | 2,169,300 (64%) | 1,901,405 (63%) | 267,895 (74%) | <0.001 |
| Heart failure | 1,704,180 (50%) | 1,475,125 (49%) | 229,055 (63%) | <0.001 |
| HIV/AIDS | 32,890 (1.0%) | 31,080 (1.0%) | 1,810 (0.5%) | <0.001 |
| Hypertension | 3,212,090 (95%) | 2,863,345 (95%) | 348,745 (96%) | <0.001 |
| Obesity | 617,580 (18%) | 457,975 (15%) | 159,605 (44%) | <0.001 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Outcomes Table:

Upon univariable analysis, patients with OSA had significantly lower in-hospital mortality rates compared to those without OSA (4.0% vs. 5.5%; p < 0.001). Cardiac arrest was less frequent among OSA patients (1.9% vs. 2.4%; p < 0.001), while rates of gastrointestinal hemorrhage were comparable between groups (8.3% vs. 8.4%; p = 0.2). The median length of stay was longer for OSA patients (5.0 [3.0–8.0] vs. 4.0 [2.0–8.0] days; p < 0.001), whereas total hospital charges were not significantly different after inflation adjustment ($52,011 vs. $51,542; p = 0.2).

| **Characteristic** | **Overall** N = 3,385,755*1* | **Renal Failure without OSA** N = 3,022,900*1* | **Renal Failure with OSA** N = 362,855*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 182,145 (5.4%) | 167,595 (5.5%) | 14,550 (4.0%) | <0.001 |
| Cardiac arrest | 80,210 (2.4%) | 73,245 (2.4%) | 6,965 (1.9%) | <0.001 |
| Gastrointestinal hemorrhage | 284,705 (8.4%) | 254,620 (8.4%) | 30,085 (8.3%) | 0.2 |
| Length of stay (days) | 4.0 (2.0, 8.0) | 4.0 (2.0, 8.0) | 5.0 (3.0, 8.0) | <0.001 |
| Inflation-adjusted total charge ($) | 51,600 (27,248, 104,284) | 51,542 (27,132, 104,617) | 52,011 (28,186, 101,495) | 0.2 |
| *1*n (%); Median (Q1, Q3) | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | |

## Multivariable Regression:

After adjustment for demographic, clinical, and hospital factors, OSA was associated with reduced odds of in-hospital mortality (adjusted OR 0.72; 95% CI 0.70–0.76; p < 0.001). OSA also conferred a protective effect against cardiac arrest (adjusted OR 0.74; 95% CI 0.70–0.79; p < 0.001). However, no significant association was observed between OSA and gastrointestinal hemorrhage (adjusted OR 1.01; 95% CI 0.98–1.05; p = 0.3).

OSA was associated with a modest reduction in length of stay (adjusted β = -0.39 days; 95% CI -0.46 to -0.32; p < 0.001) and inflation-adjusted total hospital charges (adjusted β = -$10,138; 95% CI -$11,494 to -$8,782; p < 0.001).

### All-Cause Mortality:

| **Characteristic** | **OR***1* | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Obstructive sleep apnea status |  |  |  |
| Renal Failure without OSA | — | — |  |
| Renal Failure with OSA | 0.72 | 0.70, 0.76 | <0.001 |
| Age, y | 1.03 | 1.03, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.04 | 1.02, 1.07 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.92 | 0.87, 0.98 | 0.007 |
| Black | 0.86 | 0.84, 0.89 | <0.001 |
| Hispanic | 0.89 | 0.86, 0.93 | <0.001 |
| Other | 1.07 | 1.01, 1.14 | 0.016 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.94 | 0.91, 0.97 | <0.001 |
| $66,000 - $87,999 | 0.90 | 0.87, 0.93 | <0.001 |
| $88,000 or more | 0.92 | 0.88, 0.95 | <0.001 |
| Insurance payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 0.92 | 0.88, 0.96 | <0.001 |
| Other | 1.67 | 1.55, 1.80 | <0.001 |
| Private | 1.20 | 1.14, 1.27 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.16 | 1.10, 1.22 | <0.001 |
| South | 1.12 | 1.08, 1.17 | <0.001 |
| West | 1.20 | 1.14, 1.25 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.96 | 0.93, 1.00 | 0.041 |
| Small | 0.89 | 0.85, 0.92 | <0.001 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.00 | 0.94, 1.07 | >0.9 |
| Urban, teaching | 1.14 | 1.07, 1.21 | <0.001 |
| Kidney transplant Hx |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.86, 1.02 | 0.2 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 1.00, 1.05 | 0.10 |
| Cerebrovascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.38 | 1.34, 1.43 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 0.77 | 0.74, 0.79 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.59 | 0.58, 0.61 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.31 | 1.28, 1.34 | <0.001 |
| HIV/AIDS |  |  |  |
| No | — | — |  |
| Yes | 0.37 | 0.33, 0.42 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.41 | 0.40, 0.43 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.89, 0.95 | <0.001 |
| Charlson comorbidity index | 1.21 | 1.20, 1.22 | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | | |

### Cardiac Arrest:

| **Characteristic** | **OR***1* | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Obstructive sleep apnea status |  |  |  |
| Renal Failure without OSA | — | — |  |
| Renal Failure with OSA | 0.74 | 0.70, 0.79 | <0.001 |
| Age, y | 1.01 | 1.00, 1.01 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.13 | 1.09, 1.17 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.17 | 1.07, 1.27 | <0.001 |
| Black | 1.18 | 1.13, 1.23 | <0.001 |
| Hispanic | 1.14 | 1.08, 1.20 | <0.001 |
| Other | 1.23 | 1.13, 1.34 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.93 | 0.89, 0.97 | <0.001 |
| $66,000 - $87,999 | 0.88 | 0.84, 0.93 | <0.001 |
| $88,000 or more | 0.89 | 0.84, 0.94 | <0.001 |
| Insurance payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 1.03 | 0.97, 1.09 | 0.3 |
| Other | 1.21 | 1.10, 1.34 | <0.001 |
| Private | 1.05 | 0.98, 1.13 | 0.2 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.88 | 0.83, 0.94 | <0.001 |
| South | 1.16 | 1.11, 1.22 | <0.001 |
| West | 1.10 | 1.03, 1.17 | 0.003 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 1.14 | 1.09, 1.19 | <0.001 |
| Small | 1.08 | 1.02, 1.13 | 0.007 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.13 | 1.03, 1.24 | 0.009 |
| Urban, teaching | 1.11 | 1.02, 1.21 | 0.016 |
| Kidney transplant Hx |  |  |  |
| No | — | — |  |
| Yes | 0.90 | 0.79, 1.02 | 0.10 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 1.41 | 1.36, 1.46 | <0.001 |
| Cerebrovascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.24 | 1.18, 1.31 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.80, 0.87 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.90, 0.98 | 0.004 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.53 | 1.47, 1.59 | <0.001 |
| HIV/AIDS |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.62, 0.90 | 0.002 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.54 | 0.50, 0.58 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 1.01 | 0.97, 1.06 | 0.6 |
| Charlson comorbidity index | 1.07 | 1.05, 1.08 | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | | |

### Gastrointestinal Hemorrhage:

| **Characteristic** | **OR***1* | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Obstructive sleep apnea status |  |  |  |
| Renal Failure without OSA | — | — |  |
| Renal Failure with OSA | 1.01 | 0.98, 1.05 | 0.3 |
| Age, y | 1.02 | 1.02, 1.02 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.96 | 0.94, 0.98 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.09 | 1.04, 1.15 | <0.001 |
| Black | 1.14 | 1.12, 1.17 | <0.001 |
| Hispanic | 0.97 | 0.94, 1.00 | 0.085 |
| Other | 0.99 | 0.94, 1.05 | 0.8 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.97 | 0.95, 1.0 | 0.018 |
| $66,000 - $87,999 | 1.00 | 0.97, 1.02 | 0.8 |
| $88,000 or more | 0.97 | 0.94, 1.01 | 0.10 |
| Insurance payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 1.11 | 1.07, 1.15 | <0.001 |
| Other | 0.98 | 0.92, 1.05 | 0.6 |
| Private | 1.07 | 1.02, 1.11 | 0.004 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.96 | 0.93, 0.99 | 0.015 |
| South | 0.96 | 0.93, 0.99 | 0.003 |
| West | 0.97 | 0.94, 1.00 | 0.083 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 1.00 | 0.97, 1.02 | 0.7 |
| Small | 0.97 | 0.94, 1.00 | 0.037 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.07 | 1.02, 1.13 | 0.008 |
| Urban, teaching | 1.10 | 1.05, 1.16 | <0.001 |
| Kidney transplant Hx |  |  |  |
| No | — | — |  |
| Yes | 0.97 | 0.91, 1.04 | 0.4 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 1.00, 1.04 | 0.12 |
| Cerebrovascular disease |  |  |  |
| No | — | — |  |
| Yes | 0.73 | 0.70, 0.75 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 0.82 | 0.80, 0.83 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.54 | 0.53, 0.56 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 0.78 | 0.77, 0.80 | <0.001 |
| HIV/AIDS |  |  |  |
| No | — | — |  |
| Yes | 0.32 | 0.29, 0.35 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.86 | 0.83, 0.90 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.98 | 0.96, 1.01 | 0.2 |
| Charlson comorbidity index | 1.23 | 1.22, 1.23 | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | | |

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Obstructive sleep apnea status |  |  |  |
| Renal Failure without OSA | — | — |  |
| Renal Failure with OSA | -0.39 | -0.46, -0.32 | <0.001 |
| Age, y | 0.02 | 0.02, 0.02 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.17 | 0.12, 0.22 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | -0.26 | -0.41, -0.12 | <0.001 |
| Black | -0.22 | -0.28, -0.15 | <0.001 |
| Hispanic | -0.53 | -0.64, -0.43 | <0.001 |
| Other | 0.08 | -0.07, 0.23 | 0.3 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.01 | -0.07, 0.08 | 0.9 |
| $66,000 - $87,999 | 0.06 | -0.03, 0.14 | 0.2 |
| $88,000 or more | 0.17 | 0.06, 0.27 | 0.001 |
| Insurance payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | -1.1 | -1.3, -0.99 | <0.001 |
| Other | -0.42 | -0.62, -0.22 | <0.001 |
| Private | -0.18 | -0.34, -0.03 | 0.022 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.2 | 1.1, 1.4 | <0.001 |
| South | 0.81 | 0.69, 0.93 | <0.001 |
| West | 0.18 | 0.03, 0.33 | 0.015 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -0.92 | -1.0, -0.82 | <0.001 |
| Small | -1.4 | -1.5, -1.3 | <0.001 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.96 | 0.81, 1.1 | <0.001 |
| Urban, teaching | 2.0 | 1.8, 2.1 | <0.001 |
| Kidney transplant Hx |  |  |  |
| No | — | — |  |
| Yes | -0.91 | -1.0, -0.79 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -0.59 | -0.64, -0.53 | <0.001 |
| Cerebrovascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.6 | 1.5, 1.7 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | -0.80 | -0.86, -0.73 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | -1.1 | -1.2, -1.1 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 0.57 | 0.51, 0.64 | <0.001 |
| HIV/AIDS |  |  |  |
| No | — | — |  |
| Yes | -3.0 | -3.3, -2.7 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -1.8 | -2.0, -1.6 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.71 | 0.64, 0.77 | <0.001 |
| Charlson comorbidity index | 0.56 | 0.53, 0.59 | <0.001 |
| *1*CI = Confidence Interval | | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Obstructive sleep apnea status |  |  |  |
| Renal Failure without OSA | — | — |  |
| Renal Failure with OSA | -10,138 | -11,494, -8,782 | <0.001 |
| Age, y | -116 | -155, -77 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 6,180 | 5,326, 7,034 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 6,450 | 2,171, 10,728 | 0.003 |
| Black | -4,659 | -6,397, -2,921 | <0.001 |
| Hispanic | 6,263 | 3,445, 9,081 | <0.001 |
| Other | 8,685 | 4,304, 13,066 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1,315 | -414, 3,045 | 0.14 |
| $66,000 - $87,999 | 2,838 | 744, 4,932 | 0.008 |
| $88,000 or more | 11,572 | 8,317, 14,827 | <0.001 |
| Insurance payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | -531 | -2,910, 1,848 | 0.7 |
| Other | 449 | -3,134, 4,032 | 0.8 |
| Private | 22,539 | 18,690, 26,387 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 30,614 | 25,131, 36,097 | <0.001 |
| South | 20,114 | 16,792, 23,436 | <0.001 |
| West | 48,732 | 42,061, 55,404 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -20,163 | -23,996, -16,330 | <0.001 |
| Small | -31,823 | -35,856, -27,791 | <0.001 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 34,533 | 31,182, 37,884 | <0.001 |
| Urban, teaching | 51,575 | 48,226, 54,924 | <0.001 |
| Kidney transplant Hx |  |  |  |
| No | — | — |  |
| Yes | -16,287 | -19,124, -13,450 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 641 | -512, 1,793 | 0.3 |
| Cerebrovascular disease |  |  |  |
| No | — | — |  |
| Yes | 24,735 | 22,585, 26,886 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | -14,079 | -15,503, -12,655 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | -24,708 | -26,808, -22,608 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 6,662 | 5,245, 8,078 | <0.001 |
| HIV/AIDS |  |  |  |
| No | — | — |  |
| Yes | -46,770 | -53,281, -40,258 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -33,201 | -37,868, -28,533 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 12,758 | 11,429, 14,087 | <0.001 |
| Charlson comorbidity index | 8,209 | 7,567, 8,850 | <0.001 |
| *1*CI = Confidence Interval | | | |