Clinical and Economic Outcomes Associated with Aspiration Pneumonia in Hospitalized Patients with Parkinson’s Disease: A National Inpatient Sample Analysis

Analysis for 2025April-NIS-16-IM

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## Preamble:

* **Reference Papers:**
  + [Luca et al. 2021](https://journals.sagepub.com/doi/full/10.3233/JPD-212798)
* **Study Objective**: Examine the impact of aspiration pneumonia on in-hospital outcomes among inpatient admissions with Parkinson’s disease.
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with a diagnosis of Parkinson’s disease.
* **Aspirtaion Pneumonia + Parkinson’s Disease Categories**:
  + Parkinson’s Disease with Aspirtaion Pneumonia
  + Parkinson’s Disease without Aspirtaion Pneumonia
* **Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
  + Sepsis
  + Acute respiratory failure
  + Mechanical Ventilation
  + Discharge Disposition (Discharged to home, short term facility, or long-term facility)
  + Palliative care utilization
* **Covariates for Adjustment:** All models adjusted for the following
  + Demographics: Age, sex, race, residential income, insurance, hospital region, hospital bedsize, residence (urbanicity), hospital location, and teaching status.
  + Medical History: Hypertension, diabetes mellitus, cancer, hyperlipidemia, coronary artery disease, peripheral vascular disease, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, dementia, liver disease, fluid/electrolyte imbalance.
  + Comorbidities: Elixhauser comorbidity index.
* **Statistical Methods:**
  + **Univariable Analysis:**
    - Categorical variables: Compared using Pearson’s chi-square test with Rao & Scott adjustment
    - Continuous variables: Analyzed using the design-based Kruskal–Wallis test, a non-parametric alternative suitable for survey-weighted data
  + **Multivariable Analysis:**
    - Binary outcomes (e.g., mortality): Survey-weighted logistic regression using the quasibinomial family
    - Continuous outcomes (e.g., LOS, hospital charges): Survey-weighted linear regression using the gaussian family
    - Results reported as adjusted odds ratios (aORs) or beta coefficients with 95% confidence intervals
* **Software:** All statistical analyses were performed using the 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 = 1,040,055*1* | **Parkinson's disease without aspiration pneumonia** N = 956,200*1* | **Parkinson's disease with aspiration pneumonia** N = 83,855*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 76 (10) | 76 (10) | 79 (9) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 424,615 (41%) | 400,175 (42%) | 24,440 (29%) |  |
| Male | 615,370 (59%) | 555,955 (58%) | 59,415 (71%) |  |
| Race |  |  |  | <0.001 |
| White | 814,410 (80%) | 751,640 (80%) | 62,770 (76%) |  |
| Asian or Pacific Islander | 26,440 (2.6%) | 22,385 (2.4%) | 4,055 (4.9%) |  |
| Black | 71,090 (7.0%) | 65,015 (7.0%) | 6,075 (7.4%) |  |
| Hispanic | 75,990 (7.5%) | 69,275 (7.4%) | 6,715 (8.2%) |  |
| Native American | 3,710 (0.4%) | 3,400 (0.4%) | 310 (0.4%) |  |
| Other | 25,335 (2.5%) | 23,025 (2.5%) | 2,310 (2.8%) |  |
| Elixhauser comorbidity index | 5.22 (2.21) | 5.19 (2.22) | 5.45 (2.14) | <0.001 |
| Residential income |  |  |  | <0.001 |
| $1 - $51,999 | 256,635 (25%) | 238,155 (25%) | 18,480 (22%) |  |
| $52,000 - $65,999 | 267,420 (26%) | 247,425 (26%) | 19,995 (24%) |  |
| $66,000 - $87,999 | 255,535 (25%) | 234,700 (25%) | 20,835 (25%) |  |
| $88,000 or more | 245,930 (24%) | 222,555 (24%) | 23,375 (28%) |  |
| Expected primary payer |  |  |  | <0.001 |
| Private | 84,765 (8.2%) | 79,035 (8.3%) | 5,730 (6.8%) |  |
| Medicaid | 33,200 (3.2%) | 30,930 (3.2%) | 2,270 (2.7%) |  |
| Medicare | 900,415 (87%) | 826,560 (87%) | 73,855 (88%) |  |
| Other | 20,625 (2.0%) | 18,725 (2.0%) | 1,900 (2.3%) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 242,055 (23%) | 224,765 (24%) | 17,290 (21%) |  |
| Northeast | 210,390 (20%) | 191,395 (20%) | 18,995 (23%) |  |
| South | 392,520 (38%) | 363,605 (38%) | 28,915 (34%) |  |
| West | 195,090 (19%) | 176,435 (18%) | 18,655 (22%) |  |
| Hospital bedsize |  |  |  | <0.001 |
| Large | 483,065 (46%) | 445,760 (47%) | 37,305 (44%) |  |
| Medium | 306,835 (30%) | 281,375 (29%) | 25,460 (30%) |  |
| Small | 250,155 (24%) | 229,065 (24%) | 21,090 (25%) |  |
| Hospital location and teaching status |  |  |  | <0.001 |
| Rural | 109,195 (10%) | 101,360 (11%) | 7,835 (9.3%) |  |
| Urban, non-teaching | 219,625 (21%) | 201,090 (21%) | 18,535 (22%) |  |
| Urban, teaching | 711,235 (68%) | 653,750 (68%) | 57,485 (69%) |  |
| Residence |  |  |  | <0.001 |
| Central metro ≥1 million | 287,990 (28%) | 261,220 (27%) | 26,770 (32%) |  |
| Fringe metro ≥1 million | 268,570 (26%) | 245,815 (26%) | 22,755 (27%) |  |
| Metro 250,000-999,999 | 207,990 (20%) | 192,365 (20%) | 15,625 (19%) |  |
| Metro 50,000-249,999 | 99,850 (9.6%) | 93,085 (9.8%) | 6,765 (8.1%) |  |
| Micropolitan | 98,615 (9.5%) | 91,515 (9.6%) | 7,100 (8.5%) |  |
| Other | 74,655 (7.2%) | 69,910 (7.3%) | 4,745 (5.7%) |  |
| Hypertension | 777,130 (75%) | 718,885 (75%) | 58,245 (69%) | <0.001 |
| Diabetes mellitus | 349,470 (34%) | 324,805 (34%) | 24,665 (29%) | <0.001 |
| Cancer | 46,945 (4.5%) | 43,535 (4.6%) | 3,410 (4.1%) | 0.004 |
| Heart failure | 264,480 (25%) | 240,365 (25%) | 24,115 (29%) | <0.001 |
| Hyperlipidemia | 507,855 (49%) | 473,180 (49%) | 34,675 (41%) | <0.001 |
| Coronary artery disease | 297,785 (29%) | 276,590 (29%) | 21,195 (25%) | <0.001 |
| Peripheral vascular disease | 87,935 (8.5%) | 81,530 (8.5%) | 6,405 (7.6%) | <0.001 |
| Chronic kidney disease | 251,930 (24%) | 232,740 (24%) | 19,190 (23%) | <0.001 |
| Chronic obstructive pulmonary disease | 244,775 (24%) | 223,150 (23%) | 21,625 (26%) | <0.001 |
| Cardiac arrhythmia | 356,825 (34%) | 324,595 (34%) | 32,230 (38%) | <0.001 |
| Dementia | 373,105 (36%) | 329,805 (34%) | 43,300 (52%) | <0.001 |
| Liver disease | 35,050 (3.4%) | 32,240 (3.4%) | 2,810 (3.4%) | 0.9 |
| Fluid and electrolyte disorders | 414,130 (40%) | 364,695 (38%) | 49,435 (59%) | <0.001 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Outcomes Table:

| **Characteristic** | **Overall** N = 1,040,055*1* | **Parkinson's disease without aspiration pneumonia** N = 956,200*1* | **Parkinson's disease with aspiration pneumonia** N = 83,855*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 41,695 (4.0%) | 30,420 (3.2%) | 11,275 (13%) | <0.001 |
| Length of stay (days) | 5.9 (7.2) | 5.7 (6.9) | 8.8 (9.6) | <0.001 |
| Inflation-adjusted total charge ($) | 62,963 (80,925) | 59,949 (73,380) | 97,293 (136,110) | <0.001 |
| Sepsis | 159,075 (15%) | 123,225 (13%) | 35,850 (43%) | <0.001 |
| Acute respiratory failure | 118,660 (11%) | 83,435 (8.7%) | 35,225 (42%) | <0.001 |
| Mechanical Ventilation | 42,515 (4.1%) | 28,595 (3.0%) | 13,920 (17%) | <0.001 |
| Discharged to home | 502,165 (48%) | 475,415 (50%) | 26,750 (32%) | <0.001 |
| Transferred to another short-term hospital |  |  |  |  |
| No | 1,040,055 (100%) | 956,200 (100%) | 83,855 (100%) |  |
| Transferred to skilled nursing facility, intermediate care, or another facility | 467,330 (45%) | 423,740 (44%) | 43,590 (52%) | <0.001 |
| Palliative care utilization | 80,180 (7.7%) | 60,205 (6.3%) | 19,975 (24%) | <0.001 |
| *1*n (%); Mean (SD) | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Categories |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 3.55 | 3.35, 3.76 | <0.001 |
| Age, y | 1.04 | 1.03, 1.04 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.11 | 1.06, 1.17 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.43 | 1.26, 1.62 | <0.001 |
| Black | 1.20 | 1.09, 1.32 | <0.001 |
| Hispanic | 1.22 | 1.12, 1.33 | <0.001 |
| Native American | 1.15 | 0.77, 1.70 | 0.5 |
| Other | 1.24 | 1.08, 1.42 | 0.002 |
| Elixhauser comorbidity index | 1.10 | 1.08, 1.12 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.98 | 0.91, 1.04 | 0.5 |
| $66,000 - $87,999 | 0.95 | 0.88, 1.02 | 0.2 |
| $88,000 or more | 0.95 | 0.87, 1.03 | 0.2 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 0.60 | 0.51, 0.71 | <0.001 |
| Medicare | 0.51 | 0.47, 0.56 | <0.001 |
| Other | 1.59 | 1.35, 1.86 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.26 | 1.16, 1.38 | <0.001 |
| South | 0.91 | 0.84, 0.98 | 0.010 |
| West | 1.07 | 0.99, 1.17 | 0.11 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 0.94 | 0.88, 1.01 | 0.11 |
| Metro 250,000-999,999 | 1.02 | 0.94, 1.10 | 0.7 |
| Metro 50,000-249,999 | 1.07 | 0.97, 1.19 | 0.2 |
| Micropolitan | 1.08 | 0.98, 1.19 | 0.14 |
| Other | 1.23 | 1.10, 1.37 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.72 | 0.68, 0.77 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.88, 0.98 | 0.009 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.23 | 1.11, 1.35 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.19 | 1.12, 1.26 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.71, 0.79 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.93, 1.04 | 0.6 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 0.98 | 0.90, 1.06 | 0.6 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | 0.97 | 0.91, 1.03 | 0.3 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.78, 0.88 | <0.001 |
| Cardiac arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.32 | 1.25, 1.40 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.21 | 1.15, 1.27 | <0.001 |
| Liver disease |  |  |  |
| No | — | — |  |
| Yes | 2.10 | 1.91, 2.32 | <0.001 |
| Fluid and electrolyte disorders |  |  |  |
| No | — | — |  |
| Yes | 1.92 | 1.82, 2.03 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Acute Respiratory Failure:

### Sepsis:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| PD\_AP |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 3.93 | 3.79, 4.09 | <0.001 |
| AGE | 1.00 | 1.00, 1.00 | 0.014 |
| FEMALE |  |  |  |
| Female | — | — |  |
| Male | 1.25 | 1.21, 1.28 | <0.001 |
| RACE |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.17 | 1.08, 1.26 | <0.001 |
| Black | 1.09 | 1.03, 1.14 | 0.002 |
| Hispanic | 1.17 | 1.11, 1.23 | <0.001 |
| Native American | 1.11 | 0.88, 1.39 | 0.4 |
| Other | 1.09 | 1.00, 1.19 | 0.040 |
| elixsum | 1.05 | 1.04, 1.06 | <0.001 |
| ZIPINC\_QRTL |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.97 | 0.93, 1.01 | 0.11 |
| $66,000 - $87,999 | 0.95 | 0.91, 0.99 | 0.009 |
| $88,000 or more | 0.92 | 0.88, 0.96 | <0.001 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.14 | 1.04, 1.24 | 0.004 |
| Medicare | 1.03 | 0.97, 1.08 | 0.3 |
| Other | 1.14 | 1.03, 1.27 | 0.013 |
| Hosp\_Census\_Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.12 | 1.07, 1.18 | <0.001 |
| South | 1.05 | 1.01, 1.10 | 0.027 |
| West | 1.37 | 1.30, 1.44 | <0.001 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 0.96 | 0.92, 1.01 | 0.088 |
| Metro 250,000-999,999 | 0.92 | 0.88, 0.96 | <0.001 |
| Metro 50,000-249,999 | 0.94 | 0.88, 0.99 | 0.029 |
| Micropolitan | 0.89 | 0.84, 0.94 | <0.001 |
| Other | 0.84 | 0.78, 0.90 | <0.001 |
| HTN |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.73, 0.78 | <0.001 |
| DM |  |  |  |
| No | — | — |  |
| Yes | 1.19 | 1.16, 1.23 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 0.96, 1.08 | 0.6 |
| CHF |  |  |  |
| No | — | — |  |
| Yes | 1.05 | 1.02, 1.09 | 0.004 |
| Hyperlip |  |  |  |
| No | — | — |  |
| Yes | 0.84 | 0.82, 0.87 | <0.001 |
| CAD |  |  |  |
| No | — | — |  |
| Yes | 0.84 | 0.81, 0.87 | <0.001 |
| PVD |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.94, 1.04 | 0.7 |
| CKD |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 1.0, 1.07 | 0.10 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 1.06 | 1.02, 1.09 | 0.002 |
| Cardiac\_arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 1.00, 1.07 | 0.053 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.44 | 1.40, 1.48 | <0.001 |
| Liver\_Dis |  |  |  |
| No | — | — |  |
| Yes | 1.16 | 1.08, 1.24 | <0.001 |
| Fluid\_disorders |  |  |  |
| No | — | — |  |
| Yes | 2.53 | 2.45, 2.60 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Utilization of mechanical ventilation:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| PD\_AP |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 5.40 | 5.10, 5.72 | <0.001 |
| AGE | 0.97 | 0.97, 0.98 | <0.001 |
| FEMALE |  |  |  |
| Female | — | — |  |
| Male | 1.07 | 1.02, 1.12 | 0.009 |
| RACE |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.57 | 1.39, 1.78 | <0.001 |
| Black | 1.53 | 1.41, 1.67 | <0.001 |
| Hispanic | 1.38 | 1.27, 1.50 | <0.001 |
| Native American | 1.90 | 1.37, 2.62 | <0.001 |
| Other | 1.35 | 1.18, 1.55 | <0.001 |
| elixsum | 1.09 | 1.07, 1.11 | <0.001 |
| ZIPINC\_QRTL |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.93 | 0.87, 0.99 | 0.030 |
| $66,000 - $87,999 | 0.85 | 0.79, 0.91 | <0.001 |
| $88,000 or more | 0.74 | 0.68, 0.80 | <0.001 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.05 | 0.91, 1.20 | 0.5 |
| Medicare | 1.02 | 0.94, 1.12 | 0.6 |
| Other | 1.03 | 0.86, 1.25 | 0.7 |
| Hosp\_Census\_Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.14 | 1.06, 1.24 | 0.001 |
| South | 1.03 | 0.96, 1.11 | 0.4 |
| West | 1.08 | 1.00, 1.18 | 0.054 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 0.93 | 0.87, 1.00 | 0.041 |
| Metro 250,000-999,999 | 0.81 | 0.75, 0.88 | <0.001 |
| Metro 50,000-249,999 | 0.80 | 0.72, 0.88 | <0.001 |
| Micropolitan | 0.78 | 0.70, 0.86 | <0.001 |
| Other | 0.81 | 0.72, 0.90 | <0.001 |
| HTN |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.75, 0.84 | <0.001 |
| DM |  |  |  |
| No | — | — |  |
| Yes | 1.06 | 1.00, 1.12 | 0.045 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 0.89 | 0.80, 1.00 | 0.050 |
| CHF |  |  |  |
| No | — | — |  |
| Yes | 1.32 | 1.24, 1.41 | <0.001 |
| Hyperlip |  |  |  |
| No | — | — |  |
| Yes | 0.80 | 0.76, 0.84 | <0.001 |
| CAD |  |  |  |
| No | — | — |  |
| Yes | 0.90 | 0.85, 0.95 | <0.001 |
| PVD |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.85, 1.02 | 0.12 |
| CKD |  |  |  |
| No | — | — |  |
| Yes | 0.80 | 0.75, 0.85 | <0.001 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 1.07 | 1.01, 1.14 | 0.016 |
| Cardiac\_arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.57 | 1.48, 1.66 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.96 | 0.91, 1.01 | 0.2 |
| Liver\_Dis |  |  |  |
| No | — | — |  |
| Yes | 1.65 | 1.49, 1.82 | <0.001 |
| Fluid\_disorders |  |  |  |
| No | — | — |  |
| Yes | 2.74 | 2.59, 2.90 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Discharged to home:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| PD\_AP |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 0.57 | 0.55, 0.60 | <0.001 |
| AGE | 0.98 | 0.98, 0.98 | <0.001 |
| FEMALE |  |  |  |
| Female | — | — |  |
| Male | 1.01 | 0.99, 1.03 | 0.4 |
| RACE |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.21 | 1.13, 1.29 | <0.001 |
| Black | 1.00 | 0.96, 1.04 | >0.9 |
| Hispanic | 1.36 | 1.30, 1.42 | <0.001 |
| Native American | 1.12 | 0.94, 1.34 | 0.2 |
| Other | 1.13 | 1.06, 1.21 | <0.001 |
| elixsum | 0.96 | 0.95, 0.97 | <0.001 |
| ZIPINC\_QRTL |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.98 | 0.95, 1.01 | 0.2 |
| $66,000 - $87,999 | 1.00 | 0.97, 1.04 | 0.8 |
| $88,000 or more | 1.08 | 1.04, 1.12 | <0.001 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 0.76 | 0.71, 0.82 | <0.001 |
| Medicare | 0.73 | 0.70, 0.76 | <0.001 |
| Other | 0.79 | 0.73, 0.85 | <0.001 |
| Hosp\_Census\_Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.97 | 0.94, 1.01 | 0.2 |
| South | 1.21 | 1.17, 1.25 | <0.001 |
| West | 1.31 | 1.26, 1.37 | <0.001 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 1.09 | 1.06, 1.13 | <0.001 |
| Metro 250,000-999,999 | 1.09 | 1.05, 1.13 | <0.001 |
| Metro 50,000-249,999 | 1.10 | 1.06, 1.15 | <0.001 |
| Micropolitan | 1.05 | 1.01, 1.09 | 0.028 |
| Other | 1.05 | 1.00, 1.10 | 0.059 |
| HTN |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 1.01, 1.06 | 0.009 |
| DM |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.27 | 1.21, 1.33 | <0.001 |
| CHF |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 1.00, 1.05 | 0.077 |
| Hyperlip |  |  |  |
| No | — | — |  |
| Yes | 1.14 | 1.12, 1.16 | <0.001 |
| CAD |  |  |  |
| No | — | — |  |
| Yes | 1.14 | 1.11, 1.16 | <0.001 |
| PVD |  |  |  |
| No | — | — |  |
| Yes | 1.10 | 1.06, 1.14 | <0.001 |
| CKD |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 1.00, 1.05 | 0.026 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 1.17 | 1.14, 1.20 | <0.001 |
| Cardiac\_arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.01 | 0.98, 1.03 | 0.6 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.56 | 0.55, 0.57 | <0.001 |
| Liver\_Dis |  |  |  |
| No | — | — |  |
| Yes | 1.06 | 1.00, 1.11 | 0.041 |
| Fluid\_disorders |  |  |  |
| No | — | — |  |
| Yes | 0.73 | 0.71, 0.75 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Transferred to short-term facility:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| PD\_AP |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 1.00 | 0.98, 1.02 | >0.9 |
| AGE | 1.00 | 1.00, 1.00 | >0.9 |
| FEMALE |  |  |  |
| Female | — | — |  |
| Male | 1.00 | 0.99, 1.01 | >0.9 |
| RACE |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.00 | 0.93, 1.07 | >0.9 |
| Black | 1.00 | 0.96, 1.04 | >0.9 |
| Hispanic | 1.00 | 0.95, 1.05 | >0.9 |
| Native American | 1.00 | 0.89, 1.13 | >0.9 |
| Other | 1.00 | 0.93, 1.08 | >0.9 |
| elixsum | 1.00 | 0.99, 1.01 | >0.9 |
| ZIPINC\_QRTL |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.00 | 0.97, 1.03 | >0.9 |
| $66,000 - $87,999 | 1.00 | 0.96, 1.04 | >0.9 |
| $88,000 or more | 1.00 | 0.95, 1.05 | >0.9 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.00 | 0.96, 1.05 | >0.9 |
| Medicare | 1.00 | 0.97, 1.03 | >0.9 |
| Other | 1.00 | 0.95, 1.06 | >0.9 |
| Hosp\_Census\_Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.00 | 0.95, 1.05 | >0.9 |
| South | 1.00 | 0.96, 1.04 | >0.9 |
| West | 1.00 | 0.95, 1.05 | >0.9 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 1.00 | 0.94, 1.06 | >0.9 |
| Metro 250,000-999,999 | 1.00 | 0.93, 1.08 | >0.9 |
| Metro 50,000-249,999 | 1.00 | 0.92, 1.08 | >0.9 |
| Micropolitan | 1.00 | 0.94, 1.06 | >0.9 |
| Other | 1.00 | 0.94, 1.06 | >0.9 |
| HTN |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| DM |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.97, 1.03 | >0.9 |
| CHF |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| Hyperlip |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.99, 1.01 | >0.9 |
| CAD |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.99, 1.01 | >0.9 |
| PVD |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.97, 1.03 | >0.9 |
| CKD |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| Cardiac\_arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.99, 1.01 | >0.9 |
| Liver\_Dis |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.97, 1.03 | >0.9 |
| Fluid\_disorders |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.98, 1.02 | >0.9 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Transferred to skilled nursing facility, intermediate care, or another facility:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| PD\_AP |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 1.16 | 1.12, 1.20 | <0.001 |
| AGE | 1.02 | 1.02, 1.02 | <0.001 |
| FEMALE |  |  |  |
| Female | — | — |  |
| Male | 0.96 | 0.94, 0.98 | <0.001 |
| RACE |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.77 | 0.72, 0.82 | <0.001 |
| Black | 0.96 | 0.92, 1.00 | 0.058 |
| Hispanic | 0.70 | 0.67, 0.73 | <0.001 |
| Native American | 0.84 | 0.71, 0.99 | 0.037 |
| Other | 0.82 | 0.77, 0.88 | <0.001 |
| elixsum | 1.03 | 1.02, 1.03 | <0.001 |
| ZIPINC\_QRTL |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.04 | 1.01, 1.07 | 0.006 |
| $66,000 - $87,999 | 1.02 | 0.99, 1.05 | 0.2 |
| $88,000 or more | 0.96 | 0.93, 1.00 | 0.026 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.37 | 1.28, 1.47 | <0.001 |
| Medicare | 1.58 | 1.52, 1.64 | <0.001 |
| Other | 1.03 | 0.95, 1.11 | 0.5 |
| Hosp\_Census\_Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.97 | 0.93, 1.00 | 0.087 |
| South | 0.84 | 0.81, 0.87 | <0.001 |
| West | 0.72 | 0.69, 0.75 | <0.001 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 0.91 | 0.88, 0.94 | <0.001 |
| Metro 250,000-999,999 | 0.91 | 0.88, 0.95 | <0.001 |
| Metro 50,000-249,999 | 0.89 | 0.85, 0.93 | <0.001 |
| Micropolitan | 0.88 | 0.85, 0.92 | <0.001 |
| Other | 0.85 | 0.81, 0.90 | <0.001 |
| HTN |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 1.00, 1.05 | 0.083 |
| DM |  |  |  |
| No | — | — |  |
| Yes | 1.01 | 0.99, 1.04 | 0.3 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.72, 0.78 | <0.001 |
| CHF |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.91, 0.96 | <0.001 |
| Hyperlip |  |  |  |
| No | — | — |  |
| Yes | 0.92 | 0.91, 0.94 | <0.001 |
| CAD |  |  |  |
| No | — | — |  |
| Yes | 0.87 | 0.85, 0.89 | <0.001 |
| PVD |  |  |  |
| No | — | — |  |
| Yes | 0.91 | 0.88, 0.95 | <0.001 |
| CKD |  |  |  |
| No | — | — |  |
| Yes | 0.98 | 0.95, 1.00 | 0.051 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 0.89 | 0.87, 0.91 | <0.001 |
| Cardiac\_arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.92, 0.96 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.74 | 1.71, 1.78 | <0.001 |
| Liver\_Dis |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.75, 0.83 | <0.001 |
| Fluid\_disorders |  |  |  |
| No | — | — |  |
| Yes | 1.24 | 1.21, 1.27 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Utilization of Palliative Care:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| PD\_AP |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 3.52 | 3.36, 3.69 | <0.001 |
| AGE | 1.04 | 1.04, 1.05 | <0.001 |
| FEMALE |  |  |  |
| Female | — | — |  |
| Male | 1.10 | 1.06, 1.14 | <0.001 |
| RACE |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.08 | 0.97, 1.21 | 0.2 |
| Black | 1.09 | 1.02, 1.18 | 0.016 |
| Hispanic | 1.00 | 0.92, 1.08 | >0.9 |
| Native American | 1.18 | 0.85, 1.64 | 0.3 |
| Other | 0.93 | 0.83, 1.05 | 0.2 |
| elixsum | 1.15 | 1.13, 1.17 | <0.001 |
| ZIPINC\_QRTL |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.03 | 0.98, 1.09 | 0.3 |
| $66,000 - $87,999 | 1.04 | 0.98, 1.11 | 0.2 |
| $88,000 or more | 1.11 | 1.04, 1.18 | 0.002 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 0.75 | 0.65, 0.86 | <0.001 |
| Medicare | 0.62 | 0.57, 0.66 | <0.001 |
| Other | 1.68 | 1.47, 1.92 | <0.001 |
| Hosp\_Census\_Region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.84 | 0.78, 0.90 | <0.001 |
| South | 0.83 | 0.78, 0.89 | <0.001 |
| West | 0.85 | 0.79, 0.91 | <0.001 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | 1.05 | 0.99, 1.12 | 0.086 |
| Metro 250,000-999,999 | 1.12 | 1.05, 1.20 | <0.001 |
| Metro 50,000-249,999 | 1.08 | 0.99, 1.17 | 0.076 |
| Micropolitan | 0.96 | 0.88, 1.05 | 0.4 |
| Other | 0.84 | 0.76, 0.93 | <0.001 |
| HTN |  |  |  |
| No | — | — |  |
| Yes | 0.73 | 0.70, 0.76 | <0.001 |
| DM |  |  |  |
| No | — | — |  |
| Yes | 0.81 | 0.77, 0.84 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.50 | 1.39, 1.61 | <0.001 |
| CHF |  |  |  |
| No | — | — |  |
| Yes | 1.02 | 0.97, 1.06 | 0.5 |
| Hyperlip |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.76, 0.82 | <0.001 |
| CAD |  |  |  |
| No | — | — |  |
| Yes | 0.87 | 0.84, 0.91 | <0.001 |
| PVD |  |  |  |
| No | — | — |  |
| Yes | 0.89 | 0.83, 0.95 | <0.001 |
| CKD |  |  |  |
| No | — | — |  |
| Yes | 0.85 | 0.81, 0.89 | <0.001 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 0.77 | 0.73, 0.81 | <0.001 |
| Cardiac\_arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 0.95 | 0.91, 0.99 | 0.022 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.91 | 1.84, 1.98 | <0.001 |
| Liver\_Dis |  |  |  |
| No | — | — |  |
| Yes | 1.28 | 1.17, 1.40 | <0.001 |
| Fluid\_disorders |  |  |  |
| No | — | — |  |
| Yes | 1.48 | 1.42, 1.54 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Categories |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 2.6 | 2.5, 2.8 | <0.001 |
| Age, y | -0.04 | -0.05, -0.04 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.36 | 0.29, 0.42 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.38 | 0.12, 0.64 | 0.004 |
| Black | 0.97 | 0.81, 1.1 | <0.001 |
| Hispanic | 0.10 | -0.04, 0.25 | 0.2 |
| Native American | 0.21 | -0.25, 0.67 | 0.4 |
| Other | 0.65 | 0.33, 0.97 | <0.001 |
| Elixhauser comorbidity index | 0.54 | 0.51, 0.57 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -0.10 | -0.20, -0.01 | 0.039 |
| $66,000 - $87,999 | -0.16 | -0.26, -0.05 | 0.003 |
| $88,000 or more | -0.32 | -0.44, -0.20 | <0.001 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.1 | 0.73, 1.4 | <0.001 |
| Medicare | -0.04 | -0.18, 0.10 | 0.6 |
| Other | -0.31 | -0.66, 0.04 | 0.084 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.85 | 0.72, 0.98 | <0.001 |
| South | 0.03 | -0.06, 0.13 | 0.5 |
| West | -0.22 | -0.35, -0.09 | <0.001 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | -0.25 | -0.37, -0.14 | <0.001 |
| Metro 250,000-999,999 | -0.32 | -0.44, -0.20 | <0.001 |
| Metro 50,000-249,999 | -0.34 | -0.48, -0.19 | <0.001 |
| Micropolitan | -0.38 | -0.53, -0.23 | <0.001 |
| Other | -0.21 | -0.38, -0.04 | 0.015 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -0.53 | -0.61, -0.44 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | -0.50 | -0.58, -0.42 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 0.25 | 0.09, 0.41 | 0.002 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | -0.19 | -0.28, -0.11 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -0.33 | -0.40, -0.27 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -0.23 | -0.30, -0.16 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -0.55 | -0.66, -0.44 | <0.001 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | -0.40 | -0.48, -0.32 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | -0.58 | -0.67, -0.50 | <0.001 |
| Cardiac arrhythmia |  |  |  |
| No | — | — |  |
| Yes | -0.11 | -0.19, -0.04 | 0.003 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.86 | 0.78, 0.94 | <0.001 |
| Liver disease |  |  |  |
| No | — | — |  |
| Yes | -0.59 | -0.77, -0.41 | <0.001 |
| Fluid and electrolyte disorders |  |  |  |
| No | — | — |  |
| Yes | 0.80 | 0.72, 0.87 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Categories |  |  |  |
| Parkinson's disease without aspiration pneumonia | — | — |  |
| Parkinson's disease with aspiration pneumonia | 33,200 | 30,789, 35,610 | <0.001 |
| Age, y | -689 | -740, -638 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 3,362 | 2,629, 4,094 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 11,877 | 7,341, 16,413 | <0.001 |
| Black | 2,807 | 1,037, 4,576 | 0.002 |
| Hispanic | 13,726 | 11,012, 16,439 | <0.001 |
| Native American | -9,338 | -13,607, -5,070 | <0.001 |
| Other | 14,294 | 10,109, 18,479 | <0.001 |
| Elixhauser comorbidity index | 4,851 | 4,297, 5,405 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -132 | -1,362, 1,098 | 0.8 |
| $66,000 - $87,999 | -1,277 | -2,640, 86 | 0.066 |
| $88,000 or more | 793 | -1,206, 2,792 | 0.4 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | -2,707 | -6,058, 644 | 0.11 |
| Medicare | -2,197 | -3,846, -547 | 0.009 |
| Other | -5,184 | -8,328, -2,041 | 0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 14,758 | 12,443, 17,074 | <0.001 |
| South | 12,620 | 11,090, 14,150 | <0.001 |
| West | 30,165 | 27,302, 33,029 | <0.001 |
| PL\_NCHS |  |  |  |
| Central metro ≥1 million | — | — |  |
| Fringe metro ≥1 million | -7,274 | -9,454, -5,095 | <0.001 |
| Metro 250,000-999,999 | -10,811 | -13,214, -8,408 | <0.001 |
| Metro 50,000-249,999 | -18,045 | -20,264, -15,826 | <0.001 |
| Micropolitan | -20,305 | -22,422, -18,189 | <0.001 |
| Other | -22,651 | -24,821, -20,481 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -4,899 | -5,953, -3,844 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | -4,428 | -5,446, -3,410 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 5,496 | 3,615, 7,376 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1,006 | -210, 2,221 | 0.10 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -504 | -1,267, 260 | 0.2 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 3,067 | 2,229, 3,905 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -172 | -1,755, 1,411 | 0.8 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | -5,379 | -6,415, -4,343 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | -4,998 | -6,102, -3,894 | <0.001 |
| Cardiac arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 4,338 | 3,319, 5,358 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | -2,699 | -3,469, -1,929 | <0.001 |
| Liver disease |  |  |  |
| No | — | — |  |
| Yes | 3,188 | 286, 6,090 | 0.031 |
| Fluid and electrolyte disorders |  |  |  |
| No | — | — |  |
| Yes | 8,103 | 7,078, 9,128 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |