# Insurance Status Influences the Rates of Reportable Quality Metrics in Brain Tumor Patients: A Nationwide Inpatient Sample Study

**Kristopher G. Hooten, MD**
**Dan Neal, MS**
**Rolando E. Lovaton Espadin, MD**
**Jorge N. Gil, BS**
**Hassan Azari, PhD**
**Maryam Rahman, MD, MS**

Department of Neurological Surgery, University of Florida, Gainesville, Florida

**Correspondence:**
Kristopher G. Hooten, MD,
PGY-6 Department of Neurosurgery,
University of Florida—Gainesville,
Box 100265
Gainesville, FL.
E-mail: kristopher.hooten@neurosurgery.ufl.edu

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**BACKGROUND:** In 2010, the Patient Protection and Affordable Care Act was passed to expand health insurance, narrow health care disparities, and improve health care quality in the United States. As part of this initiative, the Agency for Healthcare Research and Quality and the Centers for Medicare and Medicaid Services are now tracking quality metrics.
**OBJECTIVE:** To analyze the effects of insurance on the incidence of patient safety indicators (PSIs) and hospital-acquired conditions (HACs) using the Nationwide Inpatient Sample for patients who have brain tumors.
**METHODS:** The Nationwide Inpatient Sample was queried for all hospitalizations between 2002 and 2011 involving patients with brain tumors. Because of the confounding age restriction with Medicare, comparisons were made between Medicaid/self-pay and private insurance. To determine which factors contributed to HACs and PSIs, odds ratios were calculated for each risk factor. Logistic regression models were used to assess the effect of payer status on individual PSIs, HACs, and patient outcomes.
**RESULTS:** Medicaid/self-pay patients had a higher PSI and HAC incidence compared with private insurance patients. The greater incidence of PSIs and HACs correlated with increased length of stay, worse discharge outcomes, and increased in-hospital mortality.
**CONCLUSION:** Variability exists in the incidence of PSIs and HACs in patients with brain tumors based on insurance status. Controlling for both patient and hospital factors can explain these differences. The cause of these disparities should be studied prospectively to begin the process of improving quality metrics in vulnerable patient populations.

**KEY WORDS:** Affordable Care Act, Brain tumor, Hospital-acquired condition, Insurance status, Patient safety indicator

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Socioeconomic inequalities in the United States are well known to impact the access to health care, treatment, and outcomes.[1-9] To address these disparities, the US Congress passed the Patient Protection and Affordable Care Act in 2010.[10] One of the goals of this act is to increase the number of US citizens with health insurance coverage. Under this ruling, the federal government has created health insurance options, expanded Medicaid for individuals with low incomes, and installed an individual mandate to help provide health insurance to all US citizens.[10-12]

**ABBREVIATIONS: AHRQ,** Agency for Healthcare Research and Quality; **CMS,** Centers for Medicare and Medicaid Services; **HAC,** hospital-acquired condition; **ICD-9,** *International Classification of Diseases, 9th Revision*; **NIS,** National Inpatient Sample; **PSI,** patient safety indicators

Primary payer status alone has been associated with outcomes in many specialties, including neurosurgery. For patients undergoing craniotomy for brain tumor, patients with Medicaid had a 25% increased risk of mortality during their inpatient stay compared with Medicare patients.[9] Patients with Medicaid undergoing endovascular aneurysm treatment were less likely to be discharged home after their procedure.[13] For lumbar spine surgery, Medicaid patients were less likely to undergo fusion as a reoperation and had greater health care resource utilization as measured by hospital days, outpatient services, and medications prescribed.[1]

In addition to mandating health insurance for all US citizens, the federal government has increased its focus on improving the quality of health care delivery. Approximately 44 000 to 98 000 deaths in US hospitals occur every year because of medical errors.[14,15] To improve care, predefined patient quality indicators, such as patient safety indicators (PSIs) and hospital-acquired conditions (HACs), are now being monitored. The Agency for Healthcare Research and Quality (AHRQ) has created a list of PSIs that it uses to compare and publically report the quality of individual hospitals.[16,17] Additionally, the Department of Health and Human Services Centers for Medicare and Medicaid Services (CMS) has developed a list of HACs for which additional reimbursement will not be provided.[18] Initiated by the Affordable Care Act, CMS implemented the Hospital Value-Based Purchasing Program in October 2012.[10,19] This program withholds 1% of Medicare reimbursements and uses that money to incentivize hospitals based on their 2011 to 2012 hospital quality indicators.

Currently, few data describe the prevalence of PSIs and HACs for individual diagnosis codes nationally. Recently, national rates of PSIs and HACs for patients with brain tumors were established by evaluating the National Inpatient Sample (NIS) database.[20] In this study, the NIS database is used to evaluate the effects of insurance status on the incidence of PSIs and HACs in patients with brain tumor.

## METHODS

### Patients

The study was conducted with the use of the NIS database from 2002 to 2011. The NIS is part of a family of databases developed from the Healthcare Cost and Utilization Project, and is the largest all-payer inpatient health care database in the United States. Hospitals are selected for inclusion in the database by using a stratified random sampling technique. The NIS contains discharge information from these hospitals, creating a representative one-fifth of all nonfederal hospital admissions in the United States (www.hcup-us.ahrq.gov/nisoverview.jsp).

### Inclusion/Exclusion Criteria and Study Variables

Admissions of patients with brain tumors were defined by using *International Classification of Diseases, 9th Revision* (ICD-9) for a brain tumor (eg 191.0-0.9, 225.0-0.2, 225.9, 198.3, 192.1, 239.6, 237.1, 237.5-0.6, 227.3-04). The incidence of a particular PSI or HAC among these hospitalizations was determined by summing the number of hospital records that included the ICD-9 code or codes indicating the presence of each PSI or HAC as previously reported.[20-23] Sampling weights included in the NIS were used to estimate the national incidence. Clinical outcome measures using the NIS were adopted from previous studies.[24] Because standard functional outcome measures for patients with brain tumors (eg, Karnofsky Performance Status) cannot be obtained by using the NIS, discharge dispositions were used as a surrogate marker. Clinical discharge outcome was defined as "Good" if the patient was "discharged to home or self-care," "discharged to short-term hospital for inpatient care," "discharged to home under care of an organized home health service organization," "left against medical advice," "discharged to home provider," "discharged to another institution for outpatient services," "discharged to same institution for outpatient services," or "discharged alive, destination unknown." Clinical discharge outcome was defined as "Poor" if the patient was "discharged to a skilled nursing facility," "discharged to an intermediate care facility," "discharged to hospice," "discharged to hospital-based Medicare-approved swing bed," "discharged to inpatient rehabilitation facility," "discharged to long-term care hospital," or "discharged to nursing facility certified by Medicaid, but not certified by Medicare." Finally, deceased patients were identified by: "expired," "expired at home," "expired in a medical facility," or "expired—place unknown."

All patients with brain tumors were included. Patients whose third-party payer status was missing or recorded as "other" were excluded from the analysis. Patients were stratified by insurance type (Medicare, commercial/private, Medicaid/self-pay). The significant comorbidities score was determined by examining the Elixhauser comorbidities recorded in the NIS database for each hospitalization.[25] The Elixhauser comorbidities available in the NIS include neurological deficit in addition to other potential confounding medical conditions. This technique allows for a risk adjustment of the significant premorbid health disparities between the 2 cohorts. Dependent variables included all AHRQ PSI and CMS HAC ICD-9 diagnosis and procedures codes adopted from previous publications.[20-23] A secondary analysis was performed by hospital teaching status (teaching or nonteaching). Categories with multiple subheadings were combined for the analysis (eg, falls and trauma with fracture and falls and trauma with dislocation).

### Statistical Analysis

The SAS statistical software package (version 9.3, SAS Institute Inc) was used to calculate means, standard deviations, and frequencies for all patients and hospital characteristics and to estimate all PSI and HAC incidences. For an incidence $\geq 0.1\%$, confidence intervals (CIs) were constructed by using the Agresti-Coull method.[26,27] Odds ratios were calculated for each preexisting condition (Elixhauser comorbidities) and hospital factors to assess imbalances between the payer groups and their potential impact on hospital-acquired conditions. Multivariable modeling was performed by using generalized estimating equations logistic regression, with insurance status (Medicaid/self-pay or private), age, sex, tumor grade (malignant or benign), comorbidity score, hospital teaching status (teaching or nonteaching), hospital bed size (small, medium, or large), region (Northeast, South, West, or Midwest), hospital ownership (government, profit, nonprofit), and admission status (emergent, urgent vs elective) included as covariates. To account for the clustering of observations on hospitals, we considered hospital a repeated factor and assumed an exchangeable working correlation. Because Medicare membership is confounded with age, and members generally represent a different patient population, there was an inability to separate age as a factor, which made the group noncomparable to the other patient populations. Thus, Medicare patients were excluded from multivariable modeling to better estimate the effect of Medicaid/self-pay vs private insurance on outcomes. Statistical significance was determined by $P < .002$ using the Bonferonni correction. A secondary analysis with hospital teaching type as the primary independent variable was also performed with a similar statistical model. Note that data on hospital ownership, HAC pressure ulcer, and HAC vascular catheter infection were available in the NIS only for years 2008 to 2011, 2008 to 2011, and 2007 to 2011, respectively.

## RESULTS

The NIS query revealed 566 346 total separate admissions in which the patient was diagnosed with a brain tumor. Patients were excluded if there was a lack of primary insurer information, leaving 548 727 records for analysis. Patient and demographics for all patients with brain tumor are described in Table 1. The average age was 58.7 ± 19.1 years and the mean comorbidity score was 2.2 ± 1.6. Medicaid/self-pay patients had a lower average age than the Medicare and private insurance groups ($P < .001$). Moreover, Medicaid/self-pay patients had a higher percentage of care in government and teaching hospitals and a larger percentage population in the South ($P < .001$). The Medicare group had the highest average comorbidity score, as expected because of its representation of an older population. Medicaid/self-pay population had a higher number of prehospital comorbidities in comparison with private insurance ($P < .001$).

A total of 113 797 PSIs were identified over the study period, for an estimated national incidence of 20.7%. There were 15 810 HACs among these brain tumor admissions, estimated national rate of 2.9%. The estimated national incidence of a patient with a brain tumor experiencing 1 or more PSIs or HAC was 16.3% and 2.8%, respectively. The most common overall occurring PSI was postoperative respiratory failure at 6.2% (Table 2). Other common PSIs included pressure ulcers, deep vein thrombosis/pulmonary embolism, and sepsis. The most common HAC in this patient population was falls and trauma, occurring at an incidence of 2.1% for all admissions (Table 3).

In the univariate comparison, unadjusted for covariates, Medicaid/self-pay patients had a higher overall incidence of PSIs and HACs in comparison with privately insured patients. For PSIs, Medicaid/self-pay patients had an estimated national incidence of 20.6%, compared with 18.6% for patients with private insurance ($P < .001$). For patients experiencing 1 or more PSI, the Medicaid/self pay estimated national incidence was 16.1%, and the estimated national incidence was 14.6% for private insurance patients ($P < .001$). For HACs, Medicaid/self-pay patients had an estimated national incidence of 2.2% compared with 1.9% in private insurance patients ($P < .001$). The incidence of Medicaid/self-pay patients experiencing 1 or more HACs was 2.1%, compared with 1.8% for private insurance patients ($P < .001$). An increased incidence of PSIs and HACs in the study correlated with an average increased length of stay, increased incidence of poor discharge outcomes, and increased in-house hospital mortality (Table 4).

For multivariable comparisons, Medicare patients were excluded because of the age restriction, and only PSIs and HACs with an incidence greater than 0.1% were analyzed. After controlling for all patient factors listed in Figure 1, Medicaid/self-pay patients were estimated to experience 8.4% more PSIs per patient ($P < .001$). In addition, Medicaid/self-pay patients were estimated to experience 12.3% more HACs per patient ($P = .001$). When controlling for patient factors and preexisting conditions, the increased PSIs and

**TABLE 1. Patient Demographics by Insurance Type**[a,b]

| | Overall, n = 548 727 | Medicare, n = 240 006 (43.7%) | Medicaid/Self-Paym, n = 84 814 (15.5%) | Private Insurance, n = 223 907 (40.8%) | *P* Value[c] |
|---|---|---|---|---|---|
| Age, mean ± SD | 58.7 ± 19.1 | 72.1 ± 11.0 | 44.4 ± 18.8 | 47.7 ± 16.6 | <.001 |
| Sex, n (% females) | 297 531 (54.5) | 132 098 (55.1) | 46 031 (54.4) | 119 402 (53.6) | <.001 |
| Comorbidity score, mean ± SD | 2.2 ± 1.6 | 2.6 ± 1.6 | 1.9 ± 1.6 | 1.7 ± 1.5 | <.001 |
| Tumor grade, n (% malignant) | 116 840 (21.3) | 35 820 (14.9) | 21 039 (24.8) | 59 981 (26.8) | <.001 |
| Admission type, n (% type) | | | | | |
| Emergent | 256 563 (52.8) | 126 168 (59.0) | 42 266 (57.0) | 88 129 (44.6) | <.001 |
| Urgent | 98 181 (20.2) | 42 384 (19.8) | 15 005 (20.2) | 40 792 (20.6) | <.021 |
| Elective | 130 987 (27.0) | 45 394 (21.1) | 16 875 (22.8) | 68 718 (35.8) | <.001 |
| Hospital type, n (% type) | | | | | <.001 |
| Nonteaching | 221 005 (40.6) | 117 894 (49.4) | 27 298 (32.5) | 75 813 (34.1) | |
| Teaching | 324 065 (59.4) | 120 866 (50.6) | 56 625 (67.5) | 146 574 (65.9) | |
| Hospital size, n (% type) | | | | | <.001 |
| Small | 55 143 (10.1) | 25 345 (10.6) | 7 866 (9.4) | 21 932 (9.9) | |
| Medium | 112 601 (20.7) | 52 397 (22.0) | 17 191 (20.5) | 43 013 (19.3) | |
| Large | 377 326 (69.2) | 161 018 (67.4) | 58 866 (70.1) | 157 442 (70.8) | |
| Hospital region | | | | | <.001 |
| Northeast | 116 412 (21.2) | 52 163 (21.7) | 16 093 (19.0) | 48 156 (21.5) | |
| Midwest | 124 104 (22.6) | 55 546 (23.1) | 16 065 (18.9) | 52 493 (23.4) | |
| South | 203 520 (37.1) | 90 027 (37.5) | 35 985 (42.4) | 77 508 (34.6) | |
| West | 104 691 (19.1) | 42 270 (17.6) | 16 671 (19.7) | 45 750 (20.4) | |

[a]HAC, hospital-acquired condition; PSI, patient safety indicator.
[b]Age, sex, comorbidity score, tumor grade, and hospital type, size, and region were variables controlled for in the analysis of individual PSIs/HACs and outcomes. Additional hospital factors are presented in Figure 1.
[c]*P* values are the results of the comparison between Medicaid/self-pay vs private insurance. Significance defined as $P < .002$.

**TABLE 2.** AHRQ PSIs in Patients With Brain Tumors by Insurance Status[a,b]

| AHRQ PSI | Overall, n = 548 727 (% Population) | Medicare, n = 240 006 (43.7%) | Medicaid/Self-Pay, n = 84 814 (15.5%) | Private Insurance, n = 223 907 (40.8%) |
|---|---|---|---|---|
| Anesthetic complications | [c] | [c] | [c] | [c] |
| Pressure ulcer | 11 196 (2.0) | 6699 (2.8) | 1450 (1.7) | 3047 (1.4) |
| Foreign body | [c] | [c] | [c] | [c] |
| Iatrogenic pneumothorax | 2921 (0.53) | 1441 (0.60) | 447 (0.53) | 1033 (0.46) |
| Central venous line infection | 2968 (0.54) | 856 (0.36) | 730 (0.86) | 1382 (0.62) |
| Postoperative hip fracture | 2674 (0.49) | 2094 (0.87) | 161 (0.19) | 419 (0.19) |
| Postoperative physiological derangement—glucose control | 1309 (0.24) | 561 (0.23) | 303 (0.36) | 445 (0.20) |
| Postoperative hemorrhage | 1351 (0.25) | 595 (0.25) | 197 (0.23) | 559 (0.25) |
| Postoperative respiratory failure | 33 954 (6.2) | 15 416 (6.4) | 6062 (7.2) | 12 476 (5.6) |
| Deep vein thrombosis | 21 004 (3.8) | 9462 (3.9) | 2783 (3.3) | 8759 (3.9) |
| Pulmonary embolism | 13 387 (2.4) | 5870 (2.5) | 1759 (2.1) | 5758 (2.6) |
| Sepsis | 22 047 (4.0) | 11 296 (4.7) | 3408 (4.0) | 7343 (3.3) |
| Postoperative wound dehiscence | [c] | [c] | [c] | [c] |
| Accidental puncture or laceration | 899 (0.16) | 341 (0.14) | 114 (0.13) | 444 (0.20) |
| Transfusion reaction | [c] | [c] | [c] | [c] |

[a]AHRQ, Agency for Healthcare Research and Quality; NIS, Nationwide Inpatient Sample; PSI, patient safety indicator.
[b]All AHRQ PSIs are listed. Values shown are n (%), unless otherwise stated.
[c]For NIS reporting guidelines: events occurring less than 0.1% are not reported.

HACs correlated with a 0.8 days for Medicaid/self-pay patients ($P < .001$), an increased rate of poor discharge outcomes (odds ratio = 1.31, $P < .0001$), and trend toward in-hospital mortality (odds ratio = 1.04, $P = .012$) (Table 5). Controlling for all patient factors in Figure 1, in addition to the hospital factors and admission status listed in Figure 2, there was no significant difference between Medicaid/self-pay and private insurance in the odds of HACs and PSI ($P = .067$ PSIs and $P = .185$ HACs). In addition, when the hospital factors are controlled in addition to the preexisting patient comorbidities, the difference in outcome measures are not significant except for a slight difference in length of stay and discharge outcomes based on discharge disposition.

In the secondary analysis of hospital teaching type, a higher incidence of PSIs and HACs occurred at nonteaching hospitals. There were 49 968 PSIs in 221 005 patients with brain tumors in nonteaching hospitals compared with 63 107 PSIs among 324 065 patients with brain tumors in teaching hospitals (estimated national rates of 22.6% vs 19.5%, $P < .001$). Similarly, there were 7482 HACs among 221 005 patients in nonteaching hospitals compared with 8181 HACs among 324 065 patients in teaching hospitals

**TABLE 3.** Estimated National Incidence of HACs in Admitted Patients With Brain Tumors[a,b]

| HAC | Overall, n = 548 727 (% Population) | Medicare, n = 240 006 (43.7%) | Medicaid/Self-Pay, n = 84 814 (15.5%) | Private Insurance, n = 223 907 (40.8%) |
|---|---|---|---|---|
| Foreign object retained after surgery | [c] | [c] | [c] | [c] |
| Air embolism | [c] | [c] | [c] | [c] |
| Blood incompatibility | [c] | [c] | [c] | [c] |
| Pressure ulcer stages III & IV (2008-2011, n = 237 776) | 1029 (0.43) | 645 (0.61) | 141 (0.37) | 243 (0.26) |
| Falls and trauma resulting in injury | 11 733 (2.1) | 7759 (3.2) | 1097 (1.3) | 2877 (1.3) |
| Catheter-associated urinary tract infection | [c] | [c] | [c] | [c] |
| Vascular catheter infection (2007-2011, n = 293 058) | 978 (0.33) | 277 (0.21) | 254 (0.54) | 447 (0.38) |
| Manifestations of poor glycemic control | 1240 (0.23) | 522 (0.22) | 295 (0.35) | 423 (0.19) |
| Deep vein thrombosis | [c] | [c] | [c] | [c] |

[a]HAC, hospital-acquired condition; NIS, Nationwide Inpatient Sample.
[b]Only those categories relevant to neurosurgery are listed.
[c]For NIS reporting guidelines: Events occurring less than 0.1% are not reported.

**TABLE 4. Univariate Analyses of Overall Results and Outcomes by Primary Payer Status[a,b]**

| | Overall, n = 548 727 (% Population) | Medicare, n = 240 006 (43.7%) | Medicaid/Self-Pay, n = 84 814 (15.5%) | Private Insurance, n = 223 907 (40.8%) | *P* Value[c] |
|---|---|---|---|---|---|
| Total PSIs, n (% of pts) | 113 797 (20.7) | 54 670 (22.8) | 17 426 (20.6) | 41 701 (18.6) | <.001 |
| Total HACs, n (% of pts) | 15 810 (2.9) | 9677 (4.0) | 1887 (2.2) | 4256 (1.9) | <.001 |
| Length of stay, mean ± SD | 6.4 ± 7.8 | 6.6 ± 7.2 | 7.3 ± 10.2 | 5.9 ± 7.2 | <.001 |
| Poor outcomes, n (% of pts) | 129 396 (23.5) | 77 947 (38.7) | 15 069 (21.3) | 36 380 (19.4) | <.001 |
| Mortality, n (% of pts) | 40 760 (7.4) | 18 729 (7.8) | 6214 (7.3) | 15 817 (7.1) | <.001 |

[a]HAC, hospital-acquired condition; PSI, patient safety indicator; pts, patients.
[b]Estimated national incidence are given as percentage.
[c]*P* values represent the comparison of Medicaid/self-pay with private insurance. Significance defined as $P < .002$.

(3.4% vs 2.5%, $P < .001$). The higher incidence of overall PSIs and HACs persisted in the Medicaid/self-pay group compared with the private insurance group regardless of the type of hospital, although the difference is much less in nonteaching hospitals (Table 6). In the multivariate analysis when controlling for both patient factors and hospital factors, the differences in the odds of PSIs and HACs occurring between teaching and nonteaching hospitals are statistically similar ($P = .04$ and $P = .004$).

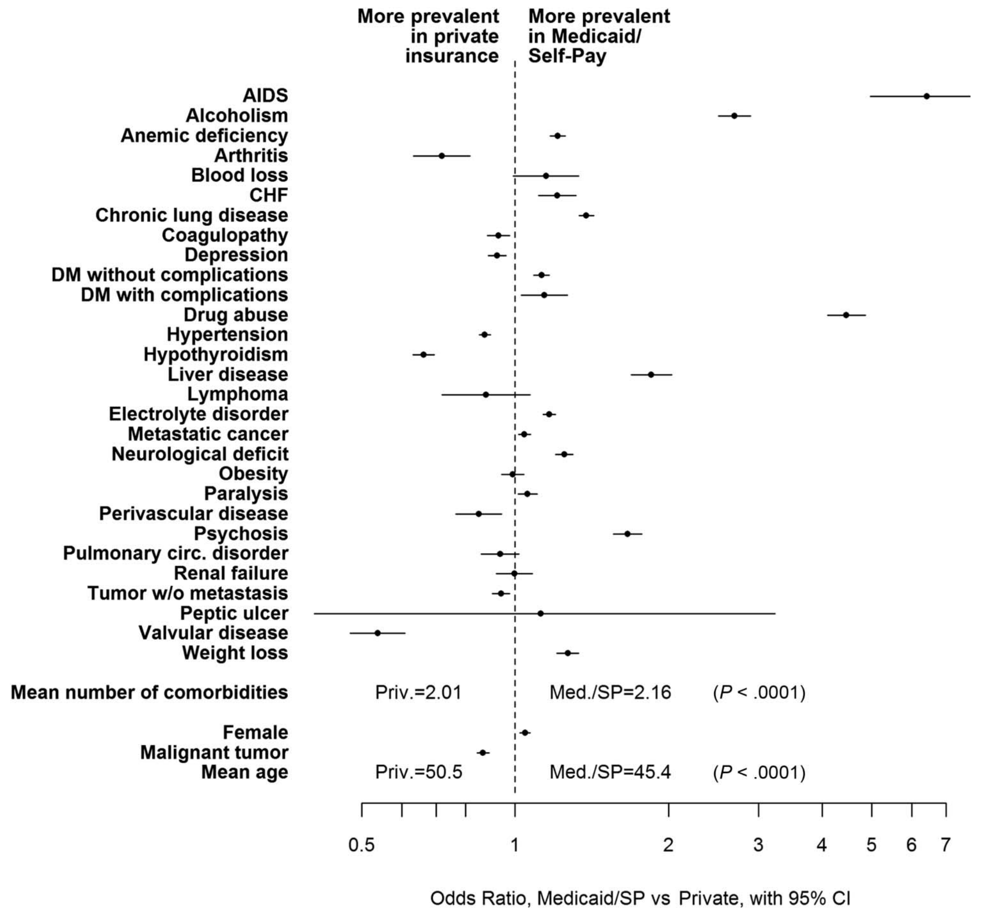


**FIGURE 1.** *Patient factor odds ratio plot. Graph demonstrates patient factors associated with primary payer status. Overall patients had more comorbidities in the Medicaid/self-pay populations than the private insurance populations (P < .001). CHS, congestive heart failure; circ., circulation; DM, diabetes mellitus; Med./SP, Medicaid/self-pay; Priv., private.*

**TABLE 5. Controlled Analyses Medicaid/Self-Pay vs Private Insurance**[a,b,c]

| | |
|---|---|
| Multivariate analysis for patient factors | |
| Total PSIs (controlling patient factors only) | Medicaid/self-pay has 8.2% more PSIs than private (95% CI, 5.00%-11.5%; $\mathbf{P < .001}$) |
| Total HACs (controlling patient factors only) | Medicaid/self-pay has 12.3% more HACs than private (95% CI, 6.18%-23.8%; $\mathbf{P = .001}$) |
| Length of stay (controlling patient factors only) | Mean 0.8 days longer for Medicaid/self-pay (95% CI, 0.651-0.907; $\mathbf{P < .001}$) |
| Poor discharge outcomes (controlling patient factors only) | Medicaid/self-pay 1.3 times the odds of poor discharge outcome (95% CI, 1.24-1.34, $\mathbf{P < .001}$) |
| Mortality (controlling patient factors only) | Medicaid/self-pay 1.04 times the odds of death (95% CI, 1.01-1.08; $P = .012$) |
| Multivariate analysis for patient and hospital factors | |
| Total PSIs (controlling patient + hospital factors) | Medicaid/self-pay and private not statistically different (95% CI, −0.02% to 6.53%; $P = .067$) |
| Total HACs (controlling patient + hospital factors) | Medicaid/self-pay and private not statistically different (95% CI, −2.83 to 16.0; $P = .185$) |
| Length of stay (controlling patient + hospital factors) | Mean 0.7 days longer for Medicaid/self-pay (95% CI, 0.580-0.849; $\mathbf{P < .001}$) |
| Poor discharge outcomes (controlling patient + hospital factors) | Medicaid/self-pay 1.2 times the odds of poor discharge outcome (95% CI, 1.15-1.25; $\mathbf{P < .001}$) |
| Mortality (controlling patient + hospital factors) | Medicaid and private are not significantly different (95% CI, 0.907-1.02; $P = .217$) |

[a]HAC, hospital-acquired condition; PSI, patient safety indicator.
[b]Multivariate analyses of overall results and outcomes by primary payer status. Patient factors include Elixhauser comorbidities, tumor grade, age, and sex found in Figure 1. Hospital factors include hospital type and admission type found in Figure 2.
[c]*P* values represent the controlled comparison of Medicaid/self-pay with private insurance. Significance defined as $P < .002$.

## DISCUSSION

In 1994, the AHRQ created the first quality indicators to gauge the performance of health care delivery in the United States.[17] These metrics were revised over the next decade to create 4 modules of indicators, including preventative, inpatient, patient safety, and pediatric indicators.[28] The PSIs present a picture of patient safety within a hospital and provide information about potentially preventable complications.[16] In addition to patient harm, PSIs are detrimental to our health care system, because they have been shown to increase inpatient mortality, hospital length of stay, and hospital charges.[20,21,23] Initiated by the Affordable Care Act, CMS implemented the Hospital Value-Based Purchasing Program in October 2012.[10,19] Now, as hospital care becomes more transparent and reimbursement is affected by metrics like PSIs and HACS, more effort will be invested in preventing potential harm events.

The review of the NIS database PSIs and HACs among patients admitted with brain tumors reveals several important findings. Overall, PSIs and HACs occur commonly in this population of patients. Patients with brain tumors have a combined incidence of PSIs and HACs greater than 20%. This incidence is greater than the reported rates of patients undergoing craniotomies for unruptured aneurysms or experiencing ischemic strokes.[21,23] Patients with brain tumors are often complex with significant comorbidities, and the high overall incidence of PSIs and HACs may also explain why many of these patients are treated at teaching institutions. Because of these high rates in this population, further investigation in preventative methods to minimize harm events is needed. Second, Medicaid/self-pay patients overall were more likely to develop PSIs or HACs than those with private insurance (Table 4). This difference in incidence is multifactorial and is discussed in detail below. Last, the increased PSIs and HACs seen in the Medicaid/self-pay patients corresponded with an increased length of stay and higher mortality rate, consistent with previous studies (Table 4).[20-23,29]

Many authors cite findings similar to ours in other surgical specialties. In 2004, it was reported that Medicaid and uninsured patients encountered worse outcomes following colorectal cancer resections.[8] In 2008, Giacovelli and colleagues demonstrated that insurance status predicted disease severity in the vascular surgery population.[30] In 2010, LaPar and group found that, in patients undergoing major surgical operations across many specialties, Medicaid and uninsured populations are at an increased risk of mortality.[4] This disparity also appears in the pediatric population, with Stone et al[6] reporting similar findings. Specific to neurosurgery patients, Curry et al[9] found significantly higher mortality and poorer discharge disposition in patients undergoing craniotomy with Medicaid compared with private insurance. Hoh et al[13] found worse discharge outcomes in patients with Medicaid undergoing endovascular aneurysm treatment. In 2013, Lad and group demonstrated that Medicaid patients had greater health care resource utilization measured by hospital days, outpatient services, and medications prescribed in patients undergoing spinal stenosis surgery.[1] Similar findings have been described in Medicaid patients undergoing spinal cord stimulator implantation.[31] PSIs and HACs are newly tracked measures of which we all must be aware; the disparities in outcomes previously described based on

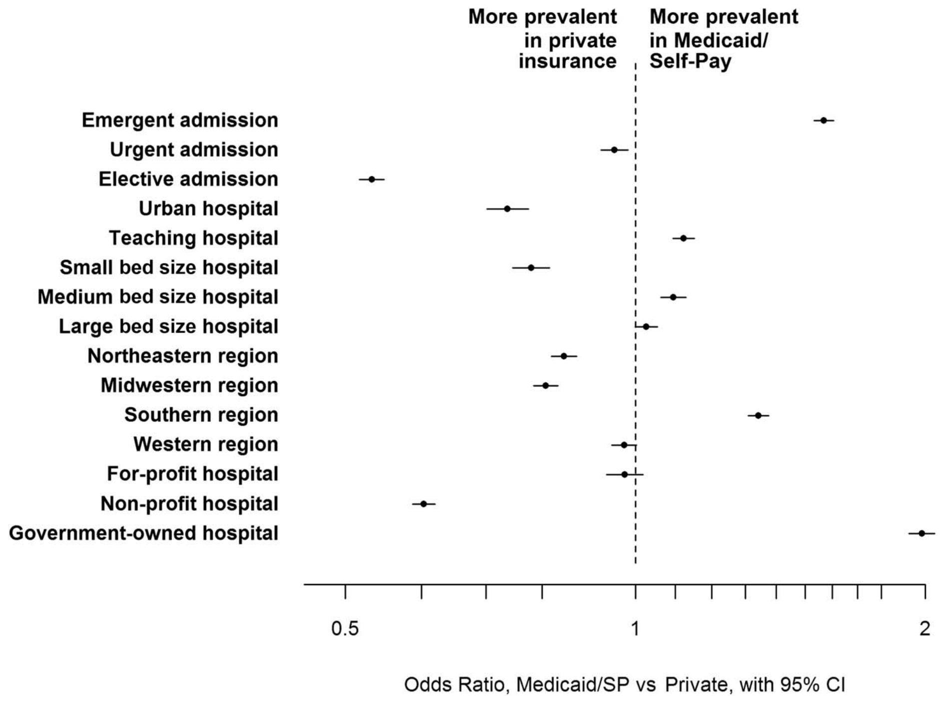


**FIGURE 2.** *Hospital factor odds ratio plot. Graph demonstrates hospital factors and admission type associated with each primary payer status. Note that Medicaid/self-pay populations were more likely to experience emergent admissions and have care at a teaching hospital and government-funded facilities. SP, self-pay.*

insurance status are also seen in these new quality measures evaluated by this study.

The impact of insurance status on outcomes is multifactorial. To determine which factors contribute to the disparity seen in patient harm events, preexisting patient factors such as comorbid diseases, hospital factors, and markers of prehospital care and access to care were analyzed. The 30 comorbid patient conditions were selected based on previous work by Elixhauser et al,[25] who identified a comprehensive set of comorbidities independently associated with increased length of stay, hospital charges, and mortality. In our study, a higher comorbidity index was seen in the Medicaid/self-pay patients compared with the private insurance patients. The higher number of comorbidities alone has been associated with more HACs and patient safety events.[20-23] The patient factors associated with each type of insurance status are outlined in Figure 1. With logistic regression modeling controlling for the patients' demographics and comorbidities, a significant difference in the odds of PSIs and HACs occurring is still present, with more patient harm events occurring in the Medicaid/self-pay population (Table 5).

It is not until the hospital factors and nature of admission are added into the regression model that the difference in PSIs and

**TABLE 6. Effect of Hospital Teaching Status on PSIs and HACs**[a,b]

| | Overall, n = 306 310 (%Population) | Teaching Medicaid/ Self-Pay, n = 56 625 (18.5%) | Teaching Private, n = 146 574 (59.1%) | Nonteaching Medicaid/ Self-Pay, n = 27 298 (8.9%) | Nonteaching Private, n = 75 813 (40.3%) |
|---|---|---|---|---|---|
| Total PSIs, n (% of pts) | 58 727 (19.2) | 11 050 (19.6) | 24 763 (16.9) | 6203 (22.8) | 16 711 (22.1) |
| Total HACs, n (% of pts) | 6040 (2.0) | 1193 (2.1) | 2482 (1.7) | 644 (2.4) | 1721 (2.3) |

[a]HAC, hospital-acquired condition; PSI, patient safety indicator; pts, patients.
[b]Effects of hospital teaching status on incidence of PSIs and HACs. Baseline incidences are presented. In univariate comparison, teaching had a lower incidence than nonteaching in each payer status and overall ($P < .001$). For multivariate analysis, by controlling for both patient factors and hospital factors as described in the text, there is no difference in odds of PSIs or HACs between teaching and nonteaching institutions ($P = .04$ and $P = .004$, respectively). Significance defined as $P < .002$.

HACs between the 2 groups can be explained. One factor is hospital type. Detailed analysis of hospital types treating Medicaid/self-pay patients is seen in Figure 2. In general, treatment of Medicaid/self-pay patients occurred at medium-sized, government-funded institutions in the South. Insurance status also affects access to health care and prehospital treatment.[4,32] Along those lines, insurance status has also been shown to affect the nature of hospital admissions.[2] Private insurance patients are more likely to undergo elective admissions and surgeries than Medicaid and self-pay patients, who are more likely to experience urgent or emergent admissions and operations.[4,7,33] This finding is also true in our population (Table 1 and Figure 2), correlating with the increased odds of PSIs and HACs in those patients with no insurance or Medicaid. A complete statistical model that can explain the differences seen in PSIs and HACs incidence based on insurance status must account for patient factors, hospital factors, as well as the nature of admissions (Table 5). The increased length of stay and increased poor discharge outcomes based on discharge disposition in this combined model suggests other factors associated with discharge placement may be directly related to Medicaid/self-pay payer status.

Because of the perceived association with teaching hospitals and care of Medicaid/self-pay populations, a secondary analysis was performed evaluating the resident teaching status of a hospital. Interestingly, in patients with brain tumors, PSIs and HACs occurred at a higher incidence in nonteaching hospital settings. Previous studies have found lower mortality and complication rates for patients undergoing a craniotomy at high-volume centers compared with lower-volume centers.[34-37] However, when controlling for all patient and hospital factors, no overall difference between teaching status was noted in this study. When comparing insurance status among each hospital type, Medicaid/self-pay patients had a higher estimated national incidence of PSIs and HACs than the private payer status at each hospital type (teaching vs nonteaching), with a more dramatic difference occurring in teaching hospitals. Similar to the finding above, when controlling for all factors in Figures 1 and 2 including patients' comorbidities, hospital type, and access to care, this difference can be explained with the similar odds of PSIs and HACs occurring (Table 6). The difference in the baseline incidences of HACs and PSIs based on teaching status is thus likely multifactorial and warrants further study.

To evaluate areas of potential clinical intervention and prevention, one can review the most common HACs and PSIs in patients with brain tumors in Tables 2 and 3, which include falls, pressure ulcers, and postoperative respiratory failure, among others. As noted above, the higher incidence of PSIs and HACs correlated with worse outcomes and increased length of stay. Research regarding preventative measures would have a large impact in reducing patient harm and health care costs. Interestingly, the incidence of the PSIs and HACs was not universally increased in the Medicaid/self-pay population. The private insurance group had a higher incidence of deep vein thrombosis/pulmonary embolism, and further studies are needed to understand this finding and its impact on patient care.

### Limitations

The limitations of this study include its retrospective design. The NIS database does have unique specific limitations. Accuracy of the data is limited by coding errors and full reporting of events. The NIS evaluates only single admissions per patient, and no outpatient data are available. Some patients may be counted multiple times if readmission occurred. Tumor type (eg, primary vs metastatic), tumor location, and neurological examination are not accessible via the database. Specifics regarding preexisting premorbid conditions are not available. Surrogate markers are used to estimate and control for these limitations. Moreover, true clinical and neurological outcomes are estimated by using discharge dispositions that may be biased by many factors, including insurance status. Despite these limitations, the NIS database allows one to better understand national trends in PSIs and HACs and variability based on insurance status after a patient is admitted. In addition, the NIS database allows one to highlight areas for potential intervention in preventing these hospital-acquired events in the future.

## CONCLUSION

Significant differences exist in the incidence of PSIs and HACs in patients with brain tumors based on insurance status, and those differences correlated with increased length of stay and worse discharge outcomes for Medicaid/self-pay insurance status. The differences seen based on insurance status result from many patient and hospital factors, which, when controlled, can explain the differences seen. With the implementation of the Patient Safety and Affordable Care Act, the cause of these factors should be studied prospectively to begin the process of improving quality metrics in vulnerable patient populations.

### Disclosure

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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## COMMENTS

This is a timely article that nicely demonstrates how socioeconomic disparities in the United States impact health care outcomes and costs. More importantly, it reveals to the Neurosurgery community specific aspects of postsurgical care (central venous line infection, respiratory failure, bed sore prevention, and glycemic control) that may be readily improved in order to achieve better patient outcomes and reduced health care costs. The data convincingly show that: (1) poorer patients come to the hospital sicker and more often on an emergent basis than do privately insured patients, and that these factors contribute to their poorer outcomes following brain tumor surgery; and (2) that government-run and academic medical centers take care of a greater proportion of these sicker patients, yet achieve superior outcomes compared with private non-teaching hospitals. Given these results, it is concerning to also learn that patients in southern states are twice as likely as citizens in the rest of the country to be categorized as Medicaid or Self-pay, especially since these same states have refused federal money to expand Medicaid roles and have fought hardest against implementation of the ACA, which seeks to reduce these health care outcome disparities. The authors are to be applauded for their efforts.

**Ron L. Alterman**
*Boston, Massachusetts*

The authors used the National Inpatient Sample database to compare patient safety indicators and hospital-acquired conditions in patients with brain tumor with Medicaid/self-pay vs private insurance. This is an important issue in the face of the Patient Protection and Affordable Care Act. After adjusting for some patient- and hospital-related factors, they found that the differences in HACs and PSIs disappeared, but there were still differences in length of stay and discharge status. Given the limited nature of the data available through NIS, many preadmission patient factors that would affect outcome were unavailable. Moreover, there are many limitations to using discharge disposition as a surrogate for poor outcome as the discharge disposition may be influenced by social or other non-medical factors. Nevertheless, these results serve as a guide for future studies, but one must be prudent in drawing far-reaching conclusions.

**Rose Du**
*Boston, Massachusetts*

This article represents one of the first publications in a peer-reviewed neurosurgery journal to evaluate quality metrics for the care of patients with brain tumor since the implementation of the 2010 Patient Protection and Affordable Care Act (ACA). The authors have identified an important area of investigation for neurosurgeons—evaluation and impact of data collected and disseminated by the Agency for Health Care Research and Quality (AHRQ) and the Centers for Medicare and Medicaid Services (CMS). The authors queried the Nationwide Inpatient Sample (NIS), which is the largest publicly available all-payer inpatient care database in the United States, containing data on more than 7 million hospitals stays each year based on a representative sample of nonfederal US hospitals. This database is administered as part of the Healthcare Cost and Utilization Project under the direction of AHRQ, The authors use the NIS discharge data to compare the incidence of Patient Safety Indicators (PSIs) and Hospital Acquired Conditions (HACs), essentially complications and untoward events, between 2 groups of patients with brain tumor: Medicaid/self-Pay and Private/Commercial insurance. Their objective is to determine if the type of insurance impacts these 2 quality measures for patients with brain tumor. The authors review multiple comorbidities and variables including hospital factors that may affect these 2 socioeconomically distinct groups to account for the differences observed in PSIs and HACs. The results show that patients with limited insurance or those without insurance had a higher incidence of complications and untoward events compared with patients having private insurance, including increased length of stay, poorer outcomes at discharge, and increased in-hospital mortality. The article informs neurosurgeons about measures being used by AHRQ to evaluate the quality and safety of care provided to our patients. Based on the findings presented here, funds distributed through pay for performance and pay for quality reimbursement programs may actually be directed away from the doctors and hospitals serving disadvantaged communities—those who may need funds most.

**Edie E. Zusman**
*Castro Valley, California*

Physicians are increasingly being held accountable for the value of care that they provide. AHRQ has developed the Patient Safety Indicators (PSI) and CMS has defined specific hospital-acquired conditions (HAC) as measures to better define quality care. The findings in this article raise the question of what factors account for the differences in outcome among insured and noninsured/Medicaid patients undergoing surgery for brain tumors? In order to answer this question, we need to start with meaningful methods to collect and analyze data. The authors appropriately note the limitations of the administrative database, the Nationwide Inpatient Sample, used in this study. In 2012, the American Association of Neurological Surgeons launched the National Neurosurgery Outcomes Database (N2QOD), a national data registry that will collect clinical data as well as patient satisfaction and disability scores. This database has the potential to provide researchers and clinicians with more robust data to identify factors related to patients, perioperative protocols and surgical techniques that may affect the outcome of patients undergoing neurological surgery.

**Amy L. Halverson**
*Chicago, Illinois*