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Predictors of 30- and 90-day readmission following craniotomy for malignant brain tumors: analysis of nationwide data

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Abstract

Hospital readmissions are a major contributor to increased health care costs and are associated with worse patient outcomes after neurosurgery. We used the newly released Nationwide Readmissions Database (NRD) to describe the association between patient, hospital and payer factors with 30- and 90-day readmission following craniotomy for malignant brain tumor. All adult inpatients undergoing craniotomy for primary and secondary malignant brain tumors in the NRD from 2013 to 2014 were included. We identified all cause readmissions within 30-and 90-days following craniotomy for tumor, excluding scheduled chemotherapeutic procedures. We used univariate and multivariate models to identify patient, hospital and administrative factors associated with readmission. We identified 27,717 admissions for brain tumor craniotomy in 2013–2014, with 3343 (13.2%) 30-day and 5271 (25.7%) 90-day readmissions. In multivariate analysis, patients with Medicaid and Medicare were more likely to be readmitted at 30- and 90-days compared to privately insured patients. Patients with two or more comorbidities were more likely to be readmitted at 30- and 90-days, and patients discharged to skilled nursing facilities or home health care were associated with increased 90-day readmission rates. Finally, hospital procedural volume above the 75th percentile was associated with decreased 90-day readmission rates. Patients treated at high volume hospitals are less likely to be readmitted at 90-days. Insurance type, non-routine discharge and patient comorbidities are predictors of postoperative non-scheduled readmission. Further studies may elucidate potentially modifiable risk factors when attempting to improve outcomes and reduce cost associated with brain tumor surgery.

Keywords

National readmission database; Healthcare cost and utilization project; Malignant brain tumor; 30-day readmission; 90-day readmission

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Introduction

Malignant brain tumors are defined by the World Health Organization (WHO) as grade III and grade IV tumors, indicating their increased rate of cellular atypia and rate of proliferation compared to benign and intermediate grade tumors (grade I–II). Malignant brain tumors are comprised of both primary and secondary (metastatic) brain tumors. All secondary brain tumors are defined as malignant since they are metastases. Primary malignant brain tumors have an estimated incidence of 5.26/100,000 patients per year [1] and secondary malignant brain tumors have an estimated incidence of 8.3–11/100,000 patients per year [2]. Surgical resection is indicated as a treatment for mass effect and to provide tissue for clinical diagnosis and research applications [1].

As part of a nationwide effort to reduce hospital readmissions, the Patient Protection and Affordable Care Act of 2010 implemented the Hospital Readmissions Reduction Program (HRRP) [3]. The HRRP requires the Centers for Medicare and Medicaid Services (CMS) to reduce payments to hospitals with high rates of readmission as defined by CMS. Despite this initiative, the rate of readmission after craniotomy for malignant brain tumor resection has remained high. In previous studies, 30-day readmission rates for resection of malignant brain tumors have ranged from 7.5 to 16.30% [4–7]. In a study using the National Surgical Quality Improvement Program (NSQIP), the most common causes for readmission were seizures, surgical site infection, and new onset of motor deficits and the mean time to readmission was 12.3 days [4]. Readmissions also represent a significant increase in the cost of care for brain tumor patients, with each readmission estimated to incur an additional $20,296 in hospital charges [4]. In the post-HRRP era, the costs of readmission may be increasingly borne by the hospital, incentivizing hospitals to reduce readmission rates.

The nationwide rate of readmission after craniotomy for malignant brain tumor surgery is not clearly defined. Past studies of postoperative readmission rates have been limited by data sources that do not allow for long-term follow-up (> 30 days) of patients or are single state databases that are not nationally representative and subject to local effects. Although selective nationwide databases such as the NSQIP provide excellent patient data from member hospitals, NSQIP member hospitals are typically high-volume centers of excellence and may not accurately represent nationwide practices. Understanding the nationwide readmission rate will provide a crucial benchmark for future readmission-prevention efforts. Furthermore, neurosurgical procedures remain relatively rare and using large nationwide datasets permits more sensitive detection of trends and effects that may not be detectable in small or more variable datasets.

In the present study, we analyzed the 2013–2014 Nationwide Readmission Database to determine the rate of readmission after craniotomy for malignant brain tumor surgery and to examine patient, hospital and admission factors which predict readmission within 30- and 90-days of discharge. The Nationwide Readmission Database (NRD) is a compilation of 22 individual State Inpatient Databases with unique patient linkage numbers. These linkage numbers permit the tracking of individual patients across a calendar year for the first time. The 2013–2014 NRD includes approximately 50% of the population of the United States and nearly 50% of the inpatient admissions, and permits the estimation of nationwide effects using weights provided in the dataset. The NRD provides patient readmission data for 12 consecutive months which may provide more complete information regarding long term surgical outcomes.

Data from the NRD has only been released recently, with few current studies employing this dataset to evaluate predictors of patient outcome. No previous studies have evaluated predictors of patient readmission following malignant tumor resection using the NRD. Furthermore, no prior studies have evaluated nationwide datasets to evaluate 90-day readmission following brain tumor surgery. We hypothesize that multiple patient and hospital factors, including procedural volume, are associated with 30- and 90-day readmission rates. We have leveraged access to the 2013–2014 NRD to evaluate patient and hospital factors associated with both 30-day and 90-day readmission.

Methods

Data source

The 2013 and 2014 cohorts of the Nationwide Readmissions Database (NRD) were utilized for this study. The NRD is a publicly available discharge database of all-payer hospital inpatient stays developed as part of the Healthcare Cost and Utilization project by the Agency for Healthcare Research and Quality. NRD data is a compilation from the individual State Inpatient Databases and contains verified patient linkage variables designed to follow patients through hospitalizations within a state for that year. Together, the 2013–2014 abstracts of the NRD contain data from 22 states representing nearly 50% of all hospitalizations nationwide [8].

Study population

Patients with a primary diagnosis of malignant brain tumor (191.0–191.9) that underwent an excision/destruction of lesion or tissue of brain (01.59) were included in this study as index cases using International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9CM) codes. We excluded patients who died during their initial stay, pediatric patients under 18 years of age, as well as patients who had planned readmissions within 90 days for chemotherapy.

Patient and hospital characteristics

For each index hospitalization, the NRD includes information regarding patient and hospital factors that were utilized in univariate and multivariable analysis. Patient factors included: payer information (Medicare, Medicaid, private insurance, no charge, other, self-pay), age, patient location (central counties and fringe counties of metro areas > 1 million, counties in metro areas of > 250,000, counties in metro areas of 50,000–250,000, micropolitan counties, and not metropolitan or micropolitan), and median household income quartile (quartiles 1–4). Patient age was included in NRD as a continuous variable and categorized for analysis (< 50, 50–64, ≥ 65 years old). Hospital factors in NRD included: bed size (small, medium, large with cut-points determined by urban/rural status and region), teaching status (metropolitan non-teaching, metropolitan teaching, non-metropolitan), and annual hospital tumor resection procedure volume. Tumor resection volume was calculated as a continuous variable and categorized for analysis (2013: < 3, 3–5, 6–12, 13 + cases/year; 2014: < 2, 2–5, 6–12, 13 + cases/ year).

Clinical factors associated with the index admission were also included in NRD. Factors such as admission from emergency department, index length of stay (0–2 days, 3–4 days, > 4 days), and All Patient Refined Diagnosis-Related Group (APRDRG): Severity of Illness were included as variables indicating severity of index admission. APRDRG is a proprietary scoring system developed by the 3M Health Information Systems. Postoperative infection during index admission was also noted using ICD-9CM codes. Other factors indicative of severity, such as day of admission (weekday vs. weekend), discharge disposition (routine, transfer to short-term hospital, transfer to other facility including skilled nursing facility and intermediate care facility, home health care, against medical advice, and discharge alive but destination unknown), and elective nature of the admission (elective, non-elective). Charge data was adjusted for inflation to represent 2016 dollars.

Statistical analysis

The NRD includes patient weights that permit national estimates. The primary outcomes of interest in this study were 30-day and 90-day readmissions following index brain tumor resection. Readmissions were identified using methodology provided by the Healthcare Cost and Utilization project. To account for multiple readmissions within 30-days and 90-days, only the first readmission was included in this analysis. Multivariable analysis was conducted utilizing survey-adjusted logistic regression. Odds ratios (OR) were used to report the results of the regression analyses. Readmissions for chemotherapy (V5811, 99.25) were removed from analysis in both models. Furthermore, patients discharged in December and October-December were removed from analysis in the 30-day and 90-day readmission models, respectively, since they would not have sufficient follow-up data.

Analysis was conducted using SAS 9.4 (Cary, NC). Significance levels were noted with a $p < 0.05$.

Results

Patient and hospital baseline characteristics

From 2013 to 2014, we identified 27,717 index cases of malignant brain tumor resections in the United States. Fifty-three percent of all patients were admitted electively (52.7%, n = 14,673), were privately insured (49.6%, n = 13,733) and had two or more comorbidities (50.0%, n = 13,871). Most were operated on in a center in the top quartile of tumor resection volume (75.3%, n = 20,869) and at a metropolitan teaching hospital (75.3%, n = 20,869). Patients' ages and socioeconomic status were relatively equally distributed between our categories. Frontal (32.3%), temporal (25.3%), and parietal (14.7%) locations were the most common. Significant perioperative morbidity was observed: 27.3% of patients had major loss of function and 35.8% had non-routine discharges. See Table 1 for complete baseline characteristics.

The index hospitalization median length of stay was 8.4 days and median cost per stay was $124,012.00.

Readmission demographics

There were 3343 readmissions (13.2%) within 30-days of discharge from the index hospitalization and 5271 (25.7%) within 90 days of discharge from the index hospitalization. Patients readmitted within 30-days had a median time to readmission of 11.9 days and a median readmission length of stay of 3.5 days. Patients readmitted within 90-days had a median time to readmission of 29.0 days and a median readmission length of stay of 3.3 days.

Table 2 lists the most common primary diagnoses at readmission. Among the most common specified diagnoses during readmission within both the 30- and 90-day cohorts were postoperative infection (998.59), nervous system complications (997.09, 348.9), septicemia (038.9), pulmonary embolism (415.19), and obstructive hydrocephalus (331.4).

Predictors of 30-day readmission

Multiple patient, hospital, and admission factors were associated with increased chance of all cause 30-day readmission (Table 3). Patients with Medicaid (OR = 1.27, $p = 0.02$) and Medicare (OR = 1.43, $p < 0.01$) were more likely to be readmitted compared to privately insured patients. Patients with two or more comorbidities were more likely to be readmitted (OR = 1.24, $p = 0.03$) within 30-days compared to patients with no comorbidities Patients who had extreme loss of function (OR 1.42, $p < 0.01$) on their index admission were more likely to be readmitted within 30-days compared to those with minor loss of function. Patients discharged to short-term hospitals, skilled nursing/intermediate care facilities, and to home healthcare agencies were respectively 40, 43 and 70% more likely to be readmitted compared to those who were routinely discharged (all $p < 0.01$). Occipital tumor location was associated with a decreased likelihood of 30-day readmission (OR = 0.63, $p = 0.01$). Postoperative infection during index hospitalization doubled the chance of readmission (OR = 2.00, $p = 0.01$).

Of note, patient age, hospital teaching status, procedure volume, emergency room admission, previous disability and income quartile had no association with the outcome of 30-day readmission.

Predictors of 90-day readmission

Table 3 lists the patient, hospital and admission factors that were associated with increased odds of readmission within 90 days. Patients with Medicaid (OR = 1.29, $p < 0.01$) and Medicare (OR = 1.31, $p < 0.01$) were more likely to be readmitted within 90-days compared to patients who were privately insured. Having two or more comorbidities (OR = 1.26, $p < 0.01$) increased a patient’s odds of readmission at 90-days compared to patients without comorbid conditions. Procedural volume was associated with readmission rate: patients treated at hospitals in the top quartile of tumor volume were less likely to be readmitted within 90-days (OR = 0.64, $p = 0.03$). Furthermore, patients transferred to SNF/ICF and home healthcare agencies were also more likely to be readmitted within 90-days compared to patients who were discharged home. However, patients discharged to short-term hospitals were not more likely to be readmitted within 90 days. Finally, patients aged 50–64 years old (OR = 1.2, $p = 0.01$) and ≥ 65 years old (OR = 1.24, $p = 0.05$) were more likely to be readmitted within 90-days (Table 3). Patients with length of stay > 4 days on their initial admission were more likely to be readmitted (OR = 1.3, p = 0.01). Patients from the ZIP codes with incomes in the lowest quartile were more likely to be readmitted compared to patients from the highest income ZIP code (OR 1.19, p = 0.04).

Of note, emergency room admission, postoperative infection during index hospitalization, loss of function and tumor location had no association with readmission at 90-days.

Discussion

We utilized the National Readmission Database (NRD), an all-payer nationwide dataset, to determine the baseline rate and predictors of postoperative readmission in 27,717 patients who underwent resection of a malignant brain tumor in 2013 and 2014. The NRD includes data from 22 individual state databases representing nearly half of all patients and admissions in the United States. Patients in the NRD can be tracked throughout the calendar year using unique de-identified linkage; the NRD is the first all-payer nationwide database that permits the analysis of readmission. Accordingly, we believe that the NRD provides most accurate method of measuring the nationwide readmission rate for patients with malignant brain tumors. We report rates of readmission at 30- and 90-days after craniotomy for malignant brain tumor resection to be 13.2 and 25.7%, respectively. Hospitals with a procedural volume above the 75th percentile were associated with decreased 90-day readmission rates, which is important because high-volume, tertiary care centers are known to provide care to complex patients who frequently have refractory or advanced disease. Patients with two or more comorbidities were more likely to be readmitted at 30- and 90-days. Further, patients discharged to home health care facilities had increased likelihood of readmission at 30-days while patients discharged to skilled nursing facilities, home health care facilities or left the hospital against medical advice were more likely to be readmitted at 90-days.

Legislation from the Hospital Readmission Reduction Program of the Affordable Care Act penalizes hospitals with excess readmission rates which underscores the need for generalizable readmission rates [3]. Prior to this study, other studies examining readmission rates after craniotomy for resection of a malignant brain tumor have predominantly used single institution, statewide or single-payer data with 30-day readmission rates ranging from 7.5 to 16.3% [4–7]. The sources of these data have inherent limitations and thus are reflected in the variability of reported rates. While single institutional databases have limited statistical power to draw conclusions reflective of a national population, single payer databases with adequate power are limited to a homogenous patient population. State-wide databases have historically been able to capture the most representative readmission rates given large sample sizes and nonuniform populations. However, our study is the first to report 30 and 90-day (13.2 and 25.7%) readmission rates that are representative of the national population.

We utilized a multivariate model to examine whether patient, hospital and admission factors affect the odds of post-operative readmission. We found that patients treated at hospitals in the top quartile for volume of malignant brain tumor resection were less likely to be readmitted within 90-days. Although others have shown that centers with increased procedural volume have better short term out-comes,[9, 10] the relationship between volume and readmission outcomes was not known. Using the Nationwide Inpatient Sample (NIS), high-volume centers have been shown to have lower in-hospital mortality rates and higher rates of routine discharge for supratentorial tumor surgery, though the NIS data is limited by inability to assess readmissions [11]. As craniotomies for resection of malignant brain tumors are typically elective procedures, an association between readmission rate and procedural volume may support centralization of care to high-volume centers to reduce readmission and increase quality of care. Centralization could be achieved through a variety of approaches, including incentivizing referral and/or transfer high-volume centers.

Patients with public insurance, such as Medicaid and Medicare, were more likely to be readmitted at 30- and 90-days compared to privately insured patients. Data has suggested patients receiving government subsidized insurance, such as MediCal (California insurance program for lower-income patients), were at increased odds of readmission after supratentorial malignant brain tumor resection, [4] while private insurance patients have significantly lower mortality and more favorable discharge disposition after tumor resection [12]. Studies have suggested potential sources of disparity may arise from systemic factors such as decreased access to care and follow-up and lower quality of care at treating institutions [13, 14]. The relationship between insurance status and readmission rates underscores the importance of evaluating all-payer databases rather than single payer or insurance claims databases to capture a heterogeneous population. Of note, the socioeconomic factor of insurance status as well as the income quartile was associated with readmission rates, as previously reported.[7].

We attempted to control for patient disease severity and medical status in multivariate analysis with multiple variables including comorbidities, hospital length of stay, and discharge disposition. In multivariate analysis, patients with two or more comorbidities were more likely to have both 30- and 90-day readmission. While previous state data analysis suggests myocardial infarction is specifically associated with 30-day readmission after malignant brain tumor surgery, number of general comorbidities was not evaluated [4]. Our findings are, however, in line with prior studies showing increasing medical comorbidities were associated with increased odds of death during the initial hospital stay and odds of worse outcome at hospital discharge after craniotomy for resection of metastatic brain tumors [12]. We further found that patients discharged to home health care had increased readmission at 30-days while those discharged to skilled nursing facilities or home health care had increased odds of 90-day readmission. Finally, patients with initial hospital stay of > 4 days had increased likelihood of both 30- and 90-day readmissions. Historically, length of stay (LOS) has been used as a surrogate marker for readmission risk,[15] with increasing stay among patients with peri-operative complications,[16–18] and increasing risk of nosocomial infections and iatrogenic errors during time as an inpatient [19, 20]. Unsurprisingly, previous state datasets have noted increasing length of stay to be associated with readmission after tumor resection [4].

Although the use of the NRD permits this first report of national rates of readmission after craniotomy for malignant brain tumors, the NRD has several important limitations. With patient identifiers present in the NRD, HCUP censors variables that may compromise confidentiality including variables of race, hospital identifier, and location. Furthermore, data is limited by common limitations inherent to national database analysis [21]. Patient data and variables are limited to available coded ICD9 diagnosis and procedure codes. As data is often input by a heterogeneous population of administrative staff, multiple coding errors, including inaccurate coding, omission of pertinent codes due to poor documentation, transcription errors, and other data-related limitations may be present. Rates of coding accuracy have been reported to be at 80% [22]. Furthermore, linkage numbers may rarely be inaccurately assigned. Although national databases allow for adequately powered clinical studies they do not provide specific clinical details important in malignant brain tumor resection patients. Due to its design, the NRD only allows patient identifiers to be repeated within the course of one calendar year. NRD does not allow for patients to be followed across calendar years. As noted in our methods, we accordingly cannot report readmissions data beyond 11 months for 30-day readmission and beyond 9 months for 90-day readmission.

There are other specific limitations which constrain our ability to control for disease specific factors that likely affect readmission in this population. We are unable to differentiate between primary and secondary malignant brain tumors, which would help refine our estimate of readmission rates since secondary malignancy patients have other systemic diseases that may result in readmission. ICD9 codes do not differentiate between types of malignant brain tumors, limiting our ability to differentiate glioblastoma multiforme from other metastatic tumors. Furthermore, ICD9 and CPT codes do not diferentiate between initial tumor operation and subsequent re-operations. Finally, although we include all patients receiving adjuvant chemotherapy and radiation treatment, ICD9 and CPT codes do not permit identification of these patients.

Conclusion

In this study, we provide the first nationwide all-payer estimates of 30- and 90-day readmissions in patients undergoing craniotomy for resection of a malignant brain tumor. We report that several patient, hospital and admission factors are associated with readmission rates. Most notably, we found that patients treated at hospitals in the top quartile for procedural volume are less likely to be readmitted at 90-days. Patients with Medicaid and Medicare and lower income patients are more likely to be readmitted. Further study may be warranted to assess potential high risk readmission populations and further explore the benefit of high volume centers in reducing unplanned readmissions.

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Table 1

Population demographics

	N	%
Payer information		
Medicare	9249	33.43
Medicaid	2763	9.99
Private insurance	13,733	49.64
Self-pay	836	3.02
No charge	116	0.42
Other	967	3.50
Income quartile based on ZIP code		
Income quartile 1	5064	18.27
Income quartile 2	6910	24.93
Income quartile 3	7295	26.32
Income quartile 4	7946	28.67
Missing income quartile	502	1.81
Age category		
<50 years old	8700	31.39
50–64 years old	10,086	36.39
≥ 65 years old	8930	32.22
Comorbidities		
0 comorbidities	6924	24.98
1 comorbidity	6922	24.97
2 comorbidities	13,871	50.04
Hospital bed size		
Small	1693	6.11
Medium	4565	16.47
Large	21,459	77.42
Hospital teaching status		
Metro non-teaching	3327	12
Metro teaching	24,046	86.75
Non-metro	344	1.24
Tumor resection volume		
< 25th volume percentile	504	1.82
25–50th volume percentile	2255	8.14
50–75th volume percentile	4089	14.75
> 75th volume percentile	20,869	75.29
Emergency room status		
No ED origin	9101	32.84
ED origin	18,616	67.16
Length of stay category		
0–2 days	5052	18.23

	N	%
3–4 days	7279	26.26
>4 days	15,386	55.51
Postoperative infection		
No postop infection	27,523	99.30
Postop infection	194	0.70
Tumor location		
Cerebrum	519	1.87
Frontal	8943	32.27
Temporal	7005	25.27
Parietal	4065	14.67
Occipital	1264	4.56
Ventricles	429	1.55
Cerebellum	837	3.02
Brain stem	151	0.55
Other brain	1961	7.08
Brain NOS	2543	9.17
APRDRG severity score		
Minor loss of function	5830	21.04
Moderate loss of function	11,965	43.17
Major loss of function	7557	27.26
Extreme loss of function	2363	8.53
Day of admission		
Weekday admission	24,533	88.51
Weekend admission	3184	11.49
Discharge disposition		
Routine	17,805	64
Transfer to short-term hospital	362	1
Transfer other: SNF, ICF	4594	17
Home health care	4904	18
AMA	38	0
Discharge alive, destination unknown	DS	0
Admission type		
Non-elective admission	12,970	46.92
Elective admission	14,673	53.08

Values depicted represent the population demographics for all index hospital admissions between 2013 and 2014 for malignant brain tumor resection

DS data suppressed in accordance to the HCUP data user agreement regarding cell values < 10

Table 2

Primary diagnosis at readmission

Diagnosis	Frequency (% of readmissions)	
	30-day	**90-day**
CNS tumor (191.1, 191.2, 191.3, 191.9)	545 (16.3)	1059 (20.0)
Post-operative infection (998.59)	200 (5.98)	250 (4.74)
Septicemia (03.89)	148 (4.42)	200 (3.79)
Pulmonary embolism (415.19)	95 (2.84)	215 (4.07)
Urinary tract infection (599.0)	76 (2.27)	88 (1.66)
Other nervous system complication (997.09)	72 (2.15)	107 (2.02)
Deep vein thrombosis (453.41)	68 (2.03)	105 (1.99)
Other convulsions (780.39)	63 (1.88)	132 (2.50)
Pneumonia (486)	61 (1.82)	106 (2.01)
Hydrocephalus (331.4)	57 (1.70)	99 (1.87)
CNS complication (997.01)	57 (1.70)	77 (1.46)

Values represent the frequency, after application of appropriate weights, and percentage of readmissions for each primary diagnosis (ICD 9 code)

Table 3

Predictors of 30 and 90-day all cause readmission: values depicted represent odds ratios, confidence intervals and p values for predictors of 30 and 90-day all cause readmissions

	30-day		90-day	
	OR	**p value**	**OR**	**p value**
Payer information				
Medicare	1.43	<0.01	1.31	0.01
Medicaid	1.27	0.02	1.29	<0.01
Private Insurance	Reference			
Age category				
<50 years old	Reference			
50–64 years old	0.98	0.82	1.2	0.01
≥ 65 years old	0.90	0.37	1.24	0.05
Comorbidities				
0 comorbidities	Reference			
1 comorbidity	1.07	0.53	1.02	0.8
2 comorbidities	1.24	0.03	1.26	<0.01
Hospital teaching status				
Metro non-teaching	Reference			
Metro teaching	0.97	0.78	0.99	0.87
Non-metro	0.98	0.94	0.84	0.5
Tumor resection volume				
< 25th volume percentile	Reference			
25–50th volume percentile	0.72	0.2	0.88	0.56
50–75th volume percentile	0.71	0.15	0.7	0.11
> 75th volume percentile	0.66	0.09	0.64	0.03
Emergency room status				
No ED origin	Reference			
ED origin	1.06	0.57	0.99	0.95
Length of stay category				
0–2 days	Reference			
3–4 days	1.14	0.22	1.08	0.4
>4 days	1.25	0.06	1.3	0.01
Postoperative infection				
No postop infection	Reference			
Postop infection	2.00	0.01	1.65	0.09
Tumor location				
Cerebrum	0.93	0.8	1.21	0.32
Frontal	Reference			
Temporal	1.07	0.51	0.96	0.65
Parietal	1.02	0.83	1.01	0.95
Occipital	0.63	0.01	0.76	0.06

	30-day		90-day	
	OR	**p value**	**OR**	**p value**
Ventricles	1.41	0.18	1.19	0.46
Cerebellum	1.03	0.85	1.07	0.72
Brain stem	1.94	0.07	1.25	0.56
Other brain	1.09	0.51	1.09	0.41
Brain NOS	1.41	<0.01	1.19	0.04
APRDRG severity score				
Minor loss of function	Reference			
Moderate loss of function	1.02	0.87	0.97	0.73
Major loss of function	1.28	0.01	1.06	0.54
Extreme loss of function	1.42	<0.01	1.15	0.2
Discharge disposition				
Routine	Reference			
Transfer to short-term hospital	1.7	<0.01	1.05	0.83
Transfer other: SNF, ICF	1.43	<0.01	1.25	<0.01
Home health care	1.4	<0.01	1.25	<0.01
AMA	1.65	0.42	2.8	0.09
Discharge alive, destination unknown				
Income quartile based on ZIP code				
Income quartile 1	1.11	0.3	1.19	0.04
Income quartile 2	0.96	0.67	1.09	0.26
Income quartile 3	0.90	0.29	1.06	0.47