Association of Language Barriers With Process Outcomes After Craniotomy for Brain Tumor

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BACKGROUND: Little is known about the independent association of language barriers on postoperative process outcomes after craniotomies.

OBJECTIVE: To evaluate the association of limited English proficiency (LEP) with length of stay (LOS), discharge disposition, hospitalization costs, and rate of 30-day readmission after craniotomy for brain tumor.

METHODS: This is a retrospective cohort study of adult patients who underwent craniotomies for brain tumor from 2015 to 2019 at a high-volume neurosurgical center. Multivariable logistic regression was used to evaluate the association of LEP with discharge disposition and 30-day readmission. Negative binomial regression was used to evaluate the association of LEP with LOS and hospitalization cost.

RESULTS: Of the 2232 patients included, 7% had LEP. LEP patients had longer LOS (median [IQR] 5 [3-8] days vs 3 [2-5] days, $P < .001$), higher costs of hospitalization (median [IQR] $27 000 [$21 000-$36 000] vs $23 000 [$19 000-$30 000], $P < .001$), and were more likely to be discharged to skilled care facilities (37% vs 21%, $P < .001$) compared with English proficient patients. In multivariable models, the association between LEP and longer LOS (incidence rate ratio 1.11, 95% CI 1.00-1.24), higher hospitalization costs (incidence rate ratio 1.13, 95% CI 1.05-1.20), and discharge to skilled care (OR 1.76, 95% CI 1.13-2.72) remained after adjusting for confounders. There was no difference in 30-day readmission rates by language status.

CONCLUSION: LEP is an independent risk factor for extended LOS, higher hospitalization cost, and discharge to skilled care in neurosurgical patients who undergo craniotomy for brain tumor. Future research should seek to understand mediators of these observed disparities.

KEY WORDS: Communication barriers, Health care disparities, Limited English proficiency, Neurosurgery, Perioperative care, Postoperative care

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Craniotomy for brain tumors has historically required multiday hospital admissions including initial monitoring in the intensive care unit and postoperative consultations with numerous specialists before discharge. In recent years, there has been increasing interest in optimizing modifiable drivers of quality, resource utilization, and cost in neurosurgical care.[1] This interest became urgent during the COVID-19 pandemic when health care resources became critically scarce.

In the United States, approximately 26 million individuals have limited English proficiency (LEP),[2] which has been associated with disparities in care and outcomes across various health care settings.[3,4] Although researchers have identified multiple sociodemographic drivers of health care inefficiencies and disparities after craniotomy,[5] little is known about the independent effect of language barriers on perioperative healthcare and recovery after craniotomies. Language barriers, however, may play a significant role in shared decision-making, ability to perform serial neurological testing, communication about concerning symptoms, and understanding of therapy goals and discharge

ABBREVIATIONS: EBL, estimated blood loss; **EP,** English proficient; **IRR,** incidence rate ratio; **LEP,** limited English proficiency; **LOS,** length of stay.

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instructions. We hypothesize that craniotomy patients with LEP experience many small differences in perioperative care that significantly influence their health care experiences, and these disparities result in consequential inefficiencies and increases in cost to health care systems.

In this study, we examined the association of LEP with surgical admission length of stay (LOS), discharge disposition, hospitalization cost, and rate of 30-day readmission after craniotomy for brain tumor.

METHODS

This report follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies.[6] Institutional Review Board approval was obtained with waiver of consent.

Study Population

This retrospective cohort study used electronic health data of patients age 18 years or older who underwent craniotomies for brain tumors from 2015 to 2019 at a high-volume neurosurgical center in California. The study institution provides in-person, phone, and video interpreter services to patients and providers without restriction as well as consent forms and discharge instructions in multiple languages. The institution does not receive federal, local, or private reimbursement for language services offered. Patients who died during hospitalization (n = 14) were excluded because there were not sufficient numbers in our sample to treat this outcome as a competing risk.[7] Characteristics of the patients who died during craniotomy for brain tumor hospitalization are presented in **Supplemental Table 1**, http://links.lww.com/NEU/D242.

Primary Predictor

The primary predictor of interest was English language proficiency, with LEP patients indicating a non-English primary language and preference for interpreter services at the time of admission.

Primary Outcomes

The primary outcome variables examined in this study included total hospitalization LOS, direct costs of hospitalization, discharge disposition (home vs skilled care), and 30-day readmission rate.

Covariates

Patient demographics and clinical characteristics collected include age, patient-reported sex, patient-reported race/ethnicity, body mass index (BMI), insurance provider, American Society of Anesthesiologists (ASA) physical classification rating, case class (elective vs urgent), surgical case length, and estimated blood loss (EBL).

Statistical Analysis

Bivariate analyses between LEP vs English proficient (EP) groups were performed using χ^2, Fisher exact, Wilcoxon rank-sum, and t tests as appropriate. The normality of continuous data was determined using histograms and the Shapiro-Wilk test. Multivariable models with covariates chosen a priori based on prior literature and database availability were used to estimate the association between LEP and outcome variables of interest. Logistic regression models were used to estimate the effect of English language proficiency on discharge disposition and 30-day readmission outcomes. Negative binomial regression models were used to accommodate the overdispersed count outcome variables LOS and hospitalization cost. Owing to the very small number of missing covariates and the assumption that missingness was completely at random, these missing values were handled using listwise deletion. Sensitivity analyses investigating the influence of limiting the multivariable models to variables with significance levels of 0.05 in bivariate analyses and including the 14 patients who died during their hospitalization for craniotomy in both bivariate and multivariable analyses revealed no changes that affected our study conclusions. Stata version 15.1 (StataCorp) was used to conduct analyses. All P values were from 2-sided tests, and the results with P values < .05 were considered statistically significant.

RESULTS

Of the 2232 patients meeting inclusion criteria for this study, 1109 (49.7%) were female, mean (SD) age was 53.0 (15.3) years, and 146 (6.5%) had LEP. LEP patients most commonly identified as Hispanic/Latinx (42.5%), Asian/Pacific Islander (39.0%), or White (11.0%). The most common primary languages spoken by LEP patients were Spanish (46.6%) or a Chinese language (33.6%). Patients with LEP undergoing craniotomy for brain tumor were more likely to have noncommercial insurance, require urgent surgery, and have slightly higher intraoperative EBL (Table 1).

In bivariate analysis, LEP craniotomy patients had longer LOS (median [IQR] 5 [3-8] days vs 3 [2-5] days, $P < .001$), higher costs of hospitalization (median [IQR] $27 000 [$21 000-$36 000] vs $23 000 [$19 000-$30 000], $P < .001$), and were more likely to be discharged to a skilled care facility (37.3% vs 20.9%, $P < .001$) compared with EP patients. There was no difference in 30-day readmission rates by language status (Table 1).

In multivariable negative binomial regression models, the association between LEP and longer LOS (incidence rate ratio [IRR] 1.11, 95% CI 1.00-1.24) and higher hospitalization costs (IRR 1.13, 95% CI 1.05-1.20) remained after adjusting for age, sex, race/ethnicity, BMI, primary insurance, ASA rating, case class, case length, EBL, and discharge disposition.

Binomial logistic regression models were used to understand the relationship of language status with discharge disposition and 30-day readmission rates after adjusting for age, sex, race/ethnicity, BMI, primary insurance, ASA rating, case class, case length, EBL, and postoperative recovery location. LEP status remained associated with discharge to skilled care (OR 1.76, 95% CI 1.13-2.72), but not with a 30-day readmission (OR 0.84, 95% CI 0.45-1.56; Table 2).

DISCUSSION

In this study of a multiethnic population undergoing craniotomy for brain tumors, limited English proficiency was an independent risk factor for extended length of stay, higher cost of hospitalization, and discharge to skilled care, but not readmission.

TABLE 1. Characteristics of Patients Undergoing Craniotomy for Brain Tumor, by English Proficiency

Characteristics and Outcomes	Total sample N = 2232 N (%)	English proficient N = 2082 N (%)	Limited English proficiency N = 150 N (%)	*P* value
Patient characteristics				
Age, mean (SD), years	53.0 (15.3)	52.8 (15.2)	55.4 (15.4)	.04[a]
Sex				.21[b]
Male	1123 (50.3%)	1055 (50.7%)	68 (45.3%)	
Female	1109 (49.7%)	1027 (49.3%)	82 (54.7%)	
Race/ethnicity				<.001[b]
White	1563 (70.0%)	1547 (74.3%)	16 (10.7%)	
Asian/Pacific Islander	236 (10.6%)	178 (8.5%)	58 (38.7%)	
Hispanic/Latinx[c]	256 (11.5%)	192 (9.2%)	64 (42.7%)	
Black	54 (2.4%)	54 (2.6%)	0 (0.0%)	
Other[d]	123 (5.5%)	111 (5.3%)	12 (8.0%)	
Language spoken				<.001[b]
English	2077 (93.1%)	2077 (99.8%)	0 (0.0%)	
Spanish	71 (3.2%)	1 (0.0%)	70 (46.7%)	
Chinese (multiple languages)	50 (2.2%)	1 (0.0%)	49 (32.7%)	
Other non-English	34 (1.5%)	3 (0.1%)	31 (20.7%)	
Primary insurance type				<.001[b]
Private	1223 (54.8%)	1187 (57.0%)	36 (24.0%)	
Public	427 (19.1%)	361 (17.3%)	66 (44.0%)	
Medicare	582 (26.1%)	534 (25.6%)	48 (32.0%)	
ASA rating				.08[e]
ASA 1	122 (5.5%)	117 (5.6%)	5 (3.3%)	
ASA 2	1189 (53.3%)	1121 (53.8%)	68 (45.3%)	
ASA 3	883 (39.6%)	810 (38.9%)	73 (48.7%)	
ASA 4	36 (1.6%)	32 (1.5%)	4 (2.7%)	
ASA 5	2 (0.1%)	2 (0.1%)	0 (0.0%)	
BMI, mean (SD), kg/m^2	27.3 (5.9)	27.3 (5.9)	27.1 (5.2)	.65[a]
Case characteristics				
Case classification				<.001[e]
Elective	2016 (90.3%)	1895 (91.0%)	121 (80.7%)	
Urgent	216 (9.7%)	187 (9.0%)	29 (19.3%)	
Case length, mean (SD), min	239.5 (105.4)	239.1 (103.7)	245.3 (126.6)	.49[a]
Estimated blood loss, mean (SD), mL	162.4 (184.1)	159.0 (180.7)	209.2 (222.4)	.001[a]
Short-term outcomes				
Length of stay, median (IQR), d	3.0 (2.0-6.0)	3.0 (2.0-5.0)	5.0 (3.0-8.0)	<.001[f]
Direct costs, median (IQR), $	23 575.8 (19 158.6-30538.4)	23 418.2 (19 109.2-29 997.8)	27 365.4 (21 118.7-35 689.9)	<.001[f]
Discharge disposition				<.001[b]
Nonhome/skilled facility	490 (22.0%)	434 (20.9%)	56 (37.3%)	
Home	1740 (78.0%)	1646 (79.1%)	94 (62.7%)	
30-d readmission				.40[b]
No	2036 (91.2%)	1902 (91.4%)	134 (89.3%)	
Yes	196 (8.8%)	180 (8.6%)	16 (10.7%)	

ASA, American Society of Anesthesiologists; BMI, body mass index.
[a]Two sample *t* test.
[b]Pearson χ^2.
[c]Hispanic/Latinx category includes anyone who self-identified as Hispanic, Latinx, or Latino ethnicity regardless of race.
[d]Other category includes patients identifying as Native Americans/Alaskan Natives as well as those with unknown or unspecified race or ethnicity.
[e]Fisher exact.
[f]Wilcoxon rank-sum.
Data are presented as mean (SD) or median (IQR) for continuous measures, and n (%) for categorical measures.

Our results indicate that language barriers may affect care efficiency and discharge disposition but have less impact on postoperative complications that would require readmission.

Our study reinforces the findings of Witt et al,[8] who found disparities in postoperative LOS and discharge disposition by primary language spoken in an analysis of the New Jersey state-wide

TABLE 2. Unadjusted and Adjusted Effect of Limited English Proficiency on Postoperative Outcomes for Patients Undergoing Craniotomy for Brain Tumor

	Surgical hospitalization length of stay				Cost of hospitalization/ direct costs				Discharge to skilled facility (vs home)				30-d readmission			
Covariates of Interest	**IRR[a]**	***P* > |*z*|**	**[95% CI]**		**IRR[a]**	***P* > |*z*|**	**[95% CI]**		**OR[b]**	***P* > |*z*|**	**[95% CI]**		**OR[b]**	***P* > |*z*|**	**[95% CI]**	
Bivariate model																
English proficient (reference)	1				1				1				1			
Limited English proficiency	1.41	<0.001	1.26	1.58	1.23	<0.001	1.14	1.33	2.26	<0.001	1.60	3.20	1.26	0.40	0.73	2.17
Multivariable model																
Language proficiency																
English proficient (reference)	1				1				1				1			
Limited English proficiency	1.11	0.04	1.00	1.24	1.13	<0.001	1.05	1.20	1.76	0.01	1.13	2.72	0.84	0.58	0.45	1.56
Age, y	1.00	0.78	1.00	1.00	1.00	0.18	1.00	1.00	1.03	<0.001	1.02	1.04	1.00	0.77	0.99	1.01
Sex																
Male (reference)	1				1				1				1			
Female	0.95	0.04	0.90	1.00	0.95	<0.001	0.92	0.98	0.92	0.44	0.73	1.14	0.84	0.28	0.62	1.15
Race/ethnicity																
White (reference)	1				1				1				1			
Asian/Pacific Islander	0.95	0.30	0.87	1.04	1.00	0.86	0.94	1.05	0.89	0.58	0.60	1.33	1.34	0.26	0.80	2.24
Hispanic/Latinx	0.97	0.52	0.89	1.06	0.98	0.41	0.93	1.03	0.87	0.50	0.59	1.29	1.28	0.32	0.79	2.07
Black	1.07	0.44	0.91	1.25	1.13	0.02	1.02	1.25	2.12	0.02	1.13	3.96	1.68	0.20	0.76	3.70
Other/unknown	1.03	0.58	0.92	1.16	0.97	0.37	0.90	1.04	0.62	0.09	0.36	1.07	0.66	0.31	0.29	1.47
Primary insurance type																
Private (reference)	1				1				1				1			
Public	1.23	<0.001	1.15	1.32	1.11	<0.001	1.07	1.16	1.72	<0.001	1.27	2.31	1.52	0.04	1.03	2.24
Medicare	1.02	0.65	0.94	1.09	1.04	0.12	0.99	1.08	1.25	0.15	0.93	1.69	1.15	0.53	0.75	1.75
ASA status																
ASA 1 (reference)	1				1				1				1			
ASA 2	1.05	0.46	0.93	1.18	1.00	0.98	0.93	1.07	0.88	0.67	0.48	1.61	2.40	0.15	0.74	7.83
ASA 3	1.28	<0.001	1.13	1.46	1.18	<0.001	1.10	1.27	1.83	0.05	0.99	3.39	5.18	0.01	1.58	16.99
ASA 4	1.45	<0.001	1.17	1.79	1.39	<0.001	1.21	1.61	5.17	<0.001	2.03	13.20	13.91	<0.001	3.45	56.09
ASA 5	2.80	<0.001	1.49	5.27	2.18	<0.001	1.30	3.65								
BMI, mean (SD), kg/m^2	0.99	<0.001	0.99	1.00	1.00	<0.001	0.99	1.00	1.00	0.83	0.98	1.02	1.01	0.48	0.98	1.03
Case classification																
Elective (reference)	1				1				1				1			
Urgent	1.64	<0.001	1.52	1.78	1.41	<0.001	1.33	1.49	2.23	<0.001	1.58	3.15	1.62	0.04	1.02	2.55
Case length, min	1.00	<0.001	1.00	1.00	1.00	<0.001	1.00	1.00	1.00	<0.001	1.00	1.00	1.00	0.24	1.00	1.00
Estimated blood loss, mL	1.00	<0.001	1.00	1.00	1.00	<0.001	1.00	1.00	1.00	<0.001	1.00	1.00	1.00	0.27	1.00	1.00
Discharge disposition																
Home	1															
Skilled facility	1.94	<0.001	1.83	2.06												
Model constant	2.78	<0.001	2.27	3.39	15 988	<0.001	14 212	17 985	0.01	<0.001	0.004	0.03	0.01	0.003	0.00	0.06

ASA, American Society of Anesthesiologists; BMI, body mass index; IRR, incidence rate ratio; OR, odds ratio.
[a]Negative binomial regression models accommodated right skew exhibited by variables length of stay and total cost; the resulting incidence rate ratios are given.
[b]Logistic regression analyses determined odds ratios for dichotomous outcome variables.

inpatient database. Other studies have found similar associations between LEP and prolonged LOS in patients undergoing emergency general surgery, coronary artery bypass graft surgery, and joint arthroplasty.[9-11] The consistency of this finding is not surprising given poor patient-provider communication and shared decision-making as reported by LEP patients, and the significantly prolonged duration of language discordant patient encounters compared with language concordant encounters.[12,13] Communication breakdown between patients and their providers may subsequently lead to more complex inpatient courses and prolonged LOS.

Our study additionally found that LEP patients trended toward higher ASA ratings (higher burden of medical comorbidities before surgery) and were much more likely to undergo urgent rather than elective surgery, findings in line with previous studies demonstrating associations between LEP and more advanced disease at presentation and increased likelihood of emergency

surgery.[14,15] Indeed, in multivariable analysis, urgent presentation and higher ASA rating were associated with longer LOS, higher cost, and discharge to skilled care. Despite adjusting for these confounders in the multivariable analysis, however, LEP itself remains an independent risk factor of prolonged LOS, increased discharge to skilled care, and increased health care costs. These findings may be due to (1) language barriers causing delays in care and assessments,[16,17] (2) underutilization of translation services,[18-20] (3) lengthier patient encounters,[13] (4) more complex discharge planning for LEP patients,[21,22] or (5) other residual confounders that are not included in our model. Language may be a marker for difficult to measure factors such as social support, economic resources, health literacy, or cultural preferences.

In contrast to other health care settings,[3,23] LEP patients in this study did not have higher rates of 30-day readmission. It has been hypothesized that LEP patients experience increased rates of readmission because of complications that arise from communicating discharge instructions or receiving necessary assistance after discharge, but equal rates of readmission suggest that post-discharge needs are being met in this population, whether at home or in skilled care facilities.

Limitations

Limitations of this study include those inherent to observational analyses of electronic health record–derived variables, including potential residual confounders. Owing to limited data availability, we did not control for interpreter usage patterns. It is noted, however, that during the study period in-person, phone, and video interpreter services were available in the clinical setting without restriction. In addition, although we do not have granular socioeconomic status data for the patients in our cohort, primary insurance is an imperfect but validated and often used proxy for socioeconomic status that has been shown to have strong associations with conventional socioeconomic status measures including income-level, educational attainment, marital status, and area-level poverty.[24] We additionally lack granular data on tumor histology and location. However, multiple recent analyses that evaluated patients who underwent craniotomy for tumor found patient baseline characteristics and not tumor histology to be the main drivers of LOS variation. Although we do not have information on metastatic disease and specific comorbidities in our patient population, ASA status is used as a proxy for underlying condition and frailty in our study. Finally, owing to lack of language data in large national data sets, our study was conducted within a single academic hospital system which may limit generalizability. In our study cohort, 6.5% of patients had LEP (defined as a non-English primary language and requested interpretation services), which is lower than the 22.6% of individuals who report speaking English less than "very well" in San Francisco County, 19.4% in California, and 8.6% in the United States.[25]

It is also worth mentioning that the Office for Civil Rights of the U.S. Department of Health and Human Services has issued policy guidance that requires all recipients of federal funds to adopt a language services plan, train staff, and provide meaningful access to interpretation and translation services to patients with LEP.[26] States currently have different reimbursement and matching fund programs for medical language services, and some neurosurgical programs and affiliated medical institutions may receive financial support for their language services programs.

CONCLUSION

In summary, this analysis found that LEP is an independent risk factor for extended LOS, increased hospitalization costs, and discharge to skilled care after craniotomy for brain tumor. These findings reflect a larger picture of health care and outcome disparities experienced by language minority patients in the American health care system. If communication barriers are found to mediate delays or complications in perioperative craniotomy care in future research, the higher costs of care for LEP patients should incentivize investment in interventions that improve communication and quality of care for LEP patients.

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Supplemental Table 1. Characteristics of patients who died during craniotomy for brain tumor hospitalization, compared to study cohort.

COMMENT

The authors present a distinctive study evaluating independent relationships between language barriers and postoperative craniotomy management through a single-center, retrospective cohort design. This study is important because it demonstrates the need for further research and intervention to mitigate postoperative complications directly related to language barrier inconsistencies. The authors use various parameters associated with postoperative care including length of stay, total hospitalization cost, discharge disposition, and 3-day readmission rate to provide an all-encompassing collection of data supporting their contention. The study plays a key role in presenting evidence of the necessity to implement strategic plans aimed at providing patients with limited English proficiency with acceptable modalities to communicate with their care providers and hospital system. The paper provides valuable insight into seemingly unobserved pitfalls in patient communication that have substantial impacts on a large and diverse patient population undergoing neurosurgical interventions. This single concept is the essence of the paper—an amalgamation of effort and understanding toward a more inclusive hospital environment is vital. Overall, the paper successfully provides neurosurgical services and hospital care teams integral information regarding discrepancies in effective patient communication that can have detrimental effects on the outcomes of postoperative patient care and how medical professionals in the United States, as a population, must move towards a more egalitarian and considerate state of medical care.

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