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Impact of English proficiency on use of Glasgow Coma Scale in geriatric patients with traumatic brain injury

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ABSTRACT

Background The relationship between English proficiency (EP), Glasgow Coma Scale (GCS) and traumatic brain injury (TBI) is not well characterized. We aimed to understand the impact of limited English proficiency (LEP) on the evaluation and outcomes of TBI.

Methods Retrospective comparative study in a single institution of patients aged ≥65 who presented to the emergency department after a fall with head strike between January 2018 and December 2021. TBI was defined as documented loss of consciousness or intracranial hemorrhage (ICH). Relationships between EP, GCS, and TBI were analyzed with multivariable and propensity score-matched models.

Results Of the 2905 included, 1233 (42%) had LEP. Most LEP patients were Asian (60%) while the majority of EP patients were non-Hispanic Caucasians (72%). In a univariate analysis, LEP had higher incidence of decreased GCS and was strongly correlated with risk of TBI (OR 1.47, CI 1.26 to 1.71). After adjusting for multiple covariates including race, LEP did not have a significantly increased risk for GCS score <13 (OR 1.66, CI 0.99 to 2.76) or increased risk of TBI. In the matched analysis, LEP had a small but significantly higher risk of GCS score <13 (OR 1.03, CI 1.02 to 1.05) without an increased risk in TBI. Decreased GCS remained strongly correlated with presence of ICH in LEP patients in the adjusted model (OR 1.39, CI 1.30 to 1.50).

Conclusions LEP correlated with lower GCS in geriatric patients with TBI. This association weakened after adjusting for factors like race, suggesting racial disparities may have more influence than language differences. Moreover, GCS remained effective for predicting ICH in LEP individuals, highlighting its value with suitable translation resources.

Level of evidence This is a Level III evidence restrospective comparative study.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The Glasgow Coma Scale (GCS) is a well-validated tool for assessing injury severity in trauma patients, but its effectiveness in those with limited English proficiency (LEP) is unclear due to potential communication barriers.

WHAT THIS STUDY ADDS

⇒ Our study found that LEP patients had a positive trend toward decreased GCS scores, but no direct association with TBI. Both LEP and English-proficient patients with lower GCS scores were correlated with intracranial hemorrhage (ICH). We found that racial differences, rather than language differences, had a greater impact on GCS scores and TBI risk.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ GCS remains a valuable predictor of ICH among LEP patients when interpreter services are used, highlighting the value of broader use of such services. Further, racial disparities may affect GCS and TBI risk more than language differences, underscoring the need for culturally sensitive clinical practices.

INTRODUCTION

Traumatic brain injury (TBI) is a major cause of morbidity and mortality in the USA, accounting for over 60 000 deaths annually.[1] Particularly in individuals aged 65 or older there is an increasing clinical impact as fall-related TBIs have surged by 78% from 2002 to 2017. Elderly patients with TBI face notable functional decline and up to 16% in-hospital mortality.[2–5] Disparities persist among specific groups, including undocumented immigrants, the uninsured, and racial minorities, who exhibit worse clinical outcomes, prolonged hospital stays, and higher mortality rates.[6–8] In TBI research, Glasgow Coma Scale (GCS) is a well-validated and commonly used tool to assess injury severity in trauma patients including those with limited English proficiency (LEP). LEP patients, however, may be more likely to experience poor communication with a healthcare provider which in turn may have an unfavorable influence on patient care, hospital duration, outcomes, and patient satisfaction.[9–13] Approximately 8% of the US population has LEP, with particularly large concentrations within large urban centers.[14] The effect of language discordance on patient care has been investigated in many areas of clinical practice,[13 15] and particularly with regard to trauma patients.[11 16 17] While LEP has been shown to affect outcomes in many clinical contexts, it is unknown how routine use of GCS, a tool that is dependent on effective communication, may affect the assessment and outcomes of TBI.

This study aimed to elucidate the relationship between LEP, GCS, and TBI in the geriatric population (aged 65 or older) who suffered a fall, given the group's propensity to these injury mechanisms and

associated morbidity and mortality.[18] By comparing LEP and EP patients, we sought to identify differences in GCS and TBI incidence, examining potential contributing factors that may result from disparities. We hypothesized that patients with LEP will have lower GCS scores but should have similar incidence of TBI when compared with EP patients.

METHODS

This retrospective single-center study, conducted at a level I trauma center in Flushing, New York, received Institutional Review Board approval with a waiver of consent. Data were obtained from the institution's internal trauma registry and supplemented by manual chart reviews.

Patient selection

Included were patients aged 65 or older presenting to the emergency department (ED) for traumatic evaluation between January 1, 2018 and December 31, 2021, with documented head trauma, including those by self-report, witnessed injury or imaging studies. TBI was defined as the documented loss of consciousness or intracranial hemorrhage (ICH). Patients were dichotomized into English-proficient and limited English-proficient groups based on documented language preference in the electronic medical records. If head strike, loss of consciousness, language preference, or total GCS score was not documented or unknown, the patient was excluded from the study.

Outcomes

The primary outcomes examined associations between language preference and decreased GCS and TBI, categorized into GCS score <15 and GCS score <13. Analyses included unadjusted and adjusted logistic regression models as well as propensity score matching for a weighted subset of EP and LEP patients.[19 20] A subanalysis was then conducted comparing decreased GCS and TBI incidence in patients speaking English as opposed to other frequently spoken languages in our cohort (Chinese, Spanish, and Other). Secondary outcomes encompassed intubation rates, trauma-level activations, hospital length of stay (LOS), ED and hospital disposition, and GCS as a predictor of ICH. Our hospital's level 1 and 2 trauma activations align with those of other level I trauma institutions. The 'Trauma delta' in our facility specifically comprised patients aged 65 and older on anticoagulants after a head trauma not meeting activation criteria for level 1 or 2. Consultations were made in patients evaluated chiefly for non-traumatic concerns but with concomitant, incidentally identified traumatic injuries. As part of our secondary outcomes, we examined the correlation between GCS and incidence of ICH in EP and LEP patients.

Statistical analysis

Descriptive statistics characterized the cohorts using appropriate tests such as the Wilcoxon rank-sum and Pearson's χ^2 or Fisher's exact test. For categorical variables with significant p values, a two-sample test for equality of proportions with continuity correction was used to test for statistically significant differences between groups of interest. Univariable and multivariable logistic regression models assessed associations between LEP, GCS, and TBI, with the latter incorporating covariates such as age, gender, race, anticoagulation and antiplatelet use, delayed presentation, mechanism of injury, Injury Severity Score (ISS), and dementia. A full propensity match was conducted with weights generated from the same covariates as the logistic regression analysis (covariate balance for the variables chosen for propensity matching shown in online supplemental file 1). Patients with missing data were omitted from analyses specific to that variable in the demographics, and from the analysis in the logistic regression and match models. Statistical significance for p values was considered at the 0.05 alpha level. RStudio and R statistical software (V.4.2.1; R Core Team 2022) were used for analysis.

RESULTS

Of the 6846 patients aged 65 or greater who presented to the ED after a traumatic injury, 2905 had documented head strike, language preference, GCS score, and TBI details (figure 1). Of them, 2857 patients (98.3%) had complete data for all variables in the adjusted models. Preferred language was reported as other than English in 1233 (42%) of the patients (refer to online supplemental file 2 for summary of all spoken languages and their frequency). For both the EP and LEP groups, the mean age was 81 years old, and gender distribution was similar (p=0.8 and p=0.2, respectively, table 1). Compared with EP patients, the majority of LEP patients were Asian (10.3% vs. 59.7%, respectively), whereas the majority of the EP patients were non-Hispanic Caucasian (72.1% vs. 16.1%). LEP patients had higher incidence of self-reported dementia (24.4% vs. 30.8%, p<0.001) and delayed presentation (8.2% vs. 11.3%, p=0.005), lower rates of anticoagulant use (18% vs. 12%, p<0.001), but similar rates of antiplatelet use (49% vs. 51%). EP patients were less likely to lack documentation regarding loss of consciousness on presentation (4.2% vs. 8.6%, p<0.001). A majority of patients (66%) had a ground-level fall, with no difference between EP and LEP groups; however, EP patients had lower ISS (4.5 vs. 5.4, p<0.001) and a lower incidence of TBI with ICH (17% vs. 26%, p<0.001) despite similar rates of concussion (17% vs. 17%, p=0.9). Asians had, overall, the highest incidence of TBI after a head strike (46%), representing the majority of the LEP cohort (table 1, details in online supplemental file 3).

GCS characteristics comparing LEP to EP

Table 2 shows that EP patients were less likely to have GCS score <15 (15.1% vs. 21.5%, p<0.001) and GCS score <13 (3.6% vs. 6.3%, p<0.001). LEP patients more frequently had lower GCS values corresponding with moderate or severe TBI (GCS scores 9–12: 2.2% vs. 4.5%, p<0.001; GCS scores 3–8: 1.4% vs. 1.8%, p=0.55). Each component of the GCS was significantly worse in the LEP cohort: eye opening <4: 2.5% versus 4%, p=0.025; verbal response <5: 13.6% versus 20.1%, p<0.001; and motor response <6: 4.4% versus 6.7%, p=0.007. In patients with documented TBI, overall GCS was also lower for LEP patients, with the verbal component of GCS scores being statistically lower (19.9% vs. 28.2%, p=0.001).

Regression analysis of language versus GCS and TBI

Figure 2 shows the regression analysis models to compare GCS scores and TBI between EP and LEP patients. In an unadjusted analysis, LEP had a higher incidence of depressed GCS, and LEP was strongly correlated with risk for TBI (OR 1.47, CI 1.26 to 1.71). After adjusting for selected covariates including race, there was no significant correlation between LEP and depressed GCS and between LEP and increased risk for TBI. In the matched analysis, there was a small but significantly increased risk for depressed GCS scores for LEP (GCS score <15, OR 1.05, CI 1.03 to 1.08; and GCS score <13, OR 1.03, CI 1.02 to 1.05) but no significant TBI risk for LEP patients (TBI, OR 1.01, CI 0.98 to 1.04).

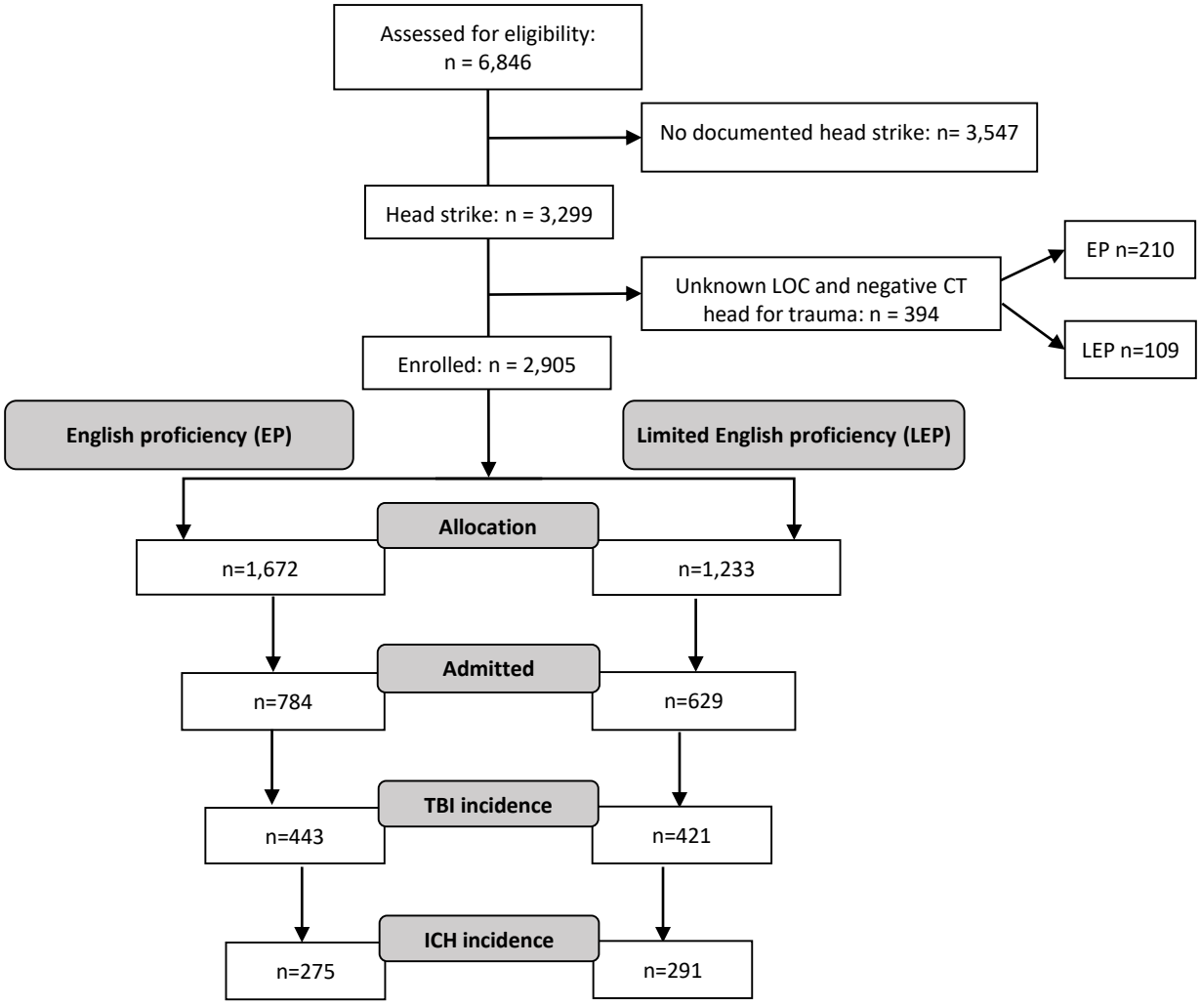


Figure 1 Inclusion criteria for patients aged 65 or greater who presented to the emergency department after a fall between 2018 and 2021. LOC, loss of consciousness; ICH, intracranial hemorrhage; TBI, traumatic brain injury.

A subgroup analysis for specific languages compared with the EP cohort. The unadjusted analysis was significant across all languages. There was no difference, however, in risk of GCS score <15 or TBI in the adjusted analysis. There was a statistical difference in the GCS score <13 in Chinese-speaking patients when compared with English speakers (OR 2.88, CI 1.27 to 7.23) .

Regression analysis of secondary outcomes versus language

GCS as a predictor of ICH

Incidence of ICH was inversely proportional to GCS score for both EP and LEP patients. Unadjusted and adjusted logistic regression models confirmed that GCS was a strong predictor for ICH in both EP and LEP patients (figure 3).

Intubated patients

Rates of intubation in the ED in EP versus LEP patients were not statistically different (2.0% vs. 2.9%, p=0.1, table 3). For patients requiring intubation that did not die in the ED, there was no difference in characteristics between EP (n=29) and LEP (n=31) groups (not shown in tables). There was no significant difference in the dispositions from the ED to the OR (21% vs. 26%) and the intensive care unit (ICU) (72% vs. 61%); they were similar between the groups (p=0.6). The duration of intubation (5.7 days vs. 3.6 days, p=0.8), and particularly rates of intubation duration greater than 48 hours between EP and LEP patients (59% vs. 48%, p=0.4) were not statistically different. Hospital disposition also did not differ between the EP and LEP cohorts, with similar rates of death (48% vs. 42%, p=0.8), discharge to rehabilitation facility (34% vs. 26%, p=0.6) and home (6.9% vs. 13%, p=0.7).

Level 1 activations

Activation-level patterns differed between the groups (p=0.003, table 1), with EP patients having lower prevalence in both level 1 activations (1.6% vs. 2.7%, p=0.063) and consultations (9.1% vs. 12.7%, p=0.003). There was no difference between EP and LEP level 1 activations (n=27 and n=33, respectively) in ISS (19 vs. 18, p=0.6), GCS severity (severe 59% vs. 45%, p=0.42), ICH incidence (74% vs. 70%, p=0.93), LOS (13 days vs. 8 days, p=0.2), ED and hospital dispositions (p=0.5 and p=0.2, respectively). There were four patients among the LEP group that had level 1 activation that were discharged home from the ED as opposed to no patients in the EP group.

Table 1 Characteristics of patients aged 65 or older who presented to the ED after a fall with confirmed head strike between 2018 and 2021 divided by language preference into English proficiency (EP) and limited English proficiency (LEP)

	EP, n=1672*	LEP, n=1233*	P value†
Age	81 (9)	81 (9)	0.8
Gender (male)	735 (44%)	516 (42%)	0.2
Race			**<0.001**
Caucasian	1189 (72.1%)	197 (16.1%)	
Asian	170 (10.3%)	730 (59.7%)	
Black or African American	120 (7.3%)	7 (0.6%)	
Hispanic or Latino	74 (4.5%)	265 (21.7%)	
Other	96 (5.8%)	23 (1.9%)	
Body mass index (BMI)	25.5 (5.5)	24.5 (5.2)	**<0.001**
Dementia at baseline	407 (24.4%)	380 (30.8%)	**<0.001**
Anticoagulation/antiplatelet use			**<0.001**
None	450 (27%)	388 (31%)	
Anticoagulation	309 (18%)	146 (12%)	
Antiplatelet	814 (49%)	633 (51%)	
Anticoagulation+antiplatelet	99 (5.9%)	65 (5.3%)	
Mechanism of injury			0.094
Ground-level fall	1124 (67.2%)	797 (64.6%)	
Fall from height	359 (21.5%)	266 (21.6%)	
Motor vehicle collision	32 (1.9%)	21 (1.7%)	
Pedestrian struck	35 (2.1%)	44 (3.6%)	
Other	122 (7.3%)	105 (8.5%)	
Loss of consciousness			**<0.001**
Yes	305 (18%)	241 (20%)	
No	1297 (78%)	886 (72%)	
Unknown	70 (4.2%)	106 (8.6%)	
Delayed presentation (yes)	137 (8.2%)	139 (11.3%)	**0.005**
Year 2020–2021	623 (37%)	464 (38%)	0.8
Insured (yes)	1550 (92.7%)	1060 (86%)	**<0.001**
Activation level			**0.003**
Level 1	27 (1.6%)	33 (2.7%)	
Level 2	219 (13.1%)	152 (12.3%)	
Delta (geriatric trauma)	1200 (71.8%)	828 (67.1%)	
Consultation	152 (9.1%)	156 (12.7%)	
Not activated	74 (4.4%)	64 (5.2%)	
Rib fractures (yes)	73 (4.4%)	63 (5.1%)	0.3
Injury Severity Score (ISS)	4.5 (5.6)	5.4 (6.2)	**<0.001**
Brain atrophy on CT	340 (20.3%)	224 (18.2%)	0.14
Traumatic brain injury (TBI) type			**<0.001**
None	1104 (66%)	703 (57%)	
Concussion	276 (17%)	206 (17%)	
Radiologic evidence of hemorrhage	292 (17%)	324 (26%)	
Preferred language			**<0.001**
English	1672 (100%)	0 (0%)	
Chinese	0 (0%)	558 (45.3%)	
Spanish	0 (0%)	287 (23.3%)	
Other	0 (0%)	388 (31.4%)	

*Mean (SD), n (frequency, %).
†Wilcoxon rank-sum test; Pearson's χ^2 test.
CT, computed tomography; ED, emergency department; EP, English proficiency; LEP, limited English proficiency.

Table 2 Glasgow Coma Scale (GCS) characteristics overall for patients aged 65 or greater after traumatic fall with confirmed head strike between 2018 and 2021 and for patients with traumatic brain injury (defined as radiographic evidence of intracranial hemorrhage or confirmed loss of consciousness) divided by language preference into English proficiency (EP) and limited English proficiency (LEP)

	EP, n=1672*	LEP, n=1233*	P value†
GCS score <15	252 (15.1%)	265 (21.5%)	**<0.001**
GCS score <13	61 (3.6%)	78 (6.3%)	**<0.001**
GCS			**0.001**
GCS scores 13–15	1611 (96.4%)	1155 (93.7%)	
GCS scores 9–12	37 (2.2%)	56 (4.5%)	
GCS scores 3–8	24 (1.4%)	22 (1.8%)	
Eye opening <4	42 (2.5%)	49 (4.0%)	**0.025**
Verbal response <5	227 (13.6%)	248 (20.1%)	**<0.001**
Motor response <6	73 (4.4%)	82 (6.7%)	**0.007**
	EP, n=568*	**LEP, n=530***	
TBI severity by GCS			**0.027**
Mild (13–15)	526 (92.6%)	470 (88.7%)	
Moderate (9–12)	21 (3.7%)	39 (7.3%)	
Severe (3–8)	21 (3.7%)	21 (4.0%)	
Eye opening <4	33 (5.8%)	42 (7.9%)	0.2
Verbal response <5	113 (19.9%)	149 (28.2%)	**0.001**
Motor response <6	48 (8.5%)	58 (11%)	0.2

*n (frequency, %).
†Fisher's exact test; Pearson's χ^2 test; Wilcoxon rank-sum test.
EP, English proficiency; GCS, Glasgow Coma Scale; LEP, limited English proficiency; TBI, traumatic brain injury.

LOS and disposition

EP patients had increased LOS compared with LEP patients (5.0 days vs. 4.5 days, p=0.017) although LOS greater than 5 days between the cohorts did not differ (22.2% vs. 21.22%, p=0.50). ED disposition among the groups differed (p=0.001), where EP patients were less likely to go to stepdown or ICU (13.2% vs. 16.6%, p=0.014) and to the operating room (0.9% vs. 2.1%, p=0.015), with similar rates of floor admission (32.2% vs. 31.9%, p=0.91). Regarding hospital disposition, EP patients were more likely to be discharged to a rehabilitation facility (24% vs. 19.5%, p=0.004), with a similar rate of discharge to home between the groups (70.6% vs. 73.6%, p=0.078). There was no difference in mortality rate among both groups (2.5% vs. 3.3%, p=0.20) (table 3).

DISCUSSION

The GCS is a commonly used metric for assessing neurological status that multiple studies have demonstrated to be a reliable and reproducible tool for assessing disturbances of consciousness as well as predicting prognosis in patients with TBI.[21 22] In our institution, GCS is used to determine level of trauma activation based on prehospital information and it is a criterion for clinical decisions such as need for intubation.

GCS scoring inherently assumes language concordance between the patient and the physician. To our knowledge, the impact of language discordance on the use of GCS in assessing TBI has not been previously studied. At our institution, approximately one in two patients require the use of interpreter services. Given our diverse population, there was a unique opportunity to study the influence of LEP on GCS scoring and its downstream effect on the assessment of TBI in elderly patients who present to the ED after a head strike.

Prior research on LEP in trauma patients has focused on general outcomes. In retrospective analysis in a level I trauma center, Castro *et al* described the association between LEP and morbidity and mortality after traumatic injury.[11] In their cohort of about 13 000 patients, 16% had LEP, which is lower than in our study. They found that LEP patients had decreased ICU

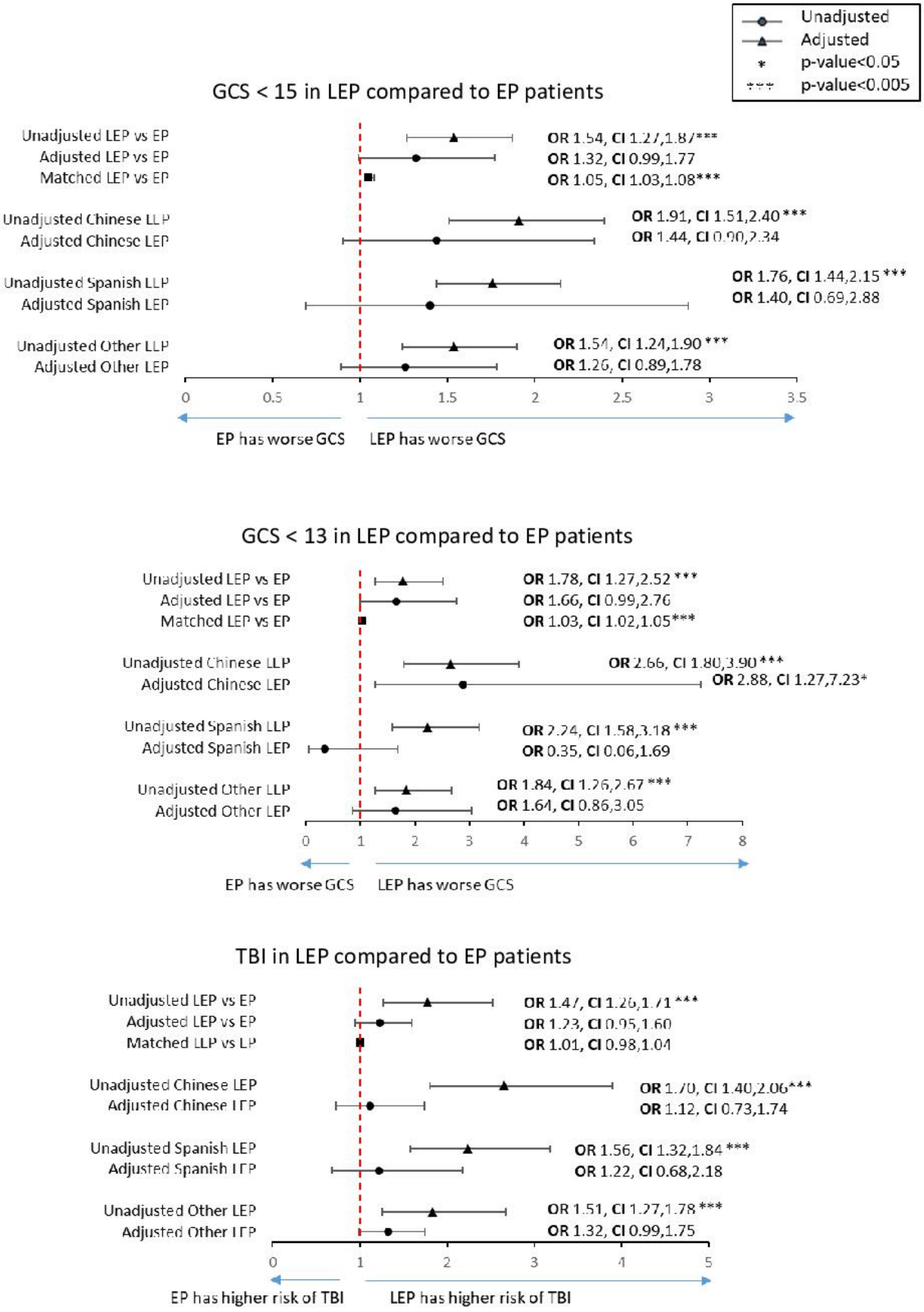
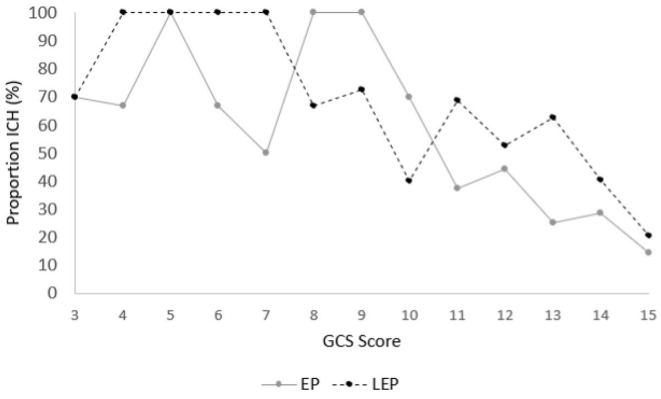


Figure 2 Forest plot based on unadjusted and multivariable logistic regression models and a matched full propensity match model for Glasgow Coma Scale (GCS) scores <15 and <13 and traumatic brain injury (TBI) for patients with English proficiency (EP) and limited English proficiency (LEP). Multivariable and full propensity matching models adjusted/weighed for the following covariates: age, gender, race, anticoagulation and antiplatelet use, dementia, delayed presentation after incident, Injury Severity Score (ISS), and mechanism of injury.



	OR	95% CI	p-value
Unadjusted			
EP	1.37	1.26, 1.50	**<0.001**
LEP	1.45	1.32, 1.61	**<0.001**
Adjusted	1.39	1.30, 1.50	**<0.001**
EP	1.41	1.28, 1.57	**<0.001**
LEP	1.39	1.30, 1.50	**<0.001**

Figure 3 Incidence of intracranial hemorrhage (ICH) by Glasgow Coma Scale (GCS) score in patients aged 65 and older who presented after traumatic fall with confirmed head strike between 2018 and 2021 divided by language preference into English proficiency (EP) and limited English proficiency (LEP). Associated univariable and multivariable logistic regression models for evaluating GCS as a predictor for ICH in all patients, EP patients, and LEP patients are also demonstrated. Multivariable model adjusted for age, gender, race, anticoagulation and antiplatelet use, dementia, delayed presentation after incident, Injury Severity Score (ISS), and mechanism of injury.

LOS but longer hospital stays. LEP patients speaking languages other than Chinese or Spanish experienced increased mortality compared with EP patients. In another recent retrospective study by Maurer *et al*, 7.3% of studied patients from two level I trauma centers had LEP.[23] After performing multivariable analysis they found that patients with LEP were less likely to be discharged to postacute care facilities and more likely to go home, but they had similar LOS and 30-day hospital readmission rates.

In our study, twice as many LEP patients presented with undocumented loss of consciousness compared with EP patients (8.6% vs. 4.2%, p<0.001). While this could be indicative of lack of clear communication between the patient and the provider, it may also be due to the higher incidence of baseline dementia (30.8% vs. 24.4%, p>0.001) or longer delays in presentation (11.3% vs. 8.2%, p=0.005) in the LEP cohort. Furthermore, LEP patients had a 9% higher incidence of ICH and similar incidence of concussion compared with EP patients (26% vs. 17%, p<0.001). Castro *et al*[11] also noticed that LEP patients had increased rates of TBI in their study (41% vs. 38%, p=0.003).

Our LEP cohort had a higher uninsured rate compared with EP patients (14% vs. 7.3%, p<0.001), consistent with prior studies.[6–8 11 23 24] These differences reflect the socioeconomic profile of our community. However, they also underscore the critical importance of addressing disparities in insurance coverage, given the well-documented significant impact of insurance status on posthospitalization outcomes.[25 26]

Several large studies have explored racial/ethnic disparities in TBI outcomes. Kuerban and Dams-O'Connor[27] analyzed 7953 patients from a national TBI database, categorizing them into Asian, white, and Hispanic. They used the Functional Independence Measure (FIM) assessment tool to evaluate differences in functional outcomes after inpatient rehabilitation discharge and 1-year functional status. FIM measures disability levels across self-care, mobility, and cognition.[28] Despite Asians having the lowest injury severity at admission, they failed to improve functional outcomes, unlike Hispanic and white patients. However, Asians comprised only a small percentage (3%) of the cohort, contrasting with our study. Notably, our study revealed a higher incidence of ICH after falls in geriatric patients (21% overall), surpassing rates reported in previous studies (5.0% in de Wit *et al*[24] and 6.9% in Lampart *et al*[29]). Also, in our study the LEP cohort exhibited a statistically significant increased rate of ICH (26% vs. 17%, p<0.001). Given that the highest TBI rates were observed in Asian patients (46%, online supplemental file 3), and Asians comprised 60% of the LEP cohort, there is likely a racial component in comparing EP and LEP. We addressed the possible influence of race by adjusting for multiple covariates in our regression models.

In our unadjusted analysis, we observed a higher incidence of GCS score <15 in the LEP group, correlating with higher rates of TBI. The majority of patients in both groups had mild TBI based on GCS scores. We chose to evaluate GCS as a binary variable based on cut-offs of GCS score <15 and GCS score <13 to power our study. Adjusting for covariates showed no significant correlation between LEP and depressed GCS or TBI, although we suspected potential bias due to unequal racial composition. A propensity score-weighted analysis yielded similar results to

Table 3 Outcomes for patients aged 65 and older who presented after traumatic fall with confirmed head strike between 2018 and 2021 divided by language preference into English proficiency (EP) and limited English proficiency (LEP)

	EP, n=1672*	LEP, n=1233*	P value†
Intubation in ED	33 (2.0%)	36 (2.9%)	0.100
ED disposition			**0.001**
Deceased/died	4 (0.2%)	8 (0.7%)	
Floor	528 (32.2%)	385 (31.9%)	
Home	878 (53.5%)	589 (48.7%)	
SISD or ICU	217 (13.2%)	200 (16.6%)	
Operating room	15 (0.9%)	25 (2.1%)	
Admitted to ICU	73 (4.4%)	58 (4.7%)	0.700
Length of hospital stay	5.0 (5.6)	4.5 (4.7)	**0.017**
LOS >5 days	372 (22.2%)	261 (21.2%)	0.500
Hospital disposition			**0.038**
Home	1179 (70.6%)	907 (73.6%)	
Rehabilitation/SNF	402 (24%)	241 (19.5%)	
AMA	24 (1.4%)	27 (2.2%)	
Other hospital	9 (0.5%)	6 (0.5%)	
Hospice care	17 (1.0%)	11 (0.9%)	
Died	41 (2.5%)	41 (3.3%)	

*n (frequency, %), mean (SD), frequency (%).
†Fisher's exact test; Pearson's χ^2 test; Wilcoxon rank-sum test.
AMA, left against medical advice; ED, emergency department; EP, English proficiency; ICU, intensive care unit; LEP, limited English proficiency; LOS, length of stay; SISD, surgical intermediate stepdown unit; SNF, skilled nursing facility.

the unadjusted group in that LEPs had lower GCS score, but no significant correlation with TBI incidence. These results suggest that GCS values may be lower in LEPs, but not necessarily associated with an increased risk of TBI. This outcome aligns with the intuitive understanding that the language spoken should not directly impact TBI risk, unless indirectly linked to socioeconomic or racial factors.

We further analyzed primary endpoints within separate language groups to assess if there is a higher incidence of decreased GCS scoring depending on language. This subanalysis aimed to account for non-English language-concordant interactions between physicians and patients within our hospital. Because we did not directly observe each patient encounter and record whether there was language discordance, we used language as a surrogate marker. At our institution, the four most common languages spoken by patients with LEP were Mandarin Chinese (34%), Spanish (30%), Korean (11%), and Russian (6%).[30] Similar to our patients, Chinese and Spanish are spoken by many of our physicians. In these two subgroups, we hypothesize there would be more language-concordant interactions between patients and physicians. In the remaining listed spoken languages in online supplemental file 2, there are considerably fewer physicians or hospital staff that could translate. A natural hypothesis is that we may see effects of language discordance in the less frequently spoken languages. However, adjusted subgroup analyses revealed no significant correlation between language and depressed GCS or TBI risk, except for one subgroup where GCS score <13 was more prevalent among Chinese speakers. The observation may be attributed to the substantial representation of Chinese speakers in the cohort.

While mild GCS rates (GCS scores 9–12) showed a significant difference (2.2% vs. 4.5%, p<0.001), rates of GCS score <9 were similar between groups. We also assessed intubation rates in EP versus LEP patients, as GCS score <9 typically requires intubation. Although the LEP group showed a 0.9% increase in intubation rate, this was not statistically significant likely due to the small number of intubated patients and inadequate study power. Additionally, despite the higher incidence of ICH in the LEP group, a closer review of the indications for intubation found that they were all appropriate. Previous research on language barriers and intubation showed mixed results; one study found a non-significant trend toward more intubations among Spanish-speaking patients that were intubated for less than 48 hours (49% vs. 38%, p=0.072[31]), while another found similar intubation rates between language groups in the ED (8.7%, p=1.0[32]). Moreover, once intubated, there was no significant difference in ventilator days between EP and LEP patients (average: EP 0.6 vs. LEP 0.4, p=0.4).

We observed a polarizing shift in trauma activations: LEP patients had both increased level 1 activations and consultations as opposed to level 2 or delta activations. While level 1 activations appeared appropriate, patients that were consultations had a higher incidence of ICH. Although not statistically significant some of these LEP consultations required operative intervention. Overtriaged activations lead to increased costs and unnecessary utilization of limited healthcare resources during activations, whereas undertriaged activations lead to delays in care. Castro *et al*[11] found that trauma activations for their LEP group were less often at the highest level and more often non-activations. While our data differ, it is consistent in suggesting that LEP may decrease the incidence of trauma activations which may impact patient care as well as appropriate utilization of healthcare resources.

LEP patients showed higher disposition rates to the operating room and stepdown/ICU (13.2% vs. 16.7%) compared with EP patients, with similar floor admission rates. This heightened stepdown/ICU admission may reflect communication challenges, potentially leading to unnecessary higher level care admissions. Castro *et al*[11] also noted increased ICU admissions among LEP patients in their trauma study, although with higher overall rates (39% vs. 36%). Despite higher rates of ICH and stepdown/ICU admissions, LEP patients were more likely to be discharged home rather than to a rehabilitation facility, aligning with Garstka *et al*[32] who observed a similar trend (86% vs. 78%, p=0.01). Increased discharge to home for LEP patients has been noted in other studies as well,[23 32] potentially reflecting cultural practices and limited resources for rehabilitation facility admission.

Studies have incorporated initial GCS assessment into prognostic models to estimate risk of ICH in patients with TBI.[33 34] Similarly, we wanted to assess the predictive ability of GCS alone for identifying ICH in our overall population as well as within the EP and LEP groups. We graphically explored linearity among GCS and our language groups as well as through unadjusted and adjusted logistic regression models (figure 3). GCS consistently demonstrated a strong correlation with ICH among all patients. This acts as both an internal validation and suggests that GCS remains a useful tool despite language barriers.

Limitations

This retrospective, single-center study was conducted in a multiethnic community, potentially limiting its generalizability to other clinical and staff populations. The availability and familiarity of healthcare providers with interpreter services in our setting may differ from hospitals with infrequent encounters of language-discordant patient populations. Additionally, the absence of comprehensive documentation regarding active language-concordant providers or the use of interpreter services poses a limitation. The dichotomization of patients into LEP and EP groups based solely on language preference lacks documentation of the extent of English language proficiency, leading to instances where EP patients may in fact exhibit LEP, or LEP patients have non-English preferences but are actually sufficiently proficient. Moreover, the self-reporting of head strike and loss of consciousness, influenced by memory recall issues (eg, dementia or transient amnesia due to injury) and communication misunderstandings related to language barriers, introduces uncertainty into GCS assessment. Excluding patients with missing variables, particularly more LEP patients with unknown loss of consciousness, may diminish the study's statistical power and introduce bias into estimates.

CONCLUSION

As a trauma center serving a diverse patient population, our study explored the impact of patient-provider language discordance on GCS assessment and TBI risk. While LEP patients showed a higher incidence of decreased GCS and strong correlation with TBI in univariate analysis, adjusting for covariates revealed a persistent trend of decreased GCS but not TBI. Our findings suggest that lower GCS and a potential increase in TBI risk may be influenced more by racial disparities than language differences in our population. This prompts further investigation into the role of race as a contributing factor to TBI risk. Despite these distinctions, GCS remained a valuable tool for predicting ICH among LEP patients.

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