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Intracerebral Hemorrhage Hospitalizations and Outcomes: Comparisons Between Institutional and National Data

Zhuobin Huang
University Of Alabama At Birmingham

INTRACEREBRAL HEMORRHAGE HOSPITALIZATIONS AND OUTCOMES: COMPARISONS BETWEEN INSTITUTIONAL AND NATIONAL DATA

by

ZHUOBIN HUANG

KIMBERLY MARTIN, COMMITTEE CHAIR
EMILY LEVITAN
CHEN LIN

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EPIDEMIOLOGY

ABSTRACT

Intracerebral hemorrhage (ICH) is associated with a high risk of in-hospital mortality therefore we decided to define the effect of procedures and other risk factors on in-hospital mortality among different regions in the US. South and UAB Hospital.

We used 2 datasets, the University of Alabama at Birmingham Hospital data and the National Inpatient Sample (NIS). We included 425 patients with a diagnosis of intracerebral hemorrhage over 18 years of age from the UAB Hospital stroke registry between 2016 to 2019; in NIS between 2016 to 2018, 68525 patients age 18 or above met inclusion criteria selected by International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) (I61.0-I61.9), and 27341 were in the South. In-hospital mortality rates were calculated for different regions, hospital size, and urban teaching hospitals. The result showed that UAB Hospital had a higher in-hospital mortality rate compare to other regions. Logistic regression model was used to assess differences in predictors of in-hospital mortality in different procedures. In the joint regression model ICH database, UAB Hospital [OR (95% CI) 1.335 (1.068, 1.670)] and East South Central Large Urban teaching hospitals [OR (95% CI) 1.141 (1.028, 1.268)] were associated with higher in-hospital mortality compared to South Atlantic Large Urban teaching hospitals adjusted for age, gender, race, insurance, and procedures.

Linear regression model was used to predict the association among UAB Hospital data and NIS South Large Urban teaching with hospital data. In the combined dataset, patients in NIS East South Central Large Urban teaching hospitals [β (95% CI), -0. 320 (-0.605, -0.034)], UAB Hospital [β (95% CI), -1.248 -1.889, -0.607)] were likely to stay in hospital less day compared to patients in South Atlantic Large Urban teaching hospitals.

In conclusion, the study found that UAB Hospital had a higher in-hospital mortality compared to the South Large Urban teaching hospitals, however, due to limitations, further studies with more covariables will help better understand the in-hospital mortality rate.

Keywords: intracerebral hemorrhage, NIS South, UAB, in-hospital mortality, length of stay (LOS), ICD-10 code

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BACKGROUND

Hemorrhagic stroke, a subtype of stroke, is due to the rupture of a blood vessel that causes bleeding into the brain.[1, 2] There are two subtypes of hemorrhagic stroke: intracerebral hemorrhage (ICH), which is bleeding into the brain tissue, and subarachnoid hemorrhage (SAH), which is bleeding into the subarachnoid space.[3] Hemorrhagic stroke accounts for about 13% of all US. stroke cases in 2008. Among 13% of all stroke cases, ICH accounted for 10%, and SAH accounted for 3%.[4] However, in some cases, hemorrhagic stroke accounts for 20% of all stroke cases at most and is causing a one-month mortality rate of about 40%.[5] Hemorrhagic stroke has a higher morbidity and mortality rate than ischemic stroke and was also associated with worse outcomes.[1] The ICH mortality rate is higher than ischemic stroke.[6, 7] However, due to the relatively smaller proportion among all stroke patients, researchers did not pay enough attention to ICH subgroup. Research using 2004 to 2014 National Inpatient Sample (NIS) data shows that age- and sex-adjusted mortality for ICH was 26.5% and 32.2% in urban and rural hospitals (urban and rural).[8] A study focused on assessing the association between Charlson Comorbidity Index (CCI) and length of stay among younger patients who under 50 years old shows that the average length of stay for low CCI and high CCI groups was 17.73 days and 19.49 days, respectively.[9] Researchers focused on analysis of variation in length of stay after ischemic and hemorrhagic stroke using the Charlson Comorbidity Index (CCI) believe that the average length of stay in 2005 to 2010 for hemorrhagic stroke and ischemic stroke was 32.3 days and 17.3 days, respectively, which suggest that hemorrhagic stroke patients needed about twice hospitalization time compared to ischemic stroke.[10] That also explains why ICH stroke was associated with a higher mortality rate. Although ICH stroke is associated with a higher mortality rate and disability rate, researchers did not pay enough attention. Researchers did not use to analyze stroke with subgroups such as hemorrhagic stroke and ischemic stroke. Researchers used to combine them in stroke groups even though ICH and ischemic stroke have different pathogenesis, which is partly because ICH only accounts for a small number of stroke patients in the US.

Hypertension is the most common risk factor for ICH.[11-13] In addition, sex, genetics, cerebral amyloid angiopathy, cholesterol, anticoagulation and antiplatelet drug use, alcohol, smoking, diabetes, microbleeds, dialysis, and substance abuse are other risk factors that are associated with hemorrhagic stroke.[1, 4, 14, 15] Studies show similar results that hypertension is the major comorbidity associated with hemorrhagic stroke; likewise, reduction in hypertension was associated with the decrease in hemorrhagic stroke rate.[16] Most people agree that hypertension is strongly associated with a longer length of stay in hospital.[17]

A study using 2009-2013 South Korean data focus on procedure shows that hospitals with a higher volume of surgery in hemorrhagic stroke patients were associated with lower mortality. The study also indicates that the craniotomy group was more effective than the trephination group (Lee et al., 2018). Other studies also support the idea that some procedures were effective to ICH patients.[18, 19] Craniotomy/craniectomy, extraventricular device (EVD), and clot evacuation are three common procedures used to surgically treat ICH patients. However, other researchers believe that even though these surgeries have theoretical benefits, they agree that there were no clinical benefits for early surgical evacuation.[20-22]

Researchers and physicians did make some progress in reducing the mortality rate of hemorrhagic stroke from 24.3% to 19.6%.[23] They also agree that the hospitalization rate of SAH decreased from 2003-2004 to 2011-2012 for ages 35-44 and 45-54.[24] Also, the hospitalization rate for ICH patients aged higher than 65 years of age decreased significantly.[24] However, there was not much research focus on the different outcomes with ICH patients in recent years after years of developing in analyses of ICH. There is also not much research focus on the association between ICH and length of stay. Some studies used NIS data to define the overall mortality rate of hemorrhagic stroke; however, the Alabama stroke data were not included in the NIS database. Alabama is one of the states in the Stroke Belt, famous for its high incidence rate and mortality rate of stroke. People agree that even though the mortality nationwide is decreasing, the mortality rate in Stroke Belt is still relatively higher.[25] People found that the crude mortality rate in Alabama ranked the fourth among all US states (20.8 per 100,000).[26] However, there was no article focused on ICH in Stroke Belt and Alabama. Hence, few statistics show the difference in the mortality of ICH in Alabama and nationwide.

To focus on the different mortality rates between US ICH stroke data and single institution in Alabama ICH data, we will compare NIS data and University of Alabama at Birmingham (UAB) hospital data to examine potential differences in in-hospital mortality performed procedures, and length of stay. We want to compare the different mortality rates, procedure, and length of stay in UAB hospital focusing on the US. South. We also want to select patients from large cities and large hospitals to compare their different mortality rates, procedure, and length of stay with UAB Hospital data to define whether a single institution in Alabama (UAB Hospital) has different outcomes from other areas in the US. We hope to use the result of our study to guide the treatment of hemorrhagic stroke in Alabama.

MATERIALS AND METHODS

Data Sources and Study Population

UAB Data

A UAB stroke registry did a chart review on the ICH patients in Neurology. The chart review combined the medical record number with the UAB Hospital patient record to extract additional variables. Four hundred twenty-five patients were used from the registry from 2016 to 2019. Patients aged 18 or above who were diagnosed with ICH or transferred to UAB hospital because of ICH were included in the database. The Institutional Review Board (IRB) of UAB approved the data collection for and analysis of data using the UAB Hospital data was proved by the UAB Hospital Stroke Registry.

National Inpatient Sample

The NIS dataset is the largest publicly available all-payer inpatients dataset in the US., sampling 20% of inpatient discharges from all U.S. community hospitals and currently contains data from more than seven million hospital stays each year in 48 states and the District of Columbia.[26] The NIS dataset includes comprehensive information such as demographic characteristics, hospital characteristics, and outcome. All baseline characteristics of patients, hospital characteristics, diagnosis codes, and procedure codes were recorded in the dataset. The analysis of NIS data was considered exempt from review by the IRB.

Inclusion and Exclusion Criteria

Patients aged 18 and older who were hospitalized with an ICH diagnosis between 2016 and 2019 in UAB data, and 2016 and 2018 patients NIS data were included in the study. Patients in both datasets involved in the sample population were ICH patients who were 18 or above. International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code I61.0-I61.9 were used to select ICH patients from NIS data. Patients whose discharge disposition was transferred out in the NIS dataset were excluded.

Variables

Primary Independent Variable

Our primary independent variable was the different hospital area subgroup variables in the combined NIS and UAB Hospital dataset. The three subgroups in NIS dataset were stratified by different variables originally collected in the NIS dataset. They are hospital bed size (small, medium, large), location/teaching status of hospital (rural, urban non-teaching, urban teaching), region of hospital (Northeast, Midwest, South, West), and census division of hospital (New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South, Central, West South Central, Mountain, Pacific). We restricted the NIS data to ICH patients in large, urban teaching hospitals in the South, and then stratified by census division of South Atlantic, East South

Central, and West South Central. After stratificationed, a variable named area with four levels of census divisions (South Atlantic Large Urban teaching, East South Central Large Urban teaching, West South Central Large Urban teaching, and UAB Hospital) was created. A second area variable was created which combined UAB Hospital dataset and East South Central Large Urban teaching hospital together to form a 3-levels census division variable with South Atlantic Large Urban teaching hospitals, and West South Central Large Urban teaching hospitals.

Primary Outcomes

Our primary outcomes were in-hospital mortality and length of stay (LOS).

Covariates

Age, gender, race, insurance, procedures, were the covariables that collected in the UAB Hospital dataset, and the South Large Urban teaching dataset. Age, gender, race, insurance, and procedures were use in all the regression models include parallel regression models and joint models. Death was covariable of analysis the association between census divisions and LOS in the adjusted linear regression models.

Patient age was recategorized as 18-44, 45-64, 65-84, and 85+. Race/ethnicity was coded as White, Black or African American, Asian, and others. Craniotomy, craniectomy, burr hole, extraventricular device (EVD), clot evacuation, clipping, coiling, ventriculoperitoneal shunting (VPS), clot aspiration, venous thrombectomy, AVM embolization, AVM resection, cranioplasty were defined as common procedures in treating ICH patients and were recategorized as three classes: 1) Clot evacuation/decompression (craniotomy, craniectomy, cranioplasty, burr hole, clot evacuation, clot aspiration); 2) Hydrocephalus-related (EVD, VPS); 3) Repair of vascular malformations (clipping, coiling, venous thrombectomy, AVM embolization, AVM resection) in both datasets. Procedures in NIS dataset were selected and coded using International Classification of Diseases, Tenth Revision, Procedure Coding System (ICD-10-PCS) (See APPENDIX A).

Statistical Analysis

For the analysis of baseline characteristics in UAB data and NIS data, continuous variables were analyzed using ANOVA, and categorical variables were analyzed using Pearson's chi-square test and Fisher's exact test, when appropriate.

The in-hospital mortality rate was estimated for UAB Hospital, the NIS overall, South, Large Urban teaching, South Large Urban teaching, and for the stratified to the subgroups (South Atlantic Large Urban teaching, East South Central Large Urban teaching, and West South Central Large Urban teaching).

Multivariable logistic regressions were built separately within UAB data, NIS South, NIS South Atlantic Large Urban teaching, NIS East South Central Large Urban teaching, and NIS West South Central Large teaching subgroups, using age, gender, race, insurance, procedures. Then UAB Hospital data was combined with NIS South Large Urban teaching to create a new dataset to build a multivariable logistic regression with age, gender, race, insurance, procedure, and four-levels of area variable (UAB Hospital, NIS South Atlantic Large Urban teaching, NIS East South Central Large Urban teaching, and NIS West South Central Large teaching). After that, another multivariable logistic regression model was further built using the combined dataset with age, gender, race, insurance, procedure, hypertension, and two-level (UAB Hospital and NIS South Large Urban teaching) in area variable. Multivariable linear regression was built to figure out the association among LOS and age, gender, race, insurance, procedures, death and four-levels of area variable (UAB Hospital, NIS South Atlantic Large Urban teaching, NIS East South Central Large Urban teaching, and NIS West South Central Large teaching). When building linear regression models to analysis the association between areas and LOS, patients who stay in hospital for more than 30 days were excluded from the model. SAS 9.4 was used to perform the statistical analysis. A P value <0.05 was considered statistically significant, and 95% confidence intervals (95% CI) were reported.[27]

RESULTS

Baseline Characteristics

As shown in Table 1, there are 425 patients in UAB Hospital dataset and 68,525 patients in the overall NIS dataset. After stratifying by regions, 27,341 patients were in the South, and 13,870 patients left after restricting the dataset to patients discharged from South Large Urban teaching hospitals (see Table 1).

Table 1

Demographic and Characteristics of UAB Data, NIS Data, and NIS South Large Urban Teaching

Characteristics	UAB (n=425)	NIS (n=68525)	NIS South (n=27341)	NIS South Large Urban teaching (n=13870)
Age				
18-44	62 (14.59)	5462 (7.97)	2234 (8.17)	1334 (9.62)
45-64	151 (35.53)	21836 (31.87)	9217 (33.71)	5002 (36.06)
65-84	176 (41.41)	31353 (45.75)	12367 (45.23)	6057 (43.67)
85+	36 (8.47)	9874 (14.41)	3523 (12.89)	1477 (10.65)
Gender				
Male	205 (48.24)	35468 (51.76)	14171 (51.83)	7198 (51.90)
Female	220 (51.76)	33057 (48.24)	13170 (48.17)	6672 (48.10)
Race				
White	221 (52.00)	43892 (64.05)	16616 (60.77)	8144 (60.64)
Black	182 (42.82)	11403 (16.64)	6302 (23.05)	3585 (25.85)
Asian	12 (2.82)	3365 (4.91)	504 (1.84)	243 (1.75)
Other	10 (2.35)	9865 (14.40)	3919 (14.33)	1631 (11.76)
Insurance				
Medicaid	54 (12.71)	8237 (12.02)	2484 (9.09)	1356 (9.78)
Medicare	218 (51.29)	40620 (59.28)	15831 (57.90)	7642 (55.10)
Private	110 (25.88)	14577 (21.27)	5890 (21.54)	3264 (23.53)
Other	43 (10.12)	5091 (7.43)	3136 (11.47)	1608 (11.59)
Clot evacuation/Decompression	31 (7.29)	287 (0.42)	107 (0.39)	70 (0.50)
Hydrocephalus-Related	51 (12.00)	4908 (7.16)	1962 (7.18)	1280 (9.23)

Repair of Vascular Malformations	5 (1.18)	2567 (3.75)	1032 (3.77)	687 (4.95)

All values reported as n (%)

When South Large Urban teaching hospitals were further stratified by census divisions, there were 8.088 patients in South Atlantic Large Urban teaching hospitals, 2,612 patients in East South Central Large Urban teaching hospitals, and 3,170 patients in West South Central Large Urban teaching hospitals. There were significant differences in the proportions of patients who had the procedures among UAB Hospital, South Large Urban teaching hospitals, East South Central Large Urban teaching hospitals, and West South Central Large Urban teaching hospitals (see Table 2)

Table 2

Demographic and Characteristics of UAB Data and NIS Data of Three Aimed Areas

	UAB	South Atlantic Large Urban teaching	East South Central Large Urban teaching	West South Central Large Urban teaching	
Characteristics	Total Population (425)	Total Population (n=8088)	Total Population (n=2612)	Total Population (3170)	*P*-value
Demographic characteristics					
Age, y: median n (%)					0.0004
18-44	62 (14.59)	750 (9.27)	246 (9.42)	338 (10.66)	
45-64	151 (35.53)	2882 (35.63)	916 (35.07)	1204 (37.98)	
65-84	176 (41.41)	3562 (44.04)	1167 (44.68)	1328 (41.89)	
85+	36 (8.47)	894 (11.05)	283 (10.83)	300 (9.46)	
Gender, n (%)					0.9537
Male	205 (48.24)	4202 (51.95)	1343 (51.42)	1653 (52.15)	
Female	220 (51.76)	3886 (48.05)	1269 (48.58)	1517 (47.85)	
Race, n (%)					<.0001
White	221 (52.00)	4843 (59.88)	1994 (76.34)	1574 (49.65)	
Black	182 (42.82)	2443 (30.21)	555 (21.25)	587 (18.52)	
Asian	12 (2.82)	152 (1.88)	11 (0.42)	80 (2.52)	
Other	10 (2.35)	650 (8.04)	52 (1.99)	929 (29.31)	
Insurance, n (%)					<.0001
Medicare	218 (51.29)	4389 (54.27)	1590 (60.87)	1663 (52.46)	
Medicaid	54 (12.71)	846 (10.46)	262 (10.03)	248 (7.82)	
Private	110 (25.88)	1999 (24.72)	505 (19.33)	760 (23.97)	
Other	42 (10.12)	854 (10.56)	255 (9.76)	499 (15.74)	
Clinical characteristics					
Clot evacuation/decompression	31 (7.29)	42 (0.52)	5 (0.19)	23 (0.73)	<.0001
Hydrocephalus-related	51 (12.00)	786 (9.72)	188 (7.20)	306 (9.65)	0.0002
Repair of vascular malformations	5 (1.18)	399 (4.93)	148 (5.67)	140 (4.42)	0.0005

In-Hospital Mortality Rate of UAB and Different Area of South.

The overall in-hospital mortality rate in UAB Hospital was 27.76 (22.76,32.77) per 100 while it was 21.69 (21.22,22.16) per 100 in NIS Large urban teaching hospitals and 22.98 (22.19,23.78) per 100 in NIS South Large urban teaching hospitals. However, the in-hospital mortality was slightly lower in South Atlantic Large urban teaching hospitals [22.33 (21.30,23.36) per 100], but higher in East South Central Large urban teaching hospitals, and West South Central Large urban teaching hospitals [24.69 (22.79,26.60) per 100, 23.25 (21.57,24.93) per 100] (See Table 3).

Table 3

In-hospital Mortality Rate of UAB Hospital and Different Areas of South

Variable	Overall	South	South Atlantic	East South Central	West South Central
UAB	27.76 (22.76,32.77)				
NIS	22.02 (21.69,22.37)	22.31 (21.75,22.87)			
Large Urban teaching	21.69 (21.22,22.16)	22.98 (22.19,23.78)	22.33 (21.30,23.36)	24.69 (22.79,26.60)	23.25 (21.57,24.93)

Parallel Logistic Regression Model of UAB and Different Areas of US. South.

Patients in UAB Hospital between age 65 to 84 and 85+ had a higher odds of in-hospital mortality compared to the age group of 18-44 [OR (95% CI) 65-84: 2.813 (1.167, 6.779), 85+: 3.501 (1.193, 10.278)] adjusted for gender, race, insurance, and procedures.

Patients who received clot evacuation/decompression procedures had a 2.258 times higher odds of in-hospital mortality higher compared to patients who did not receive the procedures controlling for age, gender, race, insurance, hydrocephalus-related procedures, and repair of vascular malformations procedures. When NIS South Large Urban teaching hospitals was divided into South Atlantic Large Urban teaching hospitals, East South Central Large Urban teaching hospitals, and West South Central Large Urban teaching hospitals, there were differences among parallel models. Patients in South Atlantic Large Urban teaching hospitals who used Medicare was associated with higher odds of mortality compared to patients who used private insurance [OR (95%CI) Medicare: 1.353 (1.153, 1.588)] controlling for age, gender, race, and procedures. Patients who received clot evacuation/decompression procedures were associated with 82.8% lower odds of in-hospital mortality compared to patients who did not receive clot evacuation/decompression procedures adjusting for age, gender, race, insurance, hydrocephalus-related procedures, and repair of vascular malformations procedures. Patients who received hydrocephalus-related procedures had a 2.349 times higher odds of in-hospital mortality compared to patients who did not receive the procedures controlling for age, gender, race, insurance, clot evacuation/decompression procedures, and repair of vascular malformations procedures. For patients in East South Central Large Urban teaching hospitals, patients who received hydrocephalus-related procedures were associated with 2 times higher odds of in-hospital mortality higher than patients who did not receive the procedures controlling for age, gender, race, insurance, clot evacuation/decompression procedures, and repair of vascular malformations procedures. In West South Central Large Urban teaching hospitals, patients who received hydrocephalus-related procedures were also associated with higher odds of in-hospital mortality than patients with no hydrocephalus-related procedures [OR (95% CI) 1.512 (1.154, 1.980)] controlling for age, gender, race, insurance, clot evacuation/decompression procedures, and repair of vascular malformations procedures. However, patients with repair of vascular malformations procedures were associated with lower odds of in-hospital mortality [OR (95% CI) 0.407 (0.243, 0.683)] adjusting for age, gender, race, insurance, clot evacuation/decompression procedures, and repair of vascular malformations procedures (See Table 4).

Table 4

Adjusted Association with In-hospital Mortality Stratified by South Divisions among Variables in UAB, and Different Area of US

	UAB		South Atlantic Large Urban teaching		East South Central Large Urban teaching		West South Central Large Urban teaching	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
AGE								
18-44	Ref		Ref		Ref		Ref	
45-64	1.305	0.577, 2.950	1.142	0.932, 1.401	1.180	0.834, 1.669	1.164	0.859, 1.576
65-84	2.813	1.167, 6.779	1.161	0.924, 1.458	1.308	0.868, 1.969	1.364	0.965, 1.929
85+	3.501	1.193, 10.278	1.177	0.899, 1.542	1.288	0.797, 2.079	1.414	0.921, 2.171
Gender, female	0.790	0.498, 1.254	0.971	0.873, 1.080	1.068	0.891, 1.281	0.944	0.798, 1.116
RACE								
White	Ref		Ref		Ref		Ref	
Black or African American	0.974	0.598, 1.586	0.941	0.832, 1.065	0.867	0.687, 1.092	0.786	0.617, 1.001
Asian	1.156	0.321, 4.171	1.157	0.793, 1.689	1.190	0.312, 4.533	0.687	0.385, 1.224
Other	0.307	0.037, 2.574	0.916	0.747, 1.123	0.764	0.386, 1.513	0.909	0.746, 1.108
INSURANCE								
Private	Ref		Ref		Ref		Ref	
Medicare	0.884	0.473, 1.652	1.353	1.153, 1.588	1.090	0.804, 1.479	1.134	0.875, 1.470

Medicaid	0.502	0.198, 1.274	1.143	0.930, 1.406	1.064	0.739, 1.532	1.020	0.709, 1.467
Other	0.557	0.207, 1.499	1.559	1.284, 1.891	1.642	1.161, 2.322	1.524	1.164, 1.995
Clot evacuation/Decompression	2.258	1.006, 5.068	0.172	0.041, 0.720	2.349	0.384, 14.376	1.186	0.460, 3.056
Hydrocephalus-Related	1.148	0.578, 2.278	2.349	2.002, 2.756	2.003	1.454, 2.761	1.512	1.154, 1.980
Repair of Vascular Malformations	2.213	0.300, 16.311	0.661	0.503, 0.869	0.788	0.525, 1.183	0.407	0.243, 0.683

UAB Data and South Large Urban Teaching Data Combined in One Model

As shown in Table 5, when UAB hospital data and South Large Urban teaching hospitals data were combined UAB Hospital and East South Large Urban teaching hospitals were associated with higher odds of in-hospital mortality compared to South Atlantic Large Urban teaching hospitals [OR (95% CI) 1.335 (1.068, 1.670), 1.141 (1.028, 1.268)] adjusting for age, gender, race, insurance, and procedure. A further comparison was made to compare UAB Hospital to East South Central Large Urban teaching hospitals. The result show that there was no significant difference between UAB Hospital and East South Central Large Urban teaching hospitals [OR (*P*-value) 0.157 (0.1926)] adjusted for age, gender race, insurance, and procedure.

Table 5

Association between Hospital Area and In-hospital Mortality, Adjusted for Selected Demographic and Clinical Characteristics

Variable	OR	95% CI	*P*-value
Area			
South Atlantic large urban teaching	Ref		
East South Central large urban teaching	1.141	1.028, 1.268	0.0136
West South Central large urban teaching	1.049	0.947, 1.163	0.3559
UAB	1.335	1.068, 1.670	0.0113

Adjusted for Age, Gender, Race, Insurance, Procedure

Therefore, a second logistic regression model were made to estimate the association between areas and in-hospital mortality, which combined UAB Hospital and East South Central Large Urban teaching hospitals into one level and formed the three levels area variable (South Atlantic Large Urban teaching hospitals, East South Central Large Urban teaching hospitals, and West South Central Large Urban teaching Hospitals). Table 6 shows that East South Central Large Urban teaching hospitals were associated with higher odds of in-hospital mortality compared to South Atlantic Large Urban teaching hospitals adjusting for age, gender, race, insurance, and procedure [OR (95%CI) 1.168 (1.058, 1.289)] (See Table 6).

Table 6

Association between Hospital Area and In-hospital Mortality Combining UAB Hospital and East South Central Large Urban Teaching in One Level, Adjusted for Selected Demographic and Clinical Characteristics

Variable	OR	95% CI	*P*-value
Area			
South Atlantic large urban teaching	1.00	Ref	
East South Central large urban teaching	1.168	1.058, 1.289	0.0021
West South Central large urban teaching	1.050	0.947, 1.163	0.3546

Adjusted for Age, Gender, Race, Insurance, Procedure

The Association between Area and Length of Stay Combining UAB and Different Level of South Large Urban Teaching Hospital Data in One Model

As shown in Table 7, the mean age of UAB Hospital and East South Central Large Urban teaching hospitals were significantly longer than the LOS in South Atlantic Large Urban teaching hospitals, and were also significantly longer than in West South Central Large Urban teaching hospitals [mean (SD) 7.35 (5.85), 7.53 (6.46), 8.18 (6.90), 8.08 (6.83) *P*-value<.0001].

Table 7

LOS of UAB and Other Large Urban Teaching Hospital in Different Area of South

	UAB	South Atlantic Large Urban teaching	East South Central Large Urban teaching	West South Central Large Urban teaching	*P*-value
LOS, d (SD)	7.35 (5.85)	8.18 (6.90)	7.53 (6.46)	8.08 (6.83)	<.0001

Among areas, East South Large Urban teaching hospitals and UAB Hospital were associated with lower LOS compared to South Atlantic Large Urban teaching hospitals [β (95% CI) -0.320 (-0.605, -0.034), -1.248 (-1.889, -0.607)] controlling for age, gender, race, insurance, and procedure. Age groups of 65-84, 85+, female and death were significantly associated with lower LOS adjusting for covariates [β (95% CI) -0.672 (-1.116, -0.229), -2.151 (-0.475, -0.050) -0.263 (-0.475, -0.050), -4.069, (-4.318, -3.819)], whereas, Black or African American, Asian, other races, Medicaid, other insurance, clot evacuation/decompression procedures, hydrocephalus-related procedures, and repair of vascular malformations procedures were significantly associated with higher LOS adjusting for covariates [β (95% CI) 1.037 (0.779, 1.296), 1.188 (0.359, 2.017), 0.538 (0.177, 0.900), 0.955 (0.531, 1.380), 0.538 (-0.784, -0.016), 3.355 (1.960, 4.750), 6.269 (5.880, 6.659), 3.024 (2.519, 3.529)]. (See Table 8).

Table 8

Adjusted Association among LOS in UAB and Other Large Urban Teaching Hospital in Different Areas of South

Variable	B	95% CI	*P*-value
AGE			
18-44			
45-64	-0.071	-0.462, 0.320	0.7224
65-84	-0.672	-1.116, -0.229	0.0030
85+	-2.151	-2.682, -1.620	<.0001
Gender, female	-0.263	-0.475, -0.050	0.0153
RACE			
White			
Black or African American	1.037	0.779, 1.296	<.0001
Asian	1.188	0.359, 2.017	0.0050
Other	0.538	0.177, 0.900	0.0035
INSURANCE			
Private			
Medicare	0.117	-0.201, 0.435	0.4700
Medicaid	0.955	0.531, 1.380	<.0001
Other	-0.400	-0.784, -0.016	0.0410
Clot evacuation/Decompression	3.355	1.960, 4.750	<.0001
Hydrocephalus-Related	6.269	5.880, 6.659	<.0001
Repair of Vascular Malformations	3.024	2.519, 3.529	<.0001
Area			
South Atlantic large urban teaching			
East South Central large urban teaching	-0.320	-0.605, -0.034	0.0281
West South Central large urban teaching	-0.107	-0.382, 0.167	0.4438
UAB	-1.248	-1.889, -0.607	0.0001
Death, yes	-4.069	-4.318, -3.819	<.0001

DISCUSSION

In this study of in-hospital mortality and LOS among UAB Hospital and South Census division of South Large Urban teaching hospitals, we found that the in-hospital mortality of UAB Hospital is higher than South Atlantic Large Urban teaching hospitals, East South Central Large Urban teaching hospitals, and West South Central Large Urban teaching hospitals. Also, the in-hospital mortality rate in East South Central Large Urban teaching hospitals was higher than the other census divisions. However, the 95% CI of in-hospital mortality is much wider than the three census divisions due to a much lower patient population. When doing joint logistic regression model with four levels in area variable, we found that patients in both UAB hospital and East South Central Large Urban teaching hospitals were more likely to die in hospital compared to South Atlantic Large Urban teaching hospitals. A further comparison within this model show that the in-hospital mortality was about the same between UAB Hospital and East South Central Large Urban teaching hospitals. When we categorized UAB Hospital back to East South Central Large Urban teaching hospitals, the in-hospital mortality was still higher compared to South Atlantic Large Urban teaching hospitals. Our study also found that the LOS of UAB Hospital and East South Central Large Urban teaching hospitals were shorter than South Atlantic Large Urban teaching hospitals as well as West South Central Large Urban teaching hospitals. In the joint linear regression model, we found that the gap of LOS shortage is more than one day.

Our in-hospital mortality is consistent with former CDC statistics that East South Central includes Mississippi, Alabama, Tennessee, and Kentucky, which were the states had the highest Hemorrhagic Stroke Death Rate among US.[28] Therefore, it is not surprising that UAB Hospital and Other NIS South Large Urban teaching hospitals had higher mortality rates compared to other census divisions in South Regions. Considering that UAB Hospital is the largest comprehensive hospital in the state, it is expected that the most severe patients are likely to be sent to UAB Hospital for procedures and treatments. Also, UAB Hospital has the registry to do different kinds of procedures that are not provided in other hospitals around the state and outside of state. It is likely that some patients who transferred to UAB Hospital were not in good condition since they were potentially looking for better medications. Therefore, it is reasonable that the in-hospital mortality rate was higher in UAB Hospital. Also, the patient population in UAB hospital is small which led to wide 95% CI; therefor, we expect to use a larger population from UAB Hospital to estimate the in-hospital mortality with narrower 95% CI. Prior studies focused on ICH procedures found that only urgent cases were benefitting from procedures while other cases were not benefit from procedures. Our study also found patients who received procedures did not have a better outcome.[29]

There are strengths in our study. The NIS dataset we are using includes a huge number of population, multiple detailed baseline characteristics and enough clinical information, which have the power to provide a precise analysis of and the result of the study. Our study also gives a chance to compare UAB Hospital as a comprehensive large urban teaching hospital in Alabama to compare the in-hospital mortality and LOS with other large urban teaching hospitals in the South regions.

There are limitations in our study that the population of UAB Hospital is too small compared to other large urban teaching hospitals in South. When making joint regressions models, the precision of estimate was affected when the UAB Hospital dataset was included in the models. Furthermore, because the UAB Hospital dataset and the NIS dataset collected information independently, there were few overlap variables in both datasets. Therefore, we are not able to adjust for comorbidities, clinical characteristics, life style and other social-economic risk factors.

In conclusion, our study indicates that the outcomes of ICH patients were statistically not as good as South Atlantic Large Urban teaching hospitals and West South Central Large Urban teaching hospitals. The finding also suggests that further studies with more detailed information are potentially needed to gain a further understanding of how UAB Hospital is performing on ICH patients.

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APPENDIX A

ICD-10-PCS CODES

Procedure	ICD-10-PCS Code
Clot evacuation/decompression	0NB30ZZ, 0NB40ZZ, 0NB50ZZ, 0NB60ZZ, 0NB70ZZ, 009440Z, 0NR107Z, 0NR10JZ, 0NR10KZ, 0NR307Z, 0NR30JZ, 0NR30KZ, 0NR407Z, 0NR40JZ, 0NR40KZ, 0NR507Z, 0NR50JZ, 0NR50KZ, 0NR607Z, 0NR60JZ, 0NR60KZ, 0NR707Z, 0NR70JZ, 0NR70KZ
Hydrocephalus-related	009C30Z, 8C01X6J
Repair of vascular malformations	03VG0CZ, 03LG3DZ, 03CG3Z7, 03CG3ZZ, 03CG4ZZ, 03LG3DZ, 00P007Z