Factors Associated With Emergency Department Length of Stay and In-hospital Mortality in Intracerebral Hemorrhage Patients

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ABSTRACT

BACKGROUND: Spontaneous intracerebral hemorrhage (ICH) is a medical emergency that requires rapid identification and focused assessment early to ensure the best possible outcomes. The purpose of this study is to evaluate the associations between system and patient factors and emergency department (ED) length of stay and in-hospital mortality in patients given a diagnosis of ICH. **METHODS:** A sample of 3108 ICH patients was selected from a statewide administrative database for cross-sectional retrospective analysis. System characteristic (hospital stroke certification), patient characteristics (age, sex, and race), and covariate conditions (stroke severity and comorbidities) were analyzed using descriptive statistics and hierarchical logistic regression models to address the study questions. **RESULTS:** The mean ED length of stay is 2.9 ± 3 hours (range, 0-42 hours) before admission to an inpatient unit. Inpatient mortality is 14.9%. Stroke center certification ($P < .000$) and stroke severity ($P \leq .000$) are significant predictors of ED length of stay, whereas age ($P < .000$), stroke severity ($P < .000$), comorbidities ($P = .047$), and ED length of stay ($P = .04$) are significant predictors of in-hospital mortality. Most notably, an ED length of stay of 3 hours or longer has a 37% increase in the odds of in-hospital mortality. **CONCLUSION:** Our findings support age, stroke severity, and ED length of stay as predictors of in-hospital mortality for ICH patients. The importance of timely admission to an inpatient unit is emphasized. Optimal systems of care and expedited inpatient admission are vital to reduce morbidity and mortality for ICH stroke patients.

Keywords: emergency department, ICH, in-hospital mortality, stroke

Spontaneous intracerebral hemorrhage (ICH) is a potentially catastrophic event and the second most common type of stroke, accounting for approximately 63 000 stroke cases annually in the United States.[1–4] Allthough ICH accounts for 10% to 15% of all stroke occurrences in the United States, it causes disproportionately high morbidity and mortality with more than half of these deaths occurring within the first 2 days of symptom onset.[5,6] Intracerebral hemorrhage is a medical emergency with the first point of hospital care for these critical patients often being the emergency department (ED). Care received in the ED is vitally important because one-third of patients with ICH will have significant hemorrhage expansion within the first 3 hours after symptom onset, increasing morbidity and mortality. In addition, clinical decline in the first 24 to 48 hours after stroke symptom onset has been associated with worse prognosis, making rapid identification and assessment[7] in the acute phase of care critical for optimal patient outcomes.[8]

Timely transfer out of the ED and quality stroke care are critical to manage ICH patient outcomes. The National Institute of Neurological Disorders and Stroke (NINDS) recommended three hours from patient arrival to admission to an inpatient unit for decreasing morbidity and mortality.[9] While this is the national standard, research has demonstrated that ICH patients are boarded in the ED for up to five hours.[6,8]

In addition to system challenges, there are disparities in stroke care based on patient characteristics. African Americans had significantly longer wait times

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for treatment of acute ischemic stroke in the ED, as well as having double the risk of highest mortality from stroke.[10–13] Stroke affects more women than men and women experience longer wait times for treatment of acute stroke compared to their male counterparts.[14–17] As with sex, age impacts stroke. The risk of stroke doubles for every decade a person is over age 55 and patients over 80 years old do not receive the same quality of care as compared to younger stroke patients.[15,18]

Comorbid conditions and stroke severity, along with age, sex, and race characteristics, can directly impact in-hospital mortality. Comorbid conditions are independently associated with more severe stroke and worse outcome.[19] Stroke severity is a vital predictor of patient outcome, which is important to evaluate in-hospital mortality.[20] The purpose of this study is to evaluate system and patient characteristics associated with ED length of stay and in-hospital mortality in patients diagnosed with ICH. We hypothesize that system and patient characteristics predict ED length of stay which in turn predicts in-hospital mortality. Specifically, the following research questions were asked:

1. What are the relationships between system and patient characteristics for the outcomes of ED length of stay and in-hospital mortality?
2. Do system and patient characteristics and ED length of stay predict in-hospital mortality, after controlling for covariates (eg, stroke severity and co-morbidity)?

Methods

This study is a cross-sectional, retrospective analysis of administrative claims from the State Inpatient Database (SID), a part of the Agency for Healthcare Research and Quality (AHRQ) sponsored Healthcare Cost and Utilization Project (HCUP).

The study included patients discharged from Florida acute care hospitals in 2014, with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) primary discharge diagnosis code of spontaneous ICH (431). We included those admitted to the ED and age 18 years or older. We excluded patients with a diagnosis of traumatic ICH, hemorrhagic cerebral infarction, hemorrhage associated with tumor or encephalitis, hemorrhagic conversion resulting from the thrombolytic treatment of ischemic stroke, or subarachnoid hemorrhage. Final sample size is 3,108. Institutional Review Board (IRB) approval was obtained for this study.

Primary Outcomes

The primary outcomes of this study are ED length of stay and in-hospital mortality. ED length of stay is measured as time from patient arrival at the ED to admission to an inpatient unit. Patients are categorized into a group with length of stay less than three hours, and another with greater than or equal to three hours based on the NINDS recommendation.[9] In-hospital mortality is measured as death during hospitalization with a selection of yes or no.

Data on stroke center certification are obtained from various sources including The Joint Commission (TJC) Quality Check, Det Norske Vertias (DNV) and the Healthcare Facilities Accreditation Program (HFAP) and categorized as national Primary Stroke Center certification (PSC), national Comprehensive Stroke Center certification (CSC), or no stroke center certification.

Age is measured in years at the time of admission, sex is categorized as male or female, race is categorized as White, Black, and Other.

Covariate conditions are constructed using diagnosis and procedure codes available in the SID. The Nationwide Inpatient Sample SAH severity score (NIS-SSS) is used to measure stroke severity on patient presentation to the hospital and categorized as less than seven or greater than seven. Because there is no currently available ICH severity score for use with administrative claims data, and stroke severity is such a vital predictor of outcome, we chose to use the NIS-SSS to account for the patient's stroke severity on arrival to the hospital. The NIS-SSS incorporates diagnosis and procedure codes (eg, coma, hydrocephalus, aphasia, ventriculostomy placement) to construct a single score ranging from zero to 19.29, with higher scores indicating more severe stroke.[21] We selected the NIS-SSS to account for stroke severity due to the similarities in neurological diagnosis and procedure codes used to construct this severity measure.

The Elixhauser index is used to measure patient comorbidities at the time of hospital admission. This score is a single value that labels the burden of comorbidities through transforming the 29 HCUP variables by applying weights and creating one comorbidity index score for each record, with index scores ranging from −19 to +89 with a higher score having a greater probability of in-hospital death.[22]

Data Analysis

We calculated descriptive statistics to characterize ED length of stay, system and patient characteristics (Table 1). Chi-Square test and Pearson's Correlation are used to analyze bivariate associations between system and patient characteristics, ED length of stay, and in-hospital mortality. Hierarchical logistic regression models are used to examine the association between system and patient characteristics and the outcomes: ED length of stay and in-hospital mortality, controlling for covariates. In Model 1, system characteristics, patient characteristics and covariate conditions are regressed on ED length of stay; and Model

TABLE 1. Sample Characteristics, Overall (N = 3108)

Characteristics	Total Sample (N = 3108)	ED LOS < 3 Hours (N = 2293)	ED LOS ≥ 3 Hours (N = 815)	*P* Value	In-hospital Mortality Did Not Die (N = 2644)	In-hospital Mortality Died (N = 464)	*P* Value
Stroke Center Certification, n (%)				<.000			.227
National Comprehensive	307 (9.9)	178 (60)	129 (40)		251 (81.8)	56 (18.2)	
National Primary	1782 (57.3)	1380 (77.4)	402 (22.6)		1521 (85.4)	261 (14.6)	
No Certification	1019 (32.8)	735 (72.1)	284 (27.9)		872 (85.6)	147 (14.4)	
Age (mean ± SD, min-max)	70.2 ± 15.2 (18–106)	-	-	.480	-	-	.287
Sex, n (%)				.062			.046
Male	1586 (51)	1193 (75.2)	393 (24.8)		1369 (86.3)	217 (13.7)	
Female	1522 (49)	1100 (72.3)	422 (27.7)		1275 (83.8)	247 (16.2)	
Race, n (%)				.693			.655
White	1952 (62.8)	1449 (74.2)	503 (25.8)		1656 (84.8)	296 (15.2)	
Black	559 (18)	405 (72.5)	154 (27.5)		473 (84.6)	86 (15.4)	
Other	597 (19.2)	439 (73.5)	158 (26.5)		515 (86.3)	82 (13.7)	
NIS-SSS (mean, min-max)	2.3 (0–16.07)			<.000			<.000
<7	2557 (82.3)	1844 (72.1)	713 (27.9)		2412 (94.3)	145 (5.7)	
>7	551 (17.7)	449 (81.5)	102 (18.5)		232 (42.1)	319 (57.9)	
Elixhauser Index (mean, min-max)	5.1 (−18–42)	-	-	.155	-	-	<.000
ED Length of Stay (mean + SD in hrs)	2.9 ± 3 (0–42)				-	-	<.000
<3 hours	2293 (73.8)	-	-		1914 (83.5)	379 (16.5)	
>3 hours	815 (14.9)	-	-		730 (89.6)	85 (10.4)	

Abbreviation: ED LOS, emergency department length of stay; NIS-SSS, Nationwide Inpatient Sample SAH Severity Score.

2 shows association between system and patient characteristics, ED length of stay and in-hospital mortality, controlling for covariate conditions (Table 2). All data analyses are performed with SPSS v 25.[23] Statistical significance is set at $P < .05$.

Results

The sample consisted of 3,108 patients diagnosed with spontaneous ICH admitted to Florida acute care hospitals in 2014. The average patient is male (51%), White (62.8%), and age 70 (range: 18–106) at hospital admission. Mean NIS-SSS score is 2.26 (range: 0–16.07) at time of presentation. Mean time spent in the ED before admission to an inpatient unit, ED length of stay, is 2.9 ± 3 hours (range: 0–42 hours) [Table 1]. In-hospital mortality is 14.9%.

The ED length of stay is significantly associated with stroke center certification (P = <.000) and NIS-SSS (P = <.000). Hospitals with a national PSC certification or no stroke certification have shorter ED lengths of stay compared to hospitals with a national CSC certification. Patients with a NIS-SSS ≥ 7 (severe stroke) have a shorter ED length of stay. Age, sex, race, and Elixhauser Index are not significantly associated with ED length of stay (Table 1).

In-hospital mortality is significantly associated with sex (P = .046), NIS-SSS (P = <.000), Elixhauser Index (P = <.000), and ED length of stay (P = <.000). More females died while hospitalized with ICH; patients presenting with a worse stroke severity on admission have more in-hospital mortality; the Elixhauser index is positively associated with in-hospital mortality; and shorter ED length of stay is associated with decreased in-hospital mortality. Age, race, and stroke center certification are not significantly associated with in-hospital mortality (Table 1).

Predictors of ED Length of Stay and In-hospital Mortality

We considered two outcomes in this study: ED length of stay and in-hospital mortality. ED length of stay is conceptualized as a precursor to in-patient mortality, thus hierarchical regression models were conducted.

In Model 1, patient characteristics, system characteristics, and covariates are regressed on ED length of stay. Model 1 is statistically significant (P = <.000) and explained 73.9% of variance in ED length of stay (see Table 2). We found stroke center certification (P = <.000) and NIS-SSS (P = <.000) to be significant predictors of ED length of stay. Hospitals with a national PSC certification (OR = 1.98, CI:1.51–2.60, P = <.000) have a 98% increase in ED length of stay compared to hospitals with a national CSC certification, while hospitals with no national stroke center certification (OR = .77,CI: .64–.92, P = <.000) have a 23% reduction in ED length of stay compared to hospitals with a national CSC certification. Patients with a NIS-SSS ≥ 7 (OR = 1.79, CI: 1.40–2.27, P = <.000) have a 79% increase in ED length of stay. Age, sex, race, and Elixhauser Index did not predict ED length of stay.

In Model 2, patient characteristics, system characteristics and ED length of stay are regressed on in-hospital mortality, controlling for co-morbidities. Model 2 is significant (P = <.000) and explains 88.4%

TABLE 2. In-hospital Mortality for ICH Patient From Hierarchical Logistic Regression Analysis (N = 3108)

In-hospital Mortality	Model 1 (ED LOS Outcome)				Model 2 (In-hospital Outcome)			
Variable	**OR**	**Lower**	**Upper**	**P**	**OR**	**Lower**	**Upper**	**P**
Stroke Center Certification				<.000				.309
National Primary	1.98	1.51	2.60	<.000	.98	.64	1.51	.932
No Certification	.77	.64	.92	.004	.82	.63	1.08	.152
Age (in years)	.99	.99	1.00	.237	1.03	1.02	1.04	<.000
Sex_Female	.87	.74	1.03	.106	.83	.65	1.06	.139
Race				.405				.536
Race_Black	.92	.74	1.13	.421	1.16	.84	1.61	.363
Race_Other	1.06	.81	1.39	.679	1.00	.67	1.51	.983
NIS-SSS	1.79	1.40	2.27	<.000	.03	.02	.04	<.000
Elixhauser Index	.99	.99	1.01	.662	.99	.97	1.00	.047
ED LOS					1.37	1.02	1.85	.040
Constant	.34			<.000	.24			<.000

Abbreviation: NIS-SSS, Nationwide Inpatient Sample SAH Severity Score; ED LOS, emergency department length of stay.

of variance in in-hospital mortality. In this model, age (OR = 1.03, CI:1.02–1.04, P = <.000), NIS-SSS (OR = .032, CI: .02–.04, P = <.000), Elixhauser Index (OR = .99, CI: .97–1.00, P = .047), and ED length of stay (OR = 1.37, CI: 1.02–1.85, P = .04) are all significant predictors of in-hospital mortality. In-hospital mortality increases with age (OR = 1.03), while in-hospital mortality decreases with more comorbid conditions on presentation. Patients with a NIS-SSS of seven or greater have decreased odds of in-hospital mortality. With every one-point increase in Elixhauser index, the patient has a 1.4% decrease in the odds of in-hospital mortality. Patients with an ED length of stay greater than or equal to three hours have a 37% increase in the odds of in-hospital mortality.

Discussion

ICH is a medical emergency that requires appropriate intervention, frequent monitoring, and timely admission to an inpatient unit for optimal patient outcomes. Often the first point of medical contact for this patient population is the ED, where the care provided is of the utmost importance due to the complex nature of the disease. The length of time spent in the ED for ICH patients in Florida in 2014 varied widely, ranging from zero to 42 hours before admission to an inpatient unit.

Patients with a more severe stroke had shorter ED length of stay. Patients with milder stroke (NIS-SSS <7) stayed in the ED longer, which is problematic because this is the population that can deteriorate quickly without proper neurological assessments and frequent monitoring. Additionally, 40% of ICH patients treated at a hospital with a national CSC certification had an ED LOS $\geq$ 3 hours, representing those patients with milder strokes. Both of these findings highlight the need for expedited transfer to a specialized stroke unit for all ICH patients to optimize patient outcomes. These patients arrive to the ED with milder stroke symptoms and fewer deficits, with the timely transfer to a specialized neuro units, the expert staff has the abilty to monitor them more closely to detect subtle changes in their condition to then provide appropriate treatment quicker to help decrease the residual effects of ICH.

Female sex, more severe stroke on presentation, higher Elixhauser Index, and increased ED length of stay are associated with in-hospital mortality. Our findings are consistent with the literature where women are significantly more likely to die while hospitalized for ICH.[14,24] It is expected that patients with a more severe stroke have a higher risk of dying while hospitalized and that stroke severity upon presentation to the hospital is a vital predictor of both outcomes. Patients with more comorbidities on presentation have higher in-hospital mortality. Further, patients with a shorter ED length of stay have a decrease in-hospital mortality, suggesting that patients are arriving with severe stroke and significant clinical deficits and are being transferred out to an inpatient unit in a more timely manner where they can receive the more frequent and detailed neurological assessments and monitoring that is important for ICH patients. This timely transfer to a neurological ICU is important because the literature has shown that care for ICH patients on these specialized units decreases mortality and improves functional outcomes.[25]

We found stroke center certification and NIS-SSS to be significant predictors of ED length of stay. Hospitals with a national PSC certification have a 98% increase in ED length of stay while hospitals with no stroke center certification have a 23% reduction in ED length of stay as compared to hospitals with a national CSC certification. These findings are not entirely surprising and suggest Primary Stroke Centers are keeping ICH patient in the ED longer while hospitals without certification are transferring patients out to a higher level of care since hospitals without a stroke certification are generally not well equipped with the extensive resources to care for ICH patients. Patients with a NIS-SSS $\geq$ 7 have a 79% increase in ED length of stay. This finding is surprising because one would anticipate patients with a more severe stroke to be admitted to an inpatient unit promptly where the focused assessment and frequent monitoring can be provided.

We found age, NIS-SSS, Elixhauser Index and ED length of stay to be significant predictors of in-hospital mortality for ICH patients. As age increases, the odds for in-hospital mortality increases. This finding is consistent with the literature that stroke mortality increases significantly with age.[26] For every one-point increase in Elixhauser Index, the patient has a 1% decrease in the odds of in-hospital mortality. We would anticipate that the fewer comorbid conditions a patient presents with, the less likely the odds of death. Stroke severity is an essential predictor of patient outcomes. Yet, our findings show that ICH patients with a NIS-SSS greater than or equal to seven have a decrease in the odds of in-hospital mortality as compared to those with a NIS-SSS less than seven. This finding may indicate that the NIS-SSS is not a sensitive proxy measure for stroke severity on presentation in the ICH patient population. Notably, we found that patients with an ED stay greater than or equal to three hours have a 37% increase in odds for in-hospital mortality. This finding supports our hypothesis that ED length of stay is associated with in-hospital mortality and emphasizes the importance of admitting ICH patients to an inpatient unit promptly.

There are non-significant predictors in our study for both ED length of stay and in-hospital mortality.

Age, sex, race and Elixhauser Index were not significant predictors of ED length of stay. These findings are not consistent with the literature for ischemic stroke patients where age, sex, and race have demonstrated disparities in timeliness and quality of stroke care provided in the ED.[10–12,15–17] Additionally, stroke center certification, sex, and race are found to be non-significant predictors of in-hospital mortality for ICH patients. These findings are also not consistent with the literature on ischemic stroke patient outcomes where stroke center certification has been shown to improve patient outcomes, female sex has a higher incidence of death and African Americans have double the risk of mortality from stroke.[14,27]

ICH is a medical emergency that requires rapid identification and timely admission to an inpatient unit. As a nurse, it is vitally important to recognize the signs and symptoms of stroke for prompt diagnosis and treatment, but also understand the importance of timely admission to an inpatient unit to help reduce morbidity and mortality for ICH stroke patients. The critical assessment skills to quickly recognize stroke symptoms can be achieved with specialized nursing care, such as staffing stroke nurses in the ED. There is also the need to improve stroke systems of care to improve survivorship for this patient population that can be achieved at a local, regional and national level.

Locally, hospitals can develop and implement protocols and pathways to prioritize these patients and admit them to an inpatient unit faster. Regionally, protocols need to be established for emergency medical services (EMS) to deliver the patient to the right hospital the first time and expedited transfer protocols need to be in place to get the patient to the right hospital in a timely manner so the patient is not transferred from one ED to another spending more time in the ED before being admitted to an inpatient unit. Nationally, stroke systems of care need to be strengthened to support the initiative of inpatient unit admission in a timely manner to decrease the odds of in-hospital mortality in ICH patients.

Further, while we found several predictors not to be significantly associated with in-hospital mortality (stroke center certification, sex, race, and comorbid conditions) perhaps these variables impact post-discharge outcomes in ICH patients. ICH is associated with greater functional disability at discharge as compared to patients with acute ischemic stroke, with ICH patients having greater increases in functional recovery during rehabilitation as compared to acute ischemic stroke patients.[28] Therefore, more research is needed to examine the association between hospital-level and patient demographics and their impact on post-discharge outcomes so we can improve recovery for these patients.

Limitations

There are limitations of analysis using an existing data set. We are limited by missing patient-specific variables such as the time from stroke symptom onset to patient arrival to the ED, hematoma size on presentation, stroke severity score on arrival, or any post-discharge outcomes. Additionally, when examining ED length of stay, other confounding factors that can influence care, such as unit census or nurse staffing ratios, were not available. Finally, the patient's transfer status was not evaluated when examining when considering care provided in the ED.

Conclusion

Our study supports known predictors of in-hospital mortality for ICH patients including age, but most notably highlights the importance of decreased ED length of stay. This important finding needs to be emphasized and worked on to improve overall stroke systems of care to reduce the burden and increase the survivorship for ICH stroke patients.

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