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Emergency department length of stay and outcome after ischemic stroke

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Abstract

Background—Emergency department length-of-stay (ED-LOS) has been associated with worse outcomes after various medical conditions. However, there is a relative paucity of data for ischemic stroke patients. We sought to determine whether a longer ED-LOS is associated with a poor 90-day outcome after ischemic stroke.

Methods—Retrospective analysis of a single-center cohort of consecutive ischemic stroke patients (n=325). Multivariable linear and logistic regression models were constructed to determine factors independently associated with ED-LOS as well as a poor 90-day outcome (modified Rankin scale [mRS] score >2), respectively.

Results—The median ED-LOS in the cohort was 5.8 hours. For patients admitted to the inpatient stroke ward (n=160) versus neurointensive care unit (NICU; n=165), the median ED-LOS was 8.2 hours versus 3.7 hours, respectively. On multivariable linear regression, NICU admission ($P<0.001$), endovascular stroke therapy ($P=0.001$), and thrombolysis ($P=0.021$) were inversely associated with the ED-LOS. Evening shift presentation was associated with a longer ED-LOS ($P=0.048$). On multivariable logistic regression, a greater admission NIHSS ($P<0.001$), worse pre-admission mRS ($P=0.001$), hemorrhagic conversion ($P=0.041$), and a shorter ED-LOS ($P=0.016$) were associated with a poor 90-day outcome. Early initiation of statin therapy ($P=0.049$), endovascular stroke therapy ($P=0.041$), NICU admission ($P=0.029$), and evening shift presentation ($P=0.035$) were associated with a good 90-day outcome.

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Author contributions

AM and NH were involved in study concept and design. AM and AP were involved in acquisition of the data. NH conducted the statistical analysis and drafted the manuscript. AM, EB, RPG, MM, and NH were involved in interpretation of the data. All authors revised the manuscript for important intellectual content. NH was involved in study supervision and coordination.

Disclosures

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Conclusions—In contrast to prior studies, a shorter ED-LOS was associated with a worse 90-day functional outcome, possibly reflecting prioritized admission of more severely affected patients who are at high risk for a poor functional outcome.

Keywords

ischemic stroke; emergency department; length of stay; functional outcome

Introduction

Emergency department (ED) overcrowding is a major public health problem worldwide because it has been shown to adversely affect patient outcomes across a variety of clinical conditions.^{1,2} Although the specific aspects of ED crowding on outcome remain to be clarified an important factor is an increased ED length of stay particularly among critically ill patients (ED-LOS).³

Stroke comprises one of the most frequent neurological emergencies in EDs,⁴ yet there is a surprising paucity of data regarding the association between the ED-LOS and outcome among stroke patients. Results have been conflicting: while some studies found an association between ED-LOS and outcome,^{5–7} others did not.^{8–10} These differences may in part relate to absent differentiation between ischemic and hemorrhagic stroke etiology, subsequent admission to a stroke ward versus intensive care unit, as well as differences between study settings including widely varying ED-LOS.^{6–9}

To better understand the impact of the ED-LOS on outcome after ischemic stroke we conducted a retrospective analysis of a cohort of ischemic stroke patients admitted to a single tertiary care academic stroke center. Our primary goal was to determine whether a longer ED-LOS predicts a poor 90-day functional outcome after adjusting for relevant confounders. Because delayed admission to dedicated stroke wards may reduce adherence to stroke guidelines in ED boarders and contribute to worse outcomes after stroke^{11–13} we also determined adherence to Get With The Guidelines (GWTG) stroke treatment measures and their association with the outcome. In secondary analyses we sought to determine whether the association of the ED-LOS and outcome differed between patients admitted to the stroke ward vs. neuroscience intensive care unit (NICU).

Methods

Study population

This study was reviewed and approved by our Institutional Review Board. We retrospectively analyzed consecutive patients with acute ischemic stroke as shown on brain MRI that were prospectively included in our local stroke registry between January 2013 and December 2013.

The ED-LOS was defined as the time (min) spent in the ED from time of patient registration in the ED to arrival on our in-hospital stroke ward or NICU. All patients were evaluated within 5 min from ED arrival by a member of the stroke service. Patient demographics, laboratory data, co-morbidities, pre-admission medications, and stroke etiology (using the

Trial of Org 10172 in Acute Stroke Treatment [TOAST] classification) after completion of diagnostic evaluation, were collected on all patients.¹⁴ NIHSS scores were assessed at the time of presentation by NIHSS certified members of the stroke team. The modified Rankin Scale (mRS) was assessed at 90 days by a stroke-trained physician or stroke study nurse certified in mRS via in-person or phone interview.^{15,16} We defined academic months as well as 4 academic quarters (3 months each) with the first academic month starting on July 1st and the first academic quarter ranging from July through September 2013 to determine whether the ED-LOS varied over the course of the academic year. To determine whether the time of patient presentation to the ED was associated with the ED-LOS or outcome we stratified the time to presentation into 7AM-3PM, 3PM-11PM, and 11PM to 7 AM shifts, which most closely represent both neurology and ED staff shifts.

We assessed adherence to the following GWTG achievement and quality measures: Early antithrombotics, antithrombotics at discharge, venous thromboembolism prophylaxis, anticoagulation for atrial fibrillation, smoking cessation advice, statin therapy, dysphagia screen, stroke education given, rehabilitation considered, and rtPA within 60 min of arrival by 2 h and 3.5 h, respectively.

We adhere to the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines (www.strobe-statement.org).

Outcomes

The primary outcome was a good functional outcome (mRS 0–2) measured at 90 days.

Statistical analysis

Unless otherwise stated, continuous variables are reported as mean±SD or median (interquartile range [IQR]). Categorical variables are reported as proportions. Normality of data was examined using Shapiro-Wilk test. Categorical variables were compared using the χ^2 -test or Fisher's Exact test. Mann-Whitney U test was performed for analysis of continuous variables. Spearman rank correlation was used to determine the strength of association between the ED-LOS and clinical variables.

To assess predictors of the ED-LOS we performed multivariable linear regression including baseline characteristics associated with the ED-LOS in univariable analyses (*P*-value for inclusion <0.2: small vessel disease, admission NIHSS, pre-admission mRS, NICU versus stroke ward admission, i.v. rtPA, endovascular stroke therapy, academic quarter, time of admission). Presence of hemorrhagic transformation, withdrawal of care, and 90-day mRS were not included in this model as these outcome measures were unknown at the time of ED presentation. To avoid model overfitting a backward elimination method (likelihood ratio) was used for linear multivariable modelling. The ED-LOS was log-transformed to achieve a more suitable distribution for linear regression.

Multivariable logistic regression analysis was performed to determine whether ED-LOS was independently associated with 90-day mRS (dependent variable). Analyses were adjusted for factors associated with the 90-day outcome in univariable analyses, NICU admission; presentation during the evening shift (3 PM to 11 PM), academic quarter of presentation,

thrombolysis with rtPA, endovascular stroke therapy, statin therapy, dysphagia screening, and their interaction terms with the ED-LOS. Variables remaining statistically significant after multivariable adjustment formed the final model.

Collinearity diagnostics were performed (and its presence rejected) for all multivariable regression models. The Hosmer-Lemeshow goodness-of-fit statistic was used to assess model fit. Two-sided significance tests were used throughout and unless stated otherwise a $P<0.05$ was considered statistically significant. All statistical analyses were performed using IBM® SPSS® Statistics Version 22 (IBM®-Armonk, NY).

Results

Study population

During the study period, a total of 442 patients with clinical diagnosis of ischemic stroke or TIA were admitted to our ED. To avoid potential confounding by misclassification of stroke mimics we excluded patients with imaging negative TIAs (i.e., absent ischemic infarct signs on head CT or brain MRI; $n=50$). We excluded all patients that were transferred from another hospital, discharged home from the ED, and who were lost to follow-up by day 90-day ($n=67$); leaving 325 patients for analysis. Table 1 summarizes baseline characteristics as stratified by the 90-day mRS.

Factors associated with the ED-LOS

Supplemental Table I summarizes the baseline characteristics of included patients in relationship to the ED-LOS in the entire cohort. The median (25th–75th percentile) time to admission was 349 min (198–576 min) in the entire cohort, 491 min (326–800 min) for stroke ward ($n=160$), and 221 min (136–393 min) for NICU ($n=165$) admitted patients.

Strongest associations with a shorter ED-LOS were noted for factors that relate to worse stroke severity and need for NICU admission. After adjustment, the relationship of NICU admission and emergent stroke treatment remained independently associated with the ED-LOS ($P<0.001$; Supplemental Table I); indicating prioritized transfer from the ED to specialized inpatient units is for the most severely affected patients.

To better understand factors that contribute to a greater ED-LOS depending on the admission to the stroke ward versus NICU unit we created multivariable linear regression models each. Among patients admitted to the stroke ward, treatment with rtPA ($P=0.038$), presentation during evening shift ($P<0.001$) and presentation earlier in the academic year ($P=0.006$) were independently associated with a longer ED-LOS (Supplemental Table II). For NICU admitted patients treatment with rtPA ($P=0.010$) and endovascular stroke therapy ($P=0.002$) were associated with a shorter ED-LOS (Supplemental Table III).

Association of adherence to GWTG measures with the 90-day outcome

Supplemental Table IV summarizes the adherence to GWTG measures. In unadjusted analyses patients that did not undergo dysphagia screening had a worse 90-day mRS than screened patients (rho -0.159 , $P=0.004$). When stratified by admission status, NICU admitted patients without dysphagia screen more frequently had a worse outcome (rho

–0.278, $P<0.001$). There was no association between dysphagia screen non-adherence and outcome among stroke ward admitted patients (ρ 0.047, $P=0.557$). Patients surviving to discharge significantly more frequent underwent dysphagia screening than those whose goals of care were shifted to comfort measures or had died by discharge (93% vs. 70%; $P=0.003$). Not receiving statins was associated with a worse 90-day mRS among stroke ward patients (ρ –0.187, $P=0.018$) but not among NICU admitted patients (ρ –0.058, $P=0.297$). There was no difference between patients that survived to discharge versus did not survive / were on comfort measures ($P=0.645$). All other GWTG measures were not significantly associated with the 90-day outcome in the entire cohort and when stratified by admission status (**not shown**).

Factors associated with 90 day functional outcome

Patients with a poor 90-day outcome had a significantly shorter ED-LOS than patients with a good outcome ($P=0.006$). After adjustment a higher admission NIHSS ($P<0.001$), greater pre-admission mRS ($P=0.001$), hemorrhagic transformation ($P=0.041$), and a shorter ED-LOS ($P=0.035$) were independently associated with a poor 90 day outcome (Table 3). Statin administration ($P=0.049$), endovascular stroke therapy ($P=0.041$), NICU admission ($P=0.029$), and presentation during the evening shift ($P=0.016$) were associated with a good 90-day outcome.

To account for unmeasured confounders unique to the stroke ward versus NICU we repeated the multivariable analyses separately for each unit. Among stroke ward admitted patients a higher admission NIHSS ($P<0.001$) and greater pre-admission mRS ($P=0.008$) were associated with a poor 90-day outcome. Statin therapy was associated with a good outcome but this did not reach statistical significance ($P=0.059$; **not shown**).

Among NICU admitted patients a worse admission NIHSS ($P<0.001$), greater pre-admission mRS ($P=0.024$), hemorrhagic transformation ($P=0.042$), shorter ED-LOS ($P=0.027$), and evening shift by ED-LOS interaction ($P=0.028$) were associated with a poor 90-day outcome (**not shown**). Endovascular stroke therapy ($P=0.012$) and presentation during the evening shift ($P=0.004$) were associated with a good 90-day outcome (**not shown**).

Discussion

The main goal of our study was to determine whether a longer ED-LOS was associated with a poor 90-day functional outcome among ischemic stroke patients. We found that factors known to adversely affect outcome were associated with a poor 3-month mRS indicating the overall validity of our model. However, contrary to our original hypothesis we found that a *shorter* ED-LOS was independently associated with a poor functional outcome at 90 days.

This finding contrasts with other studies that either found no association of the ED-LOS with outcome or noted a worse outcome with longer ED boarding times.^{6–9} In our cohort the median time to stroke ward (5.8 hours) and NICU (3.7 hours) admission was relatively short as compared to other studies (range 4.5–20 hours)^{5–7,9–11} minimizing the overall impact of the ED-LOS on outcome. We hypothesize that our findings reflect triage decisions with prioritized admission of most severely affected patients with greater likelihood for a poor

outcome. For example, patients with small vessel disease related strokes and who generally have a mild stroke severity had the longest ED-LOS. The association between ED-LOS and outcome did not depend on NICU admission as indicated by absent interactions. Nevertheless, it is important to note that the ED-LOS $\times$ evening shift presentation interaction approached significance suggesting that triage in the evening may be suboptimal and contribute to a worse outcome.

Sensitivity analyses stratified by the admission status also indicated that a *shorter* ED-LOS predicted a poor outcome among NICU admitted patients. The ED-LOS $\times$ evening shift presentation interaction was significant indicating that suboptimal triage for critical sick patients in the evening relates to a worse outcome. Interestingly, in a prior study investigating the impact of NICU admission delay in patients presenting with cerebrovascular emergencies ED-LOS and intracerebral hemorrhage, but not ischemic stroke, were independently associated with the outcome.⁶ These differences may in part relate to therapeutic options as well as the natural history of ICH versus ischemic stroke. For example, only after ischemic stroke, but not ICH, spontaneous and treatment associated reversal of catastrophic acute neurological deficits is frequently achieved.^{17,18} Hence, among ICH patients outcome more uniformly relates to the initial deficit severity. This may better allow to determine factors that correlate both with a worse outcome and delayed admission such as blood pressure control.^{13,19}

A key goal of our study was to determine whether the ED-LOS was associated with adherence to stroke guidelines and whether guideline non-adherence related to worse outcomes. The two most frequently non-adhered GWTG measures were dysphagia screening and statin therapy. Non-adherence to early statin therapy was associated with a poor 3-month consistent with prior data.²⁰ Importantly, adherence to statin therapy was not associated with the survival status at hospital discharge indicating that statin treatment was not withheld due to perceived poor patient prognosis. Thus, our observation highlights a possible opportunity to improve stroke outcome in stroke patients though enhancing stroke guideline implementation among patients boarding in the ED.

Strength of our study relate to inclusion of consecutive patients, the collection of extensive clinical information, detailed analyses of the ED-LOS with outcome measures with the rigorous adjustment for important factors associated with post-stroke functional outcome, and inclusion of additional analyses stratified by the admission status. Limitations relate to the fact the original data collection was done before trial data demonstrated efficacy of endovascular stroke therapy.¹⁸ However, we have been routinely employing this therapy since 2012 and thus our results are expected to apply to contemporary stroke care. Given our single-center study design, triage decisions and other unmeasured factors may not apply to other centers. Lastly, because of the retrospective and observational nature, as well as the modest sample size; observations should only be considered hypothesis generating pending confirmation by future prospective studies.

Conclusion

In contrast to prior studies, we found an inverse association between the ED-LOS and 90-day functional outcome after ischemic stroke, which may suggest the treatment options and clinical resources of an academic stroke center, including prioritized admission of severely affected patients counterpoise potential adverse contributions of prolonged ED-LOS. Interaction term analyses suggested that in critically ill patients evening presentation may have related to worse outcome through a longer ED-LOS. Future studies seeking to determine the association between ED-LOS and outcome should include acute triage and patient-flow metrics.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Fatovich DM. Emergency medicine. *BMJ*. 2002; 324:958–962. [PubMed: 11964343]
2. Chalfin DB, Trzeciak S, Likourezos A, et al. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. *Crit Care Med*. 2007; 35:1477–1483. [PubMed: 17440421]
3. Cowan RM, Trzeciak S. Clinical review: Emergency department overcrowding and the potential impact on the critically ill. *Crit Care*. 2005; 9:291–295. [PubMed: 15987383]
4. Rizos T, Juttler E, Sykora M, et al. Common disorders in the neurological emergency room--experience at a tertiary care hospital. *Eur J Neurol*. 2011; 18:430–435. [PubMed: 20642795]
5. Jones EM, Boehme AK, Aysenne A, et al. Prolonged Emergency Department Length of Stay as a Predictor of Adverse Outcomes in Patients with Intracranial Hemorrhage. *J Crit Care Med*. 2015; 2015
6. Rincon F, Mayer SA, Rivolta J, et al. Impact of delayed transfer of critically ill stroke patients from the Emergency Department to the Neuro-ICU. *Neurocrit Care*. 2010; 13:75–81. [PubMed: 20428969]
7. Akhtar N, Kamran S, Singh R, et al. Prolonged Stay of Stroke Patients in the Emergency Department May Lead to an Increased Risk of Complications, Poor Recovery, and Increased Mortality. *J Stroke Cerebrovasc Dis*. 2016; 25:672–678. [PubMed: 26748863]
8. Jain M, Damania D, Jain AR, et al. Does prolonged length of stay in the emergency department affect outcome for stroke patients? *West J Emerg Med*. 2014; 15:267–275. [PubMed: 24868303]
9. Al-Khathaami AM, Abulaban AA, Mohamed GE, et al. The impact of 'admit no bed' and long boarding times in the emergency department on stroke outcome. *Saudi Med J*. 2014; 35:993–998. [PubMed: 25228182]
10. Elmer J, Pallin DJ, Liu S, et al. Prolonged emergency department length of stay is not associated with worse outcomes in patients with intracerebral hemorrhage. *Neurocrit Care*. 2012; 17:334–342. [PubMed: 21912953]
11. Jauch EC, Saver JL, Adams HP Jr, et al. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2013; 44:870–947. [PubMed: 23370205]

12. Song S, Fonarow GC, Olson DM, et al. Association of Get With The Guidelines-Stroke Program Participation and Clinical Outcomes for Medicare Beneficiaries With Ischemic Stroke. *Stroke*. 2016; 47:1294–1302. [PubMed: 27079809]
13. Grise EM, Adeoye O, Lindsell C, et al. Emergency department adherence to American Heart Association guidelines for blood pressure management in acute ischemic stroke. *Stroke*. 2012; 43:557–559. [PubMed: 22033993]
14. Adams HP Jr, Bendixen BH, Kappelle LJ, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. *Stroke*. 1993; 24:35–41. [PubMed: 7678184]
15. Zaidi SF, Aghaebrahim A, Urra X, et al. Final infarct volume is a stronger predictor of outcome than recanalization in patients with proximal middle cerebral artery occlusion treated with endovascular therapy. *Stroke*. 2012; 43:3238–3244. [PubMed: 23160876]
16. Stollberger C, Schneider B, Abzieher F, et al. Diagnosis of patent foramen ovale by transesophageal contrast echocardiography. *Am J Cardiol*. 1993; 71:604–606. [PubMed: 8438751]
17. Minematsu K, Yamaguchi T, Omae T. 'Spectacular shrinking deficit': rapid recovery from a major hemispheric syndrome by migration of an embolus. *Neurology*. 1992; 42:157–162. [PubMed: 1734297]
18. Campbell BC, Donnan GA, Lees KR, et al. Endovascular stent thrombectomy: the new standard of care for large vessel ischaemic stroke. *Lancet Neurol*. 2015; 14:846–854. [PubMed: 26119323]
19. Hemphill JC 3rd, Greenberg SM, Anderson CS, et al. Guidelines for the Management of Spontaneous Intracerebral Hemorrhage: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*. 2015; 46:2032–2060. [PubMed: 26022637]
20. Cumbler E, Wald H, Bhatt DL, et al. Quality of care and outcomes for in-hospital ischemic stroke: findings from the National Get With The Guidelines-Stroke. *Stroke*. 2014; 45:231–238. [PubMed: 24253540]

Table 1

Baseline characteristics (unadjusted) of the studied patient population as stratified by 90-day outcome

	All patients	Good outcome	Poor outcome	P-value
Characteristics	(n=325)	(n=212)	(n=113)	
Female sex	134 (41%)	75 (35%)	59 (52%)	0.004
Age, years	70 (23)	67 (18)	80 (25)	<0.001
ICU Admission	165 (51%)	100 (47%)	65 (58%)	0.081
Admission NIHSS	5 (9)	3 (6)	11 (17)	<0.001
Pre-admission mRS	0 (1)	0 (1)	1 (2)	<0.001
ED-LOS, min	354 (371)	375 (330)	267 (382)	0.006
Preexisting risk factors				
Hypertension	261 (80%)	161 (76)	100 (89)	0.008
Dyslipidemia	196 (60%)	127 (60%)	69 (61%)	0.905
Diabetes mellitus	100 (31%)	59 (28%)	41 (36%)	0.130
Stroke/transient ischemic attack	67 (21%)	39 (18%)	28 (25%)	0.196
Atrial fibrillation	81 (25%)	40 (19%)	41 (36%)	0.001
Coronary artery disease	94 (29%)	53 (25%)	41 (36%)	0.040
Congestive heart failure	45 (14%)	21 (10%)	24 (21%)	0.007
Peripheral artery disease	25 (8%)	15 (7%)	10 (9%)	0.663
Smoking	68 (21%)	47 (22%)	21 (19%)	0.478
Alcohol abuse	42 (13%)	29 (14%)	13 (12%)	0.729
Preadmission medications				
Statin	164 (51%)	105 (50%)	59 (52%)	0.727
Antihypertensives	230 (71%)	142 (67%)	88 (78%)	0.041
Antiglycemic	69 (21%)	40 (19%)	29 (26%)	0.158
Antiplatelet	170 (52%)	100 (47%)	70 (62%)	0.014
Oral anticoagulant	38 (12%)	21 (10%)	16 (15%)	0.204
Final TOAST stroke mechanism				
Large artery atherosclerosis	88 (27%)	56 (26%)	32 (28%)	0.793
Small vessel disease	61 (19%)	47 (22%)	14 (12%)	0.037
Cardioembolic	94 (29%)	50 (24%)	44 (39%)	0.005
Other determined	21 (7%)	15 (7%)	6 (5%)	0.640
Undetermined	61 (19%)	44 (21%)	17 (15%)	0.235
Academic quarter of admission				0.212
July–Sept	95 (29%)	70 (33%)	25 (22%)	
Oct–Dec	89 (27%)	56 (26%)	33 (29%)	
Jan–Mar	57 (18%)	34 (16%)	23 (20%)	
Apr–Jun	84 (26%)	52 (25%)	32 (28%)	
Time of Admission				0.142
7AM–3PM	152 (47%)	93 (44%)	59 (52%)	

	All patients	Good outcome	Poor outcome	P-value
Characteristics	(n=325)	(n=212)	(n=113)	
3PM–11PM	133 (41%)	95 (45)	38 (34%)	
11PM–7AM	40 (12%)	24 (11%)	16 (14%)	
Acute interventions				
i.v. rtPA therapy [†]	67 (21%)	43 (20%)	24 (21%)	0.886
Time to rtPA, min	87 (92)	90 (90)	80 (83)	0.410
Endovascular stroke therapy [‡]	30 (9%)	17 (8%)	13 (12%)	0.319
Hemorrhagic conversion	33 (11%)	16 (8%)	17 (16%)	0.017

Data are n (%), mean ($\pm$ standard deviation), or median (interquartile range). Data are complete except as indicated (n). LDLc=low density lipoprotein cholesterol (within 24 hours of admission); mRS=modified Rankin scale score; NIHSS=National Institutes of Health Stroke Scale; rtPA=recombinant tissue plasminogen activator.

[†]Without concomitant endovascular stroke therapy.

[‡]With or without concomitant i.v. rtPA.

Table 2

Multivariable linear regression analysis of factors independently associated with the final (log-transformed) time spent in the emergency department (all patients)

Independent variable	Coefficient (95% CI)	P-value
NICU admission	−0.623 (−0.795 to −0.450)	<0.001
Endovascular stroke therapy	−0.438 (−0.696 to −0.180)	0.001
Thrombolysis with rtPA	−0.229 (−0.424 to −0.035)	0.021
Admission between 3 PM and 11 PM	0.148 (0.001 to 0.295)	0.048
Academic quarter [‡]	−0.058 (−0.120 to 0.005)	0.070

[‡]Repeating the analysis using the definition of academic month did not meaningfully change the results: neuroscience intensive care unit (NICU) admission ($P<0.001$), thrombolysis with recombinant tissue plasminogen activator (rtPA; $P=0.019$), and endovascular stroke therapy ($P=0.001$) were significantly associated with a shorter ED-LOS whereas admission between 3 PM and 11 PM ($P=0.049$) was associated with a longer ED-LOS (not shown).

Table 3

Multivariable logistic regression analysis for factors independently associated with a poor 90-day outcome.

Independent variable	Crude OR (95% CI)	P-value	Adjusted OR (95%-CI)	P-value
ED-LOS (per hour)	0.962 (0.924–1.001)	0.052	0.894 (0.806–0.992)	0.035
Evening shift presentation (ESP)	0.624 (0.388–1.003)	0.057	0.284 (0.103–0.787)	0.016
ED-LOS × ESP	0.979 (0.944–1.016)	0.272	1.116 (0.997–1.251)	0.057
Admission NIHSS (per point)	1.152 (1.106–1.200)	<0.001	1.196 (1.133–1.262)	<0.001
Pre-admission mRS (per step)	1.521 (1.190–1.943)	0.001	1.561 (1.206–2.022)	0.001
NICU admission	1.517 (0.957–2.403)	0.076	0.438 (0.209–0.917)	0.029
Hemorrhagic conversion	2.321 (1.134–4.752)	0.021	2.514 (1.036–6.098)	0.041
Endovascular stroke therapy	1.491 (0.696–3.193)	0.304	0.308 (0.099–0.953)	0.041
Statin therapy	0.522 (0.148–1.842)	0.312	0.252 (0.064–0.994)	0.049

Hosmer-Lemeshow goodness of fit χ^2 10.632, $P=0.223$. mRS indicates modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.