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What Change in the National Institutes of Health Stroke Scale Should Define Neurologic Deterioration in Acute Ischemic Stroke?

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Abstract

Background—Neurologic deterioration (ND) occurs in one-third of patients with stroke. However, the true incidence of ND and risk for adverse outcomes remains unknown because no standardized definition of ND exists. Our study compared the prognostic value of a range of definitions for ND in patients with acute ischemic stroke (AIS).

Methods—All patients who presented to our center with AIS within 48 hours of symptom onset between July 2008 and June 2010 were retrospectively identified. Patient demographics, National Institutes of Health Stroke Scale (NIHSS) scores, etiologies of ND, and outcome measures were compared between patients according to a range of ND definitions using receiver operating characteristic analyses.

Results—Three hundred forty-seven patients were included. The 2 definitions of ND with the highest sensitivity and specificity for several outcome measures were tested against each other: an increase in the NIHSS score by 2 or 4 points in a 24-hour period. More than one third (36.9%) of patients experienced 2-point ND versus 17.3% with 4-point ND. Patients who experienced ND by either definition had prolonged hospitalization ($P < .001$), poorer functional outcome (discharge modified Rankin Scale score >2 $> P < .001$), and higher discharge NIHSS score ($P < .001$) compared to patients without ND. Compared to patients without ND, a 2-point ND was associated with a 3-fold risk of death (odds ratio 3.120; 95% confidence interval 1.231–7.905; $P < .0165$) after adjusting for admission NIHSS score, serum glucose, and age.

Conclusions—A 2-point ND is a sensitive indicator of poor outcome and in-hospital mortality. An accepted definition of ND is needed to systematically study and compare results across trials for ND in patients with stroke.

Keywords

Acute stroke; definition; deterioration; National Institutes of Health Stroke Scale; prognosis

The National Institutes of Health Stroke Scale (NIHSS) is a clinical tool that has proven to be a reliable indicator of infarct size,¹ neurologic status,² and functional outcome at 3 months³ in patients who suffer from acute stroke. When compared to other stroke assessment tools, the NIHSS score is the strongest predictor of functional outcome at 3 months poststroke.⁴ It is a reliable tool that physicians and even nonphysicians can use to assess the clinical status of patients with stroke.⁵ Because the NIHSS examination takes fewer than 8 minutes to administer, has good interrater reliability with proper training,^{6–9} and is a valid prognostic indicator, its clinical application has expanded to quantify deteriorating neurologic status.²

Neurologic deterioration (ND), an event that occurs in about one-third of patients with acute ischemic stroke (AIS) and contributes to morbidity and mortality,^{10,11} has no standardized definition.¹² Currently, clinical studies use inconsistent definitions of ND with differing stroke scales in order to quantify clinical worsening over days,^{13–16} weeks,¹⁷ or months¹⁸ (Table 1). Some definitions of ND might be too narrow^{19,20} and may exclude patients whose neurologic function may be recoverable, while other definitions may be too broad^{14,21} and could prompt the unnecessary work-up of false-positive episodes of ND. While each of these definitions may relate to clinically significant outcome measures, hardly any are reused in other studies. The disparities between each of these definitions might not only explain the differences in patient outcomes observed by the investigators but they may also prohibit clinicians from evaluating and treating potentially reversible etiologies of ND during this acute period. The use of a definition of ND with poor prognostic validity could delay time-sensitive work-ups of truly deteriorating patients. The most relevant definition of ND would be one that is sensitive for modifiable adverse clinical outcome measures. In our study, we sought to determine the threshold for NIHSS increase across a range of values that would be most associated with adverse clinical outcomes in a population of patients with AIS. This threshold, once validated in other populations, could then be used in future investigations as a standardized definition of ND that is valuable in predicting potentially modifiable adverse events in patients hospitalized for AIS.

Methods

Definitions of ND

We conducted a single-center retrospective analysis of all consecutive patients who presented with acute ischemic stroke between July 2008 and June 2010. Patients were excluded if they presented >48 hours after last seen normal (LSN) or had an unknown time of LSN, because studies have shown that a significant number of patients with acute stroke will clinically worsen during the first several days of the cerebrovascular event, and that this period is the target for neuroprotection.^{13,22,23} Patients with an in-hospital stroke were also excluded because their primary illness, which necessitated hospital admission, as well as hospital exposures may have impacted their risk of ND. Ranges of definitions of ND were

compared based on sensitivity and specificity for 3 major outcome measures: poor functional outcome at the time of discharge (discharge modified Rankin Scale [mRS] >2), unfavorable discharge disposition (meaning discharge to a long-term acute care facility, skilled nursing facility, hospice, or death compared to home or an inpatient rehabilitation center), and in-hospital mortality. Among the definitions used, we assessed sensitivities and specificities of the 3 major outcome measures for an increase in 2, 3, 4, 5, and 6 points on the NIHSS within a 24-hour period during hospitalization. We did not consider an increase in 1 point among our definitions because such a mild change in NIHSS might be the result of fluctuating levels of patient alertness or subtle disparities between scorers of the NIHSS, even among properly trained hospital personnel as one study has shown.²⁴ A 24-hour timeframe for a change in NIHSS was chosen over a wider timeframe so that deterioration in neurologic function could be recognized quickly and evaluated before such deterioration became irreversible.

After exploring a range of possible definitions for ND, we selected the 2 definitions with the highest sensitivity for poor outcomes and compared them against no ND in Tables 2 and 3: 1) an increase in NIHSS score by 2 points within a 24-hour period (2-point ND) and 2) an increase in NIHSS 4 points in a 24-hour period (4-point ND). Patient demographics, admission and daily NIHSS scores, etiologies of ND, in-hospital complications (including in-hospital infection), and outcome measures were recorded. In-hospital infection was defined as symptoms of an infection in addition to any of the following: positive blood culture (excluding contaminants), positive urine culture (excluding contaminants), or chest radiograph confirmation of an infectious process. Stroke etiologies were stratified according to those previously described in the Trial of Org 10172 (TOAST).²⁵ All etiologies of ND were considered reversible except new stroke, progressive stroke, intracerebral hemorrhage, and cardiopulmonary arrest. Progressive stroke was defined as extension of ischemic findings within the distribution of the initial vessel occlusion. Outcome measures in addition to the 3 major outcome measures described above included return to pre-ND NIHSS score (return to baseline), length of stay (LOS), and NIHSS at discharge. This study was approved by our center's institutional review board.

NIHSS and mRS reporting

NIHSS examinations were performed during initial evaluation and every morning at our center by a neurology attending and/or house officer, all of whom were certified in the NIHSS examination. A neurology attending who was certified in the mRS^{26,27} documented the mRS score for each patient at the time of discharge.

Statistics

Categorical data were presented as frequencies and compared using the Pearson Chi-square or Fisher exact test where appropriate. Continuous data were presented as mean $\pm$ standard deviation or median (with interquartile range) and compared using the independent samples Student *t* or Wilcoxon rank sum tests where appropriate. Receiver operating characteristic (ROC) curve analyses were performed for ND classified as a continuous variable based on changes in NIHSS as indicators of the 3 major outcome measures: unfavorable discharge disposition, poor functional outcome at discharge, and in-hospital mortality. Sensitivity and

specificity analyses were also performed for these definitions of ND as indicators of these outcome measures. Crude logistic regression models were used to assess the odds of in-hospital mortality, unfavorable discharge disposition, and poor functional outcome at discharge for a 2-point change and a 4-point change in NIHSS. Adjusted logistic regression models were then used to investigate the odds of in-hospital mortality, discharge disposition, and discharge mRS >2 for a 2-point change and a 4-point change after adjusting for age, admission glucose, and admission NIHSS. All tests were performed at the $\alpha = 0.05$ level and were 2-sided.

Results

Demographics

Of the 438 patients screened at our center, 347 met the inclusion criteria. The mean age was 64.6 years old, with 44.4% of the patients being female and 64.6% black. ND occurred in 128 patients using the 2-point definition (36.9% of included patients) versus 60 patients using the 4-point definition (17.3% of included patients). Baseline demographic information, pertinent medical history, and percentage of patients treated with either intravenous tissue plasminogen activator or intra-arterial therapy were compared between the patients who worsened according to the 2 definitions (Tables 2 and 3). Compared to patients who did not deteriorate by at least 2 points on the NIHSS in a 24-hour period, patients who suffered a 2-point deterioration were significantly older (median age 69.0 v 62.1 years; $P < .001$), had a worse baseline NIHSS (median NIHSS 12 v 5; $P < .001$), and a higher rate of in-hospital infection (15.0% v 5.9%; $P = .005$). There were no statistically significant differences in gender (40.9% female v 46.4% female; $P = .328$) or admission glucose levels (median serum glucose 128 mg/dL v 118 mg/dL; $P = .092$) between these 2 populations.

Stroke Etiologies and Etiologies of ND

Of the 128 patients who deteriorated by 2 or more points, 65 (69.1%) had a discovered etiology of ND upon further workup. A higher percentage of patients with 4-point deterioration were found to have had an irreversible etiology of deterioration compared patients who deteriorated by 2 points (46.7% vs. 35.9%). There were no appreciable differences in deterioration due to new stroke or to progressive stroke among those who deteriorated by 4 points compared to patients with 2-point deterioration (8.3% vs. 5.5% and 36.7% vs. 29.7%, respectively).

Impact on Outcome

ROC curve analyses of our population revealed that an increasing change in NIHSS score during a 24-hour period of hospitalization was associated with worse outcome as defined by 3 major outcome measures (poor functional outcome at discharge, unfavorable discharge disposition, and in-hospital death; Fig 1). When comparing the sensitivities and specificities of a range of ND definitions across the 3 major outcome events, the 2-point threshold had the highest sensitivity for poor outcomes and the 6-point definition was the most specific for poor outcomes (data not shown). Because a change in NIHSS score of 6 points was the least sensitive predictor of poor outcomes among all definitions used, we decided to

compare the 2-point threshold for ND against the 4-point threshold, which was associated with a slightly lower sensitivity but a higher specificity for poor outcomes than the 2-point threshold. The 2-point threshold had a 52.8% sensitivity and 72.7% specificity for unfavorable discharge disposition versus the 4-point threshold which had a 44.6% sensitivity and 93.1% specificity for this outcome measure. The 2-point threshold was 33.2% sensitive and 88.0% specific for poor functional outcome at discharge compared to the 4-point threshold which was 39.5% sensitive and 89.8% specific for poor functional outcome. Lastly, the 2-point threshold was 96.4% sensitive and 68.3% specific for in-hospital mortality whereas the 4-point threshold was 92.3% sensitive and 89.7% specific for this outcome.

The 2- and 4-point definitions were both associated with an increased odds of being discharged with a mRS score of >2 (poor functional outcome), having an unfavorable discharge disposition, and in-hospital mortality when compared to patients who did not deteriorate according to these thresholds. The increased odds of these poor outcomes persisted even after adjusting for 3 baseline predictors of poor outcome: admission NIHSS, serum glucose level on admission, and age. After adjusting for these covariates, a 2-point increase in NIHSS in a 24-hour period was associated with a fourfold increase in odds of poor functional outcome (odds ratio [OR] 4.112; 95% confidence interval [CI] 1.873–9.026; $P = .0004$), nearly threefold increase in odds of unfavorable discharge disposition (OR 2.458; 95% CI 1.407–4.294; $P = .0016$), and a threefold increase in odds of in-hospital death (OR 3.120; 95% CI 1.231–7.905; $P = .0165$). After adjustment, a 4-point ND was also associated with a similar odds of unfavorable discharge disposition (OR 3.763; 95% CI 1.993–7.106; $P = .0001$) and in-hospital mortality (OR 3.048; 95% CI 1.150–8.077; $P = .025$), but only trended toward an odds of poor functional outcome (OR 3.716; 95% CI 0.903–15.287; $P = .0689$).

Compared to patients who did not deteriorate by at least 2 points, 2-point ND was associated with significantly longer LOS, higher mRS score at discharge, higher proportion of patients with an unfavorable discharge disposition, and higher in-hospital mortality (Table 4). Similar differences were observed when comparing patients with 4-point ND against those who did not deteriorate by at least 4 points during their hospitalization (Table 5). When compared to the 2-point ND group, patients with 4-point deterioration had an even higher frequency of an unfavorable discharge disposition (54.2% vs. 37.8%) and a higher in-hospital mortality rate (43.3% vs. 21.1%).

Discussion

Among all thresholds for a change in NIHSS, a 2-point change is a highly sensitive predictor of poor functional outcome, unfavorable discharge position, and in-hospital death, while a 4-point threshold for ND was found to be less sensitive although highly specific for these outcome measures (except for in-hospital mortality, for which the 4-point threshold was both highly sensitive and specific). More than one-third of the patients in our study experienced ND according to the 2-point definition, a finding that is consistent with earlier studies.^{10,11} We then turned our attention to the differences in patient demographic information, medical history, and outcome measures according to both these definitions in

order to identify risk factors for ND and associated complications. Risk factors that positively correlated with a 2-point increase in NIHSS score (and therefore worse outcome) included advanced age, presenting stroke severity, and in-hospital infection. These risk factors were also seen in patients who deteriorated by at least 4 points on the NIHSS (data not shown). When comparing patients who deteriorated by 2 points to those who did not, patients with 2-point ND had significantly prolonged LOS, higher mRS score at discharge, and were more likely to expire in the hospital or be discharged to a facility other than home or an inpatient rehabilitation center.

More than half of patients who experienced a 2- or 4-point ND were discovered upon work-up to have had a reversible etiology of ND. Because many etiologies of ND are reversible processes, an increase in the NIHSS score by as little as 2 points over a 24-hour period is clinically meaningful and warrants clinical investigation and intervention which might minimize disabling sequelae. The added health care costs associated with prolonged hospitalization, dependency, and discharge to custodial care should make ND an important target for intervention. In addition, the mortality associated with a 2- and 4-point ND is alarming. Once a consensus on definition for ND is established, more systematic research can be performed to determine predictors for and target preventable causes of ND. We suggest this threshold be validated in prospective studies conducted in varied populations and with outcomes assessed 3 months after stroke. The question remains as to how quickly an etiology of ND can be determined in patients with signs of clinical deterioration, and if is this sufficient time to treat potentially reversible causes in order to obviate secondary neurologic sequelae. The use of a consistent definition of ND would permit pooling of data regarding predictors of ND such that appropriate attention can be given to patients at risk for this physically disabling and costly process.

Our study has several limitations. First, it involved a small sample size of patients within a particular demographic distribution, which makes our results difficult to generalize. Our institution treats a predominantly black population in an urban center. Second, we quantified thresholds of ND as the change in the sum NIHSS score without taking into account changes in the scores of each item on the examination. For instance, a new onset hemiplegia in a patient with improving dysarthria and facial motor function might experience no change in the sum NIHSS score, yet this dramatic change should call for an emergent work-up of ND. Also, as a retrospective study, we can only describe associations between ND and outcomes. We cannot show that the clinical investigations or interventions after recognition of ND could have impacted patient outcome. While more than one-half of patients who experienced ND were found to have reversible etiologies of deterioration, we are unable to determine if identification of the underlying cause of ND is more frequently associated with improved outcome compared to not having discovered an etiology of deterioration. In addition, outcome measures (e.g., discharge mRS score) may have been confounded by the management plan for patients who were thought to have experienced some degree of ND. Because the clinical staff responsible for the medical decision-making of these patients were also responsible for quantification of discharge scores, the outcome measures might have been influenced by a pre-existing scorer bias.

Despite these limitations, the results of our study suggest that a 2-point change in the NIHSS score in a 24-hour period is a significant clinical indicator of neurologic worsening, poor prognosis at discharge, and even in-hospital death. Because the NIHSS examination can be administered quickly and reliably by properly trained personnel, it is not impractical to encourage hospital staff to use this tool on a daily basis while evaluating patients who suffer from stroke. The definition of ND based on a quantitative change in the NIHSS score can provide an absolute threshold for clinical evaluation of an underlying etiology of ND, and would therefore eliminate variability in clinical judgment. With a definition that evaluates deterioration over a short period (24 hours for instance), early changes in clinical management could minimize the risk of poor outcome. Prospective trials are needed to evaluate which definition of ND is the most cost-effective indicator for clinical work-up of patients with ischemic stroke in order to minimize the risk for permanent decline in neurologic status.

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Figure 1. Receiver operating characteristic (ROC) curve analysis for change in National Institutes of Health Stroke Scale score with (A) poor functional outcome at discharge (modified Rankin Scale score of >2), (B) unfavorable discharge disposition (meaning discharge to a long-term acute care facility, skilled nursing facility, hospice, or death compared to home or an inpatient rehabilitation center), and (C) in-hospital mortality.

Table 1

Examples of ND definitions

ND Definitions Using the NIHSS		
DeGraba <i>et al</i> , 1999 ¹⁶	Increase in NIHSS	3 within 48-hours
Patel <i>et al</i> , 2001 ²⁰	Increase in NIHSS	4 within 24-hours of admission
Johnston <i>et al</i> , 2003 ¹⁸	Increase in NIHSS	1 from admission to day 90
Aslanyan <i>et al</i> , 2004 ²¹	Increase in NIHSS	1 after admission, documented new stroke, or stroke-related events categorized as “serious adverse events”
Audebert <i>et al</i> , 2004 ¹⁹	Increase in NIHSS	1 for motor function during hospitalization
Weimar <i>et al</i> , 2005 ¹⁴	Increase in NIHSS	1 within 48 to 72-hours
Kwan <i>et al</i> , 2006 ¹³	Increase in NIHSS	2 from admission to day 5
Roquer <i>et al</i> , 2008 ¹⁵	Increase in NIHSS	4 within 72-hours of admission
Toyoda <i>et al</i> , 2009 ¹⁷	Increase in NIHSS	2 from admission to 3 weeks

Abbreviations: ND, Neurological Deterioration; NIHSS, National Institutes of Health Stroke Scale.

Table 2

Demographic information regarding patients who did not deteriorate versus those who deteriorated by 2 points

24-hour NIHSS Increase, points	<2 (N=219)	2 (N=128)	P value
Gender, % Male	46.5 (102/219)	59.4 (76/128)	.2817
Age, Mean years (IQR)	62.1 (54–74)	69.0 (60–79)	<.0001
Race, % patients			.3911
Black	63.9 (140/219)	65.6 (84/128)	
White	30.6 (67/219)	32.0 (41/128)	
Other	5.5 (12/219)	2.3 (3/128)	
Past Medical History, % patients			
Stroke	37.5 (81/219)	37.4 (46/128)	.9852
Coronary Artery Disease	18.1 (39/219)	25.6 (32/128)	.0983
Hyperlipidemia	44.2 (96/219)	44.4 (56/128)	.9706
Hypertension	75.7 (165/219)	75.4 (95/128)	.9517
Diabetes	33.5 (73/219)	36.2 (46/128)	.6064
Atrial Fibrillation	8.3 (18/219)	12.7 (16/128)	.1883
Home Medications, % patients			
Anti-platelet Agent	37.9 (82/219)	48.8 (61/128)	.0507
Lipid-lowering Agent	39.9 (87/219)	40.9 (52/128)	.8498
Anti-hypertensive Agent	65.6 (149/219)	65.4 (83/128)	.9569
Admission NIHSS, Median score (IQR)	5 (3–10)	12 (5–18)	<.0001
Admission Serum Glucose, Mean mg/dL (IQR)	118.0 (97–154)	127.5 (101–165)	.1122
Treatment, % patients			
Received IV tPA	29.2 (64/219)	32.8 (42/128)	.4837
Received IAT	3.2 (7/219)	8.6 (11/128)	.0287

Abbreviations: NIHSS; National Institutes of Health Stroke Scale score; ND, neurological deterioration; IQR, interquartile range; LSN, last seen normal; ED, emergency department; IV tPA, intravenous tissue plasminogen activator; IAT, intra-arterial therapy.

Table 3

Demographic information regarding patients who did not deteriorate versus those who deteriorated by 4 points

24-hour NIHSS Increase, points	<4 (N=287)	4 (N=60)	P value
Gender, % Male	54.5 (156/287)	61.7 (37/60)	.2999
Age, Mean years (IQR)	63.8 (55–76)	68.8 (61–79)	.0161
Race, % patients			.1974
Black	66.2 (190/287)	56.7 (34/60)	
White	29.6 (85/287)	38.3 (23/60)	
Other	4.2 (12/287)	5.0 (3/60)	
Past Medical History, % patients			
Stroke	37.5 (106/287)	37.5 (21/60)	.9950
Coronary Artery Disease	19.1 (54/287)	29.3 (17/60)	.0805
Hyperlipidemia	44.4 (126/287)	44.1 (26/60)	.9665
Hypertension	75.1 (214/287)	77.9 (46/60)	.6395
Diabetes	33.7 (96/287)	38.3 (23/60)	.4911
Atrial Fibrillation	8.5 (24/287)	16.9 (10/60)	.0468
Home Medications, % patients			
Anti-platelet Agent	39.9 (113/287)	50.0 (30/60)	.0972
Lipid-lowering Agent	40.4 (115/287)	40.0 (24/60)	.9598
Anti-hypertensive Agent	67.1 (198/287)	57.6 (34/60)	.1614
Admission NIHSS, Median score (IQR)	5 (3–11)	14 (9–20)	<.0001
Admission Serum Glucose, Mean mg/dL (IQR)	148.2 (98–164)	147.9 (101–164)	.4840
Treatment, % patients			
Received IV tPA	27.5 (79/287)	45.0 (27/60)	.0075
Received IAT	3.8 (11/287)	11.7 (7/60)	.0128

Abbreviations: NIHSS; National Institutes of Health Stroke Scale score; ND, neurological deterioration; IQR, interquartile range; Hx, documented history; CAD, coronary artery disease; LSN, last seen normal; ED, emergency department; IV tPA, intravenous tissue plasminogen activator; IAT, intra-arterial therapy.

Table 4

Stroke etiologies and outcome measures for patients who did not deteriorate versus those who deteriorated by 2 points

24-hour NIHSS Increase, points	<2 (N=219)	2 (N=128)	P value
TOAST, % patients			.2370
Cardioembolic	24.9 (43/173)	29.5 (28/95)	
Large Vessel Occlusion	22.5 (39/173)	29.5 (28/95)	
Small Vessel Occlusion	22.5 (39/173)	18.9 (18/95)	
Cryptogenic, >1 Cause	4.1 (7/173)	2.1 (2/95)	
Cryptogenic, Unknown Cause	22.5 (39/173)	12.6 (12/95)	
Other	3.5 (6/173)	7.4 (7/95)	
Outcome Measures			
Return to baseline, % patients	0.0 (0/219)	35.9 (46/128)	<.0001
Infection, % patients	5.9 (13/219)	14.8 (19/128)	.0104
LOS, Median days (IQR)	4 (3–7)	10 (6–20)	<.0001
NIHSS at discharge, Median score (IQR)	2 (0–4)	10 (4–22)	<.0001
Hemorrhagic infarction, % patients			
PH1	0.5 (1/219)	7.0 (9/128)	.0004
PH2	0.9 (2/219)	6.3 (8/128)	.0041
mRS at discharge, Median score (IQR)	2 (1–3)	4 (3–5)	<.0001
Unfavorable discharge disposition, % patients	15.1 (33/219)	37.8 (48/127)	<.0001
In-hospital mortality, % patients	0.5 (1/219)	21.1 (27/128)	<.0001

Abbreviations: ND, neurological deterioration; NIHSS, National Institutes of Stroke Scale score; TOAST, Trial of Org 10172 in Acute Stroke Treatment; LOS, length of stay; IQR, interquartile range; mRS, modified Rankin Scale score; PH1, parenchymal hematoma grade 1 hemorrhagic transformation; PH2, parenchymal hematoma grade 2 transformation.

Table 5

Stroke etiologies and outcome measures for patients who did not deteriorate versus those who deteriorated by 4 points

24-hour NIHSS Increase, points	<4 (N=287)	4 (N=60)	P value
TOAST, % patients			.0024
Cardioembolic	26.4 (61/231)	27.0 (10/37)	
Large Vessel Occlusion	24.7 (57/231)	27.0 (10/37)	
Small Vessel Occlusion	23.8 (55/231)	5.4 (2/37)	
Cryptogenic, >1 Cause	3.0 (7/231)	5.4 (2/37)	
Cryptogenic, Unknown Cause	19.1 (44/231)	18.9 (7/37)	
Other	3.0 (7/231)	16.2 (6/37)	
Outcome Measures			
Return to baseline, % patients	8.4 (24/287)	36.7 (22/60)	<.0001
Infection, % patients	7.7 (22/287)	16.7 (10/60)	.0701
LOS, Median days (IQR)	5 (3–8)	10 (4–21)	<.0001
NIHSS at discharge, Median score (IQR)	2 (1–6)	20 (7–42)	<.0001
Hemorrhagic infarction, % patients			
PH1	1.4 (4/287)	10.0 (6/60)	.0003
PH2	0.7 (2/287)	13.3 (8/60)	<.0001
mRS at discharge, Median score (IQR)	3 (1–4)	5 (4–6)	<.0001
Unfavorable discharge disposition, % patients	17.1 (49/287)	54.2 (32/59)	<.0001
In-hospital mortality, % patients	0.7 (2/287)	43.3 (26/60)	<.0001

Abbreviations: ND, neurological deterioration; NIHSS, National Institutes of Stroke Scale score; TOAST, Trial of Org 10172 in Acute Stroke Treatment; LOS, length of stay; IQR, interquartile range; mRS, modified Rankin Scale score; PH1, parenchymal hematoma grade 1 hemorrhagic transformation; PH2, parenchymal hematoma grade 2 transformation