

# A Simplified NIH Stroke Scale for Acute Basilar Artery Occlusion Treated with Endovascular Therapy

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## Research article

**Keywords:** basilar artery occlusion, endovascular therapy, functional outcome, simplified NIHSS

**Posted Date:** April 9th, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-21836/v1>

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# Abstract

## Background

To design a simplified NIH Stroke Scale (sNIHSS) that requires minimal training but can reflect acute basilar artery occlusion (BAO) severity and is predictive for the 90-day outcome after endovascular therapy (EVT).

## Methods

We analyzed the prospectively gathered data of acute BAO treated with EVT in a tertiary stroke center during a 6-year period. The sNIHSS (range: 0 to 20 points) consisted of 4 NIHSS items: level of consciousness - (1) questions and (2) commands; motor function - (3) arms and (4) legs. The 90-day outcomes included functional independence (mRS  $\leq$  2), favorable outcome (mRS  $\leq$  3) and death.

## Results

Of 173 patients, 62, 83 and 36 achieved functional independence, favorable outcome and death, respectively. Interobserver reliability of sNIHSS was high (ICC = 0.95), and compared with NIHSS, sNIHSS had a significant reduction of assessment time (median: 1.5 min vs. 5 min,  $P < 0.01$ ). A multivariable logistic model demonstrated that sNIHSS was independently associated with functional independence (OR = 0.82, 95% CI = 0.77-0.87), favorable outcome (OR = 0.86, 95% CI = 0.81-0.92) and death (OR = 1.24, 95% CI = 1.12-1.37). Additionally, the sNIHSS predicted 90-day outcomes almost as same discrimination as NIHSS by using DeLong test. The optimal cutoff value of sNIHSS was determined to be 12 points for predicting any outcome.

## Conclusions

The sNIHSS reflects acute BAO severity well and predicts 90-day outcomes with reasonable accuracy. Nevertheless, the sNIHSS needs further validation before it can be applied as a predictive tool for acute BAO outcome.

## Background

When acute basilar artery occlusion (BAO) is confirmed with angiography, emergency reperfusion treatment will be undertaken. Endovascular therapy (EVT) represented by mechanical thrombectomy improves the patient's functional outcome after acute ischemic stroke (AIS) caused by intracranial large vessel occlusion and has become a Class IA recommendation of the AHA/ASA Guideline.[1] However, BAO cases were excluded from previous randomized controlled trials,[2] and evidence for EVT efficacy in BAO is derived largely from observational studies and their meta-analysis.[3–6] The recently published randomized controlled trial on EVT versus standard medical therapy alone for vertebrobasilar artery occlusion patients showed no difference in 90-day favorable outcome (modified Rankin Scale [mRS]  $\leq$  3) due to the reduced sample size and the early termination of the study.[7] Another two randomized

controlled trials (<https://www.clinicaltrials.gov>: NCT01717755 and NCT02737189) are ongoing to confirm the efficacy and safety of EVT for patients with BAO, and we are looking forward to the results of these trials to provide more data on this issue.

Current mechanical endovascular techniques can recanalize about 80% of acute BAO cases.[8] Nevertheless, many recanalization procedures are still futile,[9] thus, identification of factors predictive of clinical outcome and treatment response are crucial. Among multiple prediction models, stroke severity assessed by the 15-item NIH Stroke Scale (NIHSS) has been proven to be a powerful predictor of clinical outcome in BAO patients.[4,10–12] However, it remains a complex scoring system requiring a detailed neurologic examination and necessitating regular training for accurate application, so these time-consuming and cumbersome shortcomings have limited the use of NIHSS in the emergency treatment. [13]

Therefore, the purpose of this study was to design a simplified NIHSS (sNIHSS) that: (1) requires minimal training to use accurately with a shorter assessment time, but (2) can reflect the severity of acute BAO and (3) may serve as a predictor for 90-day outcomes of acute BAO treated by EVT.

## Methods

### Study Population

A prospectively registered consecutive cohort of patients with acute BAO (n = 187) in our hospital between January 2012 and July 2018 was reviewed. All patients received EVT (including stent-retriever thrombectomy and/or intra-arterial thrombolysis and/or emergency angioplasty) within 24 hours after acute BAO onset. The time of BAO onset was described by the patients or witnesses; if unknown, it was considered to be the last time the patient was found well. In patients with mild symptoms followed by sudden onset of decreased consciousness, the time of deterioration in the clinical status was taken as estimated time of BAO onset. Intravenous thrombolysis with tissue plasminogen activator (tPA) is acceptable before EVT according to the current guideline from American Heart Association/ American Stroke Association. Otherwise, patients with a premorbid mRS score of > 3 were excluded from this study. Informed consent was obtained from all patients or their legally authorized representatives before EVT, and the study protocol was approved by the Ethics Committee of our hospital.

### Data Collection

The patient's baseline characteristics (e.g. demographic data, NIHSS score, laboratory tests, neurovascular imagings, stroke subtypes, operative information and perioperative management, etc) and functional outcomes (e.g. mRS score) within 90 days were prospectively collected.

The NIHSS score was measured at baseline,  $24 \pm 2$  hours,  $7 \pm 1$  days (or at discharge, whichever occurs first), and at any time of neurological deterioration. The mRS score was assessed at  $7 \pm 1$  days (or at

discharge, whichever occurred first) and  $90 \pm 7$  days. Only neurologists trained and qualified to use NIHSS and mRS recorded the scores.

The neurovascular imagings (computed tomography [CT] plus CT angiography [CTA] and/or magnetic resonance [MR] plus MR angiography [MRA]) were performed at baseline, within 24 hours and 7 days (or before discharge, whichever occurred first). Additional CT and/or MR were examined at any time of neurological deterioration. The imaging findings were interpreted by two independent trained radiologists blinded to the clinical data. A third experienced senior radiologist participated in the resolution of any disagreement.

## Development of the sNIHSS

The sNIHSS consisted of 4 NIHSS items selected by stroke expert consensus to be more likely affected in the outcome of acute BAO (Table 1). The sNIHSS scores were calculated from the preoperative NIHSS scores. Furthermore, in order to assess the interobserver reliability of sNIHSS and to know how much time is saved by using sNIHSS versus NIHSS, the two scales were evaluated prospectively together by 2 independent trained neurologists in a subset of 20 patients.

## Outcome Measurement

The mRS was used to assess 90-day outcomes. A follow-up blinded to baseline information was carried out by telephone interview by trained interviewers based on a standardized interview protocol. In this study, the outcome measures included functional independence and favorable outcome at 90 days, as well as death within 90 days after the procedure. Functional independence was defined as  $mRS \leq 2$ , and favorable outcome as  $mRS \leq 3$  in accordance with the BASICS definition.[3]

## Statistical Analysis

Study data were collected on standard forms, evaluated for completeness, and double keyed into an EpiData statistics data document. Baseline and outcome data were presented as mean (standard deviation [SD]) and/or median (interquartile range [IQR]) for continuous variables. Frequency and/or proportion were used for categorical variables. An intraclass correlation coefficient (ICC) was calculated for assessment of interobserver reliability of the sNIHSS scores. In univariable analysis, independent-samples T test and/or the nonparametric test (Mann-Whitney U test) were used to compare means and/or medians, whereas Pearson's chi-square test or Fisher's exact test was used to compare frequencies and/or proportions. A multivariable logistic regression model controlling for potential confounders was used to determine the adjusted odds ratios (aOR) with the corresponding 95% confidence intervals (CI) for the purpose of assessing the sNIHSS as independent predictors of 90-day outcome. Confounders were selected based on their associations with outcomes of interest in univariable

analysis ( $P < 0.1$ ) and the change-in-estimate criterion, by which a variable can be included in the final model if its inclusion in the regression model ( $\text{Logit}(Y) = \beta_0 + \beta_1 * X + \beta_2 * Z$ ; X indicates the sNIHSS; Z is the included variable) produced a change in regression coefficient of “X” by at least 10% compared with that in the basic regression model ( $\text{Logit}(Y) = \beta_0 + \beta_1 * X$ ; X indicates the sNIHSS).[14] The predictive performance of the sNIHSS was measured by area under curve (AUC) and receiver-operating characteristic (ROC) curve analysis was used to calculate the optimal cutoff value that was determined by maximizing the Youden index (sensitivity+specificity–1). Accuracy of the optimal cutoff value was assessed by the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Statistical differences in the AUC were compared between sNIHSS and NIHSS by using the method of DeLong et al.[15] In addition, we assessed whether the effects of sNIHSS on 90-day outcomes differed in certain subgroups by testing the sNIHSS-by-subgroup interaction effect with the use of logistic regression models. All tests were two-tailed and statistical significance was determined at an  $\alpha$  level of 0.05. All statistical analyses were performed with the statistical software package R (<http://www.R-project.org>, The R Foundation) and Empowerstats (<http://www.empowerstats.com>, X&Y Solutions, Inc., Boston, MA).

## Results

Between January 2012 and July 2018, 187 consecutive patients with BAO underwent emergency EVT. Because of delayed treatment ( $> 24$  hours) and unclear onset time, 8 patients were excluded. Another 6 patients with significant pre-stroke disability (mRS  $> 3$ ) were also excluded. Finally, 173 eligible patients were entered into the analysis in this study. Among them, average age was 60 years (range, 23–80 years); 147 cases (85.0%) were male, and median NIHSS score was 24 points (IQR: 11–34 points). A total of 132 cases (76.3%) were treated by mechanical thrombectomy with stent retrievers, and median onset-to-puncture time (OTP) was 7 hours (IQR: 5–9 hours). In all, 148 cases (85.5%) achieved successful recanalization (modified Thrombolysis in Cerebral Infarction [mTICI] 2b–3). During a 90-day follow-up, the proportions of functional independence (mRS  $\leq 2$ ), favorable outcome (mRS  $\leq 3$ ) and death were 35.8% (62 cases), 48.0% (83 cases) and 20.8% (36 cases), respectively.

In the subset of 20 patients assessed by 2 independent trained neurologists, interobserver reliability of the sNIHSS was high (ICC = 0.95), and the sNIHSS had a significant reduction of assessment time in comparison to the NIHSS (median: 1.5 min vs. 5 min,  $P < 0.01$ ).

## Association of the sNIHSS with 90-Day Outcomes

Confounders were selected as because of their potential associations with the outcomes of interest in univariable analysis ( $P < 0.1$ ) and a change in effect estimate of more than 10% (See Table 2 and footnotes of Table 3 for more details), and a multivariable logistic regression analysis showed that the sNIHSS as a continuous scale was independently associated with 90-day functional independence (aOR

= 0.82, 95% CI = 0.77–0.87, P = 0.01) and favorable outcome (aOR = 0.86, 95% CI = 0.81–0.92, P < 0.01), and death within 90 days (aOR = 1.24, 95% CI = 1.12–1.37, P < 0.01) (Table 3).

## Predictive Performance of the sNIHSS

The sNIHSS score had a fair discrimination ability with an AUC of 0.79 (95% CI = 0.72–0.87), 0.74 (95% CI = 0.66–0.81) and 0.78 (95% CI = 0.69–0.86) for predicting the 90-day functional independence, favorable outcome and death, respectively. In addition, the sNIHSS had a similar predictive performance for all 90-day outcomes as compared with the full NIHSS (Figure 1). No matter which outcome was predicted, the optimal cutoff value of the sNIHSS score was determined as 12 points. For predicting the functional independence, this cutoff value showed sensitivity 0.79, specificity 0.73, PPV 0.62, and NPV 0.86; for predicting the favorable outcome, it showed sensitivity 0.70, specificity 0.77, PPV 0.73, and NPV 0.73; and for prediction of death, it showed sensitivity 0.92, specificity 0.55, PPV 0.35, and NPV 0.96. The distribution of mRS at 90 days stratified by the sNIHSS (< 12 vs.  $\geq$  12 points) is shown in Figure 2. The sensitivity, specificity, PPV and NPV of the sNIHSS score when used in different cutoff value was listed in Supplemental Table I.

## Association of the sNIHSS with 90-Day Outcomes in Subgroup Analysis

We completed an exploratory subgroup analysis by age, OTP, collateral status and intracranial atherosclerotic stenosis (ICAS). The association of the sNIHSS with 90-day outcomes was consistent across all subgroups (Figure 3). There were no significant interactions in any of the 4 subgroups (P > 0.10 for all comparisons).

## Discussion

Whether in this overall cohort or in the 4 subpopulations, the sNIHSS consisting of only 4 items (level of consciousness - questions and commands, motor function - arms and legs) was found to be well associated with stroke severity and to predict 90-day outcome of acute BAO. Additionally, the 4-item sNIHSS, instead of the current gold standard scale of the full NIHSS, has similar prognostic value and may be easier to use in clinical routine with a low interobserver variability and a shorter assessment time. The largest AUC was achieved at a score of 12 for predicting any 90-day outcome. Specifically, a sNIHSS score < 12 increased by the 8-fold and 7-fold odds ratios that a BAO patient achieved 90-day functional independence and favorable outcome, respectively; but if a sNIHSS score  $\geq$  12, it would increase by the 7-fold risk that a BAO case died within 90 days.

The 4 items of the sNIHSS were selected items of the full NIHSS, which includes 15 neurologic examination items. The parameters “level of consciousness - questions and commands” were selected because we assumed that abnormal findings would indicate ischemia involving ascending reticular

activating system of brainstem and/or thalamus. The parameters “motor function - arms and legs” were included in the sNIHSS as the most robust characteristics of the full NIHSS, which can be assessed reliably and is considered to be a strong indicator of stroke severity.

The proposed sNIHSS has several limitations. First of all, the main limitation of this study is its single-center design, so our results need further validation based on a different dataset. Secondly, it was designed to serve as a predictive tool for EVT, so it could not easily be extrapolated to other therapies (e.g. intravenous tPA). Thirdly, as an observational study, the possibility that unmeasured confounders might affect the association of sNIHSS with 90-day outcome cannot be ruled out. Fourthly, as a predictor of the 90-day outcome, it is not more accurate than the NIHSS, so its limited use may be argued. However, the complexity of NIHSS necessitates regular training for accurate application and leads to its infrequent use in routine clinical care.[13] Instead, our proposed sNIHSS is more simple and quick to apply.

## Conclusions

In conclusion, the strength of the sNIHSS is its simplicity and the relatively good accuracy for prediction of acute BAO treated by EVT. In clinical practice, it may enable a wider range of clinicians to estimate treatment benefits and support more adoption of personalized treatment. In clinical research, it may help to stratify the study population in randomized clinical trials, to control case-mix variation in non-randomized clinical trials, and to select more suitable patients for optimal reperfusion therapies in controlled clinical trials, thus, reducing the required sample size. Further multicenter, prospective studies concerning the utility of the sNIHSS in the clinical setting and its ability to predict functional outcome of acute BAO are worth carrying out. Moreover, we need to further verify whether the superiority of the sNIHSS in comparison to the NIHSS should be easy and applicable for all corresponding professionals irrespective of their experience and educational level (e.g. paramedic, stroke nurse, resident and consultant).

## Abbreviations

AUC = area under curve, BAO = basilar artery occlusion, BATMAN = Basilar Artery on Computed Tomography Angiography, CI = confidence interval, DWI = diffusion weighted imaging, EVT = endovascular therapy, ICAS = intracranial atherosclerotic stenosis, IQR = interquartile range, MAP = mean arterial pressure, mRS = modified Rankin Scale, mTICI = modified Thrombolysis in Cerebral Infarction, NIHSS = NIH Stroke Scale, OR = odds ratio, OTP = onset-to-puncture time, OTR = onset-to-recanalization time, pc-ASPECTS = posterior circulation Acute Stroke Prognosis Early CT Score, PMI = Pons-Midbrain Index, ROC = receiver-operating characteristic, SD = standard deviation, sNIHSS = simplified NIH Stroke Scale, TOAST = Trial of Org 10172 in Acute Stroke Treatment, tPA = tissue Plasminogen Activator.

## Declarations

### Ethics approval and consent to participate

The study procedures were in accordance with the 1964 Helsinki declaration and its later amendments. Written informed consent was obtained from all individual participants included in the study. The protocol of this study had been approved by the ethics committee of Beijing Tiantan Hospital.

### **Consent for publication**

Not Applicable

### **Availability of data and material**

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no conflicts of interest.

### **Funding**

This study was funded by the China Postdoctoral Science Foundation (No. 2019M650773), National Key Research and Development Program of China (No. 2016YFC1301501), Beijing Municipal Science & Technology Commission (No. Z18110000171837), Hebei Provincial Health and Family Planning Commission (No. 20181258). The funding body played no role in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

### **Authors' contributions**

XT and ZM study design; JA and WW analysis of data; RL, XS, FG and YW collection of data; ZM interpretation of data. All authors have read and approved the manuscript.

### **Acknowledgements**

We thank all relevant clinicians, statisticians, and imaging and laboratory technicians.

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## Tables

**Table 1. Description of sNIHSS**

Item	Scoring definition	Score (points)
<b>LOC questions</b> - ask patient's age and current month (must be exact)	Both correct One correct or dysarthria Neither correct	0 1 2
<b>LOC commands</b> - open/close eyes and grip/release non paralytic hand (other 1 step commands or mimics ok)	Both correct (ok if impaired by weakness) One correct Neither correct	0 1 2
<b>Motor arms</b> - hold 90° (sitting) or 45° (supine) for 10 secs, score for both sides	No drift Drift but does not hit bed Some effort against gravity No effort against gravity No movement Unable to assess due to amputation or joint fusion, etc	0 1 2 3 4 X
<b>Motor legs</b> - hold 30° (supine) for 5 secs, score for both sides	No drift Drift but does not hit bed Some effort against gravity No effort against gravity No movement Unable to assess due to amputation or joint fusion, etc	0 1 2 3 4 X
<b>Total score</b>		0-20

Abbreviations: LOC=level of consciousness, sNIHSS=simplified NIH Stroke Scale.

**Table 2. Association of Baseline Characteristics with 90-Day Outcomes in Univariable Analysis**

Variable names	Functional independence (mRS 0-2)		P value	Favorable outcome (mRS 0-3)		P value	Death (mRS=6)		P value
	Yes (n=62)	No (n=111)		Yes (n=83)	No (n=90)		Yes (n=36)	No (n=137)	
<b>Demographic data</b>									
Age, mean (SD), years	59 (10)	60 (10)	0.80	60 (10)	60 (10)	0.93	60 (9)	60 (10)	0.96
Male sex	54 (87.1)	93 (83.8)	0.66	71 (85.5)	76 (84.4)	0.84	28 (77.8)	119 (86.9)	0.19
<b>Vascular risk factors</b>									
Hypertension	46 (74.2)	79 (71.2)	0.67	61 (73.5)	64 (71.1)	0.73	27 (75.0)	98 (71.5)	0.84
Diabetes mellitus	14 (22.6)	31 (27.9)	0.44	18 (21.7)	27 (30.0)	0.21	14 (38.9)	31 (22.6)	0.06
Dyslipidemia	12 (19.4)	16 (14.4)	0.40	15 (18.1)	13 (14.4)	0.52	6 (16.7)	22 (16.1)	> 0.99
Coronary heart disease	7 (11.3)	14 (12.6)	> 0.99	9 (10.8)	12 (13.3)	0.62	6 (16.7)	15 (10.9)	0.39
Atrial fibrillation	4 (6.5)	6 (5.4)	0.75	4 (4.8)	6 (6.7)	0.75	1 (2.8)	9 (6.6)	0.69
Prior stroke	12 (19.4)	24 (21.6)	0.73	17 (20.5)	19 (21.1)	0.92	2 (5.6)	34 (24.8)	0.01
Current smoking	27 (43.5)	39 (35.1)	0.28	34 (41.0)	32 (35.6)	0.46	10 (27.8)	56 (40.9)	0.15
<b>Clinical characteristics</b>									
Mode of stroke onset			0.07			0.18			0.46
Acute	37 (59.7)	49 (44.1)		47 (56.6)	39 (43.3)		15 (41.7)	71 (51.8)	
Progressive	22 (35.5)	59 (53.2)		33 (39.8)	48 (53.3)		20 (55.6)	61 (44.5)	
Fluctuating	3 (4.8)	3 (2.7)		3 (3.6)	3 (3.3)		1 (2.8)	5 (3.6)	
MAP, mean (SD), mmHg	114 (17)	111 (16)	0.36	113 (16)	111 (17)	0.49	111 (19)	113 (16)	0.66
NIHSS score, median (IQR)	10 (4-20)	30 (18-35)	< 0.01	14 (7-29)	31 (22-35)	< 0.01	34 (29-35)	19 (9-31)	< 0.01
sNIHSS score, median (IQR)	6 (2-12)	16 (12-20)	< 0.01	8 (3-16)	17 (13-20)	< 0.01	20 (16-20)	11 (5-18)	< 0.01
White blood cells, mean (SD), ×10 <sup>9</sup> /L	10.5 (3.7)	11.5 (3.9)	0.13	10.7 (3.8)	11.6 (3.8)	0.12	11.7 (4.2)	11.0 (3.7)	0.32
Blood glucose, mean (SD), mmol/L	9.0 (3.3)	9.0 (3.8)	0.92	9.0 (3.2)	9.0 (4.0)	0.87	9.7 (4.7)	8.8 (3.3)	0.20
Creatinine, mean (SD), umol/L	65.9 (16.0)	74.2 (23.9)	0.02	65.6 (15.1)	76.4 (25.3)	< 0.01	76.4 (22.2)	69.8 (21.4)	0.11
pc-ASPECTS on DWI, median (IQR)	7 (6-8)	6 (5-8)	0.09	7 (6-8)	6 (5-8)	0.08	6 (5-8)	7 (5-8)	0.26
PMI on DWI, median (IQR)	2 (0-2)	3 (2-4)	< 0.01	2 (0-2)	3 (2-4)	0.01	3 (2-4)	2 (0-3)	0.20
Occlusion site			0.07			0.65			0.63
Proximal basilar artery	41 (66.1)	55 (49.5)		49 (59.0)	47 (52.2)		18 (50.0)	78 (56.9)	
Middle basilar artery	12 (19.4)	39 (35.1)		23 (27.7)	28 (31.1)		11 (30.6)	40 (29.2)	
Distal basilar artery	9 (14.5)	17 (15.3)		11 (13.3)	15 (16.7)		7 (19.4)	19 (13.9)	
Tandem lesion	5 (8.1)	15 (13.5)	0.33	5 (6.0)	15 (16.7)	0.03	10 (27.8)	10 (7.3)	< 0.01
Underlying ICAS	40 (64.5)	70 (63.1)	0.85	57 (68.7)	53 (58.9)	0.18	19 (52.8)	91 (66.4)	0.13
BATMAN collateral score, median (IQR)	5 (3-7)	3 (2-5)	< 0.01	4 (3-7)	3 (2-5)	< 0.01	4 (2-5)	4 (3-5)	0.42
Stroke subtype by TOAST criteria			> 0.99			0.77			> 0.99
Large artery atherosclerosis	50 (80.6)	90 (81.1)		69 (83.1)	71 (78.9)		30 (83.3)	110 (80.3)	
Cardioembolic	10 (16.1)	17 (15.3)		12 (14.5)	15 (16.7)		5 (13.9)	22 (16.1)	
Other or unknown etiology	2 (3.2)	4 (3.6)		2 (2.4)	4 (4.4)		1 (2.8)	5 (3.6)	
<b>Procedural features</b>									
Prior use of intravenous tPA	14 (22.6)	20 (18.0)	0.47	18 (21.7)	16 (17.8)	0.52	6 (16.7)	28 (20.4)	0.81
General anaesthesia	41 (66.1)	97 (87.4)	< 0.01	58 (69.9)	80 (88.9)	< 0.01	32 (88.9)	106 (77.4)	0.16
Use of stent retriever	41 (66.1)	91 (82.0)	0.02	56 (67.5)	76 (84.4)	0.01	30 (83.3)	102 (74.5)	0.38
No. of passes, median (IQR)	1 (1-2)	2 (1-2)	0.35	1 (1-2)	2 (1-2)	0.25	2 (1-3)	1 (1-2)	0.01
Intra-arterial tPA or Urokinase	14 (22.6)	26 (23.4)	0.90	21 (25.3)	19 (21.1)	0.52	13 (36.1)	27 (19.7)	0.05
Infusion of Tirofiban	45 (72.6)	82 (73.9)	0.85	60 (72.3)	67 (74.4)	0.75	26 (72.2)	101 (73.7)	0.84
Heparinization	24 (38.7)	44 (39.6)	0.90	37 (44.6)	31 (34.4)	0.17	14 (38.9)	54 (39.4)	0.95
Intracranial angioplasty			0.31			> 0.99			0.30
No	29 (46.8)	40 (36.0)		33 (39.8)	36 (40.0)		18 (50.0)	51 (37.2)	
Balloon alone	12 (19.4)	21 (18.9)		16 (19.3)	17 (18.9)		7 (19.4)	26 (19.0)	
Stenting	21 (33.9)	50 (45.0)		34 (41.0)	37 (41.1)		11 (30.6)	60 (43.8)	

OTP, median (IQR), hours	6.0 (4.5-8.9)	7.0 (5.0-10.0)	0.12	6.0 (4.8-9.0)	7.0 (5.0-9.0)	0.54	8.0 (4.9-10.5)	7.0 (5.0-9.0)	0.35
OTR, median (IQR), hours	7.9 (6.0-10.1)	9.2 (6.9-12.0)	0.03	8.0 (6.0-11.0)	9.0 (6.5-11.7)	0.22	9.2 (7.0-14.1)	8.0 (6.0-11.0)	0.06
Successful recanalization (mTICI 2b-3)	59 (95.2)	89 (80.2)	0.01	79 (95.2)	69 (76.7)	< 0.01	24 (66.7)	124 (90.5)	< 0.01

Values are numbers with percentages in parentheses, unless indicated otherwise.

Abbreviations: BATMAN=Basilar Artery on Computed Tomography Angiography, DWI=diffusion weighted imaging, ICAS=intracranial atherosclerotic stenosis, IQR=interquartile range, MAP=mean arterial pressure, mRS=modified Rankin Scale, mTICI=modified Thrombolysis in Cerebral Infarction, NIHSS=NIH Stroke Scale, OTP=onset-to-puncture time, OTR=onset-to-recanalization time, pc-ASPECTS=posterior circulation Acute Stroke Prognosis Early CT Score, PMI=Pons-Midbrain Index, SD=standard deviation, sNIHSS=simplified NIH Stroke Scale, TOAST=Trials of Org 10172 in Acute Stroke Treatment, tPA=tissue Plasminogen Activator.

**Table 3. Association of sNIHSS with 90-Day Outcomes in Univariable and Multivariable Analyses**

Outcome measures	sNIHSS (0-20 points)			
	Univariable analysis		Multivariable analysis	
	cOR (95% CI)	P value	aOR (95% CI)	P value
<b>Functional independence (mRS 0-2)</b>	0.84 (0.79-0.89)	< 0.01	0.82 (0.77-0.87)	0.01*
<b>Favorable outcome (mRS 0-3)</b>	0.87 (0.83-0.92)	< 0.01	0.86 (0.81-0.92)	< 0.01†
<b>Death (mRS=6)</b>	1.20 (1.10-1.31)	< 0.01	1.24 (1.12-1.37)	< 0.01‡

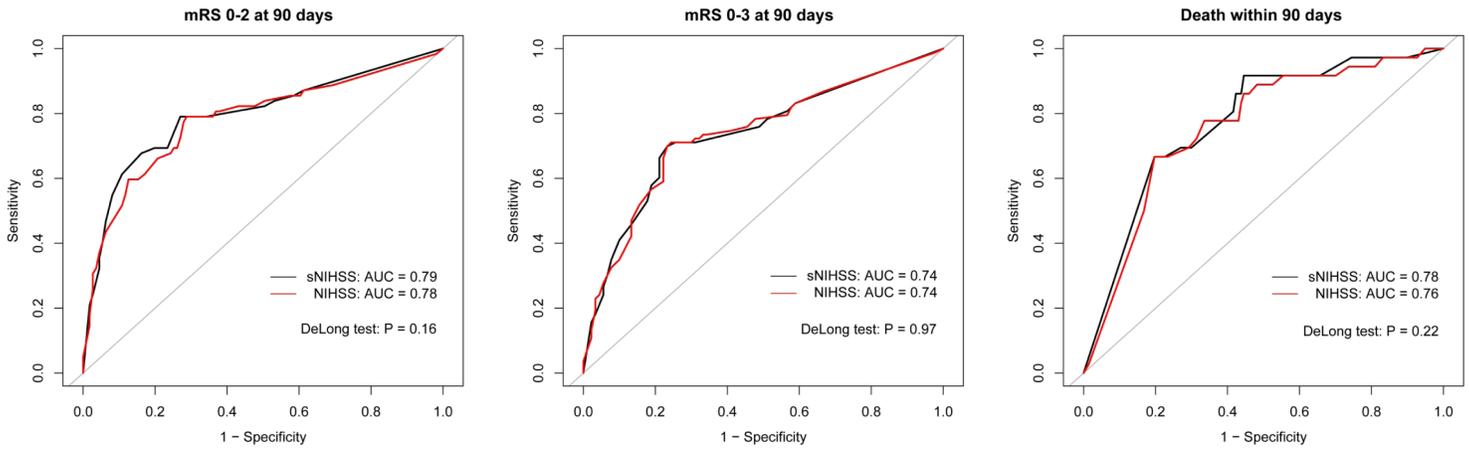
\*Adjusted for occlusion site, general anaesthesia, OTR.

†Adjusted for PMI on DWI, general anaesthesia.

‡Adjusted for tandem lesion, OTR, successful recanalization.

Abbreviations: aOR=adjusted odds ratio, CI=confidence interval, cOR=crude odds ratio, DWI=diffusion weighted imaging, mRS=modified Rankin Scale, OTR=onset-to-recanalization time, PMI=Pons-Midbrain Index, sNIHSS=simplified NIH Stroke Scale.

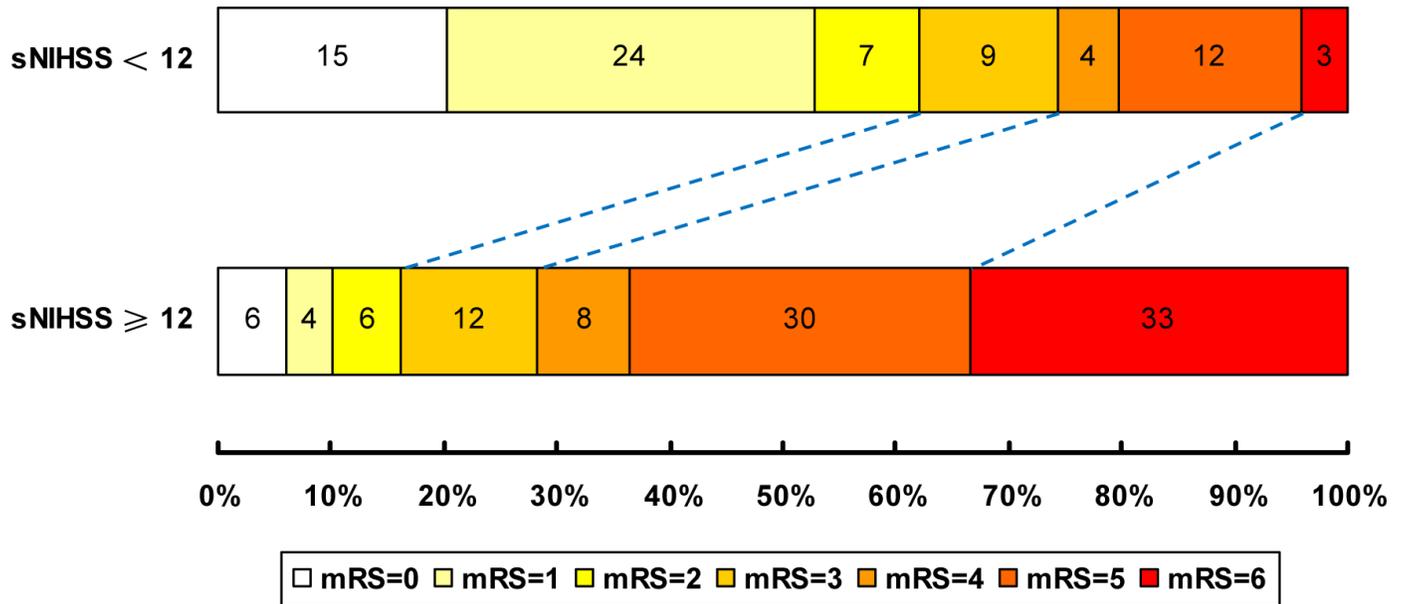
## Figures



**Figure 1. ROC Curves of sNIHSS and NIHSS Scores for Predicting the 90-Day Outcomes**

**Figure 1**

ROC Curves of sNIHSS and NIHSS Scores for Predicting the 90-Day Outcomes. Abbreviations: AUC=area under curve, mRS=modified Rankin Scale, NIHSS=NIH Stroke Scale, ROC=receiver-operating characteristic, sNIHSS=simplified NIH Stroke Scale.



**Figure 2. The Distribution of mRS at 90 Days Stratified by sNIHSS**

**Figure 2**

The Distribution of mRS at 90 Days Stratified by sNIHSS. Abbreviations: mRS= modified Rankin Scale, sNIHSS=simplified NIH Stroke Scale.

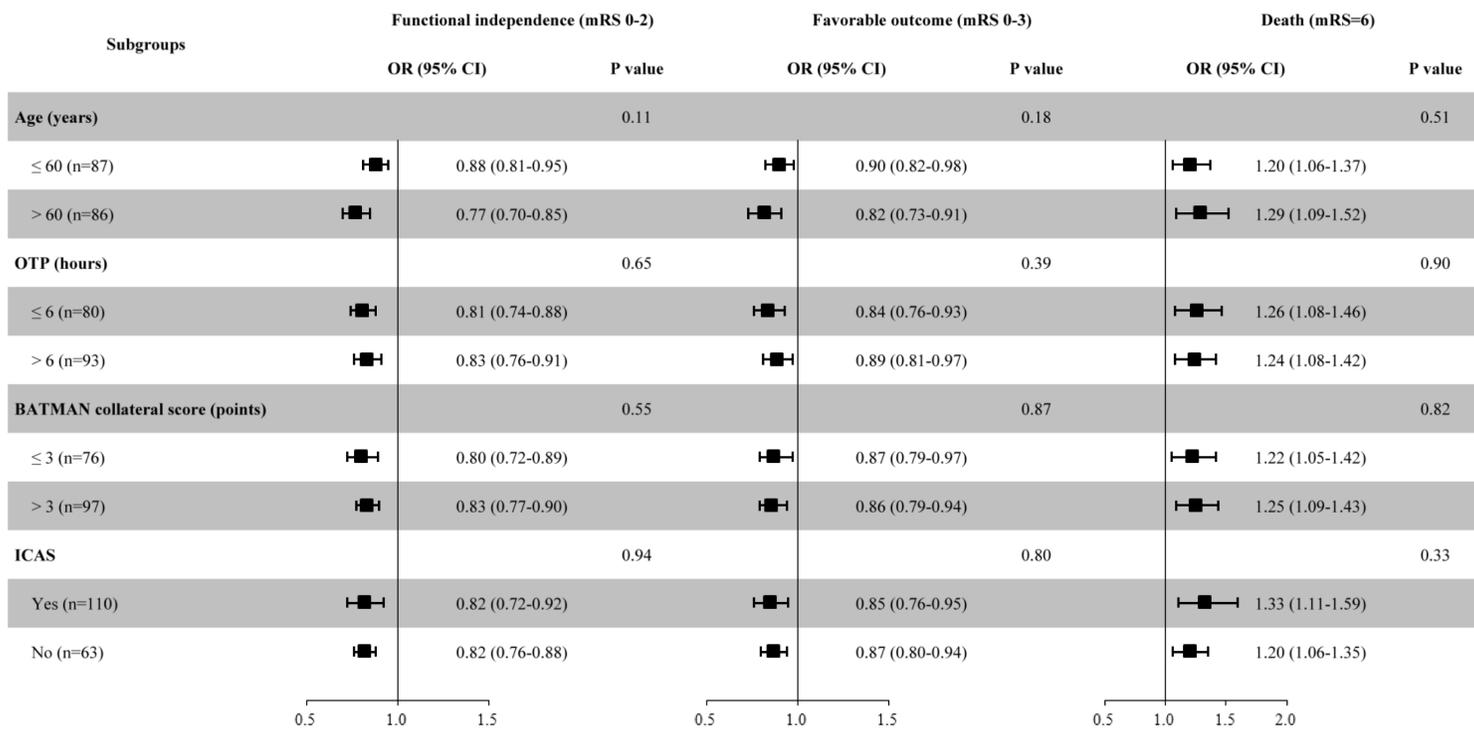


Figure 3. Association of sNIHSS with 90-Day Outcomes in Subgroup Analysis

### Figure 3

Association of sNIHSS with 90-Day Outcomes in Subgroup Analysis. Abbreviations: OR=odds ratio, BATMAN=Basilar Artery on Computed Tomography Angiography, CI=confidence interval, ICAS=intracranial atherosclerotic stenosis, mRS=modified Rankin Scale, OTP=onset-to-puncture time, sNIHSS=simplified NIH Stroke Scale.

## Supplementary Files

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- [SupplementalMaterial.docx](#)