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Pre-procedure predictors of mortality in acute ischemic stroke treated with mechanical thrombectomy: Analysis of a multicenter prospective registry

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Keywords: acute ischemic stroke, mechanical thrombectomy, mortality, predictors, score

Abstract

Objectives: We aimed to determine pre-procedure predictors of mortality within 90 days and develop a simple score for patients with mechanical thrombectomy(MT).

Design: Analysis of a multicenter prospective registry.

Setting: In six participating centers, acute ischemic stroke patients (AIS) treated by MT between March 2017 and May 2018 were documented prospectively.

Participants: 224 patients with AIS were treated by MT.

Results: Of 224 patients, 49 (21.9%) patients died, and 87 (38.8%) were independent. Variables associated with 90-day mortality were age, previous stroke, admission National Institutes of Health Stroke Scale (NIHSS), fasting blood glucose (FBG) and occlusion site. Logistic regression identified 4 variables independently associated with 90-day mortality: age≥80 (OR 3.26, 95% CI 1.45-7.33), previous stroke (OR 2.33, 95% CI 1.04-5.21), admission NIHSS≥18 (OR 2.37, 95% CI 1.13-4.99), and internal carotid artery (ICA) or basilar artery (BA) occlusion (OR 2.92, 95% CI 1.34-6.40). Using these data, we developed Predicting 90-days mortality of acute ischemic stroke with mechanical thrombectomy (PRACTICE) score ranging from 0 to 6 points. The area under the curve (AUC) of the score was 0.744 (95% CI 0.669-0.820), which suggested moderate diagnostic value for the prediction of 90-day mortality.

Conclusions: We developed a simple score to estimate the 90-day mortality of AIS patients treated with MT. But the score needs to be prospectively validated.

Strengths and limitations of this study

The study used multicenter prospective data from consecutively admitted ischemic stroke patients treated with mechanical thrombectomy.

Multivariate logistic regression analysis only used variables before the procedure, predicting 90-day mortality before mechanical thrombectomy.

The PRACTICE score was only validated in the primary dataset, and future external validation should be performed in another dataset.

Introduction

Previous randomized controlled trials (RCTs) have demonstrated the overwhelming benefit of mechanical thrombectomy (MT) for acute ischemic stroke (AIS) due to emergent large vessel occlusion[1-6]. Although patients undergo MT as first-line therapy, the mortality within 90 days remains high: more than 30% in patients with acute basilar artery occlusion and approximately 15% in patients with large-vessel occlusion in the anterior circulation[6,7]. In the last few years, a considerable number of studies have found predictors associated with mortality in ischemic stroke patients, but only a few studies have focused on predictors of mortality in patients treated with MT[7-10]. Overall, the pre-procedure predictors related to mortality of patients with MT remain unknown, and it is critical to avoid futile MT by predicting mortality from clinical and imaging information available prior to MT. Our study aimed to determine pre-procedure predictors of mortality within 90 days and develop a simple scoring instrument for patients with MT in a multicenter prospective registry study for endovascular treatment of acute ischemic stroke (ET-AIS).

Method

Patients Selection

Three hundred and two consecutive patients presenting with acute ischemic stroke treated by endovascular treatment (EVT) were registered in the ET-AIS registry during March 2017 and May 2018. ET-AIS was a multicenter, prospective and observational registry study involving 6 comprehensive stroke centers in China. Patients receiving intravenous thrombolysis prior to EVT were acceptable, consistent with current guidelines[11]. The registry study protocol was approved by the ethics committee of each participating center and registered on the Chinese Clinical Trial Registry (http://www.chictr.org.cn; ChiCTR-OOC-17013052).

All consecutive patients with the following criteria were included: (1) age 18 years or older; (2) diagnosis of an AIS with proven large vessel occlusion confirmed by digital subtraction angiography (DSA); (3) treatment with or without intravenous thrombolysis prior to MT; and (4) treated with MT within 12 hours of symptom onset. Patients with prestroke functional dependence (modified Rankin Scale [MRS] score >2) and only intracranial large vascular stenosis or anterior cerebral artery (ACA) or posterior cerebral artery (PCA) occlusion were excluded.

Study Variables and Outcome Definition

All data, including baseline characteristics, procedure details and outcome, were recorded on case report forms (CRFs). Patient demographics included age and gender. The main vascular risk factors included smoking, hypertension, diabetes, coronary artery disease, atrial fibrillation, and previous stroke. Laboratorial tests included admission fasting plasma glucose (FPG) and admission low-density lipoprotein cholesterol (LDL-C). Clinical and radiological data included the admission National Institute of Health Stroke Scale (NIHSS) score, Alberta Stroke Program Early CT Score (ASPECTS) on noncontrast computed tomography (CT), occlusion site, Trial of ORG 10172 in the Acute Stroke Treatment (TOAST) classification, preprocedure modified thrombolysis as per the cerebral infarction [m-TICI] score, time from onset to arrival at the stroke center, and time from onset to groin puncture. Procedure details included intravenous thrombolysis (IVT) prior to the procedure, methods of anesthesia, procedural approaches, procedure-related complications, time from onset to recanalization, and time from groin puncture to recanalization. Outcomes included successful recanalization (defined as postprocedure thrombolysis in cerebral infarction (TICI) ≥2b), intracranial hemorrhage within 24

hours post-MT confirmed on neuroimaging (CT or MRI), 90-day favorable outcome (defined as MRS≤2), and 90-day mortality (defined as MRS=6). Intracranial hemorrhage (ICH) was defined by the Heidelberg Bleeding Classification[12] and classified into symptomatic intracranial hemorrhage (SICH) and asymptomatic intracranial hemorrhage (aSICH). A follow-up was performed at 90 days by neurological physicians or trained research nurses during face-to-face interviews or via telephone conversations with the patient, their relatives, or their general practitioner.

Endovascular Procedures

Before entry into the neuroangiography suite, all patients or legally authorized representatives signed informed consent forms. All procedures were performed under general anesthesia or conscious sedation. The major revascularization method was MT using a stent retriever or direct aspiration at the operator's discretion. If underlying intracranial atherosclerotic stenosis (ICAS) was detected, balloon angioplasty or stenting was performed when considered necessary. Intra-arterial thrombolysis was allowed as adjuvant therapy for some patients. Recanalization status was quantified by using the TICI score based on the final angiogram, and successful recanalization was defined as a TICI score ≥2b[13]. All patients underwent head CT scan or magnetic resonance imaging within 24 hours after the procedure to assess hemorrhagic complications. Specific endovascular procedures and preoperative anesthesia methods were chosen by operators at each center. For postoperative antithrombotic drugs, antiplatelet drugs or anticoagulants were selected depending on the stroke etiology.

Statistical Analysis and Score Development

Statistical analyses were performed using SPSS 25.0 (SPSS, Chicago, IL, USA). A P value <0.05 was considered statistically significant (2-sided). Continuous variables are reported as the means ± standard deviation or medians (interquartile range [IQR]), and categorical variables are reported as frequencies. Comparisons were performed on mortality and survival using the Pearson chi-square test, independent-samples t test, and Mann-Whitney U test. To account for multiple testing, the significance level was set at P<0.05. Multivariate logistic regression analysis was performed to determine independent predictors for 90-day mortality. We tested the association of procedure-related variables with mortality; however, because the primary goal of the study was predicting mortality before the procedure, these variables were not used in the multivariate model.

The PRACTICE score was developed based on variables that were independently associated with 90-day mortality in multivariate analysis. By rounding to the next positive integer value, the score point could be defined according to the value of the β-coefficient, and the total risk score could be calculated by summing all the components of the score. The threshold values of the PRACTICE score were determined by using a receiver operating characteristic (ROC) curve and its sensitivity and specificity to evaluate the authenticity and accuracy of the PRACTICE score.

Results

During the study period, a total of 303 patients with AIS were treated by endovascular recanalization in six participating centers. Of these, 79 patients were excluded from the present study analysis for the following reasons: lost to follow-up at 90 days (n=12), only stenosis (n=54), ACA occlusion (n=5), PCA occlusion (n=3), and VA occlusion (n=5). A total of 224 patients finally met the study inclusion criteria. The mean age was 67.08±12.94 years, and 39.7% were female. Procedure-related complications occurred in 77 patients (34.3%), including vasospasm (n=33), stent thrombosis (n=4),

dissection (n=8), new vessel occlusion (n=29), and SAH caused by vascular perforation (n=3). ICH occurred in 25 patients, among whom 8 (3.6%) were symptomatic. At the 90-day follow-up, 49 (21.9%) patients had died, and 87 (38.8%) were independent (90-day MRS ≤2) .

The mortality group had a significantly higher prevalence of age≥80 (*P*<0.001), previous stroke (*P*=0.049), admission NIHSS score≥18 (*P*<0.001), FPG >150 mg/dl (*P*=0.023), and ICA or BA occlusion (*P*=0.001) than the survival group had (Table 1). There was no significant difference in the use of IVT, general anesthesia, stenting, procedure-related complications, recanalization or ICH between the mortality group and the survival group. In a multivariate logistic regression analysis (Table 2), age≥80 (adjusted odds ratio, 3.26; 95% CI, 1.45-7.33; *P*=0.004), previous stroke (adjusted odds ratio, 2.33; 95% CI, 1.04-5.21; *P*=0.040), admission NIHSS score≥18 (adjusted odds ratio, 2.37; 95% CI, 1.13-4.99; *P*=0.023), and ICA or BA occlusion (adjusted odds ratio, 2.92; 95% CI, 1.34-6.40; *P*=0.007) remained independently associated with a higher risk of 90-day mortality.

All variables positively associated with early stroke mortality in the multivariate model were subsequently used to develop the PRACTICE score, which is shown in Table 3. The AUC of the PRACTICE score was 0.744 (95% CI 0.669-0.820, *P*<0.001), which suggested moderate diagnostic value for the prediction of 90-day mortality (Figure 1). In terms of the cut-off value, ≥2.5 had a sensitivity of 69%, specificity of 67%, positive predictive value of 37%, and negative predictive value of 89% for predicting 90-day mortality.

Discussion

In our study, we used data from a multicenter prospective registry to identify pretreatment risk factors for 90-day mortality of AIS treated with MT. The score consists of 4 clinical and imaging variables: age, previous stroke, admission NIHSS and occlusion site, which can explain 69% of 90-day mortality and may provide useful information in the process of decision-making before MT.

Other studies to find pre-procedure predictors of outcome among patients undergoing endovascular treatment have been conducted. The earliest prediction model for the poor outcome of AIS with endovascular treatment is the Houston intra-arterial recanalization therapy (HIAT) score developed in 2009[14]. The HIAT score involves age 75 years, NIHSS 18 and admission glucose 150 mg/dl, with a total score of 3. The increasing HIAT scores revealed an increase in the rate of poor outcome on hospital discharge. The HIAT score is entirely based on clinical variables. However, there are a number of imaging factors that may correlate with outcome after endovascular treatment. The HIAT2 score is the optimized version of the HIAT score by inclusion of ASPECTS, which more accurately predicts poor outcome after intra-arterial recanalization therapy in anterior circulation occlusions[15]. The Stanford Age and DWI (SAD) score, a score encompassing age and diffusion-weighted imaging lesion volume[16], showed only a slightly better predictive accuracy than the HIAT score in the validation cohort (AUC for SAD = 0·69; HIAT = 0·66). Therefore, the HIAT2 and SAD scores suggest that the addition of imaging variables to a clinical prediction scoring system may enhance the ability to predict a poor outcome following endovascular treatment. However, no model seems suitable for making individual patient decisions because of their modest AUC values. In addition, the above mentioned score focused on poor outcome (MRS 4-6 points), not worst outcome/mortality. The totaled health risks in vascular events (THRIVE) incorporate history of hypertension, history of atrial fibrillation, DM, age, and stroke severity, and this assessment strongly predicts mortality at 90 days

(ROC AUC= 0.709)[10]. However, the THRIVE score only consists of clinical variables and lacks imaging variables that could contribute to mortality.

Our work is in agreement with previous research that has identified the occlusion site of the internal carotid artery/basilar artery as an independent predictor of 90-day mortality[7]. In that study, successfully recanalized patients had lower mortality (25.2% versus 46.9%, P<0.001). In our study, the survival group had higher rates of successful recanalization than the mortality group, but the difference was not statistically significant. In particular, a multiple regression analysis of the North American Solitaire Acute Stroke (NASA) registry showed that occlusion sites of the internal carotid artery or basilar artery carry a worse prognosis than middle cerebral artery (MCA) occlusions despite successful recanalization[17]. Another study examined patients with acute occlusion of the distal ICA treated with IAT or IV rt-PA, and the mortality rate was 50% despite complete recanalization[18]. Although basilar occlusion accounts for approximately 5–10% of all proximal intracranial occlusions, the mortality is higher than that in patients with large vessel occlusion of the anterior circulation[6,7]. This correlation may be the result of a high lesion volume with proximal arterial occlusion, which is an independent predictor of 90-day mortality[16,19].

High NIHSS on admission has previously been correlated with poor outcomes or mortality after endovascular treatment by several studies[3,7-10]. In the present study, we determined a cut-off value of 18, which was predictive of 90-day mortality despite recanalization. Patients who present with a high NIHSS have even poorer outcomes with intravenous therapy or medical management compared with endovascular treatment[3].

Age has previously been associated with poor outcome in patients treated with intravenous therapy and endovascular treatment[14,15,10,16,20]. In our study, age ≥80 years was a significant independent predictor of 90-day mortality and scored two points in the model. Very recently, an analysis of German Stroke Registry–Endovascular Treatment (GSR-ET) showed that patients aged ≥90 years have higher mortality for thrombectomy[21]. Decision-making for thrombectomy in patients aged ≥90 years should be premised on a case-by-case basis with regard to admission NIHSS and ASPECT scores.

PRACTICE score has only moderate predictive power (AUC=0.74) for predicting mortality, which seems unsuitable for making decision to proceed to MT.However, the MT decision should be made individually based on clinical judgment and family dscission. Until prospective data from randomized trials are available, the PRACTICE score could be useful to provide valuable prognostic data and to adjust expectations of outcome before MT.

Limitations

There are several limitations to our study. Firstly, the PRACTICE score was only validated in the primary dataset. Future external validation should be performed in another dataset. Secondly, the imaging assessments were not adjudicated by a core laboratory, which could introduce a bias in estimates. Thirdly, potential Berkson's bias (selection bias) was inevitable due to the hospital-based study design. This population was not only exactly representative of the whole general population, but it was also difficult to estimate the mortality of a matched total population sample in China, preferably in the region of Guangdong. Fourthly, some of the clinical variables obtained from medical records could have resulted in misclassification bias. Nevertheless, it seems reasonable to assume that if misclassification bias was present, it was not related to all-cause mortality, thus could be viewed as

nondifferential misclassification.Finally, the small sample size limited stratified analysis of predictor for insuffcient statistical power,scuh as age and NIHSS score.

Conclusion

In summary, a prediction score based on age, previous stroke, admission NIHSS and occlusion site predicted 90-day mortality following MT with moderate accuracy. This score may provide useful information in the process of decision-making before MT. But the score needs to be prospectively validated.

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Author Contributions

Zhi Yang and Li'an Huang organized this research. Hao Li and Shi-sheng Ye were mainly responsible for collecting data, data proofreading, data statistical analysis and writing the paper. All the authors participated in the initiation of the research project and the design of the research contents. The research plan and paper case report form (CRF) were written by Zhi Yang, Li'an Huang, Hong-zhuang Li, Wen-jun Wu, Zhi-lin Wu and Wang-tao Zhong. Yuan-ling Wu, Sheng-ming Huang, Hao Li, Shi-sheng Ye, Yong-xin Li, Kui Lu, Jing-bo Huang, Qiao-ling Wu, Hai Chen, Li Yuan, Lve Chen, Jian-zhou Wu, Wen-chuan Xian and Feng Liao were mainly responsible for the collection of cases in each center, completion of the paper CRF and the registration of data on the eCRF registration website. All authors have read and approved the final manuscript.

Statement of Ethics

The registry study protocol was approved by the ethics committee of First Affiliated Hospital of Jinan University (ID:2017007).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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Data sharing statement : The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1. Bivariate Analysis for 90-Day Mortality

Variables	Mortality N=49	Survival N=175	*P* Value
≥80, n (%)	18 36.7%	25 14.3%	*P* 0.001
Male sex, n (%)	31 63.3%	104 59.4%	*P*=0.628
Smoking, n (%)	12 24.5%	46 26.3%	*P*=0.800
Hypertension, n (%)	27 55.1%	80 45.7%	*P*=0.245
Diabetes, n (%)	12 24.5%	28 16.0%	*P*=0.170
Atrial fibrillation, n (%)	18 36.7%	54 30.9%	*P*=0.436
Coronary artery disease, n (%)	9 18.4%	17 9.7%	*P*=0.095
Previous stoke, n (%)	16 32.7%	34 19.4%	*P*=0.049
TOAST classification, n (%)			*P*=0.902
Large artery atherosclerosis, n (%)	18 36.7%	68 38.9%	
Cardioembolism, n (%)	21 42.9%	79 45.1%	
Others, n (%)	10 20.4%	28 16.0%	
Admission NIHSS score≥18, n (%)	33 67.3%	66 37.7%	*P* 0.001
FPG 150 mg/dl	22 47.8%	50 29.9%	*P*=0.023
LDL 160 mg/dl	12 (26.7%)	31 (18.6%)	*P*=0.230
Time from onset to groin puncture			*P*=0.611
6.0 hours, n (%)	27 55.1%	110 62.9%	
6.0-12.0 hours, n (%)	19 38.8%	57 32.6%	
≥12 hours, n (%)	3 6.1%	8 4.6%	
ASPECTS≥6, n (%)	30 88.2%	148 94.9%	*P*=0.233
Occlusion site, n (%)			*P*=0.001
MCA, n (%)	13 26.5%	92 52.6%	
ICA/BA, n (%)	36 73.5%	83 47.4%	
Use of IVT, n (%)	19 38.8%	67 38.3%	*P*=0.950
General anesthesia	6 12.0%	27 15.4%	*P*=0.143

Thrombectomy scheme, n (%)			*P*=0.156
Balloon guiding catheter	1 2.0%	1 0.6%	
Direct-aspiration first-pass technique	9 18.4%	17 9.7%	
Solumbra	4 8.2%	36 20.6%	
Stent retriever-mediated manual aspiration thrombectomy	2 4.1%	14 8.0%	
Routine embolectomy	30 61.2%	94 53.7%	
Mixed scheme	3 6.1%	13 7.4%	
Stenting (extracranial stenting and/or intracranial stenting)	21 41.2%	69 38.8%	*P*=0.756
Procedure-related complications			*P*=0.605
Vasospasm	5 10.4%	28 16.1%	
Stent thrombosis	0 0%	4 2.3%	
Dissection	2 4.2%	6 3.4%	
Embolism in a new territory	9 18.8%	20 11.5%	
SAH caused by vascular perforation	1 2.1%	2 1.1%	
Recanalization (postprocedure mTICI≥2b)	44 (86.3%)	157 (89.7%)	*P*=0.491
ICH			*P*=0.915
SICH	3(4.1%)	5 (2.9%)	
aSICH	6 (12.2%)	11 (6.3%)	

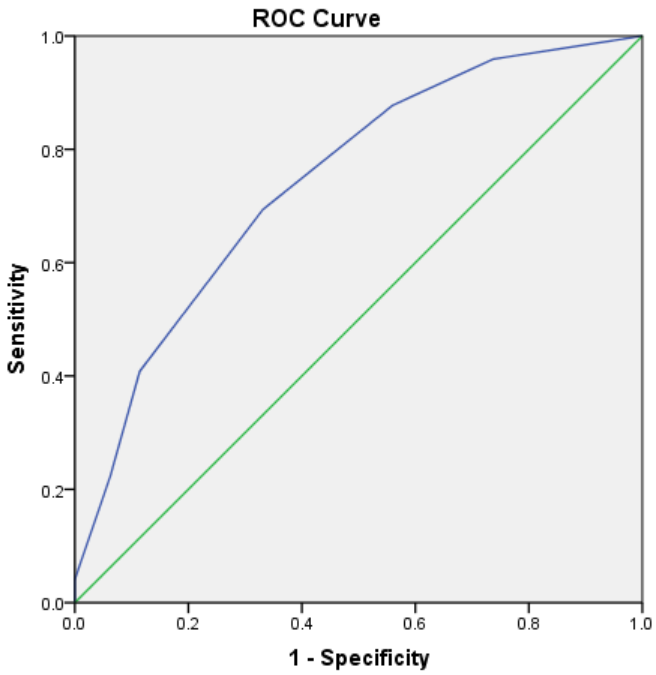
Table 2. Multivariate Logistic Regression Model Including Variables Associated with 90-Day Mortality

Variables	β	OR (95% CI)	*P* Value
Age≥80	1.181	3.26 (1.45-7.33)	*P*=0.004
Previous stoke	0.844	2.33 (1.04-5.21)	*P*=0.040
Admission NIHSS score≥18	0.863	2.37 (1.13-4.99)	*P*=0.023
FPG 150 mg/dl	0.646	1.91 (0.92-3.97)	*P*=0.084
Occlusion site			
MCA	Reference	Reference	Reference
ICA/BA	1.072	2.92 (1.34-6.40)	*P*=0.007

Table 3. Predicting 90-Day Mortality of AIS with MT (PRACTICE)

Risk factors for 90-day mortality	Points
Age≥80	2
Previous stoke	1
ICA/BA occlusion	2
Admission NIHSS≥18	1
Maximal score points	6

Figure 1. AUC of the Predicting 90-Day Mortality of AIS with MT (PRACTICE) score.



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	3
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*3-4*
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	n/a

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	n/a
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	4

Continued on next page

Results			
Participants	13 *	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14 *	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15 *	*Cohort study*—Report numbers of outcome events or summary measures over time	*5*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	8

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Predicting mortality in acute ischemic stroke treated with mechanical thrombectomy: Analysis of a multicenter prospective registry

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Predicting mortality in acute ischemic stroke treated with mechanical thrombectomy: Analysis of a multicenter prospective registry

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†Both authors contributed equally to this work.

Number of Tables: 3; Number of Figures: 1; Word count: 3105.

Keywords: acute ischemic stroke, mechanical thrombectomy, mortality, predictors, score

Abstract

Objectives: We aimed to determine predictors of mortality within 90 days and develop a simple score for patients with mechanical thrombectomy(MT).
Design: Analysis of a multicenter prospective registry.
Setting: In six participating centers, acute ischemic stroke patients (AIS) treated by MT between March 2017 and May 2018 were documented prospectively.
Participants: 224 patients with AIS were treated by MT.
Results: Of 224 patients, 49 (21.9%) patients died, and 87 (38.8%) were independent. Variables associated with 90-day mortality were age, previous stroke, admission National Institutes of Health Stroke Scale (NIHSS), fasting blood glucose (FBG) and occlusion site. Logistic regression identified 4 variables independently associated with 90-day mortality: age≥80 (OR 3.26, 95% CI 1.45-7.33), previous stroke (OR 2.33, 95% CI 1.04-5.21), admission NIHSS≥18 (OR 2.37, 95% CI 1.13-4.99), and internal carotid artery (ICA) or basilar artery (BA) occlusion (OR 2.92, 95% CI 1.34-6.40). Using these data, we developed Predicting 90-days mortality of acute ischemic stroke with mechanical thrombectomy (PRACTICE) score ranging from 0 to 6 points. The receiver operator curve analysis found that PRACTICE score (area under the curve[AUC] = 0.744, 95% confidence interval [CI] 0.669-0.820) was numerically better than iScore (AUC =0.661, 95% CI 0.577-0.745) and PREMISE score (AUC =0.638, 95% CI 0.551-0.725) for predicting 90-day mortality.
Conclusions: We developed a simple score to estimate the 90-day mortality of AIS patients treated with MT. But the score needs to be prospectively validated.

Strengths and limitations of this study

The study used multicenter prospective data from consecutively admitted ischemic stroke patients treated with mechanical thrombectomy.
Multivariate logistic regression analysis only used variables before the procedure, predicting 90-day mortality before mechanical thrombectomy.
The PRACTICE score was only validated in the primary dataset, and future external validation should be performed in another dataset.
The study was based on a retrospective analysis of a prospective observational registry.

Introduction

Previous randomized controlled trials (RCTs) have demonstrated the overwhelming benefit of mechanical thrombectomy (MT) for acute ischemic stroke (AIS) due to emergent large vessel occlusion[1-6]. Although patients undergo MT as first-line therapy, the mortality within 90 days remains high: more than 30% in patients with acute basilar artery occlusion and approximately 15% in patients with large-vessel occlusion in the anterior circulation[6,7]. Previous studies have found predictors associated with mortality in ischemic stroke patients, such as age, diabetes mellitus, National Institute of Health Stroke Scale (NIHSS) score, vessel occlusion site, increased DWI lesional volume**,** passes with the thrombectomy device and use of rescue therapy[7-11].The ability to predict mortality from information available prior to MT could be informative for patients and their family members. Such knowledge would impact on family members decision-making before MT and neurologists management decisions as well as medical care after MT. Unfortunatly, a prognostic scoring system to predict mortality in patients undergoing MT has been less intensively addressed thus far. Many prognostic scoring system , such as Houston intra-arterial recanalization therapy (HIAT) score, HIAT2 score,Stanford Age and DWI (SAD) score and the totaled health risks in vascular events (THRIVE) score were developed to predict poor outcome[8,11-13], but not for mortality specially. The iScore and PLAN score were developed for mortality prediction in acute ischemic stroke[14,15]. However, iScore and PLAN score were validated to predict outcomes in patients undergoing endovascular therapy due to anterior circulation large artery occlusion, showing moderate predictive accuracy (iScore AUC =0.76 and PLAN score AUC =0.73)[16]. Recently, the Predicting Early Mortality from Ischemic Stroke (PREMISE) score was developed to estimate early mortality of ischemic stroke patients treated at a stroke unit with good predictive accuracy (AUC =0.879)[10]. Howervr, PREMISE score derived from nationwide Austrian Stroke Unit Registry, including a relatively small patients treated with MT, and the validation of PREMISE score in thrombectomy cohort has not been reported yet.

Overall, the prognostic scoring system to predict mortality of patients with MT remain lacking, and it is critical to avoid futile MT by predicting mortality from clinical and imaging information available prior to MT. Our study aimed to determine predictors of mortality within 90 days, develop a simple scoring instrument for patients with MT and compared the predictive power with the previous prognostic tools(iScore, PREMISE score) in a multicenter prospective registry study for endovascular treatment of acute ischemic stroke (ET-AIS).

Method

Patients Selection

Three hundred and three consecutive patients presenting with acute ischemic stroke treated by endovascular treatment (EVT) were registered in the ET-AIS registry during March 2017 and May 2018. ET-AIS was a multicenter, prospective and observational registry study involving six comprehensive stroke centers in China. In our study, six comprehensive stroke centers were divided into low volume center (Zhongshan People's Hospital, Yunfu People's Hospital,Affiliated Hospital of Guangdong Medical University), medium volume center (First Affiliated Hospital of Jinan University, Shunde Hospital of Southern Medical University)and high volume center(Maoming People's Hospital) according to the number of patients included in ET-AIS registry. Low, medium and high volume center were defined as number of included patients <50, 50≤ included patients <100, and included patients ⩾ 100. Patients receiving intravenous thrombolysis (IVT) prior to EVT were acceptable, consistent with current guidelines[17]. The registry study protocol was approved by the ethics committee of each participating center, including ethics committee of First Affiliated Hospital of Jinan University**,** **e**thics **c**ommittee of Maoming People's Hospital, **e**thics **c**ommittee of Shunde Hospital of Southern Medical University, **e**thics **c**ommittee of Zhongshan People's Hospital, **e**thics **c**ommittee of Yunfu People's Hospital and **e**thics **c**ommittee of Affiliated Hospital of Guangdong Medical University, and registered on the Chinese Clinical Trial Registry (http://www.chictr.org.cn; ChiCTR-OOC-17013052).

All consecutive patients with the following criteria were included: (1) age 18 years or older; (2) diagnosis of an AIS with proven large vessel occlusion confirmed by digital subtraction angiography (DSA); (3) treatment with or without intravenous thrombolysis prior to MT; and (4) treated with MT within 12 hours of symptom onset. Patients with prestroke functional dependence (modified Rankin

Scale [MRS] score >2), only intracranial large vascular stenosis, only anterior cerebral artery (ACA) occlusion, only posterior cerebral artery (PCA) or vertebral artery (VA) occlusion were excluded.

Study Variables and Outcome Definition

All data, including baseline characteristics, procedure details and outcome, were recorded on case report forms (CRFs). Patient demographics included age and gender. The main vascular risk factors included smoking(defined as self-reports of cigarette smoking in the past, or currently), hypertension, diabetes mellitus, coronary artery disease, atrial fibrillation, and previous stroke. A history of hypertension, diabetes mellitus, coronary artery disease, and atrial fibrillation was based on documentation at admission and did not include a new diagnosis made during incident hospitalization. Laboratorial tests included admission fasting plasma glucose (FPG) and admission low-density lipoprotein cholesterol (LDL-C). Clinical and radiological data included the admission National Institute of Health Stroke Scale (NIHSS) score, Alberta Stroke Program Early CT Score (ASPECTS) on noncontrast computed tomography (CT), occlusion site, Trial of ORG 10172 in the Acute Stroke Treatment (TOAST) classification, preprocedure modified thrombolysis in cerebral infarction [m-TICI] score and time from onset to groin puncture. Procedure details included intravenous thrombolysis (IVT) prior to the procedure, methods of anesthesia, stenting (extracranial stenting and/or intracranial stenting), procedure-related complications. Outcomes included successful recanalization (defined as postprocedure m-TICI ≥2b), intracranial hemorrhage within 24 hours post-MT, 90-day favorable outcome (defined as MRS≤2), and 90-day mortality (defined as MRS=6). Intracranial hemorrhage (ICH) was defined by the Heidelberg Bleeding Classification and classified into symptomatic intracranial hemorrhage (SICH) and asymptomatic intracranial hemorrhage (aSICH) [18]. SICH confirmed by the 24 hours follow-up head CT or magnetic resonance imaging (MRI) with a ⩾4 point NIHSS score increase according to the Heidelberg criteria. A follow-up was performed at 90 days by neurological physicians or trained research nurses during face-to-face interviews or via telephone conversations with the patient, their relatives, or their general practitioner. More details of variables and outcomes definition are shown in supplementary material.

Endovascular Procedures

Before entry into the neuroangiography suite, all patients or legally authorized representatives signed informed consent forms. All procedures were performed under general anesthesia or conscious sedation. The major revascularization method was MT using a stent retriever or direct aspiration at the operator's discretion. If underlying intracranial atherosclerotic stenosis (ICAS) was detected, balloon angioplasty or stenting was performed when considered necessary. Intra-arterial thrombolysis was allowed as adjuvant therapy for some patients. Recanalization status was quantified by using the m-TICI score based on the final angiogram, and successful recanalization was defined as a m-TICI score ≥2b[19]. All patients underwent head CT scan or MRI within 24 hours after the procedure to assess hemorrhagic complications. Specific endovascular procedures and preoperative anesthesia methods were chosen by operators at each center. For postoperative antithrombotic drugs, antiplatelet drugs or anticoagulants were selected depending on the stroke etiology.

Calculation of iScore and PREMISE Score

The iScore has 30-Day and 1-Year version, and we use the 30-day version in this study, which derived from age(1 point for per year), sex(10 points for male), stroke severity (105 points for Canadian Neurological Scale (CNS)=0, 65 points for CNS ≤4, 40 points for CNS=5-7 and 0 point for CNS ≥8), stroke subtype(0 point for lacunar, 30 points for nonlacunar and 35 points for undetermined origin), risk factor(10 points for atrial fibrillation and congestive heart failure respectively), comorbid condition(10 points for cancer and 35 points for renal dialysis), preadmission disability(15 points for dependent), and glucose on admission(15 points for≥ 135mg/dl)[14]. In ET-AIS registry, stroke severity was assessed on admission by using the NIHSS, which could be converted to CNS score according to the following conversion: a CNS score of 1 to 4 equals an NIHSS score of 14 to 22, a CNS score of 5 to 7 equals an NIHSS score of 9 to 13, a CNS score of ≥ 8 equals an NIHSS score of ≤8, and a CNS score of 0 equals an NIHSS score of >22[20].

The PREMISE score with a total score of 12 was calculated on the basis of age(1 point for 60-69 years and 2 point for ≥70 years), stroke severity (2 points for NIHSS score 5-11, 4 points for NIHSS score 12-23, 5 points for NIHSS score ≥24), prestroke functional disability (1 point for MRS scores 1–5),

preexisting heart disease(1 point for yes), diabetes mellitus(1 point for yes), posterior circulation stroke syndrome(1 point for yes), and nonlacunar stroke cause(1 point for yes)[10].

Statistical Analysis and Score Development

Statistical analyses were performed using SPSS 25.0 (SPSS, Chicago, IL, USA). A *P* value <0.05 was considered statistically significant (2-sided). Continuous variables are reported as the means ± standard deviation or medians (interquartile range [IQR]), and categorical variables are reported as frequencies. Comparisons were performed on mortality and survival using the Pearson chi-square test, independent-samples *t* test, and Mann-Whitney *U* test. To account for multiple testing, the significance level was set at *P*<0.05. Multivariate logistic regression analysis was performed to determine independent predictors for 90-day mortality. We tested the association of procedure-related variables with mortality; however, because the primary goal of the study was predicting mortality before the procedure, these variables were not used in the multivariate model.

The PRACTICE score was developed based on variables that were independently associated with 90-day mortality in multivariate analysis. By rounding to the next positive integer value, the score point could be defined according to the value of the β-coefficient, and the total risk score could be calculated by summing all the components of the score. The threshold values of the PRACTICE score were determined by using a receiver operating characteristic (ROC) curve and its sensitivity and specificity to evaluate the authenticity and accuracy of the PRACTICE score. We also validated the iScore and PREMISE score in our registry, comparing the predictive power with PRACTICE score. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test.

Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Results

During the study period, a total of 303 patients with AIS were treated by endovascular recanalization in six participating centers. Of these, 79 patients were excluded from the present study analysis for the following reasons: lost to follow-up at 90 days (n=12), only stenosis (n=54), ACA occlusion (n=5), PCA occlusion (n=3), and VA occlusion (n=5). A total of 224 patients finally met the study inclusion criteria. The mean age was 67.08±12.94 years, and 39.7% were female. Procedure-related complications occurred in 77 patients (34.3%), including vasospasm (n=33), stent thrombosis (n=4), dissection (n=8), new vessel occlusion (n=29), and subarachnoid hemorrhage (SAH) caused by vascular perforation (n=3). ICH occurred in 25 patients, among whom 8 (3.6%) were symptomatic. At the 90-day follow-up, 49 (21.9%) patients had died, and 87 (38.8%) were independent (90-day MRS ≤2) .

The mortality group had a significantly higher prevalence of age≥80 (*P*<0.001), previous stroke (*P*=0.049), admission NIHSS score≥18 (*P*<0.001), FPG >150 mg/dl (*P*=0.023), and ICA or BA occlusion (*P*=0.001) than the survival group had (Table 1). There was no significant difference in the use of IVT, general anesthesia, stenting, procedure-related complications, recanalization or ICH between the mortality group and the survival group. In a multivariate logistic regression analysis (Table 2), age≥80 (adjusted odds ratio, 3.26; 95% CI, 1.45-7.33; *P*=0.004), previous stroke (adjusted odds ratio, 2.33; 95% CI, 1.04-5.21; *P*=0.040), admission NIHSS score≥18 (adjusted odds ratio, 2.37; 95% CI, 1.13-4.99; *P*=0.023), and ICA or BA occlusion (adjusted odds ratio, 2.92; 95% CI, 1.34-6.40; *P*=0.007) remained independently associated with a higher risk of 90-day mortality. Calibration of the model was good (Hosmer-Lemeshow goodness-of-fit P=0.77).

All variables positively associated with early stroke mortality in the multivariate model were subsequently used to develop the PRACTICE score, which is shown in Table 3. The AUC of the PRACTICE score was 0.744 (95% CI 0.669-0.820, *P*<0.001), which suggested moderate diagnostic value for the prediction of 90-day mortality (Figure 1). In terms of the cut-off value, ≥2.5 had a sensitivity of 69%, specificity of 67%, positive predictive value of 37%, and negative predictive value of 89% for predicting 90-day mortality. Furthermore, PRACTICE score had better prediction power than iScore (AUC =0.661, 95% CI 0.577-0.745) and PREMISE score (AUC =0.638, 95% CI 0.551-0.725) for predicting 90-day mortality.

Discussion

In our study, we used data from a multicenter prospective registry to identify pretreatment risk factors for 90-day mortality of AIS treated with MT. The score consists of 4 clinical and imaging variables: age, previous stroke, admission NIHSS and occlusion site, which can explain 69% of 90-day mortality and may provide useful information in the process of decision-making before MT.

Other studies to find predictors of outcome among patients undergoing endovascular treatment have been conducted. The earliest prediction model for the poor outcome of AIS with endovascular treatment is the Houston intra-arterial recanalization therapy (HIAT) score developed in 2009[12]. The HIAT score involves age＞75 years, NIHSS ＞18 and admission glucose ＞150 mg/dl, with a total score of 3. The increasing HIAT scores revealed an increase in the rate of poor outcome on hospital discharge. The HIAT score is entirely based on clinical variables. However, there are a number of imaging factors that may correlate with outcome after endovascular treatment. The HIAT2 score is the optimized version of the HIAT score by inclusion of ASPECTS, which more accurately predicts poor outcome after intra-arterial recanalization therapy in anterior circulation occlusions[13]. The Stanford Age and DWI (SAD) score, a score encompassing age and diffusion-weighted imaging lesion volume[11], showed only a slightly better predictive accuracy than the HIAT score in the validation cohort (AUC for SAD = 0·69; HIAT = 0·66). Therefore, the HIAT2 and SAD scores suggest that the addition of imaging variables to a clinical prediction scoring system may enhance the ability to predict a poor outcome following endovascular treatment. However, no model seems suitable for making individual patient decisions because of their modest AUC values. In addition, the above mentioned score focused on poor outcome (MRS 4-6 points), not worst outcome/mortality. The totaled health risks in vascular events (THRIVE) incorporate history of hypertension, history of atrial fibrillation, DM, age, and stroke severity, and this assessment strongly predicts mortality at 90 days (ROC AUC= 0.709)[8]. However, the THRIVE score only consists of clinical variables and lacks imaging variables that could contribute to mortality.

The score variables of iScore and PLAN score were easy-to-collect clinical parameters and comorbid conditions, which were available at the time of admission and may be determined by nonspecialist clinicians. But in the our registry, the detail of neurologic deficit (each item of NIHSS score) was not performed systematically, so the variable were not available on all patients and PLAN score was not included in the analysis. Xiaopeng Chu et al[16] validated iScore and PLAN score in AIS with anterior circulation large vessel occlusion undergoing MT in Chinese, and found that iScore is a more valid predictive tool. In our study, PRACTICE score performed better than iScore(AUC = 0.744 VS AUC =0.661). The PREMISE score showed a low predictive power (AUC=0.638) for predicting 90-day mortality in our study. It is possible that PREMISE score was more suitable for predicting early (≤7 days poststroke) mortality of patients admitted with ischemic stroke treated with medical treatment.

Our work is in agreement with previous research that has identified the occlusion site of the internal carotid artery/basilar artery as an independent predictor of 90-day mortality[7]. In that study, successfully recanalized patients had lower mortality (25.2% versus 46.9%, P<0.001). In our study, the survival group had higher rates of successful recanalization than the mortality group, but the difference was not statistically significant. In particular, a multiple regression analysis of the North American Solitaire Acute Stroke (NASA) registry showed that occlusion sites of the internal carotid artery or basilar artery carry a worse prognosis than middle cerebral artery (MCA) occlusions despite successful recanalization[21]. Another study examined patients with acute occlusion of the distal ICA treated with IAT or IV rt-PA, and the mortality rate was 50% despite complete recanalization[22]. Although basilar occlusion accounts for approximately 5–10% of all proximal intracranial occlusions, the mortality is higher than that in patients with large vessel occlusion of the anterior circulation[6,7]. This correlation may be the result of a high lesion volume with proximal arterial occlusion, which is an independent predictor of 90-day mortality[11,23].

High NIHSS on admission has previously been correlated with poor outcomes or mortality after endovascular treatment by several studies[3,7-10]. In the present study, we determined a cut-off value of 18, which was predictive of 90-day mortality. Patients who present with a high NIHSS have even poorer outcomes with intravenous therapy or medical management compared with endovascular treatment[3].

Age has previously been associated with poor outcome in patients treated with intravenous therapy and endovascular treatment[10-13,24]. In our study, age ≥80 years was a significant independent predictor of 90-day mortality and scored two points in the model. Very recently, an analysis of German Stroke Registry–Endovascular Treatment (GSR-ET) showed that patients aged ≥90 years have higher mortality for

thrombectomy[25]. Decision-making for thrombectomy in patients aged ≥90 years should be premised on a case-by-case basis with regard to admission NIHSS and ASPECT scores.

PRACTICE score has only moderate predictive power (AUC=0.74) for predicting mortality, which seems unsuitable for making decision to proceed to MT.However, the MT decision should be made individually based on clinical judgment and family dscission. Until prospective data from randomized trials are available, the PRACTICE score could be useful to provide valuable prognostic data and to adjust expectations of outcome before MT.

Limitations

This study has several limitations. Firstly, the study was based on a retrospective analysis of a prospective observational registry, and PRACTICE score needs to be validated prospectively in another dataset. Secondly, the imaging assessments were not adjudicated by a core laboratory, which could introduce a bias in estimates. Thirdly, potential Berkson's bias (selection bias) was inevitable due to the hospital-based study design. This population was not only exactly representative of the whole general population, but it was also difficult to estimate the mortality of a matched total population sample in China, preferably in the region of Guangdong. Fourthly, some of the clinical variables obtained from medical records could have resulted in misclassification bias. Nevertheless, it seems reasonable to assume that if misclassification bias was present, it was not related to all-cause mortality, thus could be viewed as nondifferential misclassification.Finally, the small sample size limited stratified analysis of predictor for insuffcient statistical power,such as age and NIHSS score.

Conclusion

In summary, a prediction score based on age, previous stroke, admission NIHSS and occlusion site predicted 90-day mortality following MT with moderate accuracy. This score may provide useful information in the process of decision-making before MT. But the score needs to be prospectively validated.

Author affliations

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Acknowledgement : We thank all ET-AIS registry collaborators.

Author Contributions

Zhi Yang and Li'an Huang organized this research. Hao Li and Shi-sheng Ye were mainly responsible for collecting data, data proofreading, data statistical analysis and writing the paper. All the authors participated in the initiation of the research project and the design of the research contents. The research plan and paper case report form (CRF) were written by Zhi Yang, Li'an Huang, Hong-zhuang Li, Wen-jun Wu, Zhi-lin Wu and Wang-tao Zhong. Yuan-ling Wu, Sheng-ming Huang, Hao Li, Shi-sheng Ye, Yong-xin Li, Kui Lu, Jing-bo Huang, Qiao-ling Wu, Hai Chen, Li Yuan, Lve Chen, Jian-zhou Wu, Wen-chuan Xian and Feng Liao were mainly responsible for the collection of cases in each center, completion of the paper CRF and the registration of data on the eCRF registration website. Tao-hsin Tung assisted with analysis of data and manuscript revision. All authors have read and approved the final manuscript.

Statement of Ethics

The registry study protocol was approved by the ethics committee of First Affiliated Hospital of Jinan University (ID:2017007), ethics committee of Maoming People's Hospital, ethics committee of Shunde Hospital of Southern Medical University, ethics committee of Zhongshan People's Hospital, ethics committee of Yunfu People's Hospital and ethics committee of Affiliated Hospital of Guangdong Medical University.

Conflict of Interest Statement

None declared.

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Data sharing statement : The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1. Bivariate Analysis for 90-Day Mortality

Variables	Mortality N=49	Survival N=175	*P* Value
≥80, n (%)	18（36.7%）	25（14.3%）	*P*＜0.001
Male sex, n (%)	31（63.3%）	104（59.4%）	*P*=0.628
Smoking, n (%)	12（24.5%）	46（26.3%）	*P*=0.800
Hypertension, n (%)	27（55.1%）	80（45.7%）	*P*=0.245
Diabetes, n (%)	12（24.5%）	28（16.0%）	*P*=0.170
Atrial fibrillation, n (%)	18（36.7%）	54（30.9%）	*P*=0.436
Coronary artery disease, n (%)	9（18.4%）	17（9.7%）	*P*=0.095
Previous stoke, n (%)	16（32.7%）	34（19.4%）	*P*=0.049
TOAST classification, n (%)			*P*=0.902
Large artery atherosclerosis, n (%)	18（36.7%）	68（38.9%）	
Cardioembolism, n (%)	21（42.9%）	79（45.1%）	
Others, n (%)	10（20.4%）	28（16.0%）	
Admission NIHSS score≥18, n (%)	33（67.3%）	66（37.7%）	*P*＜0.001
FPG ＞150 mg/dl	22（47.8%）	50（29.9%）	*P*=0.023
LDL-C＞160 mg/dl	12 (26.7%)	31 (18.6%)	*P*=0.230
Time from onset to groin puncture			*P*=0.611
＜6.0 hours, n (%)	27（55.1%）	110（62.9%）	
6.0-12.0 hours, n (%)	19（38.8%）	57（32.6%）	
≥12 hours, n (%)	3（6.1%）	8（4.6%）	
ASPECTS≥6, n (%)	30（88.2%）	148（94.9%）	*P*=0.233
Occlusion site, n (%)			*P*=0.001
MCA, n (%)	13（26.5%）	92（52.6%）	
ICA/BA, n (%)	36（73.5%）	83（47.4%）	
Use of IVT, n (%)	19（38.8%）	67（38.3%）	*P*=0.950
General anesthesia	6（12.0%）	27（15.4%）	*P*=0.143
Stenting (extracranial stenting and/or intracranial stenting)	21（41.2%）	69（38.8%）	*P*=0.756
Procedure-related complications			*P*=0.605
Vasospasm	5（10.4%）	28（16.1%）	
Stent thrombosis	0（0%）	4（2.3%）	
Dissection	2（4.2%）	6（3.4%）	
Embolism in a new territory	9（18.8%）	20（11.5%）	
SAH caused by vascular perforation	1（2.1%）	2（1.1%）	
Recanalization (postprocedure mTICI≥2b)	44 (86.3%)	157 (89.7%)	*P*=0.491
ICH			*P*=0.915
SICH	3(4.1%)	5 (2.9%)	
aSICH	6 (12.2%)	11 (6.3%)	

TOAST: Trial of ORG 10172 in the Acute Stroke Treatment; FPG: fasting plasma glucose; LDL-C: low-density lipoprotein cholesterol; ASPECTS: Alberta Stroke Program Early CT Score; MCA: middle cerebral artery; ICA: internal carotid artery; BA:basilar artery; IVT: intravenous thrombolysis; SAH: subarachnoid hemorrhage; mTICI: modified thrombolysis in cerebral infarction; ICH: intracranial hemorrhage; SICH: symptomatic intracranial hemorrhage; aSICH: asymptomatic intracranial hemorrhage.

Table 2. Multivariate Logistic Regression Model Including Variables Associated with 90-Day Mortality

Variables	β	OR (95% CI)	*P* Value
Age≥80	1.181	3.26 (1.45-7.33)	*P*=0.004
Previous stoke	0.844	2.33 (1.04-5.21)	*P*=0.040
Admission NIHSS score≥18	0.863	2.37 (1.13-4.99)	*P*=0.023
FPG ＞150 mg/dl	0.646	1.91 (0.92-3.97)	*P*=0.084
Occlusion site			
MCA	Reference	Reference	Reference
ICA/BA	1.072	2.92 (1.34-6.40)	*P*=0.007

FPG: fasting plasma glucose; MCA: middle cerebral artery; ICA: internal carotid artery; BA:basilar artery.

Table 3. Predicting 90-Day Mortality of AIS with MT (PRACTICE)

Risk factors for 90-day mortality	Points
Age≥80	2
Previous stoke	1
ICA/BA occlusion	2
Admission NIHSS≥18	1
Maximal score points	6

ICA: internal carotid artery; BA:basilar artery.

Figure legend

Figure 1. Comparison of PRACTICE with iScore and PREMISE score by ROC curve analysis.

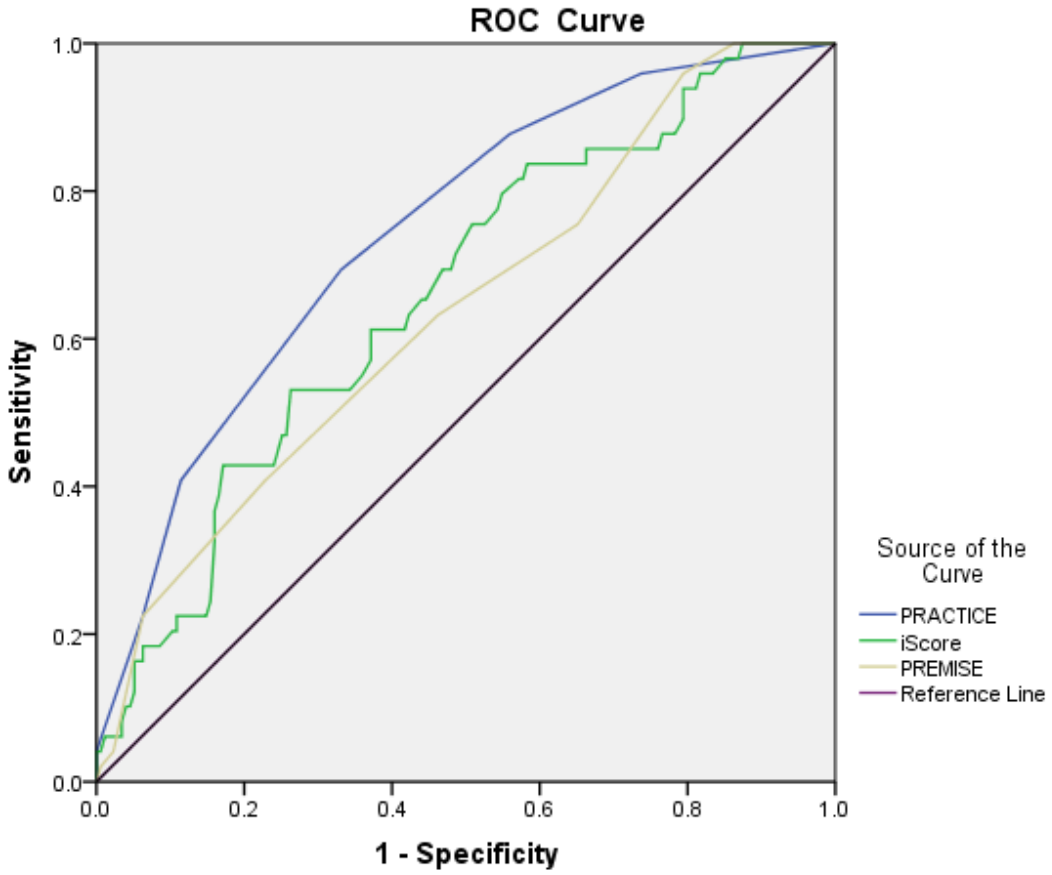

Figure 1. Comparison of PRACTICE with iScore and PREMISE score by ROC curve analysis.

List of study variables and outcomes definition

Smoking: defined as self-reports of cigarette smoking in the past, or currently.

Diabetes mellitus: defined as self-reports of diabetes mellitus or taking oral antidiabetic agents or injecting insulin.

Hypertension: defined as self-reports of hypertension, taking antihypertensive agents.

Atrial fibrillation: defined as self-reports of atrial fibrillation, taking or not taking anticoagulant agents.

Coronary artery disease: defined as self-reports of Coronary artery disease.

Previous stoke: defined as self-reports of stroke, including hemorrhagic and ischemic stroke.

TOAST classification: assessed by MRI, MRA and CTA based on Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria [1].

Vasospasm: vasospasm confirmed by angiogram during mechanical thrombectomy.

Stent thrombosis: stent thrombosis confirmed by angiogram during mechanical thrombectomy.

Dissection: dissection confirmed by angiogram during mechanical thrombectomy.

New vessel occlusion: new vessel occlusion confirmed by angiogram during mechanical thrombectomy.

SAH caused by vascular perforation: contrast material extravasation confirmed by angiogram during mechanical thrombectomy.

Intracranial hemorrhage: defined by the Heidelberg Bleeding Classification[2].

Symptomatic intracranial hemorrhage: confirmed by the 24 hours follow-up head CT/MRI with a ≥4 points NIHSS score increase according to the Heidelberg criteria [2].

Recanalization: defined as m-TICI score ≥2b on the final angiogram after thrombectomy[3].

Favorable outcome: defined as MRS score ≤2 points at the 90-day follow-up.

Mortality: defined as MRS score =6 at the 90-day follow-up.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	3
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4*
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	n/a

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	n/a
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-5
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	5

Continued on next page

Results			
Participants	13 *	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4-5
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14 *	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15 *	*Cohort study*—Report numbers of outcome events or summary measures over time	*5*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	8

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.