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National Institute of Health Stroke Scale was associated with the immediate and long-term prognosis of patients with acute ischemic stroke treated with intravenous thrombolysis

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SUMMARY

OBJECTIVE: The objective of this study was to examine whether the National Institute of Health Stroke Scale was associated with the short- and long-term prognosis of patients with acute ischemic stroke treated with intravenous thrombolysis.

METHODS: A total of 247 patients with acute ischemic stroke admitted to the hospital from April 2019 to October 2020 were retrospectively selected as study subjects, and the immediate and long-term prognosis after thrombolysis was assessed using the modified Rankin Scale and divided into good prognosis group (119 cases) and poor prognosis group (128 cases) based on the effect of thrombolysis. Both groups were treated with alteplase, the National Institute of Health Stroke Scale of the two groups was compared, and the factors affecting the prognosis of acute ischemic stroke were analyzed.

RESULTS: After intravenous thrombolysis, 24 h, and 7 days of treatment, the National Institute of Health Stroke Scale in the poor prognosis group was higher than those of patients in the good prognosis group, and the differences were statistically significant ($p<0.05$). The results of the multivariate analysis suggested that National Institute of Health Stroke Scale before treatment was an independent factor associated with the 3-month (OR: 1.068, 95%CI 1.015–1.123, $p=0.011$) and long-term poor prognosis (OR: 1.064, 95%CI 1.012–1.119, $p=0.015$) in patients with acute ischemic stroke receiving intravenous thrombolysis after adjustment of age, gender, body mass index, smoking, alcohol consumer, onset-to-door time, door-to-needle time, and imaging score.

CONCLUSION: The National Institute of Health Stroke Scale could be a promising indicator for the prognosis, and active intervention is needed to improve the quality of life in patients with acute ischemic stroke.

KEYWORDS: Acute ischemic stroke. Prognosis. Thrombolytic therapies.

INTRODUCTION

Acute ischemic stroke (AIS) is a common cerebrovascular disease with a rapid onset and a high disability and mortality rate[1]. It is a localized disorder of blood supply to the brain tissue region due to various causes, which subsequently results in neurological deficits due to Ischemia and hypoxia of brain tissue[2]. Most of these patients have severe vascular atherosclerosis and are often combined with other systemic diseases, which results in a relatively poor prognosis. Early opening of occluded vessels and restoration of intracerebral blood circulation are the keys to saving the lives of patients with AIS and improving their prognosis. Numerous studies have demonstrated that the ischemic hemispheric zone has viable cells, and early intravenous thrombolysis can re-establish circulation in the ischemic zone and reduce neuronal cell damage[3]. In this study, we used intravenous thrombolytic therapy with alteplase to treat the patients with AIS and analyzed the factors associated with the immediate and long-term prognosis of AIS.

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METHODS

Study design and population

This study was carried out in the Neurology Department of our hospital, in the period from April 2019 to October 2020. Patients were eligible for inclusion in the study if they were ≥18 years, had received the clinical diagnosis of AIS, and presenting within 24 h of symptom onset. IV rTPA was administered based on the Chinese Stroke Rehabilitation Guidelines for the early management of the AIS 2019 scientific statement. The IV thrombolysis administered was alteplase (Actilyse) by Boehringer-Ingelheim, Germany.

Inclusion criteria were as follows: (1) clinical symptoms met the diagnostic criteria of "Chinese Stroke Rehabilitation Guidelines (2011)"; (2) a confirmed diagnosis by physical examination, imaging, and neurological examination; (3) duration of illness <4.5 h; (4) indication for thrombolysis, i.e., blood pressure not exceeding 180/100 mmHg; and (5) patient (or family) agreed to thrombolytic therapy and signed an informed consent form.

Exclusion criteria were as follows: (1) combination with cerebrovascular malformation, cerebral aneurysm, and other diseases; (2) combination with active bleeding disease; (3) combination with renal failure, liver cancer, and other serious organic diseases; (4) combination with severe hypertension; (5) major surgery within the last 2 weeks; (6) recent use of anticoagulant drugs; and (7) allergic to the drugs used in the study.

The following clinical data were collected from patients, including age, sex, baseline characteristics, time from admission to thrombolysis (DNT), time from onset to thrombolysis (ONT), past history (smoking, hypertension, hyperlipidemia, diabetes, atrial fibrillation, stroke, history of antiplatelet drug use, and history of anticoagulant drug use), and modified Rankin Scale (mRS) score assessed 3 months after thrombolysis.

Intravenous thrombolysis

Patients were given 10% alteplase (Boehringer Ingelheim Pharma GmbH & Co. KG, specification: 50 mg/stem) mixed with saline and administered intravenously at 0.9 mg/kg, with a total drug volume of <90 mg. The remaining 90% alteplase was mixed with saline and administered intravenously by drip, with the dosing time controlled within 1 h. After treatment, patients with a stable condition and stable signs after treatment were considered to have a good prognosis (mRS≤2), and patients with insignificant changes or continuous deterioration or death after treatment were considered to have a poor prognosis (mRS≥2).

Observation indexes and evaluation criteria

The National Institute of Health Stroke Scale (NIHSS) was compared between the two groups[4-7]. The neurological deficits were scored based on the NIHSS scale before, after, 24 h, and 1 week after the treatment, respectively, with the highest score of 20, and the higher score indicates the more serious neurological deficits of the patients. The clinical outcome of patients was assessed by the mRS at 3 months and 1 year after the treatment. Patients were followed up for 1 year and inquired about their health condition. The mRS is a measuring method for disability. Scores according to the mRS range from 0 (no symptoms at all) to 6 (death). Patients' clinical outcome was categorized as favorable (score 0–2) or unfavorable (score 3–6)[8]. Systolic blood pressure: normal adult systolic blood pressure should be ≤140 mmHg; the higher the value, the more serious the disease. Diabetes history taunt: human blood glucose value >3.9–6.1 mmol/L can be determined as diabetes, and the higher the value, the more serious the degree of disease.

Statistical analysis

SPSS version 18.0 statistical software was used for data analysis. The measurement data were expressed as mean±standard deviation, and the count data were expressed as counts (percentages). The chi-square test was used for comparison between groups. Potential variables associated with the poor prognosis were screened in the univariate analysis, and confounding factors were adjusted in the multivariate analysis to obtain a risk model combined with independent risk factors. The difference was considered statistically significant when $p<0.05$.

RESULTS

Comparison of basic information between groups before and after treatment

In total, 247 patients were included in this study with a mean age of 61.9±13.4 years and 161 males (65.2%). There were 128 and 129 patients with a poor prognosis at 3-month and long-term follow-ups, respectively. Compared with patients with a good prognosis, those with a poor prognosis were more likely to be older and have a higher pre-onset mRS and imaging score ($p<0.05$ for both). There was no significant difference in other baseline characteristics between the two groups (Tables 1 and 2).

Comparison of National Institute of Health Stroke Scale scores between the 3-month good prognosis and bad prognosis before and after treatment

Table 1. Baseline characteristics based on the 3-month prognosis.

	Good prognosis (n=119)	Poor prognosis (n=128)	p-value
Age, years	59.7±12.9	63.9±13.5	0.013
Male	80 (67.2%)	81 (63.3%)	0.515
Height, cm	168.4±7.7	167.8±7.35	0.500
Weight, kg	69.0±10.7	69.6±12.2	0.684
BMI, kg/m^2	24.3±3.1	24.7±4.0	0.356
Pre-onset mRS	2.18±1.44	2.65±1.49	0.014
Systolic BP, mmHg	146.3±22.6	148.4±20.9	0.452
Diastolic BP, mmHg	85.2±12.8	84.2±13.2	0.573
Hypertension	44 (37.0%)	50 (39.1%)	0.736
Diabetes mellitus	17 (14.3%)	22 (17.2%)	0.532
Smoking	45 (37.8%)	42 (32.8%)	0.411
Alcohol consumer	28 (23.5%)	25 (19.5%)	0.444
ONT, min	148.3±70.3	152.5±56.3	0.607
DNT, min	51.5±32.4	50.2±28.9	0.745
rtPA, mg	54.33±11.62	54.94±13.60	0.706
NIHSS			
Before treatment	5.55±4.67	7.51±6.37	0.006
After treatment	3.90±3.89	6.31±5.98	<0.001
24 h after treatment	3.03±3.93	5.75±6.06	<0.001
7 days after treatment	1.79±2.93	4.42±5.81	<0.001
Imaging score	1.66±0.77	1.84±0.73	0.054

Values are expressed as n (%) or mean±standard deviation.

Table 2. Baseline characteristics based on the long-term prognosis.

	Good prognosis (n=118)	Poor prognosis (n=129)	p-value
Age, years	59.7±13.0	63.9±13.5	0.013
Male	79 (66.9%)	82 (63.6%)	0.577
Height, cm	168.4±7.7	167.8±7.3	0.577
Weight, kg	69.0±10.8	69.6±12.2	0.695
BMI, kg/m^2	24.3±3.1	24.7±4.0	0.399
Pre-onset mRS	2.18±1.44	2.65±1.48	0.012
Systolic BP, mmHg	146.2±22.7	148.5±20.8	0.412
Diastolic BP, mmHg	85.1±12.8	84.3±13.1	0.616
Hypertension	44 (37.3%)	50 (38.8%)	0.896
Diabetes mellitus	17 (14.4%)	22 (17.1%)	0.569
Smoking	44 (37.3%)	43 (33.3%)	0.516
Alcohol consumer	27 (22.9%)	26 (20.2%)	0.602
ONT, min	148.7±70.5	152.1±56.2	0.672
DNT, min	51.5±32.5	50.3±28.8	0.755
rtPA, mg	54.27±11.65	54.98±13.56	0.659
NIHSS			
Before treatment	5.58±4.68	7.47±6.35	0.008
After treatment	3.91±3.90	6.29±5.96	<0.001
24 h after treatment	3.06±3.94	5.70±6.06	<0.001
7 days after treatment	1.81±2.93	4.39±5.80	<0.001
Imaging score	1.64±0.76	1.85±0.73	0.032

Values are expressed as n (%) or mean±standard deviation.

Before the treatment, the NIHSS scores of the two groups were compared, and the difference was statistically significant (p<0.05). After the treatment, 24 h, and 7 days of treatment, the NIHSS scores of both groups were lower than those before treatment, and the NIHSS scores of the group with good prognosis were lower than those of the group with poor prognosis, and the differences were statistically significant (p<0.05) (Table 1).

Comparison of National Institute of Health Stroke Scale scores between the long-term good prognosis and bad prognosis before and after treatment

Before the treatment, the NIHSS scores of the two groups were compared, and the difference was statistically significant (p<0.05). After the treatment, 24 h, and 7 days of treatment, the NIHSS scores of both groups were lower than those before treatment, and the NIHSS scores of the group with a good prognosis were lower than those of the group with a poor prognosis, and the differences were statistically significant (p<0.05) (Table 2).

Multivariate logistic regression analysis for the 3-month pprognosis of ppatients with acute ischemic stroke

After adjustment of other confounding variables, the multivariate analysis suggested that only NIHSS before treatment (OR: 1.068, 95%CI 1.015–1.123, p=0.011) was associated with the 3-month poor prognosis in patients with AIS (Table 3).

Multivariate logistic regression analysis for the long-term prognosis of patients with acute ischemic stroke

Similar to the above, the multivariate analysis suggested that NIHSS before treatment (OR: 1.064, 95%CI 1.012–1.119, p=0.015) was an independent factor associated with the long-term poor prognosis in patients with AIS receiving intravenous thrombolysis after adjustment of age, gender, body mass index (BMI), smoking, alcohol consumer, onset-to-door time (ODT), DNT, and imaging score (Table 3).

Table 3. Multivariate logistic regression analysis.

Multivariate logistic regression analysis for 3-month prognosis			
Variables	**OR**	**95%CI**	**p-value**
Age ≥60 years	1.362	0.784–2.366	0.273
Male	1.037	0.544–1.974	0.203
BMI	1.044	0.970–1.123	0.251
Smoking	0.780	0.379–1.606	0.500
Alcohol consumer	0.978	0.454–2.110	0.955
ODT	1.002	0.997–1.006	0.450
DNT	0.996	0.987–1.006	0.443
NIHSS before treatment	1.068	1.015–1.123	0.011
Imaging score	1.263	0.882–1.808	0.203
Multivariate logistic regression analysis for long-term prognosis			
Variables	OR	95%CI	p-value
Age ≥60 years	1.399	0.805–2.428	0.233
Male	1.041	0.546–1.982	0.903
BMI	1.040	0.967–1.119	0.288
Smoking	0.800	0.389–1.647	0.545
Alcohol consumer	1.051	0.488–2.266	0.899
ODT	1.001	0.997–1.006	0.543
DNT	0.997	0.987–1.006	0.507
NIHSS before treatment	1.064	1.012–1.119	0.015
Imaging score	1.312	0.916–1.881	0.139

BMI: body mass index; ODT: onset-to-door time; DNT: door-to-needle time; NIHSS: National Institute of Health Stroke Scale.

DISCUSSION

As the aging society becomes more and more severe, the proportion of patients with AIS is increasing year by year, mainly because the elderly generally need to be bedridden for a long period of time, exercise is reduced, clinical symptoms are not obvious, various bodily functions are reduced, and the metabolic level is low, thus making atherosclerosis. AIS accounts for about 70% of all strokes. Early intravenous thrombolytic therapy effectively dissolves the thrombus, promotes the recovery of nerve and blood flow, prevents the occurrence of tissue edema, and provides protection for the patient's physical health. The clinical principles of treatment are thrombolysis, protection of the nervous system, lowering blood pressure, and increasing mobility. Early intravenous thrombolytic therapy effectively dissolves the thrombus, inhibits lipid peroxidation, and protects nerve cell function in order to promote the recovery of nerve and blood flow and prevent the occurrence of tissue edema, thus changing the patient's neurological deficit[3,9].

Intravenous thrombolysis is an important method for the early treatment of AIS. The European Travel Plan recommends first-line drug alteplase within 3 h of the acute onset of ischemic stroke, and the majority of scholars believe that intravenous thrombolysis for AIS can extend the time window to 4.5 h[10,11]. Alteplase is a thrombolytic agent, unlike the traditional thrombolytic drug urokinase, which specifically binds to the fibrin on the surface of the thrombus, activates fibrinogen, and converts it into fibrin, thus exerting an antithrombotic effect. Clinical studies have demonstrated that patients with AIS can be treated in hospitals 3–6 h after the onset of stroke. The shorter the time is, the more significant the treatment effect will be. The shorter the time is, the more significant the treatment effect will be, so early interventional intravenous thrombolysis treatment is the main method. In this study, after treatment, the NIHSS scores after treatment, 24 h, and 7 days in the poor prognosis group were higher than those in the good prognosis group, and the difference was statistically significant ($p<0.05$). It is suggested that NIHSS after treatment has a certain indicative function for both future and distant prognosis, and if patients have unsatisfactory NIHSS scores after thrombolytic therapy, it should be brought to the attention of physicians.

There are many causes of AIS, such as hypertension, coronary heart disease, atrial fibrillation, chronic bronchitis, diabetes mellitus, hyperlipidemia, and bad habits such as smoking and drinking, all of which can lead to insufficient blood supply to the brain, causing necrosis of brain tissue, which leads to sclerosis or thrombosis of the blood[12,13], and then blockage of blood vessels and acute cerebral hypoperfusion, which can seriously threaten life safety. Therefore, the earlier the clinical intervention of intravenous thrombolysis for AIS, the better the recovery of patients' health, thus reducing the death and disability rate and improving the treatment effect of patients[14,15].

There are some shortcomings in this study: first, this study is retrospective; again, non-intravenous thrombolysis patients were not included in this study, and some in-hospital stroke patients may have been lost to thrombolysis because of too late detection or process delays, which may have underestimated in-hospital stroke delays. Therefore, there is a need to further expand the sample size and conduct a more in-depth and objective study of in-hospital stroke.

In summary, the use of intravenous thrombolytic therapy in patients with AIS is clinically effective, and the shorter the duration of treatment, the more beneficial it is in reducing neurological deficits in patients with AIS. The shorter the treatment time, the better the reduction in neurological impairment.

The factors associated with AIS are related to underlying conditions such as hypertension, which require clinical intervention, and NIHSS scores after thrombolysis, which can help indicate prognosis and improve the quality of life.

AVAILABILITY OF DATA AND MATERIALS

Data not directly reported in this publication can be obtained from the corresponding author upon reasonable request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of the Xingtai People's Hospital. Written informed consent was obtained from all participants.

AUTHORS' CONTRIBUTIONS

QX: Conceptualization, Funding acquisition, Resources, Supervision, Writing – original draft, Writing – review & editing. **YS:** Conceptualization, Resources, Validation, Writing – original draft, Writing – review & editing. **JW:** Data curation, Project administration, Software, Writing – original draft, Writing – review & editing. **YFL:** Formal Analysis, Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing. **YTL:** Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. **YLL:** Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. **XS:** Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. **ZL:** Formal Analysis, Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing. **BZ:** Formal Analysis, Methodology, Writing – original draft, Writing – review & editing.

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