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Effect of multi-level stroke education on treatment and prognosis of acute ischemic stroke

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Abstract. This observational study aimed at the significance of multi-level education in the treatment and prognosis of acute ischemic stroke. Multi-level stroke education was carried out among residents and medical staff for one year in Guancheng district. After 1 year, 519 patients with acute ischemic stroke admitted to The First People's Hospital of Zhengzhou were invited to the study, 272 patients from the Guancheng district were divided into the experimental group, and 247 patients who were not from the Guancheng district but in the neighborhood of The First People's Hospital of Zhengzhou were divided into the control group. Statistical methods were applied to analyze the degree of awareness of stroke, the time from onset to hospital, the route to hospital, the number of patients coming to the hospital within 4.5 h, the number of intravenous thrombolysis, door-to-needle time (DNT), modified Rankin scale (MRS) score, and the number of hemorrhagic transformation cases. After one year of multi-level systematic stroke education, there were significant differences in stroke awareness between the experimental group and the control group in terms of limb weakness (87.87 vs. 62.75%), speech inarticulation (78.3 vs. 55.06%), facial paralysis (69.12 vs. 38.06%), limb numbness (57.35 vs. 29.15%), consciousness disorder (62.50 vs. 42.11%), walking instability with severe dizziness (39.97 vs. 15.79%) ($P<0.05$). There was no statistical significant difference in unclear vision or blind eyes or severe headache ($P>0.05$). There were statistical differences between the two groups in the time from the onset to the hospital (14.82±17.67 vs. 25.92±25.23), emergency medical services (EMS) (36.02 vs. 16.19%), number of patients coming to the hospital within 4.5 h (67 vs. 32), venous thrombolysis cases (55 vs. 17), DNT time (42.43±17.30 vs. 63.35±26.53), hemorrhagic transformation cases (11 vs. 21), and MRS score grade ≥2 (230 vs. 169) ($P<0.05$). Multi-level education can effectively improve the patient's awareness of stroke, encourage more patients to use EMS system to the hospital. More patients were aware that they should reach the hospital within 4.5 h. It helps shorten DNT time and give more patients the opportunity to receive intravenous thrombolysis or intravascular thrombectomy, which may improve the prognosis and reduce hemorrhagic transformation without reducing mortality.

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Introduction

Acute ischemic stroke is a serious worldwide public health problem. It is the main cause of death and disability, ranking second among the causes of death among Chinese residents (1,2). Vascular patency and cerebral tissue perfusion in acute phase are effective methods to reduce disability rate and mortality. Intravenous thrombolysis and intravascular mechanical thrombus are highly recommended as the treatment of vascular opening in the guidelines for the treatment of ischemic stroke in China and the guidelines for early management of acute ischemic stroke issued by the American Heart Association/American Stroke Association (AHA/ASA) (3,4). By continuous research around the world, mechanical thrombus extraction in part of anterior circulation can be extended to 24 h by screening time window and 9 h by intravenous thrombolysis time window. But the two treatments are still highly time-dependent. Therefore, it is very important to transfer stroke patients to eligible hospitals as soon as possible (5,6). The chance of intravenous thrombolysis in China is low, only 2.4%, and the chance of intravascular mechanical thrombus extraction is even lower, which is closely related to the limited awareness of stroke of residents and primary medical staff in China, and the delay of pre-hospital treatment and hospital treatment (7,8). Therefore, it is very important to improve the understanding of stroke among residents and medical staff. Our hospital is a national senior stroke center. Based on Zhengzhou Science and Technology Huimin Project, Zhengzhou residents and medical staff were given multi-level stroke education to improve their understanding of stroke and explore the impact on the treatment and prognosis of acute ischemic stroke.

Patients and methods

Study subjective. In this study, 519 patients with acute ischemic stroke were collected. They were treated in The

First People's Hospital of Zhengzhou (Henan, China) from January 2018 to December 2018. Among them, 247 patients not from Guancheng district but in the neighborhood of The First People's Hospital of Zhengzhou were divided into the control group, including 132 males and 115 females aged 29-94 years, with a mean age of 63.85±14.29 and 272 cases from Guancheng district were divided into the experimental group, including 159 males and 113 females, aged 34-93 years, with a mean age of 64.03±14.51.

Inclusion criteria: Patients in accordance with the diagnostic criteria in Guidelines for the diagnosis and treatment of acute ischemic stroke in China (3), and diagnosed with acute or ischemic stroke by CT or MR; Patients living in Zhengzhou for more than 2 years; for patients who were not from Guancheng district, they should have lived in the stroke treatment area of The First People's Hospital of Zhengzhou (1 h golden stroke time within the treatment circle), and their living area had high geographical homology with Guancheng district.

Exclusion criteria: patients with ischemic stroke who live beyond 1 h golden stroke treatment circle; stroke patients with DWI-negative or TIA; modified Rankin scale (MRS) before the onset grade ≥2; patients with unknown onset time; patients with organ bleeding; patients with severe liver and kidney dysfunction; patients with disorder of consciousness and no relatives and patients who were unwilling to participate in the study.

The study was approved by the Ethics Committee of The First People's Hospital of Zhengzhou. Signed informed consents were obtained from the patients and/or guardians.

Education method. The treatment of stroke depends on the joint efforts of patients, their relatives, and medical staff to achieve good results. However, they play different roles in the treatment of stroke. Different methods of education should be used to improve efficiency. In January 2017, multi-level stroke education was started for residents and medical personnel in Guancheng district of Zhengzhou city. It lasted for about 1 year, and patients in non-Guancheng districts did not receive targeted publicity and education.

Medical staff education. Based on the Zhengzhou Guancheng district Health Committee, all medical staff within the jurisdiction were given education and training on stroke knowledge. Due to the different participation of different medical personnel in the treatment of stroke, they accepted different education programs, which were divided into three levels. Primary hospital doctors and community doctors play important roles in the treatment of stroke. They are involved in stroke education, stroke identification, stroke transfer, and secondary prevention of stroke. Primary stroke doctors and community doctors were trained in stroke definition, symptom recognition, stroke fast-cognition recognition, stroke first aid skills, and stroke secondary prevention. A total of eight sessions were held, each session was respectively evaluated. If the doctors failed the assessment, they entered the training again until they passed the assessment. Individual clinics and primary hospitals were trained in post stroke identification methods and stroke first aid flow charts, stroke emergency calls. The emergency center plays an important role in stroke identification and rapid transfer, and reached an agreement with the stroke emergency center to build a 1 h prime time treatment circle for stroke in The First People's Hospital of Zhengzhou. Stroke patients in the stroke treatment circle are preferentially transported to the hospital to reduce stroke rescue procedures, so the emergency doctors were mainly trained in the common symptoms of stroke, rapid recognition of stroke, first aid for stroke and stroke transport. The training was conducted every 3 months. Specialist doctors participated in the treatment of acute stroke in the whole process, and they were responsible for the education of patients, community doctors, primary doctors, and emergency doctors. Specialist doctors received more stringent trainings once a month. Specialists need to understand the frontier knowledge of stroke treatment, the latest stroke treatment guidelines. They should improve their professional skills and control the quality of stroke treatment cases, summarize the experience and lessons of stroke treatment, and continuously optimize the stroke treatment process.

Residents education. Residents' missions differ in the way they receive stroke knowledge due to differences in age and education. For example, young and middle-aged people are more likely to receive stroke education from the media and the internet. Older people may prefer newspapers, books, or even face-to-face talk. Therefore, a combination of multi-level education is used. Community doctors and primary hospital doctors enter the community for acute stroke education and distribute stroke treatment manuals (including stroke identification, stroke transport, stroke emergency call, secondary stroke prevention, prevention and control of stroke risk factors, healthy diet and exercise), once a week. Our hospital selects senior attending or title doctors to enter the community for stroke education and distribute stroke treatment manuals. Our hospital hold stroke seminars 5 times a week to promote stroke knowledge. Hospitalize stroke patients and their relatives can participate once or several times per week. Residents of Guancheng district are encouraged to participate. Media, we-media, television, internet and other channels are used to promote stroke knowledge.

Social platform. A social platform was developed for the treatment of stroke patients and stroke education, and the second line of thrombolysis (7x24 h) was responsible for consultation in the platform. The stroke treatment social platform mainly helps community doctors and emergency doctors in stroke identification, necessary examinations, and rapid transfer, and the handover between specialists and emergency medical services (EMS). The stroke education platform is mainly responsible for the residents' stroke consultation and education, guiding patients on exercise, diet, reasonable medication, and regular follow-up.

Questionnaire. A stroke questionnaire was designed by the second in line of stroke (senior professional title) according to the literature worldwide, to investigate the degree of stroke recognition. The contents included five aspects of stroke identification, stroke first aid method, patient transport route, awareness of intravenous thrombolysis, intravenous thrombolysis time window, awareness of intravascular mechanical thrombus. It was filled out by patients and immediate family members.

Table I. General information of acute ischemic stroke.

General information	Experimental group (n=272)	Control group (n=247)	P-value
Age (years, mean ± SD)	63.85±14.29	64.03±14.51	0.887
Systolic pressure (mmHg, mean ± SD)	163.99±107.05	165.01±93.78	0.998
LDL (mmol/l, mean ± SD)	2.98±1.08	3.01±0.94	0.449
NIHSS score	7.31±5.84	7.06±6.08	0.634
Sex			0.25
Male	159	132	
Female	113	115	
Hypertension	165	155	0.625
Diabetes mellitus	102	96	0.749
Coronary disease	33	39	0.229
Personal history			
Smoking	132	109	0.316
Drinking	72	67	0.866
Degree of education			0.866
Primary school and below	161	148	
Middle school and above	111	99	
Ethnicity			0.153
Hui	31	19	
Han	241	228	

SD, standard deviation; LDL, low density lipoprotein NIHSS, National Institutes of Health Stroke Scale.

Observation index. The following indexes were recorded: Age, sex, educational level, understanding of stroke, the time from onset to hospital, the way of coming to hospital, the number of patients coming to hospital within 4.5 h, the number of intravenous thrombus cases, door-to-needle time (DNT) and MRS score at 90 days, and the conversion cases of acute ischemic stroke hemorrhage. On the 90th day, MRS rating 0-2 suggested good prognosis, and MRS rating 3-6 suggested poor prognosis.

Statistical analysis. SPSS 17.0 (SPSS, Inc.) statistical software was used. If the measurement data were in accordance with normal distribution, t-test was used. If the measurement data was not in accordance with normal distribution, rank sum test was used. The counting data were tested by Chi-square test. $P<0.05$ was considered statistically significant.

Results

General information on the subject of the survey. In this study, 519 patients with acute ischemic stroke were collected. The following data were recorded: Age, sex, hypertension, diabetes mellitus, NIHSS score at admission, personal history, ethnicity and educational level. There was no significant difference between the experimental and the control group by Chi-square test and independent sample t-test (Table I).

Stroke awareness. There was a difference in the discrimination degree of stroke symptoms between the experimental and the control group. There were significant differences in limb weakness (87.87 vs. 62.75%), unclear speech (78.3 vs. 58.06%), oblique mouth angle or facial paralysis (69.12 vs. 38.06%), limb numbness (57.35 vs. 29.15%), disturbance of consciousness (62.50 vs. 42.11%) and severe dizziness and walking instability (39.97 vs. 15.79%). The difference was statistically significant ($P<0.05$). There was no significant difference in visual acuity or binocular blindness, or severe headache ($P>0.05$).

There were statistically significant differences between the experimental and the control group in stroke treatment methods, such as EMS (35.29 vs. 17.81%), seeing a doctor through other transportation (38.97 vs. 47.77%), taking medicine by oneself or waiting at home (25.74 vs. 34.41%) ($P<0.05$). There were significant differences between the experimental and the control group in intravenous thrombolysis, intravenous thrombolysis time window and intravascular mechanical thrombus extraction, and there was significant difference between the experimental group and the control group ($P<0.05$) (Table II).

Treatment of acute ischemic stroke. In the experimental group, the shortest onset time was 20 min and the longest was 168 h, with an average of 14.82±17.67 h. In the control group, the shortest onset time was 36 min and the longest was 192 h, with an average of 25.92±25.23 h. The difference was statistically significant ($P<0.05$). Ninety-eight patients were transported by EMS in the experimental group, accounting for 36.02% of the patients with acute ischemic stroke, while 40 patients in the control group were transported by EMS, accounting for 16.19%

Table II. Stroke awareness.

Items	Experimental group (n=272)	Control group (n=247)	P-value
Stroke identification			
Limb weakness	239 (87.87%)	155 (62.75%)	<0.001
Unclear speech	213 (78.3%)	136 (55.06%)	<0.001
Oblique mouth angle or facial paralysis	188 (69.12%)	94 (38.06%)	<0.001
Limb numbness	156 (57.35%)	72 (29.15%)	<0.001
Unclear vision or binocular blindness	37 (13.6%)	30 (12.14%)	0.621
Disturbance of consciousness	170 (62.5%)	104 (42.11%)	<0.001
Severe headache	58 (21.32%)	49 (19.83%)	0.676
Severe dizziness and walking instability	106 (39.97%)	39 (15.79%)	<0.001
First aid methods for stroke			
EMS	96 (35.29%)	44 (17.81%)	<0.001
Other ways of seeing a doctor	176 (64.71%)	203 (82.19%)	
Understanding intravenous thrombolysis	193 (70.96%)	58 (23.48%)	<0.001
Understanding the time window of intravenous thrombolysis	72 (26.47%)	16 (6.48%)	<0.001
Understanding intravascular mechanical thrombus removal	28 (10.29%)	11 (4.45%)	0.012

EMS, emergency medical services.

Table III. Stroke treatment table.

Assessment index	Experimental group (n=272)	Control group (n=247)	P-value
Time from onset to arrival in hospital (h)	14.82±17.67	25.92±25.23	<0.001
Number of patients transferred by EMS	98	40	<0.001
Number of persons arriving in the hospital within 4.5 h	67	32	<0.001
Number of cases of intravenous thrombolysis	55	17	<0.001
Intravascular mechanical thrombus removal	13 cases	3 cases	<0.001
DNT time (m)	42.43±17.30	63.35±26.53	<0.001

DNT, door-to-needle time; EMS, emergency medical services.

of the patients with acute ischemic stroke, the difference was statistically significant (P<0.05).

Sixty-seven patients arrived in hospital within 4.5 h in the experimental group, accounting for 24.63% of the patients with acute ischemic stroke, while 32 patients in the control group had a gross onset of 4.5 h, accounting for 12.96% of the patients with acute ischemic stroke, the difference was statistically significant.

The number of cases of venous thrombolysis in the experimental group was 55, accounting for 82.09% of the number of hospitalizations within 4.5 h, accounting for 22.27% of the number of acute ischemic stroke. The number of cases of venous thrombolysis in the control group was 17, accounting for 53.12% of the number of hospitalizations within 4.5 h, accounting for 6.9% of the number of acute ischemic stroke. There was significant difference between the two groups (P<0.05).

There were 13 cases of intravascular mechanical thrombectomy in the test group, accounting for 4.78% of ischemic stroke, and 3 cases of intravascular mechanical thrombectomy in the control group, accounting for 1.21% of the number of acute ischemic stroke. The difference was statistically significant.

There was significant difference in DNT test between the experimental and the control group (42.43±17.30 vs. 63.35±26.53), and there was statistical significance (P<0.05) (Table III).

Recurrence and prognosis. In the experimental group, there were 128 patients with MRS0 grade and 102 patients with MRS1-2 grade (230 patients with good prognosis), accounting for 84.56% of patients with acute ischemic stroke. In the control group, there were 92 patients with MRSO grade and 77 patients with MRS1-2 grade (169 patients with good prognosis), accounting for 68.42% of patients with acute ischemic stroke. The difference between the two groups was statistically significant.

There were 11 cases of hemorrhagic transformation in the test group, accounting for 4.04% of acute ischemic stroke,

Table IV. Prognosis.

Prognosis and outcome	Experimental group (n=272)	Control group (n=247)	P-value
Favourable prognosis	230	169	<0.001
Unfavourable prognosis	42	78	
Hemorrhagic transformation	11	21	0.035
Death	12	18	0.161

12 cases of death, accounting for 4.41% of ischemic stroke, 21 cases of hemorrhagic transformation in the control group, accounting for 8.50% of acute ischemic stroke, and 18 cases of death, accounting for 7.29% of ischemic stroke. There was a difference in hemorrhagic transformation after stroke between the two groups (P<0.05), and there was no difference in the number of deaths between the two groups (P>0.05) (Table IV).

Discussion

Acute ischemic stroke is the most common type of stroke, accounting for 70% of the cases. More than 60% of the patients still have different degrees of neurological dysfunction after treatment, only 1/3 of the patients after treatment are completely asymptomatic (9-11). Restoring circulation for the purpose of intravenous thrombolysis or mechanical thrombolysis in acute treatment of ischemic stroke improved the prognosis of stroke patients, but the time window was narrow and the curative effect depends on time. In the United States, <25% of eligible stroke patients arrive in the emergency department within 3 h of treatment, while in China, only ~20% of the patients can reach the emergency department within 3 h of onset (8,12). The effective measures to reduce the delay of stroke treatment include rapid stroke identification, rapid stroke transport, high efficiency treatment in hospital, and high cooperation between patients and their families (13,14). With the construction of senior stroke center in China, hospital treatment and rapid transportation have been constantly improved, the rapid identification of stroke and the cooperation of patients still need continuous improvement. The identification of stroke by patients and relatives, and the adoption of rapid and reasonable transport measures were essential to enable patients to reach the hospital quickly. The rapid identification of stroke by primary medical staff and 120 medical staff enables the key factors to ensure the rapid transport of patients.

The recognition of early warning signs of stroke by the public is still low, and there are great differences in sex, age, race and living area (14-17). Studies worldwide have found that educational intervention can improve public recognition of stroke. The study of Morgenstern *et al* (18) found that propaganda and education on stroke among middle school students and their parents can significantly improve their stroke recognition ability and increase the thrombolysis rate of stroke patients. After a year of multi-level apoplexy education, it was found that the patients and their families in the experimental group had significantly improved the recognition ability of stroke, especially in the aspects of limb weakness, unclear speech, oblique or facial paralysis of mouth angle and disturbance of consciousness. Degree of recognition of limb weakness was the highest, and that of unclear speech was second. Patients and relatives have poor recognition of symptoms such as unclear vision and severe headache. There is no statistical significance compared with those after publicity and education. Considering the age of onset of the disease, it is related to the experience of eye diseases and headaches. The understanding of intravenous thrombolysis, intravascular mechanical thrombectomy and intravenous thrombolysis time window was significantly improved, the difference was statistically significant (P<0.05), but the understanding of thrombolysis time window and mechanical thrombectomy was still insufficient, and the proportion was low. More comprehensive and detailed stroke education may be needed to further improve residents' awareness of stroke.

Time is the brain. Emergency medical care service (EMS) is considered to be an effective way to quickly send patients to hospital. It could shorten the time for patients to arrive in hospital, and is an important means to improve the medical response and treatment of acute ischemic stroke (19-22). By EMS, hospitals can be notified in advance that patients who are likely to have stroke are being transported; stroke assessment team could act in advance and play an important role in increasing the number of patients undergoing thrombolysis, and can improve the prognosis of patients (23,24). Patel *et al* (25) conducted a study of stroke patients in North Carolina (n=13,894). It was found that compared with patients arriving by private transport, EMS pre-notice increased the number of patients receiving ≤25 min imaging and ≤45 min imaging reports, and more patients could receive thrombolysis. In this study, more patients in the experimental group used EMS (98 vs. 40) and more patients were treated with thrombolysis (55 vs. 17) than those in the control group, while ~2% of the patients in the United States adopted emergency services. Compared with the United States, the utilization rate of emergency medical service is still low, so it is necessary to carry out various forms of stroke education, enhance the concept of using first aid service, so that patients with acute ischemic stroke can be treated in time and effectively in the shortest possible time, so as to reduce disability and improve the quality of life of patients. For strokes that have already occurred, patients should be transferred to a hospital capable of treatment as soon as possible, so that patients can be treated in a timely and reasonable manner. This is also the purpose of this article. Through multi-level stroke education, stroke symptoms can be identified timely, patients can be quickly transferred, green channels can be started in time, rapid diagnosis and medication can be used to enable patients to have a better prognosis.

Thrombolysis is the most effective treatment for acute ischemic stroke, but the time window is narrow and the thrombolysis rate is low. In an Australian study (26), only 14.7% of patients with acute ischemic stroke received thrombolysis within the time window (4.5 h after onset). From 2007 to 2008, the proportion of thrombolysis in China's national stroke registration (27) was 1.9%, accounting for 11.3% of the patients who arrived in emergency within 3 h after onset. In 2016, the National Health and Health Commission released a report showing that the proportion of patients receiving intravenous thrombolytic therapy was increased, accounting for 4.1% of all

patients with ischemic stroke, but different regions, different levels of hospitals have a big difference (16). In this study, after education on stroke, the time from onset to hospital was reduced from 25.92±25.23 h in 2016 to 14.82±17.67 h on average, and the time to visit was greatly shortened. The number of patients arriving in hospital at 4.5 h accounted for 12.96% of all acute ischemic stroke, and increased to 24.63%. The difference was statistically significant. In the United States, only 2.4-5.2% could arrive in hospital within 4.5 h among all patients with acute ischemic stroke. In the experimental group, 55 cases (82.09%) received thrombolysis, accounting for 22.27% in acute ischemic stroke patients who arrived in hospital within 4.5 h. While in the control group, 17 cases received thrombolysis, accounting for 53.12% among patients who arrived hospital within 4.5 h, and accounting for 6.9% among all patients with acute ischemic stroke, which is better than those reported abroad, owing to our multi-level systematic education of stroke.

The sooner the blood vessels were opened and perfused, the prognosis of the patients was better. Since the construction of the stroke center in China, great achievements have been made in the treatment of stroke (28), from 125 min in 2013 to 54.8 min in 2017, door-to-needle time (DNT) was shortened from 125 min in 2013 to 54.8 min. In this study, the DNT of the experimental group and the control group (42.43±17.30 vs. 63.35±26.53) were significantly shortened, the prognosis of the experimental group was better (84.56 vs. 68.42%), the bleeding conversion control group was decreased (4.04 vs. 8.50%), and the mortality of the experimental group was not significantly different from that of the control group (4.41 vs. 7.29%). It is suggested that multi-level stroke education can shorten the time of DNT, give the patients a better prognosis, and can reduce the transformation of bleeding after infarction, but cannot reduce mortality.

Collectively, multi-level systematic education can effectively improve the identification of stroke and the understanding of stroke treatment methods. It could promote the rapid transport of patients to hospital, so that more patients would be able to obtain intravenous thrombolysis or intravascular thrombus therapy, which may improve the prognosis of patients and reduce the transformation of bleeding after infarction. The sample of this study is small and the region is limited, so it still needs to be further studied. The First People's Hospital of Zhengzhou is located in the center of Zhengzhou city, at the junction of the three districts. Therefore, the residents in the neighborhood of The First People's Hospital of Zhengzhou (within the golden 1 h treatment time circle) were selected as the research subjects, which have a high degree of homology and excludes factors that interfere with the trial as much as possible. But the weather and road conditions at the time of onset, and residents' value on health may still have a certain impact on the treatment of stroke. Relevant data have not been collected in this study, and there are certain limitations in this study. Further research will be conducted. However, we believe that multi-level stroke education is beneficial to stroke treatment and worth promoting.

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Availability of data and materials

The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

Authors' contributions

YL, XC and XZ conceived and designed the study. YL, XX, YZ, CW and XZ were responsible for the collection and analysis of the experimental data. YL and XC interpreted the data and drafted the manuscript. YL and XZ revised the manuscript critically for important intellectual content. YL wrote the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of The First People's Hospital of Zhengzhou (Henan, China). Signed informed consents were obtained from the patients and/or guardians.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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