

# Influence of Acupuncture and Other Clinical Factors on the Recovery of Limb Motor Function in Patients After Stroke: A Retrospective Study

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**Background:** Limb motor disorders after stroke are very common, and the clinical related factors of improving limb motor function are still unclear. As a part of comprehensive rehabilitation strategy, acupuncture has been widely used in rehabilitation after stroke in China. But more evidence is needed for the influence of acupuncture and some other clinical factors on post-stroke motor disorders.

**Patients and Methods:** A retrospective study was conducted using the database of patients with post-stroke motor disorders admitted to the Neurological Rehabilitation Unit of the First Teaching Hospital of Tianjin University of Traditional Chinese Medicine. The included patients were grouped according to whether NIHSS improved or muscle strength improved. The positive logistic regression was used to analyze the influencing factors of possible NIHSS improvement. Combined with the influencing factors of NIHSS improvement and muscle strength improvement, the influencing factors of limb motor function recovery after stroke were obtained.

**Results:** When analyzing the baseline of the included patients, it was found that patients with NIHSS improvement had earlier acupuncture intervention time (M, (IQR):13.5 (14), OR=0.716, 95% CI [0.591–0.869], p=0.001), more cumulative acupuncture treatment times (M,(IQR):29 (12), OR=0.744, 95% CI [0.608–0.910], p=0.004), and less hypertension history (OR=0.256, 95% CI [0.082–0.801], p=0.019). Smoking history only has positive significance in univariate and multivariate analysis of NIHSS, not muscle strength (OR=0.274, 95% CI [0.097–0.779], p=0.015).

**Conclusion:** The earlier acupuncture intervention and the more cumulative acupuncture treatment times are, the more beneficial the limb function of stroke patients with motor disorders will be. The previous history of hypertension is the influencing factor of limb motor function not improving in patients with limb motor disorder after a stroke. The effect of smoking history on limb movement function of patients with limb motor disorder after stroke needs further study.

**Keywords:** acupuncture, stroke, limb motor disorder, retrospective study, influencing factors

## Introduction

The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017 shows stroke is the third leading cause of the five major causes of DALYs (measured by disability-adjusted life-years) worldwide and the second leading cause of death in the world in 2017. In 2019, stroke remained the second leading cause of death and the third leading cause of disability in the world.<sup>1–3</sup> In china, due to the aging population, increased risk factors (hypertension, etc.), significant regional differences in access and quality of stroke care, and unreasonable allocation of medical resources, the prevalence and incidence rate of stroke have increased significantly and become the first leading cause of death.<sup>4,5</sup> More than half of stroke survivors have neurological deficit symptoms,<sup>6</sup> and the most common injury is motor disorder, such as contralateral limb hemiplegia,<sup>7</sup> which seriously affects their physical and mental health and quality of life. The burden on patients increases

significantly,<sup>3</sup> which also leads to the continuous growth of demand for stroke rehabilitation services.<sup>8</sup> Therefore, a better understanding of the influencing factors of motor function improvement in stroke patients with motor disorders may lead to more timely and effective prevention and intervention measures to prevent disease progression, improve the quality of life of patients and reduce disability rates.

A 1987 study on 'Recovery from physical disability after stroke: normal patterns as a basis for evaluation' showed that limb rehabilitation after stroke will be affected by many factors, such as age, stroke type, onset time, social and psychological variables.<sup>9</sup> The onset time often represents the time when rehabilitation begins to intervene. When should rehabilitation begin after stroke be beneficial to the prognosis of patients? There is still no clear answer to this question. A retrospective cohort study showed that the earlier stroke patients were admitted to a rehabilitation hospital (IRH), the better their function improved.<sup>10</sup> Strategies for improving motor function after stroke include rehabilitation physiotherapy and drugs, acupuncture as part of a comprehensive rehabilitation strategy is widely used in post-stroke rehabilitation in China.<sup>11</sup> Some evidence suggests that acupuncture improves motor function in patients after stroke,<sup>12–15</sup> and is a beneficial intervention factor for improving motor function in stroke patients with motor disorders. For stroke patients, ancient Chinese suggested early intervention with acupuncture,<sup>16</sup> modern studies have shown that acupuncture at the early stage of stroke can improve recovery and reduce mortality,<sup>17</sup> Before the active muscles of hemiplegic limbs do not have spasms, acupuncture can effectively reduce the occurrence of limb spasms after stroke.<sup>18</sup> On the intervention time of acupuncture in rehabilitation after stroke, the current research conclusions are not consistent. A meta-analysis showed that the best time of acupuncture intervention for stroke was within 48 hours after stroke and lasted for 15 days;<sup>19</sup> In a study of 2523 stroke patients (including 1922 cases of ischemic stroke and 601 cases of hemorrhagic stroke) treated by acupuncture, Shi et al<sup>20</sup> showed that the cure rate in the group within 10 days of onset was significantly higher than that in the group within 11–20 days of onset, 21–120 days of onset and 4–12 months of onset, but there was no significant difference among the three groups within 10 days ( $\leq 48$  h, 49–72 h and 4–10 days). However, it has also been reported that the promising good trend of early rehabilitation intervention after stroke is mostly reflected in small, single-center, and other pilot experiments,<sup>21</sup> in a large-scale and confident Phase III trial conducted by AVERT investigators, the effectiveness of very early mobilization intervention was not proved.<sup>22</sup> But there is no research showing that early acupuncture intervention after stroke has no good effect or even has the opposite effect, which is generally the dispute of intervention time. At present, other factors affecting the improvement of limb motor function after stroke need to be further studied.

Therefore, we designed this retrospective study to explore the influence of acupuncture and other clinical factors on the limb motor function of stroke patients, and the results are expected to save more health resources, hoping to provide an evidence-based reference for clinicians and researchers.

## Materials and Methods

### Study Design and Population

The First Teaching Hospital of Tianjin University of Traditional Chinese Medicine is the National Clinical Research Center for Chinese Medicine Acupuncture and Moxibustion, which integrates medicine, teaching, and research. The neurological rehabilitation unit is mainly to diagnose and treat neurological diseases, of which stroke accounts for more than 95%. Here we conducted a retrospective study on influencing factors of functional improvement in stroke patients with limb motor disorders. At least 5000 stroke patients are discharged from the neurological rehabilitation unit every year. The hospital has a broad professional foundation and provides advanced diagnostic procedures (such as MRI diagnosis). In this retrospective study, we screened and analyzed the electronic medical records of 5046 patients with post-stroke limb motor disorder hospitalized in the neurological rehabilitation unit of the First Affiliated Hospital of Tianjin University of Traditional Chinese Medicine from January 1, 2020, to January 1, 2022.

### Definition

The course of disease = time from onset to treatment + hospital stay. Acupuncture intervention time is counted in days, which refers to the time from the onset of the disease to the beginning of acupuncture intervention. Acupuncture

treatment times is counted in days, the patients are treated with acupuncture once a day from admission to discharge, the number of times of acupuncture treatment is approximately equal to the number of days in the hospital, and the cumulative number of times of acupuncture treatment is the total number of days in the hospital. The improvement of motor function in this study was evaluated by NIHSS score and Improvement of muscle strength. NIHSS score is a comprehensive score of the nervous system, including the score of limb motor function. In this study, improved NIHSS (One of the three scales for early prediction of stroke recovery<sup>23</sup>) is defined as the difference between admission NIHSS and discharge NIHSS > 0, Not Improved NIHSS is defined as the difference between admission NIHSS and discharge NIHSS ≤ 0. The improvement of muscle strength means that the patient's muscle strength at the time of discharge is higher than that at the time of admission. The improvement of NIHSS and muscle strength means that the motor function of stroke limbs can be restored to a certain extent. Limb muscle strength ≤ IV: Muscle strength is divided into six levels from 0 to 5, the higher the muscle strength, the more normal, the fourth level of muscle strength means that the limbs can resist some resistance and gravity, but it is worse than normal people.

## Inclusion Criteria

(1) Patients with first attack of stroke who had a definite diagnosis of bleeding or ischemic lesions by MRI or CT examination (Include patients with first stroke to reduce the impact of confounding factors) (2) Stroke patients with a course of disease between 40 and 50 days, age, gender not limited (3) Stroke patients with limb motor disorders (at least one limb muscle strength ≤ IV) (4) NIHSS score at admission ranged from 7 to 14 (5) The patient has not received any form of acupuncture treatment from the onset to hospitalization (The reason for choosing the course of disease of 40–50 days and NIHSS score of 7–14 is that there is no statistical difference in the baseline level of NIHSS of hospitalized patients within this range, and the NIHSS improved group is comparable with the non-improved group.)

## Exclusion Criteria

(1) Patients with stroke motor disorder who refused acupuncture treatment after admission (2) Persons who are participating in or have participated in other trials for less than 3 months (3) Patients with a motor disorder caused by other reasons except for stroke (4) Severe medical disease, cancer or bleeding tendency (5) Incomplete electronic medical records.

See [Figure 1](#) for the study flowchart.

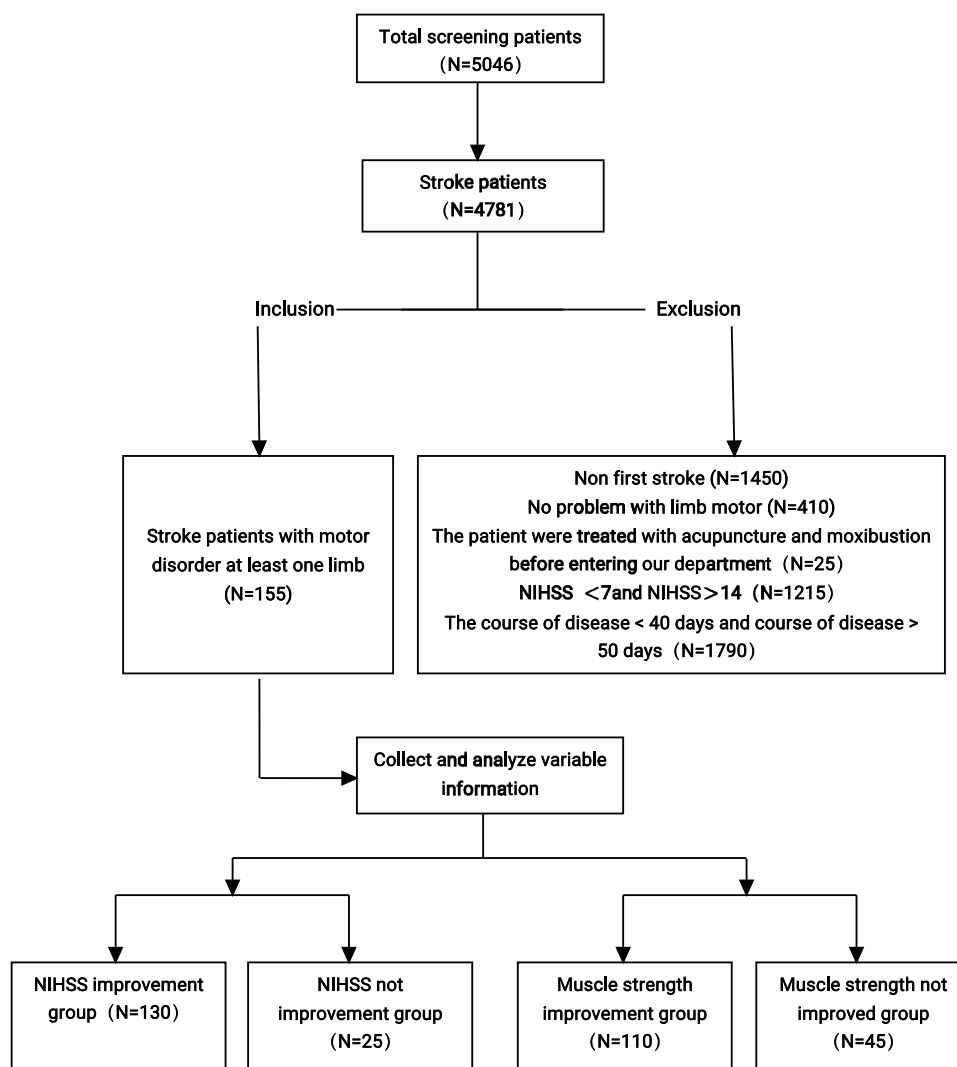
## Data Collection

First Teaching Hospital of Tianjin University of Traditional Chinese Medicine of Electronic Medical Record System is a Multimedia Electronic Medical Record Management System in Donghua-DHC-EMR, all medical records consist of a basic unit, composite unit, data template, and interface template, using the efficient indexing ability of cache database, data can be retrieved with high performance and complexity. In the electronic medical record system, the target patient population is determined according to the above Inclusion criteria. The medical records of this part of the population are retrieved by specially trained doctors (skilled in operating the electronic medical record hospitalization system), and the following variable information is extracted:

(1) Baseline characteristics: age, gender, hospital stay, smoking history, drinking history, past history, and family history (2) Motor function improvement assessment: neurological examination and clinical severity assessment, using the National Institutes of Health Stroke Scale (NIHSS) (scores from 0 to 42, the higher the score indicates greater neurological deficits); Muscle strength at admission and discharge (3) Acupuncture intervention time(days) and accumulated times of acupuncture treatment (number of times) (4) Complications.

## Treatment

Patients with post-stroke motor disorders were given corresponding basic treatment, and blood pressure, blood glucose, water-electrolyte balance, nutritional support, active prevention, and treatment of complications were controlled. Antiplatelet drugs, anticoagulant drugs, lipid-lowering, fiber-lowering, nerve protection, and other symptomatic treatment were used. Routine rehabilitation guidance training for all patients. The patient received acupuncture treatment every day



**Figure 1** Study flowchart.

from the date of admission to discharge (Cases who refused to accept acupuncture treatment were not included in this study, and the treatment course is the days of hospitalization of the patient, that is, the patient receive acupuncture treatment every day during the period of hospitalization, and the treatment intensity is based on the patient's tolerance). Acupuncture clinicians were trained by standard operating procedures, and the "sharpening mind and inducing consciousness"<sup>24</sup> acupuncture method established by Academician Shi Xuemin was adopted.

## Statistical Analysis

The data was extracted and exported from the platform in the form of Excel form. After export, the data was summarized and processed in Excel software. The processed data was imported into IBM SPSS (Statistical Product and Service Solutions) Statistics 25.0 (Hereinafter referred to as SPSS) analysis software for further screening and processing. SPSS is the earliest statistical analysis software in the world. It was developed by Norman H. Nie, C Hadlai (Tex) Hull, and Dale H. Bent and succeeded in research and development in 1968. At the same time, they established the SPSS Company. In 1975, they established a corporate organization and established SPSS headquarters in Chicago. On July 28, 2009, IBM announced that it would purchase SPSS, a statistical analysis software provider, with \$1.2 billion in cash. The non-normally distributed numerical variables and grade data were analyzed with a non-parametric test (Mann–Whitney *U*-test). Count data are analyzed by chi-square test. Frequency (percentage) was used for categorical

variables. Non-normal variables use median (Interquartile range, IQR). A value of  $p < 0.05$  was considered statistically significant. A binary logistic regression model was used to analyze each explanatory variable, interpreted as odds ratio, 95% CI, and p-value. Whether they have hypertension history, or smoking history, were assigned values: yes 1, no 0.

## Results

### General Characteristics of Stroke Patients with Limb Motor Disorder

A total of 5046 patients with stroke were admitted to the First Teaching Hospital of Tianjin University of Traditional Chinese Medicine from January 1, 2020, to January 1, 2022. There were 745 cases of non-first stroke, 410 cases of normal limb muscle strength, 265 cases of non-stroke, 705 cases of stroke sequelae, and 25 cases of acupuncture after the onset, a total of 1215 patients were admitted with NIHSS less than 7 or NIHSS greater than 14, the course of the disease was less than 50 days and more than 40 days, a total of 1790 cases. A total of 155 cases met the inclusion criteria, including 130 cases in the NIHSS improvement group and 25 cases in the non-improvement group (Table 1).

**Table 1** Baseline of Stroke Patients with Motor Disorder

Information	Total N=155	Improved* N=130	Not Improved** N=25
Female (n%)	80 (51.6)	70 (87.5)	10 (12.5)
Male (n%)	75 (48.4)	60 (80)	15 (20)
Average age (years)	63.6	63.1	66.0
Average length of hospital stay (days)	30.1	30.8	26.6
Average acupuncture intervention times (days)	14.5	13.5	19.6
Smoke (n%)	54 (34.8)	40 (74.1)	14 (25.9)
Drink (n%)	69 (44.5)	55 (79.7)	14 (20.3)
Cerebral infarction (n%)	110 (71.0)	90 (81.8)	20 (18.1)
Cerebral hemorrhage (n%)	45 (29.0)	40 (88.9)	5 (11.1)
Affected side(Left) (n%)	100 (64.5)	80 (80)	20 (20)
Affected side(right) (n%)	45 (29.0)	40 (88.9)	5 (11.1)
Affected side (both sides) (n%)	10 (6.5)	10 (100)	0 (0)
NIHSS improved (n%)	130 (83.9)	130 (100)	0 (0)
NIHSS not improved (n%)	25 (16.1)	0 (0)	25 (100)
Past history			
Hypertension (n%)	54 (34.8)	40 (74.1)	14 (25.9)
Diabetes (n%)	15 (9.7)	10 (66.7)	5 (33.3)
Coronary artery disease (n%)	20 (13.0)	15 (75)	5 (25)
Family history			
Hypertension (n%)	113 (73.0)	95 (84.1)	18 (15.9)
Diabetes (n%)	70 (45.1)	60 (85.7)	10 (14.3)
Coronary artery disease (n%)	40 (25.8)	35 (87.5)	5 (12.5)
Atrial fibrillation (n%)	25 (16.1)	20 (80)	5 (20)

(Continued)

**Table 1** (Continued).

Information	Total N=155	Improved* N=130	Not Improved** N=25
Stroke site			
Brainstem (n%)	22 (14.2)	15 (68.2)	7 (31.8)
Right cerebral hemisphere (n%)	96 (62.0)	80 (83.3)	16 (16.7)
Left cerebral hemisphere (n%)	27 (17.4)	25 (92.6)	2 (7.4)
Bilateral cerebral hemispheres (n%)	10 (6.5)	10 (100)	0 (0)
Complications			
Pulmonary infection (n%)	24 (15.4)	20 (83.3)	4 (16.7)
Urinary tract infection (n%)	15 (9.7)	10 (66.7)	5 (33.3)
Deep venous thrombosis (n%)	24 (15.4)	19 (79.2)	5 (20.8)
Hyperlipidemia (n%)	76 (49.0)	64 (84.2)	12 (15.8)
Hyperhomocysteinemia (n%)	10 (6.5)	5 (50)	5 (50)
High fibrinogen (n%)	35 (22.6)	29 (82.9)	6 (17.1)
Hypoproteinemia (n%)	38 (24.5)	34 (89.5)	4 (10.5)
Anemia (n%)	34 (21.9)	30 (88.2)	4 (11.8)
Electrolyte metabolism disorder (n%)	12 (7.7)	10 (83.3)	2 (16.7)

**Notes:** Data are presented the demographic and clinical characteristics of all including patients. Figures represent the number of people who meet the requirements, and expressed as the number with the percentage in parenthesis. \*Improved, the limb motor function (NIHSS) of patients with post-stroke dyskinesia improved after hospitalization compared with that before hospitalization. \*\*Not improved, the limb motor function (NIHSS) of patients with post-stroke dyskinesia did not improve after hospitalization compared with that before hospitalization.

## Factors Affecting the Improvement of Motor Function in Patients with Stroke and Multivariate Analysis

According to the difference between admission NIHSS and discharge NIHSS, the patients were divided into two groups (improved group and non-improved group). Smoking, hypertension, and hyperhomocysteinemia in the non-improved group were significantly higher than those in the improved group ( $p < 0.05$ ). The acupuncture intervention time in the non-improved group was longer and the number of acupuncture treatments were less ( $p < 0.05$ ) (Table 2).

**Table 2** Differences of Related Factors Between NIHSS Improvement Group and NIHSS No Improvement Group

Risk Factors	Improved N=130	Not Improved N=25	P-value
Female, n (%)	70 (53.8)	10 (40.0)	0.205
Male, n (%)	60 (46.2)	15 (60.0)	
Age, M (IQR)	65 (18)	64 (20)	0.542
NIHSS score on admission, M (IQR)	10.5 (4)	8 (4)	0.064
Acupuncture intervention time, M (IQR)	13.5 (14)	14 (15)	0.010
Cumulative times of acupuncture treatment, M (IQR)	29 (12)	28 (12)	0.023
Smoke, n (%)	40 (30.8)	14 (56.0)	0.015

(Continued)

**Table 2** (Continued).

Risk Factors	Improved N=130	Not Improved N=25	P-value
Drink, n (%)	55 (42.3)	14 (56.0)	0.207
Cerebral infarction, n (%)	90 (69.2)	20 (80.0)	0.277
Cerebral hemorrhage, n (%)	40 (30.8)	5 (20.0)	
Past history, n (%)			
Hypertension	40 (30.8)	14 (56)	0.015
Diabetes	10 (7.7)	5 (20.0)	0.124
Coronary artery disease	15 (11.5)	5 (20.0)	0.407
Family history, n (%)			
Hypertension	95 (73.1)	18 (72.0)	0.912
Diabetes	60 (46.2)	10 (40.0)	0.571
Coronary artery disease	35 (26.0)	5 (20.0)	0.469
Atrial fibrillation	20 (15.4)	5 (20.0)	0.781
Stroke site, n (%)			
Right cerebral hemisphere	80 (61.5)	16 (64.0)	0.816
Left cerebral hemisphere	25 (19.2)	2 (8.0)	0.286
Brainstem	15 (11.5)	7 (28.0)	0.065
Bilateral cerebral hemispheres	10 (7.7)	0 (0.0)	0.323
Complications, n (%)			
Pulmonary infection	20 (15.4)	4 (16.0)	1.000
Urinary tract infection	10 (7.7)	5 (20.0)	0.124
Deep venous thrombosis	19 (14.6)	5 (20.0)	0.704
Hyperlipidemia	64 (49.2)	12 (48)	0.910
Hyperhomocysteinemia	5 (3.8)	5 (20.0)	0.010
High fibrinogen	29 (22.3)	6 (24.0)	0.853
Hypoproteinemia	34 (26.2)	4 (16.0)	0.280
Anemia	30 (23.1)	4 (16.0)	0.434
Electrolyte metabolism disorder	10 (7.7)	2 (12.0)	0.751

According to the difference between the muscle strength at admission and that at discharge, the patients were divided into two groups (muscle strength improvement group and muscle strength non-improvement group). The past history of hypertension in the improvement group was significantly lower than that in the non-improvement group ( $p < 0.05$ ), the acupuncture intervention time in the improvement group was earlier and the cumulative number of acupuncture was more (Table 3).

The influencing factors related to NIHSS improvement in univariate analysis were smoking, hypertension, hyperhomocysteinemia, acupuncture intervention time, and acupuncture treatment times ( $p < 0.05$ ). In multivariate analysis, combined with the above-influencing factors, smoking (OR = 0.274, 95% CI [0.097–0.779],  $p < 0.05$ ), hypertension (OR = 0.256, 95% CI [0.082–0.801],  $p < 0.05$ ), acupuncture intervention time (OR = 0.716, 95% CI [0.591–0.869],  $p < 0.05$ ), acupuncture treatment times (OR = 0.744, 95% CI [0.608–0.910],  $p < 0.05$ ) were important predictors of NIHSS



**Table 3** Difference of Related Factors Between Muscle Strength Improvement Group and Muscle Strength Non-Improvement Group

Risk Factors	Muscle Strength Improvement Group* N=110	Muscle Strength Non-Improvement Group* N=45	P-value
Acupuncture intervention time, M (IQR)	13 (15)	18 (15)	0.000
Cumulative times of acupuncture treatment, M (IQR)	29.5 (12)	28 (12)	0.000
Smoke, n (%)	38 (34.5)	16 (35.6)	0.905
Previous history of hypertension, n (%)	30 (27.3)	24 (53.3)	0.002

**Notes:** \*Muscle strength improvement group, muscle strength non-improvement group: The muscle strength evaluated on the day of discharge was compared with the muscle strength evaluated on the day of admission. The muscle strength improved when the discharge muscle strength was greater than the admission muscle strength, and the muscle strength not improved when the discharge muscle strength  $\leq$  the admission muscle strength.

**Table 4** Univariate and Multivariate Analysis of NIHSS Improvement and Clinical Characteristics of Stroke Patients with Motor Disorders

Factors	Univariate Analysis*			Multivariate Analysis*		
	OR	95% CI	p-value	OR	95% CI	p-value
CUMULATIVE TIMES OF ACUPUNCTURE TREATMENT	1.057	1.006–1.110	0.028	0.744	0.608–0.910	0.004
ACUPUNCTURE INTERVENTION TIME	0.927	0.882–0.975	0.003	0.716	0.591–0.869	0.001
SMOKE	0.349	0.146–0.836	0.018	0.274	0.097–0.779	0.015
HYPERTENSION	0.488	0.195–1.222	0.125	0.256	0.082–0.801	0.019
HYPERHOMOCYSTEINEM	0.160	0.042–0.603	0.007	/	/	/

**Notes:** \*The Univariate and multivariate logistic regression (forward selection) was applied to analyze all explanatory variables.

**Abbreviation:** OR, odds ratio.

improvement in patients with stroke limb motor disorders. The possibility of non-improvement of NIHSS in smokers was 0.274 times that in non-smokers. The possibility of no improvement in NIHSS in patients with hypertension was 0.256 times that in patients without hypertension. The possibility of no improvement of NIHSS in patients with late acupuncture intervention is 0.716 times that in patients with early acupuncture intervention. The possibility of no improvement of NIHSS in patients with less cumulative acupuncture treatment is 0.744 times that in patients with more cumulative acupuncture treatment (Table 4).

It can be further discussed that smoking is significant in the group with NIHSS improved in Table 2, but not in the group with muscle strength improved in Table 3.

## Discussion

Post-stroke limb movement disorder brings heavy economic and psychological burdens to patients, families, and society, leading to a substantial increase in demand for rehabilitation services. Therefore, understanding the influencing factors of functional improvement in patients with post-stroke limb motor disorders may produce more effective prevention and intervention methods for patients with post-stroke motor disorders. Here, we demonstrate that acupuncture intervention time, cumulative acupuncture treatment times, and hypertension history are the influence factors for improving limb function of stroke patients with motor disorders. Among them, the earlier the acupuncture intervention time is, the more times the accumulated acupuncture treatment is, the more beneficial to the improvement of limb function of stroke patients with motor disorders. A past history of hypertension is an unfavorable factor for the recovery of limb motor function of patients with stroke motor disorder. The effect of smoking on the limb motor function of patients with stroke motor disorder is effective for further study.



Whether acupuncture should be applied as soon as possible remains controversial in previous studies and guidelines on stroke, some studies<sup>25,26</sup> have shown that the timing of acupuncture intervention is an independent factor affecting the disability status and degree of limb motor dysfunction in patients with limb dysfunction in cerebral infarction, early intervention may be better than late intervention, acupuncture intervention at the super early stage (within 6 hours) of stroke has obvious clinical value in terms of clinical efficacy, neurological function score, and muscle strength recovery. This study proposes that the earlier acupuncture intervention showed a better effect on motor dysfunction after stroke. It is reported that acupuncture can promote cell and neurogenesis in the injured area, and the regulation of neurochemicals induced by acupuncture is considered to be the main therapeutic mechanism.<sup>27</sup> Ni et al believed that the curative effect, superoxide dismutase (SOD) activity, and malondialdehyde(MDA) content of early acupuncture intervention were better than those of stable acupuncture intervention in patients with cerebral infarction, early acupuncture treatment is more beneficial to improve the curative effect and anti-free radical ability of patients with cerebral infarction.<sup>28,29</sup> Acupuncture is an alternative passive rehabilitation method, combined with active functional exercise that can better promote the recovery of motor function and daily life activities.<sup>29</sup> In addition, based on the plasticity and functional reorganization of the nervous system, early acupuncture intervention can accelerate the establishment of cerebral collateral circulation, increase cerebral blood flow, improve cerebral oxygen metabolism, protect central neurons, reduce neuronal apoptosis, and promote the reorganization and compensation of surrounding tissues or healthy brain cells.<sup>29–33</sup>

However, due to the influence of non-therapeutic factors such as natural recovery rate within 3 weeks, the conclusion of early intervention remains to be discussed,<sup>25</sup> and most of the studies ignore the different acupuncture cumulative amount with different acupuncture intervention time, which should also be considered as one of the factors.<sup>25</sup> This study concluded that the more times cumulative acupuncture treatment is, the more beneficial to the improvement of limb motor function. The number of acupuncture times was a component of the cumulative amount of acupuncture treatment. In addition, it also included the cumulative acupuncture time. Many researchers believe that early rehabilitation is very important for maximum recovery from stroke, and the correlation between better results and early rehabilitation is recorded.<sup>34</sup> In published reports, the increased time between stroke onset and rehabilitation onset is associated with poor prognosis. However, when other variables are adjusted, the time after stroke onset has little effect on the outcome before entering the rehabilitation facility.<sup>35</sup> In summary, although acupuncture therapy has been widely used in acute stroke, the relationship between the specific intervention time and the benefit of motor function recovery needs to be further confirmed by more high-quality randomized controlled trials.

Smoking remains a major risk factor for stroke, and the dose-response relationship between smoking duration and stroke risk nearly doubles stroke risk.<sup>36,37</sup> Compared with some unchangeable risk factors, such as age, gender, and family history, stroke prevention usually focuses on changeable risk factors. Lifestyle and behavioral changes, such as quitting smoking, can reduce not only the risk of stroke but also other cardiovascular diseases.<sup>38</sup> Studies have shown that the risk of stroke in people who smoke only one cigarette per day is half that in people who smoke 20 cigarettes per day, much higher than expected.<sup>39</sup> Smoking also harms the prognosis of motor function,<sup>40</sup> smokers should aim at quitting smoking rather than reducing smoking, to reduce the risk of stroke and improve the prognosis. In the results in Table 2 and Table 4, smoking is an adverse factor affecting the recovery of limb motor function after stroke, but in Table 3, although the smoking rate in the muscle strength improvement group is 34.5%, and the smoking rate in the muscle strength non-improvement group is 35.6%, there is no statistical significance ( $p \geq 0.05$ ), which may require further research.

The risk of stroke is closely related to blood pressure control,<sup>41</sup> according to the latest evidence from clinical studies and randomized controlled trials (RCTs), the decline in stroke mortality observed over the past 50 years is partly due to improvements in control strategies and treatment for hypertension (BP).<sup>42</sup> However, the effect of hypertension on the improvement of stroke motor function needs further high-quality clinical RCT studies to verify.

In the future, the optimal time for rehabilitation after a stroke may need to better understand the molecular mechanism of early physical activity induced by ischemic tissue, and provide the biological basis for selecting an intervention time window.<sup>22</sup> Another challenge in early rehabilitation studies comes from the inherent heterogeneity of stroke patients, as other experts have observed.<sup>21</sup> Developing biomarkers and other tools, the benefits of interventions that can be detected by reliable stratification of patients in the early stages of stroke according to their recovery potential are not visible in

other undifferentiated populations. In addition, it is necessary to better understand the neurobiological mechanisms of spontaneous recovery and treatment-induced recovery in human subjects and understand the phenotype of stroke recovery,<sup>43</sup> and avoid controllable human risk factors. In the future, whether to use a higher level of specificity scale score to evaluate the improvement of stroke motor function, or to collect and record only items about limb motor score in NIHSS score alone are factors that need to be reconsidered.

## Limitations

This study has several limitations. Firstly, this retrospective study is a single-center design, which may be affected by bias. Second, according to the previous study,<sup>44</sup> we can complete the screening of influencing factors for the improvement of the function of stroke patients with the motor disorder, but increasing the sample size may make the results more stable and reliable.

## Conclusion

Acupuncture intervention time, cumulative times of acupuncture treatment, smoking, and hypertension have an impact on the improvement of NIHSS in patients with post-stroke motor disorders, that is, it has a certain impact on the recovery of limb motor function in patients with post-stroke motor disorders. Among them, receiving acupuncture treatment as soon as possible and persisting in acupuncture treatment for as long as possible may have a positive effect on the recovery of motor function of patients with post-stroke limb motor dysfunction, while patients with post-stroke motor dysfunction who have a history of hypertension may be more difficult to recover their limb motor function. The effect of smoking history on the recovery of limb motor function in patients with post-stroke motor disorder needs further discussion. Therefore, early acupuncture intervention, more accumulated times of acupuncture treatment, and no hypertension history may be the influencing factors of NIHSS improvement, that is, the beneficial factors for the recovery of limb motor function in patients with post-stroke motor disorders.

## Data Sharing Statement

The database is publicly available within the hospital and allows unlimited reuse through open licensing.

## Ethics Statement

This study has been approved by the IRB of The First Teaching Hospital of Tianjin University of TCM within which this study was undertaken. And that it conforms to the provisions of the Declaration of Helsinki. This clinical study is a retrospective study, which only collects the clinical data of patients, does not interfere with the treatment plan of patients, and will not bring risks to the physiology of patients. The data obtained remain anonymous. The collection of research data complies with national laws, regulations, and social ethics. The authors receive the approval of the institutional review board: The patients consent to review the medical records in this research was not required because the study design of this research is a retrospective study, it only collects the patient's clinical data, does not interfere with the patient's treatment plan, and will not bring risks to the patient's physiology, has no harm to patients and no conflict of interest.

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## Disclosure

The authors declare that there is no conflict of interest regarding the publication of this article.

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