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Original Article

Influences of a hierarchical nursing model on rescue outcomes and nursing quality of patients with acute cerebral infarction

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Abstract: Objective: To investigate the influence of a hierarchical nursing model on rescue outcomes and nursing quality of patients with acute cerebral infarction (ACI). Methods: A total of 120 patients with ACI admitted to our hospital from January 2020 and December 2020 were selected as the study subjects and were divided into a study group and a control group, with 60 patients in each group. The study group was treated with a hierarchical nursing model, while the control group was treated with a conventional nursing model. The rescue effects, living abilities, neurological function deficits before and after nursing, nursing quality, families' and physicians' satisfaction with rescue and nursing, and incidence rates of adverse reactions were compared between the two groups. Results: The time from intravenous injection to thrombolysis (*i.e.*, door-to-needle time, DNT), time from pre-examination to triage for thrombectomy, and retention time in the emergency room of the study group were lower than those of the control group, while the success rate of rescue in the study group was higher than that in the control group ($P < 0.05$). After nursing intervention, the scores of the National Institutes of Health Stroke Scale (NIHSS) and incidence rate of adverse reactions in the study group were lower than those in the control group, while the scores of Barthel scale and nursing quality and families' and physicians' satisfaction with nursing in the study group were higher than those in the control group ($P < 0.05$). Conclusion: Hierarchical nursing can remarkably shorten the rescue time, improve the success rate of rescue, neurological function and quality of life of patients with ACI, improve nursing quality of nursing staff, and reduce the incidence rate of adverse reactions.

Keywords: Hierarchical nursing, acute cerebral infarction, rescue outcomes, nursing quality, investigation of influences

Introduction

Acute cerebral infarction (ACI), also known as ischemic stroke, results in an area of necrotic tissue in the brain caused by a blockage or narrowing of the arteries supplying blood and oxygen to the brain [1]. The pathogenesis of ACI is complex, and its etiology may be cerebral artery stenosis or blockage induced by vascular, blood or hemodynamic abnormalities. The major risk factors of ACI include hypertension, coronary heart disease, diabetes, hyperlipidemia, smoking, alcohol drinking, and obesity [2, 3]. Clinical studies have indicated that ACI is characterized by acute onset, rapid progression of disease and poor prognosis. Epidemiology shows that there are over 8 million patients with ACI in China every year, and about 1.5 million patients with ACI die. To date, ACI ranks the first in the incidence of cerebrovascular diseases, bringing a very heavy burden to patients and their families [4, 5].

Clinically, it is found that patients with ACI experience ischemia and hypoxia in local cerebral tissues, and the body quickly enters a stress state and starts the inflammatory process, leading to the secretion of massive inflammatory factors. Even if the blood supply to the ischemic site is restored, the cerebral tissues of the patients suffer irreversible damage. Therefore, timely and effective rescue and nursing intervention are crucial to improve the prognosis of patients with ACI [6, 7]. The current recognized

time window for the treatment of ACI is 3 hours. Related studies have indicated that pre-hospital treatment for patients with ACI and the door-to-needle time (DNT) has a significant impact on the restoration of neurological function of the patients in late stages [8]. However, the emergency treatment of ACI also has some deficiencies, such as improper allocation of personnel and resource scheduling and low nursing quality, restricting the follow-up treatment for patients with ACI to a certain extent [9].

Hierarchical nursing, a new nursing intervention, recently implemented, is an improved option to allocate human nursing resources, rationally. Currently, there is an acute shortage of nursing and human resources in medical institutions in China [10]. The existing studies have revealed that proper hierarchical nursing can optimize the implementation efficiency of nursing staff to the greatest extent, which is of positive significance to improve nursing quality. A retrospective analysis of patients in ICU wards shows that the implementation of measures [*e.g.*, continuous shift for advanced practice nurses (APNs), formulation of work guidelines and quality standards, hierarchical training, assessment and promotion], can remarkably improve the work efficiency and psychological state of nursing staff in the ICU as well as the patients' satisfaction with nursing care, and ensure the continuity of nursing work [11]. The objective of this study was to explore the feasibility of the hierarchical nursing model for the treatment of patients with ACI, and to analyze the influence of hierarchical nursing on the rescue outcomes and nursing quality of patients with ACI, so as to provide clinical references for the improvement of the prognosis of patients with ACI.

Materials and methods

General data

A total of 120 patients with ACI admitted to our hospital from January 2020 to December 2020 were selected as the study subjects and they were divided into the study group and the control group, with 60 patients in each group. The study group was treated with a hierarchical nursing model, while the control group was treated with a conventional nursing model.

Inclusion criteria: (1) those in compliance with the diagnostic criteria for ACI in the *Guidelines for Diagnosis and Treatment of Ischemic Cerebrovascular Diseases* [12] and with corresponding clinical symptoms; (2) those with complete clinical medical records. This study was approved by the Ethics Committee of the Central Hospital of Wuhan, Tongji Medical College, Huazhong University of Science and Technology. Informed consent form was signed by the patients' families.

Exclusion criteria: (1) those who were complicated with mental illness; (2) those with an estimated survival time of less than 6 months; (3) those complicated with severe hepatic and renal dysfunction; (4) those complicated with primary or secondary dementia; (5) those complicated with myocardial infarction and severe pulmonary hypertension; (6) those during pregnancy or lactation; (7) those complicated with autoimmune diseases or systemic infection.

Rejection criteria: (1) loss to follow up during the investigation; (2) voluntary withdrawal during the investigation.

Intervention methods

The control group received conventional emergency treatment for ACI. The patients were pre-examined and triaged after admission, followed by being diagnosed by a physician from the emergency department of internal medicine after registration. After the assessment by the physician, the patients received routine blood tests, coagulation tests, and cranial CT scans, and they were finally sent to the emergency room. A consultation with neurologists on the best treatment was performed. The patients were confirmed to have no contraindications to thrombolysis and thrombectomy, and then they received the best corresponding treatment. During this process, the nursing staff conducted vital sign monitoring, oxygen inhalation and sputum aspiration based on the physician's advice.

The study group was treated with a hierarchical nursing model. The specific measures were as follows: (i) Hierarchical management of the nursing human resources. A grading system of N1 to N3 was established based on the qualifications of each nursing staff. N1 was rated when a nurse had engaged in emergency treatment for more than 2 years, N2 was rated when a senior nurse had engaged in emergency treatment for more than 5 years, and N3 was rated when a supervisor nurse had engaged in

emergency treatment for more than 10 years. (ii) Grouping and shift system. The nurses were divided into a pre-examination and triage group, a critical care rescue group, and secondary care rescue group. Pre-examination: a nurse (N1) and a supervisor nurse (N3); Critical care rescue: a nurse (N1), a senior nurse (N2) and a supervisor nurse (N3). Secondary care rescue: a nurse (N1) and a senior nurse (N2). The grouping and shift system was implemented for the three groups. (iii) Intervention process: All emergency nursing staff attended training on ACI-related nursing knowledge to be familiar with key points and procedures of the rescue and nursing for patients with ACI. After admission of patients, a nurse (N1) performed the vital sign monitoring, and a senior nurse (N3) carried out a fast triage based on the signs of patients with ACI. A fast-track lane was immediately made available for those who had symptoms of anterior or posterior circulation stroke, and the patients were placed in the stroke bed unit. Nursing staff in the secondary care rescue group carried out ECG monitoring, oxygen inhalation, and sample collection, and opened the venous channel, and informed the neurologists to bring a thrombolytic kit to conduct the emergency treatment through performing thrombolysis or thrombectomy based on the physician's judgment.

Observational indices and assessment criteria

Relevant indices of rescue effects: The responsible nurse recorded DNT, time from pre-examination to triage for thrombectomy, emergency treatment duration in the emergency room, and the success rate of rescue.

Assessment on nursing quality: The nursing quality in the two groups was assessed using the nursing quality questionnaire prepared by the hospital. The scale comprises five items: ward management, nursing operations, graded nursing, emergency response ability, and assessment on patient risks. Each item was scored using a scoring system of 0-20 point(s), and the total score of the scale was 100 points. A higher score indicated a higher nursing quality.

Assessment on daily living abilities and neurological function deficits before and after nursing intervention

Before intervention and at 48 h, 72 h and 7 d after intervention, the daily living abilities and neurological function deficits were assessed using the National Institutes of Health Stroke Scale (NIHSS) and Barthel scale. The NIHSS comprises 11 items, such as consciousness level, gaze, visual field, prosopoplegia, upper and lower limb motions, and extremity ataxia. The scale was scored using a scoring system of 0-42 points. A higher score indicated more serious neurological function deficits [13]. The Barthel scale consists of 10 items (*e.g.*, feeding, bathing, and dressing). Each item was scored using 0 points, 5 points, or 10 points. The total score of the scale is the sum of the scores of all items, and the total score of the scale is 100 points. A higher score indicated greater self-care abilities of the subjects [14].

Assessment on families' and physicians' satisfaction with nursing

Nursing staff distributed the satisfaction questionnaires for emergency rescue and nursing prepared by the hospital to the patients' families. The scale was divided into three grades: very satisfied, satisfied and dissatisfied. The total satisfaction = (very satisfied + satisfied)/total number of cases × 100%. In this study, there was a total of 100 family members of 60 patients in the study group, and 110 family members of 60 patients in the control group, who were included for satisfaction evaluation. Nursing staff distributed the nursing satisfaction questionnaire prepared by the hospital to the neurologists. The scale was divided into three grades: very satisfied, satisfied and dissatisfied. The total satisfaction = (very satisfied + satisfied)/total number of cases × 100%. In this study, 6 physicians in the study group and 6 physicians in the control group were included for satisfaction evaluation.

Incidence rate of adverse reactions and assessment on the long-term prognosis

The statistics on the incidence rates of multiple adverse reactions (*e.g.*, bleeding gums, upper gastrointestinal hemorrhage, and hemorrhage in the urinary system) in the two groups were performed during the intervention, and the differences were compared between the two groups. Meanwhile, the two groups were followed up for 6 months. The stroke impact scale (SIS) was used to assess the overall recovery of patients after discharge. The scale includes hand function, strength, memory and thinking,

Table 1. Comparison of general clinical indices between the two groups ($\bar{x} \pm s$)/[n (%)]

General clinical data		Study group (n = 60)	Control group (n = 60)	t/X^2	*P*
Gender	M	37	38	0.547	0.362
	F	23	22		
Mean age (years)		45.98±4.33	46.01±4.29	0.036	0.987
Mean weight (kg)		64.29±3.91	64.34±3.89	0.066	0.917
Mean course of disease (years)		2.89±0.28	2.93±0.18	0.871	0.317

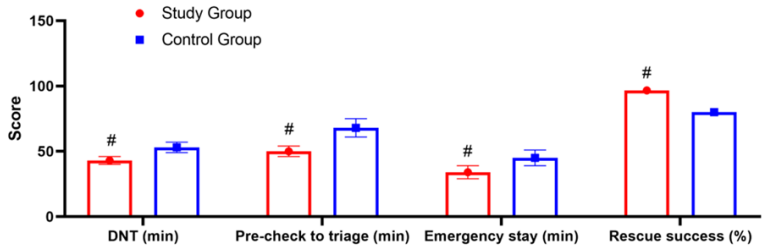

Figure 1. Comparison of differences in related indices of rescue effects between the two groups. DNT, time from pre-examination to triage for thrombectomy, emergency treatment duration in emergency room in the study group were markedly lower than those in the control group ($P < 0.05$). #indicates a statistically significant difference in the same indices between the two groups.

and participation. A higher score indicated a better recovery of the subjects.

Statistical methods

The collected data were input into an EXCEL table, and SPSS 22.0 was adopted for statistical analysis. The statistical charts were prepared by Graphpad Prism 8. The collected data were detected using a normal distribution. The data conforming to a normal distribution were expressed using [n (%)]. The differences between groups were analyzed using Chi-square test. The measurement data were expressed using mean ± standard deviation (mean ± SD). The differences between groups were analyzed using t test, and the comparison of differences in continuous variables was detected using t test. $P < 0.05$ indicated a statistically significant difference.

Results

Comparison of differences in the general data between the two groups

The comparison of the differences in the general clinical data (*e.g.*, gender, age, and weight) revealed that there was no statistically significant difference in the general clinical data between the two groups ($P > 0.05$), and the groups were comparable (**Table 1**).

Comparison of differences in the related indices of rescue effects between the two groups

The DNT, time from pre-examination to triage for thrombectomy, emergency treatment duration in emergency room in the study group were markedly lower than those in the control group, while the success rate of rescue in the study group (96.67%) was significantly higher than that in the control group (80.00%) ($P < 0.05$) (**Figure 1**).

Comparison of differences in nursing quality between the two groups

The scores of ward management, nursing operations, graded nursing, emergency response abilities, and assessment on patient risks in the study group were remarkably higher than those in the control group ($P < 0.05$) (**Figure 2**).

Assessment on daily living abilities and neurological function deficits before and after nursing intervention

Before intervention and at 48 h, 72 h and 7 d after intervention, the daily living abilities and neurological function deficits in the two groups were assessed, and the differences between groups were compared. The results showed that there was no marked difference in the scores of NIHSS and Barthel scale between the two groups before intervention ($P > 0.05$). The scores of NIHSS in the two groups showed a downward trend, while the scores of Barthel scale showed an upward trend after intervention. At 48 h, 72 h and 7 d after intervention, the scores of NIHSS and Barthel scale in the

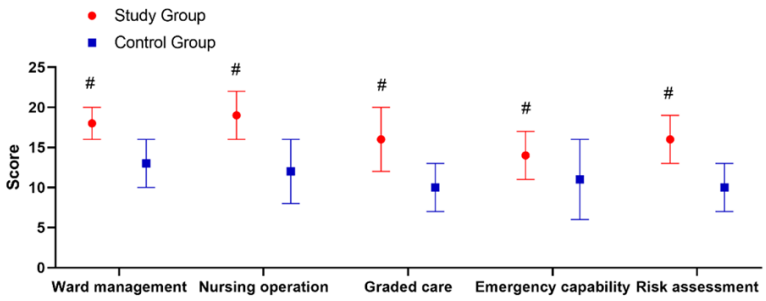

Figure 2. Comparison of differences in nursing quality between the two groups. The scores of ward management, nursing operations, graded nursing, emergency response abilities, as were assessment on patient risks in the study group were significantly higher than those in the control group ($P < 0.05$). #indicates a statistically significant difference in the same indices between the two groups.

study group were lower than those in the control group ($P < 0.05$) (**Figure 3**).

Assessment on families' and physicians' satisfaction with nursing

The families' and physicians' satisfaction with nursing were assessed by our scale. The results revealed that the satisfaction rates of 100 families and 6 physicians in the study group were 96.00% and 100.00% respectively, while the satisfaction rates of 110 families and 6 physicians in the control group were 63.64% and 50.00% respectively, exhibiting marked differences in the satisfaction rate between the two groups ($P < 0.05$) (**Table 2**).

Incidence rate of adverse reactions and assessment on the long-term prognosis

The statistics on the incidence rates of adverse reactions in the two groups during the intervention suggested that there was 1 case of bleeding gums in the study group, and the incidence rate of adverse reactions was 1.67% in the study group. There were 3 cases of bleeding gums, 2 cases of gastrointestinal hemorrhage, and 2 cases of urinary tract hemorrhage in the control group, and the total incidence rate of adverse reactions was 11.67% in the control group, showing significant differences between the two groups ($P < 0.05$) (**Table 3**). The comparison of the 6-month follow-up between the two groups revealed that the scores of hand function, strength, memory and thinking, and participation in SIS scale in the study group were remarkably higher than those in the control group ($P < 0.05$) (**Figure 4**).

Discussion

ACI is an acute cardiovascular and cerebrovascular disease with a high morbidity, mortality, disability and recurrence rate, which can be life-threatening [15]. The *Declaration on Stroke* (2011) indicates that ACI has become the leading cause of death and disability in China. About 70% of patients with ACI have different degrees of dysfunction, and about 40% of patients with ACI have severe dysfunction and severe loss of labor capacity, which adds a serious burden to the patients and their families [16].

ACI manifests as a critical illness with rapid progression. Clinical results show that human tissues have different degrees of tolerance to ischemia and hypoxia. The time for ischemic and hypoxic tolerance of the cerebrum, medulla oblongata, and cerebellum are approximately 5-10 min, 20-25 min, and 10-15 min, respectively [17]. The cerebral tissues of patients with ACI are in an active state in the early stages of onset. A timely rescue intervention can significantly improve neurological function deficits and impairments of reversible neurological function [18]. Emergency nursing is the first intervention for patients with ACI after admission. Traditional emergency nursing for patients with ACI has some shortcomings, such as undefined levels of intervention, long retention time of patients and low transport efficiency, which affect the rescue efficiency of patients with ACI to a certain extent [19]. In a multi-center retrospective analysis from 2010 to 2011, only 236 of 17,593 patients with ACI were successfully treated with thrombolytic therapy, and the thrombolytic rate was only 1.39%. This may be due to the fact that the patients did not receive thrombolytic therapy within the time window, indicating that timely and effective emergency nursing is crucial to ensure that patients with ACI receive proper treatment [20].

In this study, the two groups were established to explore the influences of hierarchical nursing on the rescue outcomes and nursing quality of patients with ACI. The results showed that DNT, time from pre-examination to triage for throm-

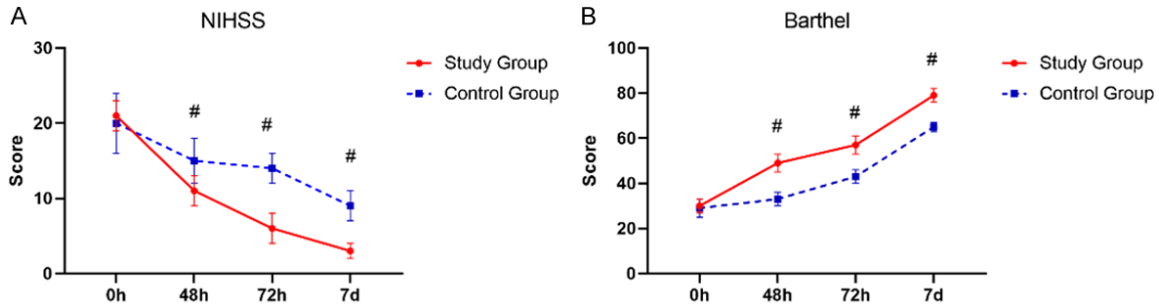

Figure 3. Assessment on daily living abilities and neurological function deficits before and after nursing intervention. There was no marked difference in the scores of NIHSS (A) and Barthel (B) between the two groups before intervention ($P > 0.05$). The scores of NIHSS and Barthel in the study group were lower than those in the control group at 48 h, 72 h and 7 d after intervention ($P < 0.05$). #indicates a statistically significant difference in the same indices at the same time points between the two groups.

Table 2. Assessment on nursing satisfaction of families and physicians [n (%)]

Group	Families' satisfaction with nursing		Physicians' satisfaction with nursing	
	Number of families	Satisfaction rate	Number of physicians	Satisfaction rate
Study group	100	96 (96.00)	6	6 (100.00)
Control group	110	70 (63.64)	6	3 (50.00)
X^2	-	33.126	-	4.0
P	-	< 0.001	-	0.046

Table 3. Comparison of incidence rates of adverse reactions between the two groups [n (%)]

Group	Number of cases	Bleeding gums	Gastrointestinal hemorrhage	Urinary tract hemorrhage	Total incidence rate
Study group	60	1 (1.67)	0 (0.00)	0 (0.00)	1 (1.67)
Control group	60	3 (5.00)	2 (3.33)	2 (3.33)	7 (11.67)
X^2	-	-	-	-	4.821
P	-	-	-	-	0.028

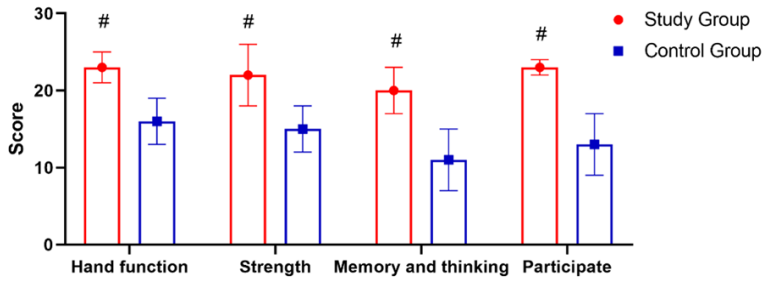

Figure 4. Comparison of assessments on the long-term prognosis between the two groups. The scores of hand function, strength, memory and thinking, and participation in SIS in the study group were remarkably higher than those in the control group ($P < 0.05$). #indicates a statistically significant difference in the same indices between the two groups.

bectomy, and emergency treatment duration in the emergency room in the study group were remarkably lower than those in the control group, while the success rate of rescue in the study group was higher than that in the control group, revealing that the hierarchical nursing model not only shortened the emergency rescue time of patients with ACI, but also improved the rescue efficiency. A comparative study conducted on 84 patients with ACI showed that by optimizing the pre-hospital emergency nursing and medical treatment process, the proportion of patients with pre-hospital delay of more than 5 h was significantly reduced (19.05% vs. 59.52%), and the 48 h mortality rate of patients was reduced from 16.67% to 2.38%, indicating that the optimization of the nursing process remained crucial to improve the prognosis of patients with ACI [21]. The authors believe that

regarding conventional nursing, patients have to register first, and then seek a physician for examination. Thrombolysis is implemented only after diagnosis. This process is rather lengthy, and it is very likely to miss the optimal treatment opportunity. Supervisor nurses (N3) can quickly assess the conditions of patients with ACI using the hierarchical nursing model. Therefore, critical patients can be directly sent to the stroke treatment unit without the use of the fast track lane procedures, and physicians can be asked to perform a vital sign check-up, and the thrombolytic intervention based on the conditions of the patients can be performed, thereby effectively shortening the early detection time of patients with ACI [22].

In this study, the daily living abilities and neurological function deficits of patients in the two groups were further assessed. The results revealed that at 48 h, 72 h and 7 d after intervention, NIHSS scores in the study group were lower than those in the control group, while Barthel scores in the study group were higher than those in the control group. Scholars indicate that neurological defects and living abilities can be used to assess the prognosis of patients with ACI, and a good emergency nursing can improve the quality of life of the patients [23]. An investigation has pointed out that hierarchical nursing can optimize the utilization rate of nursing staff, give play to the spirit of teamwork, maximize the practical abilities of nursing staff, enable nursing staff to perform their duties and have a definite division of labor, and ensure the implementation of subdivided works, thereby exhibiting a remarkable effect on improving nursing quality [24]. The authors believe that hierarchical nursing can shorten the intervention time of patients with ACI before thrombolysis, and the time of cerebral ischemia and hypoxia, so that the impairments of neurological function of the patients can be further alleviated and their living abilities can be improved. The assessment results on nursing quality and families' and physicians' satisfaction with nursing show that hierarchical nursing can also improve nursing quality and families' and physicians' satisfactions with nursing [25]. 'Another study has found that hierarchical nursing contributes to the improvement of the utilization rate of medical resources and the increase of the degree of cooperation of medical staff, thus showing a positive significance in improving physicians' evaluation of nursing staff [26]. Finally, the assessment on the incidence rate of adverse reactions and long-term prognosis shows that hierarchical nursing is also helpful to reduce the incidence rate of adverse reactions and improve the long-term living abilities of patients with ACI. This may be related to the small impairments of neurological function of the patients at the early stage.

In summary, the hierarchical nursing can remarkably shorten the rescue time, improve the success rate of rescue, neurological function and quality of life of patients with ACI, improve the nursing quality of nursing staff, and reduce the incidence rate of adverse reactions. Therefore, hierarchical nursing is worthy of clinical promotion and implementation. The innovation of this study lies in comprehensive evaluation of the influences of hierarchical nursing on the rescue outcomes and nursing quality of patients with ACI from the perspectives of patients, families, physicians and nursing staff, so as to provide a theoretical reference for the follow-up studies. The deficiencies of this study lie in the lack of laboratory or imaging indices, and the failure to carry out quantitative analysis on the conditions of patients with ACI, which are planned to be improved in the future studies.

Disclosure of conflict of interest

None.

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