Effects of a Prehospital Emergency Care System on the Treatment and Prognosis of Stroke Patients

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ABSTRACT

Objective: We sought to study a recently implemented prehospital emergency care system and its effects on the treatment level and prognosis of stroke patients. Prior to the introduction of the new system, no dispatch triage or prehospital care was available, and most patients accessed emergency care directly, without calling an emergency number.

Methods: From April 2014 to March 2015, at our associate hospital's emergency department, 325 first-time acute stroke patients were admitted to the emergency department. This cohort was divided according to hospital admission method. The group receiving dispatch triage and pre-admission first-aid comprised 171 cases and was designated as the Prehospital Emergency Care Group; the group admitted by family members comprised 154 cases and was designated as the Self-Treatment Group. A statistical comparison of the emergency treatment time, mortality rate, morbidity rate, National Institutes of Health Stroke Scale (NIHSS) percentage, and Barthel Index (BI) score at the times of admission and discharge was performed for the two groups.

Results: The Prehospital Emergency Care Group's emergency treatment time, mortality rate, and morbidity rate were lower than those of the Self-Treatment Group, and the difference was statistically significant ($P < 0.05$); relative to the self-treatment group, the Prehospital Emergency Care Group's NIHSS percentage reduction and BI scores were increased, and the difference was statistically significant ($P < 0.05$). In conclusion, the introduction of a dispatch triage and prehospital care system functioned to provide timely and effective treatment of stroke patients, significantly reducing the prehospital mortality and disability rates of stroke patients and improving patient outcomes.

INTRODUCTION

Stroke is one of the most common acute conditions seen in China's emergency rooms, endangering the life and health of the elderly in particular. In recent years, stroke ranked first and second place as a cause of death among domestic urban and rural populations, respectively. According to World Health Organization statistics, as of this writing, morbidity and mortality due to stroke have been decreasing significantly in the majority of countries around the world, but China has shown an increasing trend, becoming a country with one of the highest incidences of stroke in the world. Every year, approximately 1.5 million people die from cerebrovascular diseases, and about three-fourths of patients who survive suffer from varying degrees of loss of ability to work, causing a heavy burden to society and to their families.[1]

The 2014 Edition of the China Acute Stroke Treatment Guidelines clearly states that the key to prehospital treatment of stroke is rapid assessment and emergency treatment, as well as timely dispatch to a hospital equipped to deal with the condition. In order to achieve these goals, the studied system implemented a complete dispatch triage and instruction program to provide prehospital telephone-based care and to encourage citizens to use the improved emergency number system. The system selected to manage the new system and provide dispatch triage and care was the Medical Priority Dispatch System (MPDS).

The MPDS, a medical priority classification system widely used in developed countries worldwide in emergency command centers, is a professional system software package for standardizing emergency scheduling, medical treatment, and classification.[2] Prior to the introduction of the MPDS in the studied system, as in much of China, an emergency num-

Group	Patients	Sex	Age	Type		Prior History		
		Male/Female		Hemorrhagic	Ischemic	Hypertension	Diabetes	Hyperlipidemia
Prehospital Care Group	171	105/66	58.42 ± 11.75	73	98	101	34	56
Self-Treatment Group	154	91/63	56.84 ± 13:81	58	96	93	26	51
Test Value		0.1803	1.1140*	0.8496	0.8496	0.0587	0.4840	0.0049
P Value		0.6714	0.2661	0.3567	0.3567	0.8086	0.4866	0.9442

*indicates a *t* value, while X2 values are unmarked

Table 1. Comparison of the general data for stroke patients in the two groups analyzed

ber (1-2-0) was available, but no telephone triage was conducted, calls were not prioritized by complaint type or needed response, and no telephone instructions or dispatch first aid were given. As a result, most patients made their own way to the hospital, without any kind of prehospital care. In this study, we sought to analyze whether the new system of prehospital emergency care, including MPDS guidance and also on-scene and in-ambulance medical care, had a positive impact on the treatment and prognosis of stroke patients.

Data and Methods

1. Subjects

We selected a tertiary hospital within our city that had a comprehensive prehospital emergency network system and a mature, developed stroke diagnosis and thrombolytic and surgical treatment program as a staging ground (collaborating hospital) for the study. Follow-up visits were conducted between April 2014 and March 2015 for first-time acute stroke patients in the hospital's emergency department who were diagnosed following admission using CT scans, and fulfilled the "Key Points for the Diagnosis of Various Cerebrovascular Diseases" diagnostic criteria, drawn up during the Fourth National Cerebrovascular Disease Conference.[3]

For all patients, the time from onset to treatment was 24 hours or less, and patients whose condition was associated with cardiovascular, liver, kidney, circulatory, or other serious primary diseases were excluded. A total of 325 patients fulfilled the inclusion criteria. Of these, 196 were male and 129 were female, and the cohort ranged in age from 34 to 78 years. The cohort was divided into two groups, depending on the type of help they received after calling China's 120 emergency number. 171 patients who received guidance via the Medical Priority Dispatch System and were admitted by prehospital staff were assigned to the Prehospital Care Group. The other group, designated as the Self-Treatment Group, included 154 patients who did not access 120 at all, or were not given any prehospital telephone advice and were taken to the hospital by a relative. There were no statistically significant differences between the two groups in terms of gender, age, type of stroke, or past history ($P > 0.05$) (Table 1).

2. Research Methods and Measures

The study employed the prospective study method to observe and track corresponding indicators for patients in both groups, research and analyze the impact of MPDS-guided prehospital triage and medical treatment and self-treatment on the treatment and prognosis of hospitalized stroke patients, and investigate whether MPDS-guided advanced prehospital care can significantly improve the survival rate and recovery rate of patients with stroke.

2.1. For the Prehospital Emergency Care Group, after patients placed a 120 emergency call for aid, they received guidance via the Medical Priority Dispatch System for pre-admission treatment. The process primarily included the following:

(1) An MPDS telephone assessment involving the use of the internationally-accepted Cincinnati rating scale to ask the caller to look for three signs: signs of facial numbness or weakness, arm weakness or numbness, and unclear pronunciation (or other speech or comprehension difficulties) in the patient; approximate time of symptom onset was also recorded.

(2) After immediately dispatching an ambulance, and before the arrival of the ambulance, self-treatment guidance was provided over the phone to, for example, ensure that the patient maintained a correct body position, and in the case of cardiac arrest, guide the patient's family members to provide cardiopulmonary resuscitation.

(3) Emergency personnel rushed to the scene immediately after receiving the dispatcher's order and, upon arrival, an emergency physician immediately examined the vital signs of the stroke patient to assess the patient's condition and provide treatment; during transit, the patient's physical position was checked, ECG was conducted, pulse oxygen saturation was monitored, oxygen was administered when necessary, intravenous access was kept open, and the patient's airways were kept open to avoid aspiration. Monitoring of the patient's ECG, blood pressure and blood glucose was performed; in cases of airway obstruction or respiratory failure, suction, a supraglottic airway, or endotracheal oxygen treatment was administered; if physical signs of high intracranial pressure or convulsions were observed, appropriate symptomatic treatment was given.

(4) On the way to the hospital, the emergency physician further evaluated the patient's condition, taking a complete history and performing a physical examination of the patient's nervous system, assigning a Glasgow Coma Score (GCS), and using the ambulance's radio to transmit essential details pertaining to the

patient to the destination hospital to allow relevant specialists to prepare for emergency treatment.

(5) The patient was transported to a cooperating hospital capable of treating the stroke patient, an express lane was established upon arrival at the hospital, cranial CT or MRI checks were performed, and the emergency stroke care unit was activated to gain needed time for thrombolytic treatment or surgery.

2.2. Patients in the Self-Treatment Group did not receive telephone advice or prehospital treatment. In the absence of professional prehospital emergency treatment, they were taken to the hospital by family members or non-medical personnel. In these cases, no prehospital treatments were performed at all. This group was selected as the control because they represented the best available analogue to the system that existed prior to the implementation of the new MPDS-guided triage and prehospital care process.

3. Study Outcome Measures

The following outcome measures were used to assess the Prehospital Emergency Care Group and Self-Treatment Group:

(1) Emergency Treatment Data: Emergency treatment time (the time from onset to emergency treatment at the hospital and from admission to the time the patient was subject to diagnostic imaging), mortality rate (excluding, in both treatment groups, cases of mortality due to post-surgical complications because it was not clear whether these were related to the initial stroke or to problems introduced during surgery), and the incidence of complications;

(2) Prognosis Rating: The percentage decrease from the time of hospitalization versus discharge in the patient's National Institutes of Health Stroke Scale (NIHSS) was calculated using the formula [(NIHSS at Admission – NIHSS at Discharge) / NIHSS at Admission * 100%] to determine the extent of the patient's recovery in terms of neurological disability;[4] the Barthel Index (BI) at discharge was used to score the patient's capacity for routine daily activity.[5]

4. Statistical Methods

The SPSS 19.0 statistical software package was used to conduct statistical analyses. All measured data were expressed in terms of a mean and standard deviation ($\bar{x} \pm s$), inter-group result comparisons were performed using a t test, and count data were compared using a chi-squared test. $P < 0.05$ was used as the threshold of statistical significance.

RESULTS

1. Comparing the Emergency Treatment Times for Both Groups of Stroke Patients

For the Prehospital Emergency Care Group, the time from onset to arrival at the hospital's emergency department was (74 ± 12) min, and the time from hospitalization to imaging diagnosis was (26 ± 10) min, which was on average lower than the Self-treatment group, and the difference was statistically significant ($P < 0.01$) (Table 2).

2. Comparison of Complications and Mortality Rate in Both Groups of Stroke Patients

There was a reduction in airway obstruction, encephalopathy incidence, and complications in the Prehospital Emergency Care Group compared to the Self-Treatment Group, and the difference was statistically significant ($P < 0.05$). The Prehospital Emergency Care Group showed a decreased mortality rate compared to the Self-Treatment Group, and the difference was statistically significant ($P < 0.05$) (Table 3).

Group	Number of Patients	Time from Onset to Hospital Treatment	Time from Admission to Imaging Diagnosis
Prehospital Care Group	171	74 ± 12	26 ± 10
Self-Treatment Group	154	158 ± 22	57 ± 18
t value		43.2989	19.4369
P value		0.0000	0.0000

Table 2. Comparison of emergency treatment time for both groups of stroke patients (min)

Group	Number of Patients	Complications		Death
		Respiratory Obstruction	Cerebral Hernia	
Emergency Care Group	171	3 (1.8)	7 (4.1)	6 (3.5)
Self-Treatment Group	154	14 (9.2)	16 (10.5)	15 (9.7)
X^2 value		8.7864	4.8815	5.2073
P value		0.0030	0.0271	0.0224

Table 3. Comparison of morbidity and mortality in both groups of stroke patients [n (%)]

Group	Number of Patients	Decrease in NIHSS Percentage Rating at Discharge (%)	BI Score at Discharge
Emergency Care Group	171	38. 59 ± 10. 67	66. 57 ± 23. 01
Self-Treatment Group	154	20.89 ± 11.90	52.80 ± 20. 48
T value		14.0946	5.6557
P value		0.0000	0.0000

Table 4. Comparison of NIHSS and BI scores for both groups of stroke patients

3. Assessing the Prognosis of the Two Groups of Stroke Patients

Patients in the Prehospital Emergency Care Group showed a decreased NIHSS percentage score at discharge—i.e., [(NIHSS at Admission – NIHSS at Discharge) / NIHSS at Admission * 100%] was equal to (38.59 ± 10.67)%, and at discharge the Barthes Index (BI) was 66.57 ± 23.01, both significantly higher than the Self-Treatment Group ($P < 0.01$) (Table 4). Patients in the Prehospital Emergency Care Group showed both a higher degree of recovery in terms of capacity for routine activities and

fewer neurological defects at the time of discharge compared to the Self-Treatment Group, and prognosis was better for the Prehospital Emergency Care Group.

DISCUSSION

Stroke is an acute cerebral circulatory disorder that quickly leads to clinically significant focal or diffuse brain injury, and, according to its pathological properties, can be classified as either ischemic stroke or hemorrhagic stroke. For the treatment of patients with acute stroke, there exists a therapeutic time window. Currently, the safest and most effective method recommended by international guidelines for the treatment of acute ischemic stroke is thrombolytic therapy performed within 3 - 4.5 hours after the onset of symptoms, to help the patient recover as much nerve function as possible. For hemorrhagic stroke, the patient should preferably undergo surgery within 6-7 hours.[6,7] However, most patients experience the onset of stroke at home and do not get the attention of their family members in the early stages of onset, so proper steps are not taken in response, often resulting in a failure to obtain treatment during the best time frame for thrombolytic therapy, or resulting in delayed treatment. Shortening patient treatment time before hospital admission is an issue of interest to medical specialists throughout the world. With the implementation of a scripted, protocol-based dispatch triage program (MPDS) and accurate, priority-based allocation of prehospital care responders, each of our city's first-aid stations can provide care in line with the MPDS guidelines,[8] including the provision of a clinically validated stroke scale and guidance in patient care before the arrival of responders on scene.

The results of this study show that the system of prehospital care improved outcomes. First, the time from onset to hospital emergency treatment and the time from admission to imaging diagnosis were significantly shorter in the Prehospital Emergency Care Group. Second, the treatment group's mortality rate, incidence of airway obstruction, and incidence of encephalopathy complications were significantly lower than for the controls. Finally, at discharge, the treatment group showed much greater decreases in NIHSS scores and Barthel Index scores, demonstrating that by leveraging prehospital emergency guidance, stroke patients achieved a better recovery from neurological deficits and better performance in routine activities. Also, notifying a specialist and enabling the prehospital emergency system to faster and more effectively activate the hospital's stroke treatment unit, represented a critical element in reducing disability among stroke patients.[9] This could be done earlier and more accurately because of the use of the stroke scale conducted at the earliest possible point of care, the dispatch point.

The purpose of acute stroke treatment is to reduce patient mortality, as well as improve the patient's prognosis and ability to maintain daily activities. Studies conducted in recent years have emphasized that "from the onset of a patient's symptoms, time is brain [function]"; shortening the time from onset to admission is key to increasing treatment effectiveness in stroke patients.[10] Targeted self-help can save lives and prevent worsening of the patient's medical condition, and the introduction of a prehospital care system directed by scripted EMD protocols allows the family members of stroke patients to participate in the rescue instead of waiting to get the patient to a care provider on their own, thus significantly increasing the success rate of on-site rescue.[11] Also, with MPDS-based resource assignment, all of the city's first-aid stations follow emergency medical instructions which are based on the prehospital emergency principle of dispatching the "nearest, most urgent and most functional" aid, with ambulance dispatch performed within 2 minutes, achieving an emergency response time of 10 minutes for urban areas. Compared to the Self-Treatment Group, care was able to reach patients in the treatment group sooner, providing quick and effective treatment and safe transportation, as well as obtaining the patient's medical history before arriving at the hospital while concurrently transmitting information to the hospital's pre-arrival notification platform so patients could obtain an imaging diagnosis faster, greatly improving treatment efficacy. Thus, the introduction of a prehospital care system, driven by information obtained through a stroke scale at the dispatch point, brought the system more in line with current standards of care for stroke patients.

Limitations

The study used a control group made up of patients who, during the period of the study, made their own way to the hospital, usually driven by family members. This means that the study was not a direct comparison of the pre-implementation and post-implementation outcomes for stroke patients before and after the new system was put in place. However, this control group almost exactly matched the service available to patients before implementation, when very few used the emergency number at all, and those who did received no dispatch triage, no telephone self-help instructions, and little (if any) prehospital care.

In addition, this study compared the control group to a two-part intervention, meaning that it is not completely clear which intervention (the implementation of a scripted dispatch protocol allowing for triage and instructions, or the use of prehospital responder care) had the most impact on increases in patient outcomes. However, as most of China, like many countries, has until recently been without any kind of dispatch-based or prehospital care, the comparison between the two-part system as implemented and a group of patients with no intervention does make an argument for prehospital care generally, especially for critical patients, such as those suffering from strokes.

CONCLUSION

Current stroke morbidity and mortality rates in China remain high due to a limited optimal therapeutic time window. According to the results of this study, implementation of a prehospital emergency care process, guided by a scripted protocol system (MPDS) and including prehospital treatment by accurately-dispatched responders, improved the emergency care system's provision of stroke patients with more timely and professional emergency diagnosis and treatment as well as more comprehensive and efficient medical services, effectively shortening treatment time, reducing the rates of mortality and disability in stroke patients, and improving prognosis.

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