Review paper

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The application of pre-hospital first aid mode in patients with acute stroke: meta-analysis

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Abstract

Introduction: *To systematically evaluate the application effect of pre-hospital and in-hospital emergency mode in patients with acute stroke.*

Material and methods: *The study was conducted by systematic search of Chinese (CNKI, Wanfang and VIP) and English (PubMed, EMBASE and Cochrane Library) databases. The case-control studies comparing the role of pre-hospital and in-hospital emergency mode for patients with acute stroke were included in this study. Outcome indicators included the time from admission to thrombolytic therapy (DNT), the time from calling for help to receiving professional treatment, the first aid effect (effective rate, disability rate and mortality), complications and prognosis. Meta-analysis was performed using RevMan 5.3.*

Results: *Seventeen studies were included in the final analysis. Compared with traditional emergency measures, pre-hospital and in-hospital emergency measures can significantly reduce DNT (mean difference [MD] = –22.63, $p < 0.00001$), time from call to professional treatment (MD: –13.22, $p < 0.00001$), disability rate (RR = 0.88, $p = 0.004$), fatality rate (RR = 0.58, $p < 0.00001$), central cerebral fever (RR = 0.44, $p = 0.0009$), and gastrointestinal bleeding (RR = 0.44, $p = 0.002$). In addition, daily living ability (MD = 16.56, $p < 0.00001$) and emergency response rate (RR = 1.50, $p < 0.00001$) were significantly improved.*

Conclusions: *The pre-hospital and in-hospital emergency mode has a significant emergency effect in patients with acute stroke, which is a protective factor. This emergency mode can be widely used in clinical practice.*

Key words: *acute stroke, pre-hospital emergency, hospital first aid.*

Introduction

Stroke is the most common cause of death and the leading cause of sexual disability in adults worldwide [3]. The World Health Organization calls stroke the 'epidemic of the 21st century' [21]; in the United States, about 795,000 adults experience a new or recurrent stroke every year [2]. Stroke not only has a high incidence, but also causes high mortality, high disability rate and complications, which seriously endanger the life safety and quality of life of patients [14].

The main principle for the treatment of acute stroke is to implement thrombolytic therapy as soon as possible, and experimental and systematic evaluation studies have shown that the effect of intravenous injection of tissue plasminogen activator (tPA) on patients with acute stroke depends on the time from onset to injection of tPA [8,15,19], and the treatment time window for acute stroke is 6 hours from onset to admission. However, previous studies have found that most patients with acute stroke receive treatment beyond the most effective time window. For example, the median time from onset to

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treatment of acute stroke patients in the Get-With-The-Guidelines Center of the United States is 144 minutes [22]; the median time from onset to treatment of acute stroke patients in the European Research Centre is 140 minutes [26]. On the other hand, effective emergency measures have significantly improved the prognosis and complications of patients [16]. Therefore, rapid and effective pre-hospital emergency measures play an important role in improving the emergency effect and prognosis of patients with acute stroke. On the surface of a large number of original studies, the implementation of pre-hospital and in-hospital emergency measures can shorten the thrombolysis time of patients with acute stroke [23,28], improve limb motor ability, daily living ability and neurological function [4,29], and also the prognosis of patients. However, there is a lack of systematic evaluation research in this field, so it is necessary to carry out this study.

In this study, we aimed to systematically evaluate the application effect of pre-hospital and in-hospital emergency mode in patients with acute stroke through systematic retrieval of public databases, so as to provide reference for the promotion and improvement of emergency mode of acute stroke.

Material and methods

Literature retrieval strategy

Following the guidance manual of PRISMA, three English databases including PubMed, EMBASE and Cochrane Library, and three Chinese databases including CNKI, Wanfang and VIP were systematically searched. The search concerned the period from database construction to 30 October 2021. The English database retrieval strategy includes the following keywords: 'stroke'; 'pre-hospital', 'in-hospital', and 'emergency care'. The Chinese database retrieval strategy includes the following keywords: 'stroke', 'cerebral infarction', 'cerebral haemorrhage', 'pre-hospital emergency care', 'hospital emergency care', and 'integrated emergency care'.

Inclusion and exclusion criteria

Inclusion criteria: 1) patients diagnosed as cerebral haemorrhage or stroke by clinical diagnosis and confirmed by computed tomography (CT) or magnetic resonance imaging (MRI); 2) the observation group adopted pre-hospital first aid or in-hospital first aid or pre-hospital and in-hospital integrated first aid measures, while the control group adopted conventional first aid methods for cerebrovascular diseases; 3) outcome indicators include first aid time (min), first aid effect (including efficiency, disability and mortality), complications and prognosis after first aid. The Barthel index was used to evaluate the prognosis after first aid. Reporting one of these outcome indicators is sufficient for inclusion in this study; 4) case-control study; and 5) Chinese literature only included core journal articles.

Exclusion criteria: 1) non-original studies such as systematic review and case report; 2) lack of the conventional emergency control group; 3) literature with incomplete outcome indicators and no data analysis.

Literature screening and data extraction

Two researchers separately screened the literature according to the inclusion and exclusion criteria. When the two people were inconsistent, the third researcher was consulted for discussion to reach a unified opinion. After literature screening, the data were extracted by two researchers, including literature information, demographic characteristics of the subjects, first aid methods, related outcome indicators, research types and other information.

Quality evaluation

Newcastle-Ottawa scale (NOS) was used to evaluate the quality of case-control studies. The scale was evaluated for three aspects: case selection, comparability and results. The full score was 9, and the total score of 7 or more represented high quality literature.

Statistical analysis method

RevMan 5.3 software was used for statistical analysis. The effect of count data and measurement data is represented by relative risk (RR) and weighted mean difference (MD), respectively, and the interval range of effect is estimated by 95% confidence interval (CI). Heterogeneity test was used to determine the size of heterogeneity. It was considered that the included literature was homogeneous and analysed by the fixed effect model (Mantel-Haenszel). If $I^2 > 50\%$ or $p \leq 0.1$, it is considered that the included studies are not homogeneous, and the random effect model (DerSimonian-Laird) is used for analysis. If the heterogeneity is large, subgroup analysis or sensitivity analysis are used to explore the source of heterogeneity.

Results

Inclusion of research characteristics and quality evaluation

A total of 17 studies were included in the final analysis after screening according to inclusion and exclusion criteria [4-6,10,13,16,17,20,23-25,27-32]. The flow

chart of literature screening is shown in Figure 1. Among the 17 included studies, there were 3653 people who had pre-hospital or in-hospital first aid implemented, 5939 people who had routine first aid measures implemented, and 4683 (48.82%) men. All included studies concerned pre-hospital first aid, and 5 studies added hospital first aid measures on the basis of pre-hospital first aid. The quality of the included studies is high, and 13 studies belong to high-quality studies. The basic characteristics of the included studies are shown in Table I.

Emergency time

Four studies reported the time from admission to thrombolytic therapy and the time from rescue to professional treatment. The results of meta-analysis on DNT (Fig. 2A) showed that compared with conventional first aid, pre-hospital/in-hospital first aid could effectively shorten the time from admission to thrombolytic therapy (MD = –22.63, 95% CI: –27.14, 18.11, $p < 0.00001$). After excluding a study that only used pre-hospital emergency measures [11], the overall heterogeneity decreased from 64% to 0%, and the results were still statistically significant. The overall effect size was –24.30 (95% CI: –26.14, –22.23). Figure 2B shows the comparison results of the time from calling for help to receiving professional treatment between the two groups. Stroke patients who had pre-hospital/in-hospital first aid implemented could receive professional treatment faster (MD = –13.22, 95% CI: –18.86, –7.58, $p < 0.00001$). After excluding a study with low quality [28], the overall heterogeneity decreased from 91% to 41%, and the overall effect size

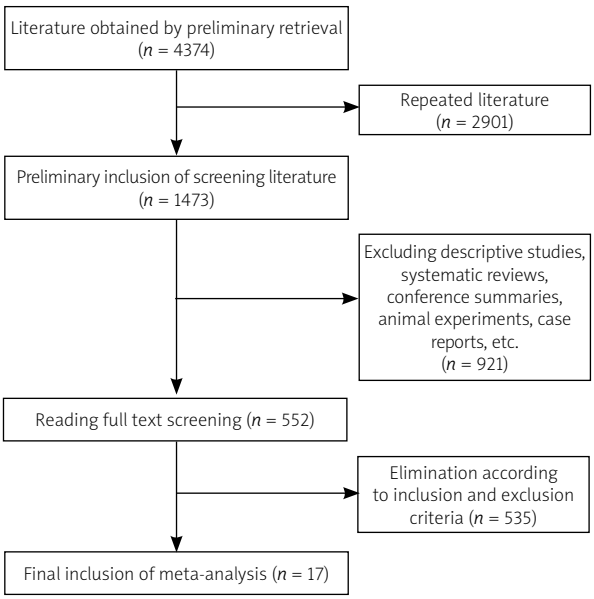

Fig. 1. Flow chart.

was –9.33 (95% CI: –11.52, –7.14), the difference was statistically significant ($p < 0.00001$).

Emergency effect

Through the analysis of the effective rate, disability rate and mortality rate, it was found that compared with conventional emergency measures, pre-hospital/in-hospital emergency can significantly improve the effective rate (RR = 1.50, 95% CI: 1.28, 1.76, $p < 0.00001$; Fig. 3A), and decrease the disability rate (RR = 0.88, 95% CI: 0.80, 0.96, $p = 0.004$, Fig. 3B) and mortality (RR = 0.58, 95% CI: 0.49, 0.70, $p < 0.00001$; Fig. 4). From the subgroup analysis of results of mortality, it can be seen that compared with only pre-hospital emergency measures (RR = 0.61, 95% CI: 0.51, 0.74, $p < 0.00001$). The effect of pre-hospital and in-hospital emergency measures was more significant (RR = 0.38, 95% CI: 0.21, 0.68, $p = 0.001$). In addition, the heterogeneity analysis showed that the heterogeneity was small (0%, 0% and 46%, respectively), and the included studies had good homogeneity.

Complications

Results of central brain fever and gastrointestinal bleeding were reported in five studies. The results showed that pre-hospital/in-hospital emergency measures could reduce the incidence of central brain fever and gastrointestinal bleeding complications. Compared with conventional emergency measures, the risk of central cerebral fever in the pre-hospital/in-hospital emergency group was 0.44 (95% CI: 0.27, 0.72, $p = 0.0009$; Fig. 5A); and the risk of gastrointestinal bleeding was 0.44 (95% CI: 0.26, 0.73, $p = 0.002$; Fig. 5B).

Prognostic activities of daily living

A total of three studies reported the life ability of patients with prognosis. Compared with the conventional first aid group, the prognosis of stroke patients with pre-hospital/in-hospital emergency measures was better, and their daily living ability was improved, with the overall effect of 16.56 (95% CI: 10.78, 22.34, $p < 0.00001$). The results of heterogeneity analysis showed that the heterogeneity was large ($I^2 = 96\%$, $p < 0.00001$), and the total effect size after sensitivity analysis was still statistically significant, suggesting that the heterogeneity was relatively stable (see Fig. 6).

Discussion

In our study, compared with conventional emergency measures, patients with acute stroke who received

pre-hospital first aid in the hospital can significantly shorten the time from admission to thrombolytic therapy by about 22.63 minutes, and shorten the time from calling for help to receiving professional treatment by about 13.22 minutes. The results of this study suggested that the effect of effective pre-hospital and in-hospital first aid was very obvious, and the effective rate was 1.5 times that of conventional first aid. The disability rate and mortality rate of patients were lower than those of patients with acute stroke who received conventional first aid. In addition, the incidence of complications (central cerebral fever and gastrointestinal bleeding) was significantly lower than that of the control group, suggesting that pre-hospital and in-hospital emergency measures are a protective factor for patients with acute stroke. From the perspective of prognosis, the daily living ability of patients with pre-hospital and in-hospital first aid was improved, and the Barthel index was higher. As far as we know, this is the first systematic study to evaluate the effect of pre-hospital care in patients with acute stroke at home and abroad.

The results of this study are consistent with previous studies, suggesting that early emergency measures can improve the clinical results and mortality of patients with acute stroke [8,15,22]. A study of 15 subjects found that intravenous thrombolysis within 60 minutes after stroke was more likely to be discharged [7]. Studies have shown that more than 50% of the delay in the treatment time of stroke is due to the admission procedure after admission [9,26]. Therefore, shortening the time of first aid for stroke patients is crucial. Some scholars have shown that the time from admission to injection of thrombolytic drugs can be shortened about 20-30 minutes by pre-hospital notification and rapid shunt to CT scanner [11,18]. The results of this study clearly show that the reduction in treatment delay can be better achieved only by optimizing all aspects of the stroke emergency chain, although the evidence for the effectiveness of these measures is not yet clear, but thrombolysis rates in many countries indicate that more and more patients are reaching hospital within the thrombolysis time window [1]. It also provides a direction for domestic medical institutions to optimize pre-hospital and in-hospital emergency care for patients with acute stroke.

Table I. Inclusion of the basic features of the study

Research	Sample size		Age		Sex	First aid method	NOS score
	Pre-hospital/ in-hospital first aid group	Routine first aid group	Pre-hospital/ in-hospital first aid group	Routine first aid group			
Rong Wu, 2011	141	127	56.63 ±13.25		M 182, F 86	Pre-hospital care	5
Limei Cheng, 2011	68	52	62.18 ±9.28	61.95 ±6.93	M 80, F 40	Pre-hospital care	6
E Zhong, 2014	135	135	51.9 ±21.2		M 182, F 88	Pre-hospital care	8
Matthias Wendt, 2015	1804	4378	73.9 ±15.0	74.2 ±14.9	M 2616, F 3566	Pre-hospital care	9
Xiongying Shao, 2015	40	40	63.3 ±5.4	63.2 ±5.3	M 47, F 33	Pre-hospital care	8
Wen Li, 2015	180	120	70.2 ±7.1	69.6 ±7.4	M 176, F 124	Pre-hospital and in-hospital emergency	5
Ning Li, 2015	70	60	69.9 ±3.7	70.5 ±3.2	M 72, F 58	Pre-hospital care	8
Yanhua Ma, 2016	42	40	61.03 ±2.91		M 51, F 31	Pre-hospital care	6
Alexander Kunz, 2016	305	353	72 (63-79)	72 (65-79)	M 382, F 276	Pre-hospital care	9
Xiao Zhang, 2017	180	120	70.2 ±7.1	69.6 ±7.4	M 176, F 124	Pre-hospital care	7
Jie Yang, 2017	90	90	65.3 ±5.1	64.9 ±4.8	M 94, F 86	Pre-hospital and in-hospital emergency	6
Lijuan Wang, 2018	56	52	35-80	31-78	M 61, F 47	Pre-hospital and in-hospital emergency	8
ShaoMin Zhi, 2018	53	53	74.06 ±5.32	72.43 ±6.91	M 58, F 48	Pre-hospital care	8
Yanjie Meng, 2019	49	49	58.96 ±10.27	60.14 ±9.75	M 58, F 40	Pre-hospital care	8
Xianfeng Deng, 2019	208	59	65.07 ±13.17	64.25 ±11.93	M 177, F 90	Pre-hospital and in-hospital emergency	8
Yang Zhao, 2021	36	44	65.29 ±5.09	65.18 ±5.23	M 61, F 19	Pre-hospital care	9
Yifei Chen, 2019	196	167	68 ±13.2	65 ±11.2	M 210, F 153	Pre-hospital and in-hospital emergency	9

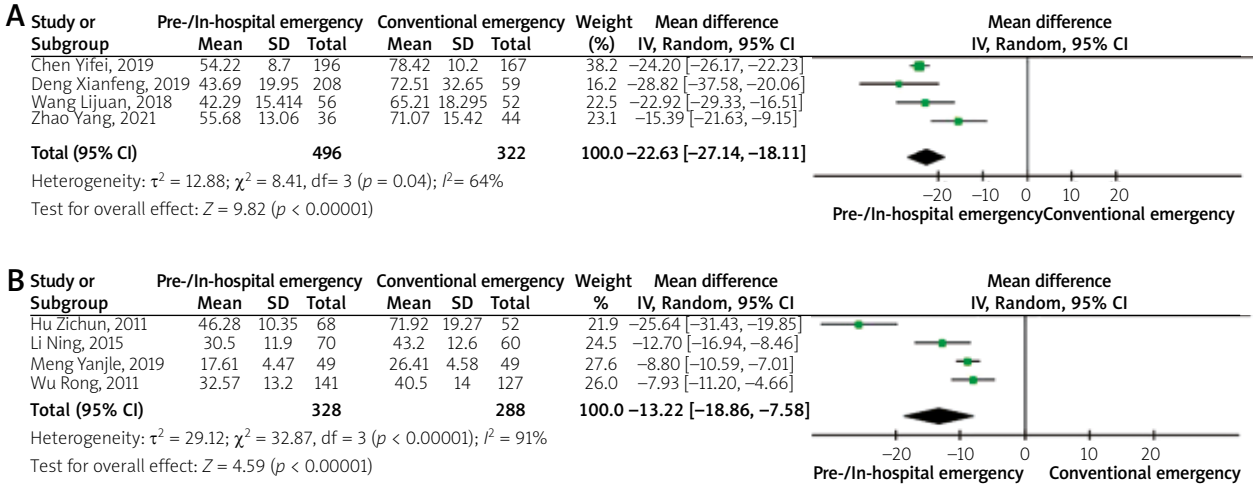

Fig. 2. A) Results of DNT between admission and thrombolytic therapy group. **B)** Outcome of the call to professional treatment time between the two groups.

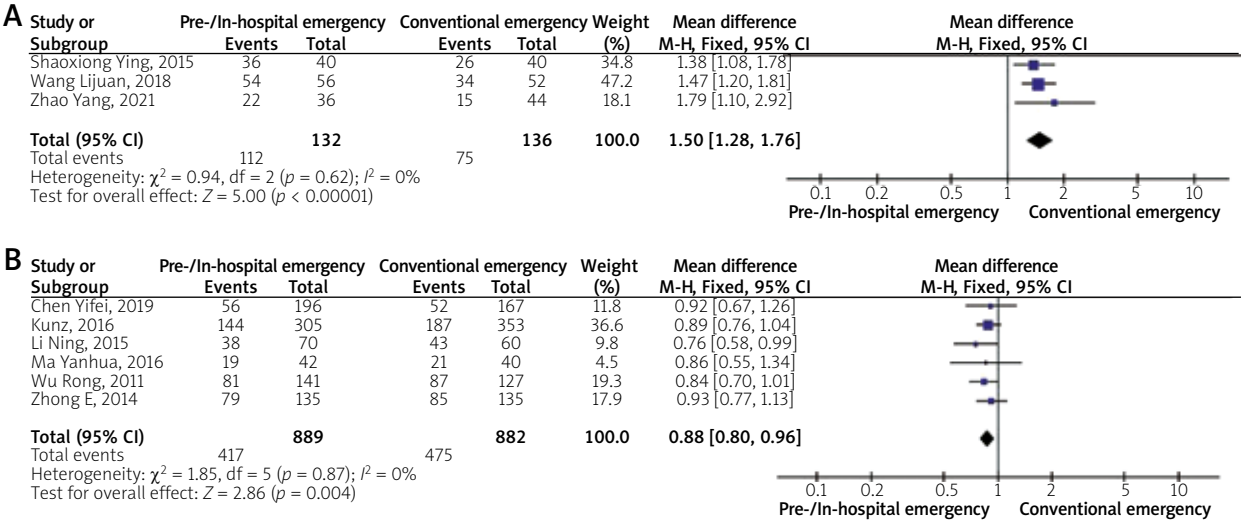

Fig. 3. A) Comparison of efficiency between the two groups. **B)** Comparison results of disability rate between the two groups.

This study has certain limitations: 1) a number of original studies included are single-centre studies, and the selection of research objects and controls is not representative to a certain extent, which is prone to bias; 2) the literature data come from different regions and hospitals. There are some differences in pre-hospital and in-hospital emergency measures for acute stroke in medical centres, which cannot fully guarantee the consistency of pre-hospital and in-hospital emergency measures; 3) in addition, based on search strategies and inclusion and exclusion criteria, only two foreign studies were included in the final analysis, making the results not sufficiently representative among non-Chinese populations; 4) due to the lack of sufficient original studies, the evaluation indicators of this study are not very comprehensive, such as the lack of evaluation of onset to thrombolysis time, thrombolysis rate, patient satisfaction and prognosis of limb movement.

Conclusions

In summary, the results of this study show that the implementation of effective pre-hospital and in-hospital emergency measures in patients with acute stroke can shorten the time for thrombolytic therapy, indicating that early emergency treatment can be transformed into better treatment results, reduce disability rate and mortality, and improve the prognosis of patients.

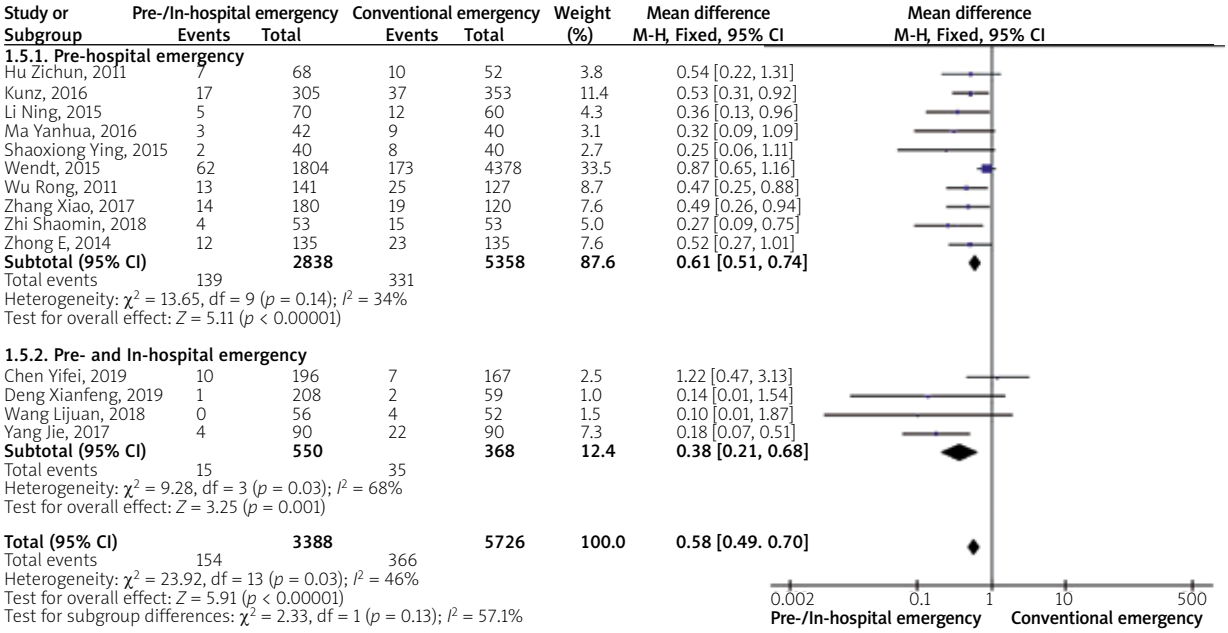

Fig. 4. Subgroup analysis results of mortality between the two groups.

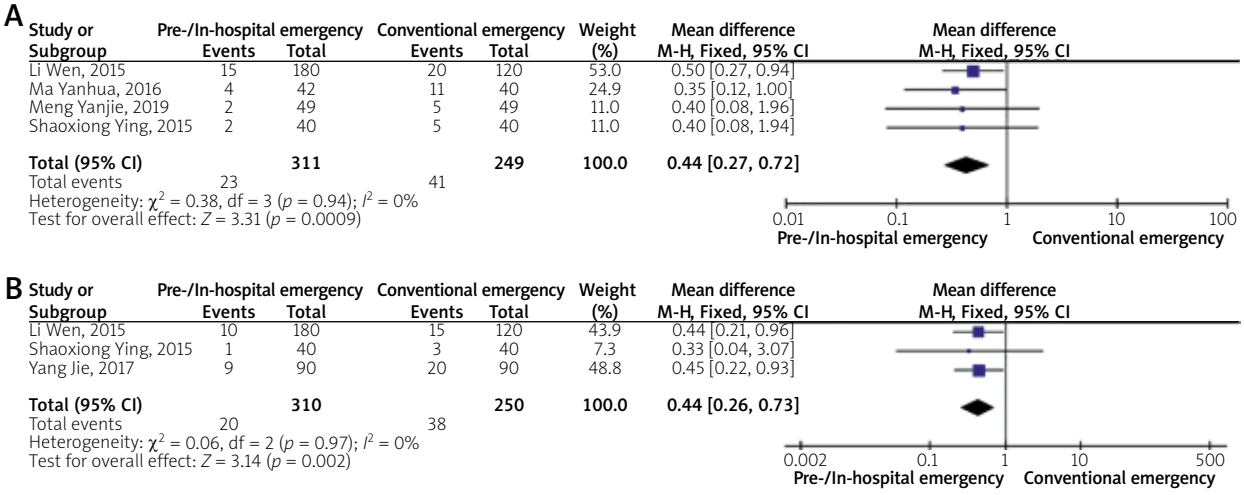

Fig. 5. A) Comparison results of central cerebral fever between the two groups. **B**) Comparison of gastrointestinal bleeding between two groups.

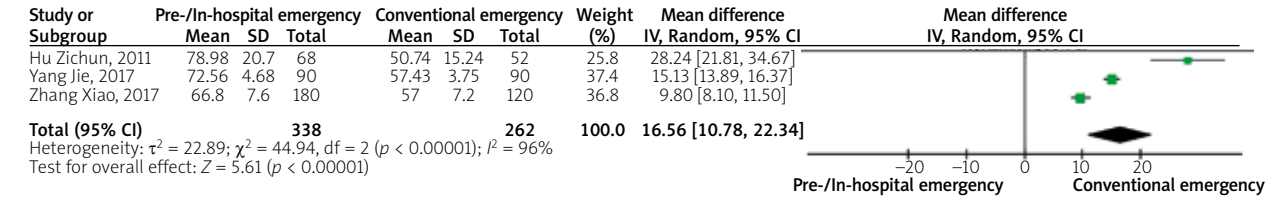

Fig. 6. Comparison results of daily living ability between the two groups.

The results of this study suggest that the better clinical results of patients with acute stroke are related to the early implementation of emergency measures, and pre-hospital and in-hospital emergency care is worthy of wide application in clinical practice. On the other hand, based on some limitations of this study, more large-scale multi-centre studies based on different populations are needed to confirm the conclusions of this study.

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of Sandun Hospital.

Disclosure

The authors report no conflict of interest.

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