

Application of Time-Tracking Platform in the Reperfusion Treatment of Patients with Acute Ischemic Stroke in Primary Hospitals

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Abstract

Objective To explore the application effect of time tracking platform in improving the reperfusion treatment of patients with acute ischemic stroke in primary hospitals. **Methods and Results** Patients with acute ischemic stroke who carried out emergency intravenous thrombolysis and arterial thrombectomy in our hospital in 2021, 2022 and 2023 were selected. The time tracking mode was implemented, and the patients were recorded at each time node of the hospital and the whole-process digital management was conducted. Compared the mean DNT (Door to Needle Time) of intravenous thrombolysis in emergency stroke patients in 2021, 2022 and 2023, the total number of hospital cases within 4.5 h of onset, the total number of thrombolysis cases within 4.5 h of onset, the number of intravenous thrombolysis in 60 minutes of acute ischemic stroke, and the number of thrombolysis cases. The results show that from 2021 to 2023 our emergency stroke patients with intravenous thrombolysis average DNT shortened year by year, to the hospital within 4.5 h after the onset of the difference is statistically significant (all $P < 0.05$) conclusion through the application of stroke time tracking platform, is beneficial to shorten the treatment time of each link, can effectively reduce the hospital time delay, improve the rate of thrombolysis, improve the reperfusion of stroke centers in primary hospitals.

Keywords

Time-Tracking Platform, Acute Ischemic Stroke, Thrombolysis, Thrombectomy

1. Introduction

Stroke plays a leading role in the causes of death and adult disability in Chinese

residents. For the treatment of acute ischemic stroke (AIS), its core is the rapid and effective opening of occluded blood vessels to ensure adequate perfusion of the brain, so as to minimize the irreversible damage caused by brain tissue ischemia [1]. Intravenous thrombolysis has a strict time window requirement. In most guidelines, the relatively safe intravenous thrombolysis time window is 6 h. The earlier the use of recombinant tissue plasminogen activator (recombinant tissue-type plasminogen activator, rt-PA) in 3 - 4.5 h after stroke, the less the risk of treatment and the better the prognosis of [2]. However, in addition to the hospital delay, pre-hospital delay, emergency hospital delay, and the local hospital delay [3] [4], and some hospitals cannot emergency before and after the hospital, covering the “whole life cycle” [5]; and limited by local emergency platform, the pre-hospital emergency patient information cannot be pushed to the hospital emergency platform is a problem to be solved [6]. So how to time the tracking platform applied to hospitals at all levels in China, solve the emergency hospital before hospital defects of each process, make each part as a whole scheduling smooth, good cohesion, efficient communication, establish a set of system, standard, reasonable and efficient operation mode, shorten the delay of acute stroke reperfusion treatment, improve the success rate of regional stroke patients, reduce the mortality and disability rate, improve the prognosis, is the new issue.

2. Methodology

2.1. Research Objects

Patients with acute ischemic stroke who underwent emergency intravenous thrombolysis and arterial thrombectomy in our hospital in 2021, 2022 and 2023 were selected as the study subjects.

2.2. Treatment Methods

Implement time tracking mode, using the time tracking of acute ischemic stroke patients emergency thrombolysis system, namely the Internet of things technology for the key nodes in the process of stroke first aid, real-time automatic acquisition each node time, instead of manual recording, and then statistical analysis of each link time, found thrombolysis process problems, targeted improvement, strengthen the quality management of stroke acute medical treatment, to reduce the DNT, to improve the effect of patient prognosis (see **Figure 1**, **Figure 2**).

The platform mainly includes two parts: hospital time acquisition app and data management background, and all the devices are deployed under one network. During the first aid in the hospital, the time point related to the location is automatically collected through the wireless beacon and other professional collection equipment, and the mobile phone app is used to manually register the doctor's processing method, the onset time, and the final normal time. Improve the patient and diagnosis and treatment information, register to the data management background, and complete the data management and system manage-

ment (see Figure 3).

The system can help personalized, automated, rapid and accurate patient time information in the process of emergency, and through the system automatic calculation, remove redundant data, accurate matching time, and the data record and statistics, so that the hospital specialist further improve pre-hospital identification or transport and hospital thrombolysis process, improve the attention of doctors to the time window, shorten the onset to bolt time, improve the area of acute stroke patients in the time window thrombolysis rate.

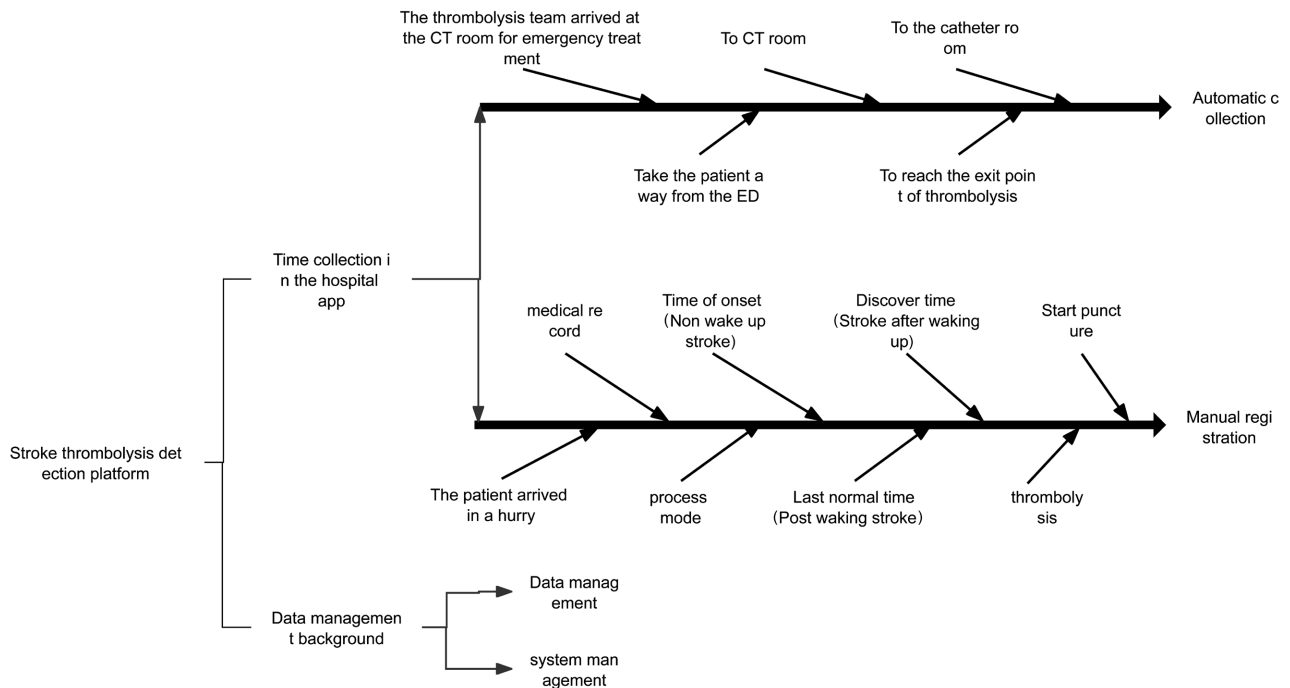


Figure 1. Functional architecture of the stroke thrombolysis monitoring platform

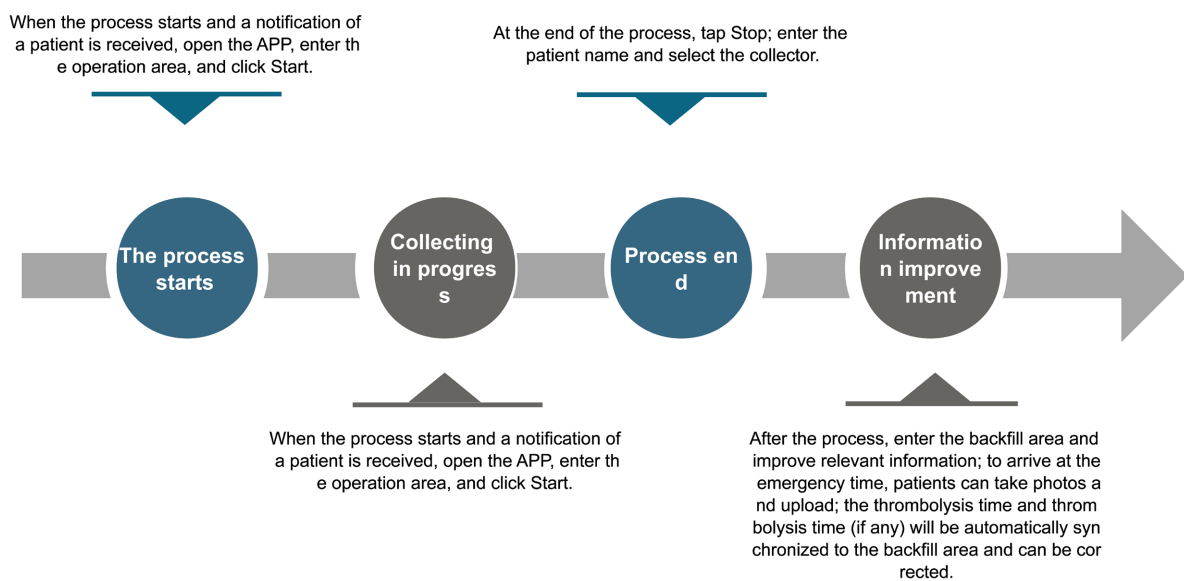


Figure 2. Acquisition steps

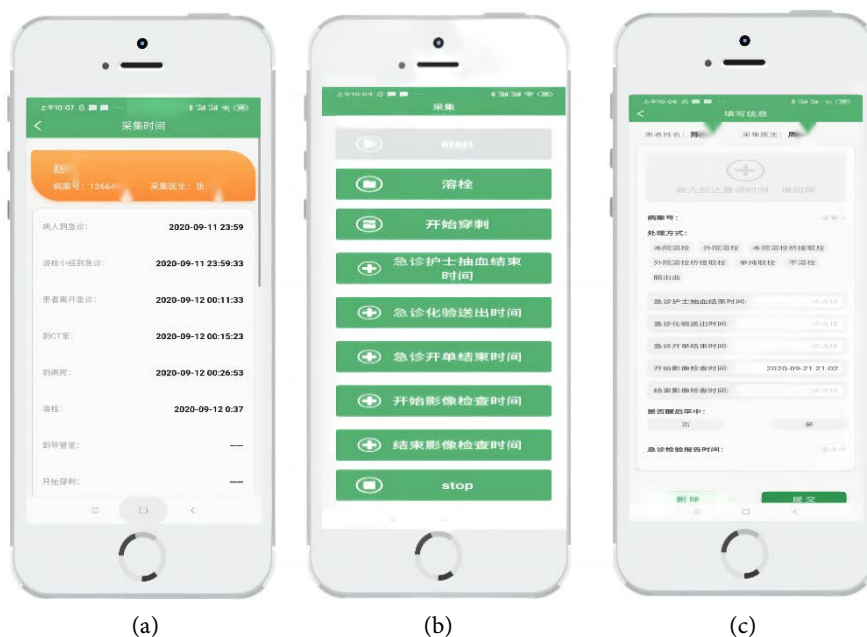


Figure 3. (a) App historical data; (b) Chance; (c) Back filled region.

2.3. Index Observation Test

The average DNT of intravenous thrombolysis in emergency stroke patients in 2021, 2022 and 2023, the total number of cases in hospital within 4.5 h of onset, the total number of cases of thrombolytic therapy within 4.5 h of onset, the number of intravenous thrombolysis in 60 minutes of acute ischemic stroke and the number of thrombolysis were recorded in detail.

2.4. Quality Control

Time tracking platform as a monitoring method can shorten the DNT and DPT, and through the time tracking presented big data information to improve thrombolysis process to increase the fundamental purpose of reperfusion treatment quality management, for thrombolysis patients time tracking method, can dynamically monitor the operation at each time steps, requires the surgeon has rich experience, the ultimate goal minimize reduce vascular damage, guarantee patients comprehensive benefit.

2.5. Statistical Analysis

The statistical analysis used SPSS 22.0 statistical software, count data were represented by χ^2 test, measurement data were expressed by $(x \pm s)$, the comparison between two groups using group t-test, data and grade data do not conform to normality and homogeneity of variance, Wilcoxon test and Mann-Whitney U test.

3. Results

The mean DNT/DPT in 2022 and 2023 decreased from 2021, which was statisti-

cally significant ($P < 0.05$), as shown in **Table 1**. From 2021 to 2023, the total number of cases coming to the hospital within 60 h, and the number of intravenous thrombolysis in DNT within 60 min within 4.5 h after the onset increased year by year, and the difference was statistically significant (all $P < 0.05$) see **Table 2**.

Table 1. Mean DNT and DPT from emergency triage to thrombolysis and thrombectomy.

Year	Average DNT (from emergency triage to intravenous thrombolysis) (min)	Average DPT (from emergency triage to thrombectomy) (min)
2021	50.03 ± 21.57 ^{#*}	80.36 ± 13.55 ^{#*}
2022	45.22 ± 15.34	70.79 ± 11.01
2023	44.25 ± 17.88	66.61 ± 12.68
F	4.140	6.300
P	0.016	0.003

Note: [#]P = 0.040 compared to 2022; *P = 0.005 compared to 2023; [#]P = 0.037 compared to 2022; *P = 0.001 compared to 2023.

Table 2. Improvement of key indicators of quality management of stroke center in our hospital.

Year	Total Number of Stroke Emergency Cases (arrived within 4.5 hours of onset)	Total Number of Stroke Emergency Thrombolysis Cases (arrived within 4.5 hours of onset and received thrombolysis)	Number of Intravenous Thrombolysis Cases with DNT ≤ 60 minutes	Number of Thrombectomy Cases
2021	227	114 (50.2%)	93 (41.0%)	11 (4.8%)
2022	231	129 (55.8%)	110 (47.6%)	24 (10.4%)
2023	404	273 (67.6%) ^{#*}	233 (57.7%) ^{#*}	80 (19.8%) ^{#*}
χ^2		20.335	17.330	30.498
P		<0.001	<0.001	<0.001

Note: $\chi^2 = 18.456$, [#]P < 0.001 versus 2021; $\chi^2 = 8.705$, *P = 0.003 versus 2022; $\chi^2 = 16.239$, [#]P < 0.001 versus 2021; $\chi^2 = 5.981$, *P = 0.014 versus 2022; $\chi^2 = 26.342$, [#]P < 0.001 versus 2021; $\chi^2 = 9.507$, *P = 0.002 versus 2022.

4. Discussions

Acute ischemic stroke is one of the important causes of death and disability in humans, bringing serious economic and medical burden to individuals, families and society. To better solve this problem, we proposed the detection platform of stroke thrombolysis. This platform is conducive to shortening the treatment time of each link, reducing reperfusion treatment and preoperative delay, creating favorable conditions for follow-up treatment, and can significantly improve the thrombolysis rate of patients in the time window and improve the prognosis of patients. It also reduces the complicated and meaningless connection of emergency department, radiology department, laboratory department, anesthe-

siology department and related consultation departments, greatly reduces the waste of human resources and reduces the medical cost of patients in this aspect.

For patients with acute ischemic stroke, “time is the brain”, but in reality, there are many factors that can lead to a delay in the time of [7]. Most studies have divided the visit delay into “in-hospital delay” and “out-of-hospital delay”: [8]. According to the American College of Cardiology/Stroke Committee guidelines, the time from admission to thrombolysis (door to needle time, DNT) should be less than 60 min, and the DNT above 60 is the “hospital delay” [9]. However, all kinds of studies show that the delay time in China is longer, and significantly longer than that in foreign countries. The main factors causing hospital delay include: complicated medical treatment process, untact cooperation of stroke emergency team, long time for examination and waiting results, lack of green channel management, long time of consent from patients or family members and other [10]. Wang Yilong *et al.* [11] found that among the 20 cases of thrombolysis after acute ischemic stroke, 17 patients arrived at the hospital within 2 h, but only 6 patients completed thrombolysis within the time window of 3 h from onset to thrombolysis. The study by Zhang Wanli *et al.* [12] also confirmed that the extension of onset to admission (onset to door time, ODT) was an independent factor promoting shortening. This result shows that some doctors have “procrastination psychology” in the current clinical emergency treatment, and also exposes the existing problems of irregular management of thrombolysis process.

In order to solve the problem of hospital delay, many scholars verified and verified that the time tracking mode was used to record the time point of each process and the influencing factors of the time spent in each link between admission and thrombolysis. Zhao Hongying [13] *et al.* found that through time tracking, the time of each link of thrombolysis was limited and the efficiency of thrombolysis was improved. At the same time, it improves the problem of doctors’ insufficient attention to the time window in their work, and eliminates the correlation between DNT and ODT. However, Yang Shanshan [14] *et al.* subdivided the thrombectomy process into three stages through time tracking, and based on the statistical results of the time flow table, optimized the CT thrombectomy process and limited the duration of each section of the process, shortened the DNT, and the thrombolysis rate and the DNT rate <60 min within 4.5 h were improved. However, there are still a series of problems in the time tracking of paper manual version, such as untimely recording and the influence of human factors [15]. Therefore, with the development of technology, a time tracking platform for automatic collection has become a demand.

The continuous emergence of new technologies such as the Internet of Things, 5G, big data and cloud computing provides the necessary conditions for the establishment of a time monitoring platform for stroke thrombolysis [16]-[18]. The stroke thrombolysis monitoring platform based on the Internet of Things is a platform that uses the Internet of Things technology to automatically collect

the time of each node in real time in the stroke first aid process and replace the manual recording mode of medical staff. The platform can collect the time of each node and statistically analyze the time needed for each link to find the problems of thrombolysis process, improve and strengthen the medical quality management in the acute phase of stroke. At present, such systems have achieved some results in some hospitals. Li Bingbing [19] *et al.* have reduced the average DNT from 89.72 min to 45.06 min by using the DNT information system with time tracking, and achieved good results, which is conducive to the optimization of thrombolysis process.

At present, although the hospital uses the time tracking table in the acute stroke process, there are problems in manual recording. How to integrate time tracking into pre-hospital emergency treatment, optimize the process, and quickly transport patients is still a challenge. The time tracking system for acute ischemic stroke developed by our team focuses on neurosurgery and surgery, helps the hospital to optimize the process, promote the rapid transfer of patients, smooth docking in the hospital, reduce time consumption, so that patients can receive reperfusion treatment earlier and achieve a good prognosis. In the first aid of patients with acute ischemic stroke, the research team recorded the treatment time in real time through the time tracking platform, so as to urge and strengthen the time concept of relevant personnel, and improve and strengthen the medical quality management in the acute stage of stroke. According to the data of the National Center for Medical Quality Control of Neurological Diseases, the thrombolysis rate of stroke patients increased to 67.6% within 4.5 h, and the proportion of patients with DNT 60 min reached 57.7%, and the rate of thrombectomy patients increased year by year. The Internet of Things system promotes the development of disciplines through Internet+, and helps county-level hospitals to rescue patients with neuro-critical diseases in the “golden time”, and improve the survival rate, cure rate and satisfaction of patients. The limitations of this study include the limited sample size and the absence of long-term patient outcomes indicators. However, in the future work, the tracking and management of the process will be further improved and the multi-center research will be carried out to ensure the continuous improvement of the quality of the process.

5. Conclusion

Although time tracking, as a monitoring means, can significantly shorten DNT, the essence of intravenous thrombolysis quality management is to use the big data information presented by time tracking to continuously optimize the thrombolysis process, so as to improve the effect of thrombolytic therapy. In future studies, this aspect can be further explored.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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