Continuous Educational Interventions Help Emergency Medical Services Effectively Reduce the Therapeutic Time in Acute Ischemic Stroke

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Background: Early recognition of stroke symptoms, pre-notification to the hospital, and rapid transport of the patients has been associated with faster intervention and better outcomes. We studied the impact of continuous monthly educational intervention to the emergency medical services (EMS) members on the therapeutic time till mechanical thrombectomy in acute ischemic stroke.

Methods: Our hospital manages Doctor Heli (DH) and Doctor Car (DC). Since April 2017, continuous monthly educational sessions on stroke care have been conducted involving the EMS doctors and paramedics, using the modalities like lectures and focus group discussions. We evaluated the change in performance time indicators prior to and after the initiation of this educational intervention.

Results: In all, 10 patients underwent mechanical thrombectomy for acute ischemic stroke before and 36 patients underwent the procedure after the initiation of educational intervention program. The number of EMS-transported patients (by DH and DC) out of the total patients who underwent mechanical thrombectomy increased from 20% to 42% after the initiation of the educational intervention. The median time interval of onset to door (O2D) decreased from 109.5 to 71 minutes and that of door to recanalization (D2R) decreased from 164 to 88 minutes following the educational intervention. Other performance time indicators were also notably reduced. This improvement of time indicators was observed gradually and annually.

Conclusion: This study showed that the continuous monthly education on stroke care to EMS members notably increased the number of EMS-transported patients as well as improved the performance time indicators till treatment in acute ischemic stroke.

Keywords ► emergency medical services, stroke, thrombectomy, stroke education

Introduction

The treatment for acute ischemic stroke has made a significant impact on the outcomes of the patients concerning the disease morbidity and mortality, owing to the advent of treatments like intravenous thrombolytic tissue plasminogen activator (tPA) and endovascular therapy, that is, mechanical thrombectomy. However, the outcomes of these treatments highly depend on the time since ictus.1–4) As a result, a limited number of patients with stroke become eligible for the treatment.5) Therefore, the importance of a well-coordinated stroke care system comes into play to reduce the time of onset to treatment and prevent disability. Emergency medical services (EMS) constitute...
an important part of this stroke care system. Early recognition of stroke symptoms, pre-notification to the hospital, and rapid transport of the patients has been associated with faster intervention and better outcomes.6)

It has been reported that brief educational session improves EMS stroke recognition and faster treatment; however, the improvements were seen immediately following the educational intervention and were not sustained through provision of performance feedback to paramedics.7) In this study, we evaluated the impact of continuous monthly educational intervention on the therapeutic time window of endovascular treatment, carried out at a regional stroke care center involving the EMS members. We also compared various time-related indicators and outcomes before and after the initiation of educational intervention.

Materials and Methods

Kagoshima City Hospital, a regional care hospital, has been operating “Doctor Car” (DC) and “Doctor Heli” (DH) as components of EMS. Since April 2017, continuous monthly educational sessions on stroke care have been conducted with the EMS doctors and paramedics (ambulance crew, nurses, radiologists, and clerks) as the main target group. The educational session, lasting for almost 30 minutes every month, included modalities from lectures to focus group discussions among the doctors and paramedics. Typically, five ambulance crew members, eight doctors of emergency department, eight nurses, and three radiologists participate in one educational session every month. The contents of education are symptoms of acute stroke, pre-hospital large vessel occlusion (LVO) score, optimal transport, timing and availability of the treatments, overview and indication of mechanical thrombectomy, review of thrombectomy cases, thrombectomy procedure manual announcement, procedure manual improvements, recent evidences (e.g., extended time window) and publications, efforts at other hospitals and also feedback related to these discussions. Educational session was short but monthly continued. The education incorporated short previous review (about 5 minutes) so that the participants can take part in shifts. We were able to actively engage in discussions through education. Education recognized the need for protocols and led to the creation of procedure manual for thrombectomy and checklists for DH and DC.

We evaluated various parameters in the patients who underwent mechanical thrombectomy for acute ischemic stroke, a year before and 2 years after the initiation of educational sessions in April 2017. Demographics of the patients and severity of stroke both clinically and radiologically were recorded. The time indicators included time of onset to door (O2D), door to imaging (D2I), door to needle (D2N), door to puncture (D2P), puncture to recanalization (P2R), and door to recanalization (D2R). Angiographic recanalization was evaluated by the thrombolysis in cerebral infarction (TICI) score and the clinical outcome was defined by modified Rankin Scale (mRS).

This study was approved by Kagoshima City Hospital IRB (Reference no. 2019-03). The authors certify that this study involving human subjects was conducted in accordance with the Helsinki declaration of 1975 as revised in 2000 and the Ethical Guidelines for Medical and Health Research Involving Human Subjects (effective February 9, 2015) promulgated by the Ministry of Health, Labor and Welfare, Japan. To protect patient privacy, all data were collected and analyzed under anonymization in an unlinkable fashion.

Univariate statistical analysis was conducted using JMP14.2.0 software (SAS Institute Inc., Cary, NC, USA). A p value of 0.05 was regarded as significant.

Results

Number of patients

During the period before the educational intervention (from 2016/4 to 2017/3), 10 (eight males and two females; mean age: 65.4 years) patients underwent mechanical thrombectomy for acute ischemic stroke, whereas following the educational intervention (from 2017/4 to 2019/3), 36 patients (24 males and 12 females; mean age: 74.7 years) underwent mechanical thrombectomy. EMS-transported patients comprised only 20% (2/10) in the former group (Fig. 1A) while those increased to 42% (15/36) in the latter (Fig. 1B), (p = 0.28; result of 2 × 2 chi-square test and Fisher’s test; Table 1).

Characteristics of the patients

Cardiogenic thromboembolic stroke was seen as the cause in 70% (7/10) of the patients in the pre-intervention and in 83.3% (30/36) in the post-intervention period. tPA was administered in 70% (7/10) in the former and in 61.1% (22/36) in the latter period. During the pre-intervention and post-intervention periods, the median National Institutes of Health Stroke Scale (NIHSS) was 19.5 and 22, respectively, and the median diffusion-weighted imaging–Alberta
Stroke Program Early Computed Tomography Scores (DWI-ASPECTS) was 8.0 and 7.0, respectively (Table 1).

**Change in time indicators**

The performance time indicators have remarkably changed after the initiation of the educational sessions. The median time interval (min) of O2D decreased from 109.5 to 71 after the educational intervention; \( p = 0.5579 \) (Mann–Whitney \( U \) test). After arrival to the hospital, time interval (min) of door to image (D2I) reduced from 22 to 16, D2N from 68 to 41, D2P from 88 to 51.5 and P2R from 75 to 39. Overall, the median D2R time notably decreased from 164 to 88 minutes following the educational intervention; \( p = 0.0002 \) (Mann–Whitney \( U \) test) (Table 2).

**Yearly change of time indicators**

As the educational sessions to the EMS members have been regularly carried out on monthly basis since April 2017, we further divided the post-intervention period into 2017/4–2018/3 and 2018/4–2019/3 to evaluate whether the changes are occurring gradually over the period of time. The median O2D time, which was 109.5 min during 2016/4–2017/3 decreased to 75.5 min during 2017/4–2018/3 and further decreased to 62.5 min during 2018/4–2019/3 (Fig. 2A). Similarly, the median D2R reduced from 164 min to 115 min and subsequently to 82.5 min during the time periods mentioned above (Fig. 2B).

**Outcome**

The favorable recanalization, that is, TICI 2b or more was achieved in 90% (9/10) of the patients in the pre-intervention period, whereas in 83.3% (30/36) in the post-intervention period; \( p = 0.98 \) (result of \( 2 \times 2 \) chi-square test and Fisher’s test). Good clinical outcome, as measured by mRS 0-2 at 3 months, was seen in 40% of the patients in the pre-intervention and 30.5% in the post-intervention period; \( p = 0.85 \) (result of \( 2 \times 2 \) chi-square test and Fisher’s test).

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**Table 1** Characteristics of the patients who underwent mechanical thrombectomy

<table>
<thead>
<tr>
<th></th>
<th>2016/4–2017/3 (10 patients)</th>
<th>2017/4–2019/3 (36 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M:F</td>
<td>8:2</td>
<td>24:12</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>65.4</td>
<td>74.7</td>
</tr>
<tr>
<td>Cardiogenic thromboembolic stroke</td>
<td>70% (7/10)</td>
<td>83.3% (30/36)</td>
</tr>
<tr>
<td>tPA administration</td>
<td>70% (7/10)</td>
<td>61.1% (22/36)</td>
</tr>
<tr>
<td>NIHSS (median)</td>
<td>19.5</td>
<td>22.0</td>
</tr>
<tr>
<td>DWI-ASPECTS (median)</td>
<td>8.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

DWI-ASPECTS: diffusion-weighted imaging–Alberta Stroke Program Early Computed Tomography Scores; F: female; M: male; NIHSS: National Institutes of Health Stroke Scale; tPA: tissue plasminogen activator.
April 2017 with focus group discussions among the members of EMS. There was a remarkable increase in the number of EMS-transported patients who underwent thrombectomy after the initiation of educational intervention. This might be attributed to better recognition of stroke symptoms by EMS due to the continuous educational sessions and also rapid transport to the hospital. The time of symptom onset to hospital arrival decreased after the start of educational intervention. Although there were improvements in the pre-hospital factors, statistical difference was not observed between the pre-hospital factors in the pre-intervention period and those in the post-intervention period.

We present feedback from a young EMS crew member as an example to demonstrate the efficacy of our educational sessions. He reported one incident where he had a patient with nausea, vertigo, and hemianopsia and his dilemma to consider acute stroke as a differential diagnosis. He had learnt from our monthly educational session some cases with acute stroke of posterior circulation presenting with such variable symptoms and without hemiparesis. He then decided to transfer the patient to our emergency room with suspected stroke. As a result, the patient was diagnosed with basilar artery occlusion and underwent immediate mechanical thrombectomy. Thus, the EMS crew emphasized the efficacy of our monthly review and discussion.

A notable improvement in hospital pre-notification was observed, which improved the preparedness of the emergency team in the hospital. Multiple reports have shown that pre-notification for acute stroke has improved timeliness of care including time to imaging and time to thrombolytic administration. The time from door to acquisition of image reduced in our study as well. In spite of the decrease in D2N time, the percentage of patients receiving tPA has decreased compared to the pre-intervention period. This can be explained by shorter time window for tPA (4.5 hours) as compared to thrombectomy (8 hours), thereby many patients being eligible for thrombectomy but not for tPA. The other reason could be relatively lesser number of patients in the pre-intervention period.

### Discussion

Stroke recognition by EMS and hospital pre-notification have been associated with decreased therapeutic time and improved stroke outcomes. However, the sensitivity of pre-hospital assessment has been very diverse ranging from 44% to 91% as shown by previous studies. Such a difference in the results can be attributed to the challenges posed by diverse clinical presentations of stroke, differences in assessment scales, training level of emergency medical personnel, urban versus rural settings, inconsistent communication between hospitals and EMS, and various other factors.

Regarding the educational intervention program, we considered that continuous education would be more effective than one-point educational intervention. Previous studies have also recommended re-training at frequent intervals rather than a single intervention due to tendency of falling stroke recognition with time. So, we have been conducting educational intervention every month since 2016.
The educational intervention not only reduced the pre-hospital time but also enhanced the in-hospital performance of the team. We believe that involvement of the in-hospital emergency team in the educational sessions plays an important role in meeting the overall in-hospital time targets. In our study, the time of D2P as well as P2R reduced in the post-intervention period. Addition of more specialist neurointerventionalists in the department and regular training to the younger doctors on thrombectomy might have played a key role in overall coordination and performance during the procedure, reducing the time from P2R. With the combined effort of many members, the overall D2R time remarkably decreased from a median of 164 min to 88 min. To evaluate whether the changes are occurring gradually over the period of time, we further divided the post-intervention period on annual basis. The time indicators were found to have gradually decreased over the 2 years, rather than abruptly changed. This phenomenon can be attributed to the continuous mode of educational intervention on monthly basis, which keeps the EMS members up-to-date and gradually enhances the performance. Learning curve due to increase in the number of cases and proficiency of the technique might have some contribution to the improved result. However, there was no change in the number of neuroendovascular specialists and other medical staff during the early and later periods.

Despite improvement in the time indicators related to pre-hospital and in-hospital performance, the mRS of the patients at 3 months in the post-intervention period was slightly poor as compared to those in the pre-intervention period. The less number of patients in the pre-intervention period and lower DWI-ASPECTS in the patients of post-intervention period may explain this contrast. The angiographic recanalization of TICI 2b or more was achieved in a significant number of patients well comparable to the previous studies1–3; however, the mRS at 3 months was lower as compared to those. This can be explained by low DWI-ASPECTS, high NIHSS in our patients of post-intervention period, as compared to those previous studies. Also, patients with poor baseline mRS sometimes underwent treatment, which did not improve after the treatment.

The most important limitation of this study is the small number of patients and our study also carries the limitations inherent in a study of retrospective nature. Furthermore, we presented a single institutional experience. Nevertheless, this study demonstrates that continuous education helps EMS improve the therapeutic time till thrombectomy in acute ischemic stroke. We also believe that such continuous program is effective for educating EMS crew and also for up-to-date communications.

## Conclusion

This study showed the impact of continuous education to EMS members regarding stroke care from recognition to treatment on the therapeutic time till thrombectomy. It showed that the continuous monthly education notably improved the O2D time as well as D2R time in acute ischemic stroke. Future studies including larger number of patients will be helpful in deducing more definitive and generalized conclusions.

## Disclosure of Conflict of Interest

All authors have no conflict of interest.

## References


