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Prehospital Notification from the Emergency Medical Service Reduces the Transfer and Intra-Hospital Processing Times for Acute Stroke Patients

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Background and Purpose There is little information available about the effects of Emergency Medical Service (EMS) hospital notification on transfer and intrahospital processing times in cases of acute ischemic stroke.

Methods This study retrospectively investigated the real transfer and imaging processing times for cases of suspected acute stroke (AS) with EMS notification of a requirement for intravenous (IV) tissue-type plasminogen activator (t-PA) and for cases without notification. Also we compared the intra-hospital processing times for receiving t-PA between patients with and without EMS prehospital notification.

Results Between December 2008 and August 2009, the EMS transported 102 patients with suspected AS to our stroke center. During the same period, 33 patients received IV t-PA without prehospital notification from the EMS. The mean real transfer time after the EMS call was 56.0±32.0 min. Patients with a transfer distance of more than 40 km could not be transported to our center within 60 min. Among the 102 patients, 55 were transferred via the EMS to our emergency room for IV t-PA. The positive predictive value for stroke (90.9% vs. 68.1%, p=0.005) was much higher and the real transfer time was much faster in patients with an EMS t-PA call (47.7±23.1 min, p=0.004) than in those without one (56.3±32.4 min). The door-to-imaging time (17.8±11.0 min vs. 26.9±11.5 min, p=0.01) and door-to-needle time (29.7±9.6 min vs. 42.1±18.1 min, p=0.01) were significantly shorter in the 18 patients for whom there was prehospital notification and who ultimately received t-PA than in those for whom there was no prehospital notification.

Conclusions Our results indicate that prehospital notification could enable the rapid dispatch of AS patients needing IV t-PA to a stroke centre. In addition, it could reduce intrahospital delays, particularly, imaging processing times. **J Clin Neurol 2010;6:138-142**

Key Words stroke, thrombolysis, prehospital notification, stroke care system.

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Introduction

The administration of intravenous (IV) tissue-type plasminogen activator (t-PA) is the only approved therapeutic modality for recanalizing occluded vessels and improving clinical outcomes in acute ischemic stroke (AIS).[1] However, its rate of use remains lower than expected, at under 7%,[2-5] which may be due to several factors, especially including delay in transportation and intra-hospital processing for its use. According to the Korean Stroke Registry,[6] only 20% of ischemic stroke patients arrive at the emergency room (ER) within 3 h, a rate that is much lower than in many other countries.[4,7] Furthermore, the rate of t-PA administration does not exceed 3% in Korea,[6] indicating the possibility of considerable delays in transportation and intra-hospital processing for patients with AIS.

According to recent guidelines for AIS,[8] stroke centres sh-

ould have a relay system in conjunction with the local Emergency Medical Service (EMS) as a necessary intervention for acute stroke (AS) patients. The implementation of a prehospital notification system between the local EMS and the stroke centre has also been emphazised.[9]

We recently reproted data on the utility of prehospital notifications to reduce the door-to- needle time for t-PA therapy in AIS.[10] However, there are no detailed published notification data from the EMS.

This study retrospectively investigated transportation delays from the referred hospital to our stroke centre and any related difference in intra-hospital processing times for IV t-PA between patients with and without a prehospital notification from the EMS.

Methods

Our hospital is a tertiary teaching hospital located in the Busan metropolitan area (size: 765.64 km^2, population: -4 million) in South Korea. For acute care for ischemic stroke patients, two attending stroke neurologists, two neuro-radiologists, and eight residents word at our stroke centre. Since January 2006, to shorten the processing time to within the time window of IV t-PA use, we have applied a central alerting system to recruit all available stroke team members to the ER as soon as possible after the arrival of a suspected stroke patient. From October 2007, we also implemented a hotline system[11] in conjunction with the Korean Emergency Medical Information System (1339) for prehospital notification whenever it is felt that a stroke patient requires emergency care at other general hospitals in our metropolitan area. The primary role of the 1339 system has been to connect a patient needing an emergency intervention or operation in community hospitals with appropriate available hospitals.

In cases of stroke patients, the 1339 system gives us detailed information regarding their status, including the onset time, severity of neurologic deficit, and location of the hospital wanting to refer the patient. After receiving a prehospital notification from 1339, we recruit the stroke team members at the ER and prepare the imaging machines (MRI) before the arrival of the suspected stroke patient from the referring hospital. Between December 2008 and August 2009, we estimated the expected transfer time using the Global Positioning System (GPS) and the real transfer time, using the actual time to arrive at our ER from the hospital that dispatched the suspected stroke patient. We analyzed the positive predictive value for stroke among the suspected stroke patients dispatched to our hospital. To elucidate the efficacy of prehospital notification in reducing intra-hospital processing times, such as the door-to-imaging and door-to-needle times for IV t-PA, we compared each time point with that of non-notified stroke patients in the same period. Since this was a retrospective study design, no formal ehtical approval was needed according to local guidelines.

Definition of the time interval

We assessed the expected transfer time (GPS-based ideal transfer time from a hospital dispatching a patient to arrival at our ER), the real transfer time (actual transfer time between the two), the door-to-imaging time (from ER arrival to imaging), the door-to-needle time (from ER arrival to IV t-PA use), and the onset-to-needle time (from symptom onset to IV t-PA use).

Statistical analysis

All statistical analyses were performed using SPSS. Student's *t*-tests were used for all continuous variables, and Chi-square or Fisher's exact tests for all categorical variables. All data are presented as mean±SD values, and the level of statistical significance was set at $p<0.05$.

Results

Between December 2008 and August 2009, 102 suspected AS patients were transferred from 38 hospitals around the Busan-Kyungnam area (Fig. 1) to our stroke centre with a prehospital notification from EMS. The distance from the hospital requesting dispatch to our hospital was 24.0±24.4 km (range, 2.9-153.0 km), the expected transfer time (as calculated by GPS) was 34.4±22.8 min (range, 6-153 min), and the real transfer time was 56.0±32 min (range, 7-203 min). After adjusting the real arrival time according to the transfer distance, the arrival time within 10 km of the transferred distance was 43.1±20.3min; within 20 km, it was 45.6±22.2 min; and within 40 km, it was 58.0±20.0 min. However, at distances over 40 km,

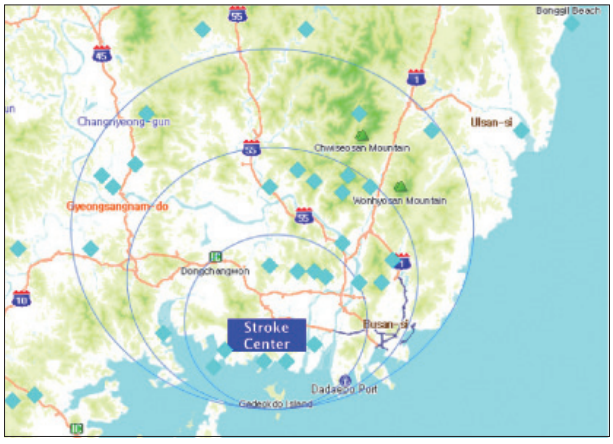

Fig. 1. Location of our stroke centre and distribution of transfer hospitals.

any patients with suspected AS were unable to arrive at our hospital within 60 min. All patients arriving at our hospital with suspected stroke were sent to the MRI room; the door-to-imaging time was 28.9±22.0 min (5-93 min).

Of the 102 suspected AS patients, 55 (53.9%) were transferred to our hospital to receive IV t-PA. Of these, 63 (61.8%) were transferred during weekends or holidays and 82 (80.4%) were ultimately identified to be true AS patients through neurologic examination and brain imaging. Table 1 presents comparisons of the clinical and time parameters between patients with thrombolysis call and those without it. The positive predictive rate of stroke was significantly higher in patients with thrombolysis prenotification (90.9% vs. 68.1%, p=0.005) than in those without it. The real transfer time (47.7±23.1 min vs. 56.3±32.4 min, p=0.004) and door-to-imaging time (17.8±11.0 min vs. 28.8±21.8 min, p=0.001) were much shorter in patients with the thrombolysis call than in those without it (Table 1).

Among the 55 patients for whom there had been an IV t-PA call, 50 (47-AIS and 3-brain hemorrhage) had AS (90.9%). Of the 47 with AIS, 18 (36.7%) received IV t-PA. The reasons for not using IV t-PA were as follows; 1) time delays (n=9), 2) large infarctions (n=7), 3) contraindications (n=6), 4) rapidly improved symptoms (n=4), 5) brain haemorrhage (n=3), and 6) transient ischaemic attack (n=3).

During the observation period, 33 patients received IV t-PA in our hospital without EMS prehospital notification. Table 2 summarizes the differences in processing time for IV t-PA between patients with and without a prehospital notification. The door-to-needle time was 29.7±9.6 min (range, 15-52 min) in the 18 patients with a notification who received IV t-PA. The door-to-imaging and door-to-needle times were significantly shorter for 18 patients with EMS prehospital notification than for those without it. However, the onset-to-needle time was significantly delayed in the notified group compared to the non-notified group.

Table 1. Comparison of transfer and intra-hospital processing times between patients with a prehospital tissue type plasmonogen activator (t-PA) notification call and without such a notification

	With 1339	Without 1339	p
Number	55	47	
Men (%)	36	29	
Age (yrs)	64.8±11.6	64.4±12.7	n.s.
Distance (km)	22.0±20.9	24.3±24.6	n.s.
Expected transfer time (min)	33.5±20.4	34.6±22.9	n.s.
Real transfer time (min)	47.7±23.1	56.3±32.4	0.004
Door-to-imaging time (min)	22.0±16.2	28.8±21.8	0.002
Rate of correct diagnosis stroke (%)	50 (90.9)	32 (68.1)	0.006

Expected transfer time: transfer time as assessed using the Global Positioning System.

Table 2. Comparisons of clinical and time parameters after intravenous t-PA use between patients with and without a prehospital notification by the Emergency Medical Service

	Without 1339	With 1339	p
Number	33	18	
Men (%)	17 (51.5)	14 (77.7)	0.08
Age (yrs)	67.8±11.2	63.6±11.6	0.21
Door-to-imaging time (min)	26.9±11.5	17.8±11.0	0.01
Door-to-needle time (min)	42.1±18.1	29.7± 9.6	0.01
Onset-to-needle time (min)	128.6±40.2	150.8±26.4	0.03
Onset-to-door time (min)	86.5±13.8	124.4±16.8	0.02

Discussion

The EMS is key to reducing the time delay to IV t-PA in AIS. Therefore, therapeutic guidelines strongly recommend the implementation of a stroke-care system-related community EMS. A previous study[12] showed that stroke patients using the EMS arrived at the ER 200 min faster than those not using the EMS, suggesting the usefulness of the EMS in optimizing rapid transport and greatly decreasing arrival times to the ER. However, little information is available regarding the time required to transfer a stroke patient via the EMS relative to the distance from the dispatching hospital to the stroke centre; we therefore addressed this in the present study.

This study identified a time discrepancy of roughly 21 min between the expected transportation time estimated using GPS and the real transportation time for patients with suspected AS. Several factors may have contribute to this time difference. The finding of given a difference of only 2 min between dispatch distances of 10 km and 20 km to our stroke centre was attributed to, some intra-ER delay. Also, distances of over 40 km prevented at the ER within 60 min. Given that the onset to call time was 89±21 min (data not shown) for patients with a thrombolysis call in this study, a dispatch distance of more than 40 km may be an unrealistic boundary for a stroke-care system in our community.

Several studies have shown that the EMS enables a rapid dispatch of AS patients to a stroke centre[13,14] and consequently enhances the rate of being able to use IV t-PA.[10] In the present study, the transport time was shorter for patients eligible for IV t-PA than for those who were not eligible, indicating that the EMS system may have transferred AS patients eligible for IV t-PA more rapidly to our stroke centre. In particular, the time discerpancy between the expected and real transfer times was significantly shorter for patients with an IV t-PA call (14 min) than for those without one (21 min), suggesting the necessity of close cooperation in the ER for dispatched patients needing IV t-PA and using the EMS.

Prehospital notification might provide the greatest benefit for EMS-related AS care in a stroke centre. The EMS can provide useful information to the stroke centre, enabling the stroke team to cut the time required for intra-hospital processing, such as gathering team members at the ER and preparing the MRI before the arrival of an AS patient needing IV t-PA. In patients with myocardial infarction, prehospital transmission of the ECG and notification of the hospital decreased the time to thrombolysis from 130 min to 81 min.[15] However, no previous study has shown similar time savings using this approach in stroke. We recently demonstrated that prehospital notification reduced the door-to-needle time for receiving IV t-PA in AIS. In the current study, the door-to-imaging time based on MRI and the door-to-needle time for IV t-PA were faster for those patients with prehospital notification than for those without it. Our previous report[10] presumed that a shorter door-to-imaging time might also have involved a significantly shorter door-to-needle time for IV t-PA in the group with prehospital notification. In fact, it has been shown that reducing the imaging time might be the main obstacle to shortening the door-to-needle time for IV t-PA in AIS.[16,17] In the present study, prehospital notification shaved 10 min off the door-to-imaging time for using IV t-PA compared to patients without pre-notification. In fact, with the 1339 notification system, we had enough time to prepare the necessary equipment before patient arrivals. Our data indicate that patients who underwent MRI with prehospital notification had door-to-needle times of almost 30 min, corresponding to 10 min faster than those without it. This reduction was achieved by a combination of the prehospital notification system and our central alert system for assembling the stroke team. In particular, 10 min reduction in imaging time might have played a pivotal role in the faster door-to-needle times in the prehospital notified group.

In this study, 61% of patients were transferred on holidays and weekends. Interestingly, almost all patients who transferred to our stroke centre from a hospital had a neurologist or neurosurgeon available to administer IV t-PA for AIS. However, on holidays and weekends, these hospitals have a shortfall of facilities and staff to care for patients after receiving IV t-PA. A previous study showed that lower staffing levels on weekends were related to a poor outcome in AIS patients.[18] We suggest that the community hospitals in this study did indeed experience this so-called "weekend effect" in terms of AS, leading to the higher transfer rate to our stroke center on weekends and holidays. Because of this, there is an emphasis on the important role of a comprehensive stroke centre to ameliorate this "weekend effect" in AS.[19]

Prehospital notification reduced the intra-hospital processing time before AIS patients received t-PA in the current work. However, the onset-to-needle time was significantly delayed (25 min, p=0.03) in the EMS pre-notified group compared to those patients without pre-notification. This paradoxical result might be related to a drawback of our community stroke rescue system. The 1339 system actually connects an AS patients needing more aggressive treatment from the ER of a community hospital to an available stroke centre, which is responsible for some differences between our results and those from previous studies showing a reduction in the onset-to-needle time with help from the EMS. In the current study, of the 49 AIS patients with EMS pre-notification calls, only 18 (36.7%) received IV t-PA, and the most frequent cause of not using IV t-PA was the delayed time window. Therefore, our community requires an improved mechanism for using the EMS to directly connect an AS patient eligible for thrombolysis to a stroke centre.

In addition, the positive predictive value of stroke was 80.4% in this study. This value is slightly higher than those reported previously.[20,21] Considering that most of the initial diagnoses were made by on-duty doctors in the ERs, we conclude that this difference is probably not meaningful. However, among patients with a thrombolysis call from 1339, the value climbed to more than 92%, which is a relatively good diagnostic rate. A correct diagnosis with prehospital notification is important in a stroke-care system, as frequent incorrect prehospital diagnosis of stroke could cause fatigue among the members of a stroke team, who need to be alert state.[9] Therefore, in cases of thrombolysis, a relatively high rate of stroke identification from the 1339 system could help maintain an efficient stroke network for using IV t-PA.

The findings of this study demonstrate the beneficial effects of prehospital notification from the EMS (1339) with regard to reducing the transfer time and intrahospital processing for AS patients. However, ours was an observational case study based on a stroke centre in a single metropolitan area, and therefore, we cannot assert that this study reveals the whole picture of a stroke-care system using the EMS. Therefore, future well-designed, prospective multicenter trials are needed.

Conflicts of Interest

The authors have no financial conflicts of interest.

Acknowledgements

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