Impact of Prehospital Intervention on Delay Time to Thrombolytic Therapy in a Stroke Center with a Systemized Stroke Code Program

Dae-Hyun Kim, MD,*† Hyun-Wook Nah, MD,*† Hyun-Seok Park, MD,* Jae-Hyung Choi, MD,* Myong-Jin Kang, MD,* Jae-Taeck Huh, MD,* and Jae-Kwan Cha, MD*†

Background: The use of emergency medical services (EMS) and notification to hospitals by paramedics for patients with suspected stroke are crucial determinants in reducing delay time to acute stroke treatment. The aim of this study is to investigate whether EMS use and prehospital notification (PN) can shorten the time to thrombolytic therapy in a stroke center with a systemized stroke code program. *Methods:* Beginning in January 2012, stroke experts in our stroke center received direct calls via mobile phone from paramedics prenotifying the transport of patients with suspected stroke. We compared baseline characteristics and prehospital/in-hospital delay time in stroke patients treated with intravenous recombinant tissue plasminogen activator for 44 months with and without EMS use and/or PN. *Results:* Intravenous thrombolytic therapy was performed on 274 patients. Of those patients, 215 (78.5%) were transported to the hospital via EMS and 59 (21.5%) were admitted via private modes of transportation. The patients who used EMS had shorter median onset-to-arrival times (62 minutes versus 116 minutes, $P < .001$). There was no difference in in-hospital delay time between the 2 groups. In 28 cases (13%) of EMS transport, EMS personnel called the clinical staff to notify the incoming patient. Prenotification by EMS was associated with shorter median door-to-imaging time (9 minutes versus 12 minutes, $P = .045$) and door-to-needle time (20 minutes versus 29 minutes, $P = .011$). *Conclusions:* We found that EMS use reduces prehospital delay time. However, EMS use without prenotification does not shorten in-hospital processing time in a stroke center with a systemized stroke code program. **Key Words:** Stroke—emergency medicine—prenotification—thrombolysis—door-to-needle time.

From the *Busan-Ulsan Regional Cardiocerebrovascular Center, Dong-A University Hospital, Busan, Republic of Korea; and †Department of Neurology, College of Medicine, Dong-A University, Busan, Republic of Korea.

Received November 9, 2015; revision received January 19, 2016; accepted February 6, 2016.

This work was supported by the Dong-A University Research Fund.

Address correspondence to Dae-Hyun Kim, MD, Department of Neurology, College of Medicine, Dong-A University, 1, 3-ga Dongdaesin-dong, Seo-gu, Busan 602-715, Republic of Korea. E-mail: kdh6542@hanmail.net.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2016.02.011

Introduction

Thrombolysis with intravenous tissue-type plasminogen activator (tPA) is the only evidence-based medical treatment for acute ischemic stroke (AIS) within 4.5 hours of symptom onset. The benefits of intravenous tPA are time-dependent, and a shorter time from stroke onset to tPA therapy is correlated with better outcomes.[1-3]

Prehospital interventions may reduce time from stroke onset to tPA treatment.[4] Transport of stroke patients to the hospital by emergency medical services (EMS) is associated with shorter prehospital delay and time interval from arrival to brain imaging.[5-8] Prehospital notification

(PN) of a stroke patient's arrival by EMS paramedics markedly reduces in-hospital delay because it facilitates earlier activation of a stroke team and mobilization of imaging modalities before the patient's arrival.[7,9,10]

However, EMS systems for transport of potential stroke patients vary greatly between countries and in-hospital processing time to tPA therapy are different in each receiving hospital. Thus, the effect of EMS transport and PN on prehospital/in-hospital delay time may differ by location and hospital.

The present study was designed to explore whether EMS use and implementation of PN in cases of suspected stroke could reduce the time interval from symptom onset to imaging evaluation and tPA therapy in a stroke center with an in-hospital stroke code program.

Methods

The present study was retrospectively conducted with a prospectively collected stroke registry of a single stroke center. Our hospital is a tertiary care facility that treats more than 600 patients with AIS or transient ischemic attack per year who are admitted through the emergency room (ER). Our hospital is situated in Busan Metropolitan City, South Korea, which is a highly industrialized area with a population of 3.7 million people. It is a regional comprehensive stroke center supported by the Korean government.

We reported that PN reduced door-to-imaging time in patients transferred from other hospitals to our stroke center.[11] Since 2011, all 119 EMS paramedics in our city have received annual training using the Cincinnati Prehospital Stroke Scale[12] for early detection and transport of stroke patients. However, the decision to transport a patient to a particular hospital and whether to prenotify the hospital were made by individual paramedics based on each patient's clinical condition. Beginning in January 2012, stroke team members in our stroke center started to receive direct calls from paramedics via mobile phone prenotifying suspected AIS patients' arrival on the scene. They collected information on baseline characteristics, initial clinical assessment, and time of symptom onset from paramedics.

Systemized Stroke Code Program

In January 2009, a systemized stroke code program was implemented in an effort to more effectively treat acute stroke; this coincided with our hospital's establishment as a comprehensive stroke center. Acute stroke expertise and imaging facilities are provided 24 hours a day, 7 days a week in our center.

When a patient had at least 1 stroke warning sign by American Heart Association Stroke Council criteria, ER doctors or nurses activated the stroke code program, thereby initiating a predetermined set of events and recruiting the stroke team, which included neurologists, neurosurgeons, and an interventional neuroradiologist, by both a text message on their mobile phones and a broadcasting system. After stroke code activation, the patient's information was automatically sent to related departments such as laboratories, radiology, and the pharmacy. Individuals in these departments began to prepare for thrombolysis. The stroke code is useful in evaluating the program's efficacy because time data for each step can be obtained from the automated system. Details of the in-hospital strategies used were previously reported, along with data on the in-hospital delay time in our stroke center.[13]

Patients and Data Collection

We included patients treated with intravenous tPA after direct admission to our stroke center between January 2012 and August 2015. Patients who experienced stroke onset in the hospital, transferred from another hospital, or admitted through the outpatient neurology clinic were excluded.

EMS arrivals, each patient's clinical details, and prehospital and in-hospital delay times were obtained through hospital medical records or ambulance patient care records made by EMS personnel. "Private" hospital arrival was defined as arrival by private car, taxi, or other.

In the present study, timelines included onset-to-arrival time, door-to-imaging time, door-to-needle time, and onset-to-needle time. We evaluated the proportion of patients with onset-to-arrival time less than 60 minutes, door-to-imaging time less than 10 minutes, door-to-needle time less than 30 minutes, and onset-to-needle-time less than 120 minutes. On-hour arrival was defined as arrival at the emergency department between 8 AM and 6 PM from Monday to Friday.

Statistical Analysis

Statistical significance of intergroup differences was assessed by chi-squared tests or the Fisher exact test for categorical variables. Continuous variables were expressed as the mean ± standard deviation or median and interquartile range, which were compared using the Student *t*-test or the Mann–Whitney *U*-test as appropriate.

We compared baseline characteristics and prehospital/in-hospital delays (onset-to-admission, door-to-imaging, door-to-needle, and onset-to-needle times) between patients with private admission and EMS use. To identify the factors and prehospital delay times associated with EMS use, all potential factors were entered into a stepwise logistic regression model as dependent variables and the inclusion criteria were set at a univariate association with a probability value less than .1. For patients who were transported by EMS, we compared patients' characteristics and time interval to tPA therapy by PN