# Adherence to Guidelines by Emergency Medical Services During Transport of Stroke Patients Receiving Intravenous Thrombolytic Infusion

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*Background:* The "drip and ship" paradigm among acute ischemic stroke (AIS) patients has resulted in expansion of thrombolytic treatment in patients eligible for intravenous (IV) recombinant tissue plasminogen activator (rt-PA). It remains controversial whether the settings within the emergency medical services (EMS) transport are adequate for IV rt-PA infusion. We sought to determine EMS adherence to guidelines during the transport of drip and ship AIS patients treated with IV rt-PA while being transferred to comprehensive stroke centers (CSCs) and the effect of nonadherence on outcome upon discharge. *Methods:* A retrospective evaluation of patients transferred to our CSC was conducted to determine the rates of adherence to quality parameters during EMS transport with infusion of IV rt-PA. Favorable outcome was defined as modified Rankin Scale (mRS) score ≤1 upon discharge. *Results:* Among the 40 patients studied (55% men; mean age 71.9 ± 13.9 years), 38 patients received vital sign monitoring at 10- to 20-minute intervals. The mean transit time was 37.7 ± 20.2 minutes. Of the 39 patients with blood pressure (BP) monitoring, 7 patients had at least 1 episode of BP elevation above the recommended parameters (>180/105 mm Hg); only 1 of those was treated with an antihypertensive agent. Five of the 40 patients were considered to have worsened between the outside ED and CSC ED evaluations without IV rt-PA discontinuation during transfer. The rate of favorable outcome of patients who had interim neurologic deterioration without discontinuation of IV rt-PA or BP >180/105 mm Hg without antihypertensive treatment was similar to those who experienced neither event (41.7% and 35.7%; $P = .736$). *Conclusions:* Efforts are required to improve EMS adherence to guidelines in patients receiving IV rt-PA during EMS transport in anticipation of broader use of the "drip and ship" paradigm. **Key Words:** Acute stroke—"drip and ship"—emergency medical services—guidelines—prehospital setting—thrombolysis.


The outcomes of patients treated with intravenous (IV) thrombolytic therapy at a referral facility are similar to those who are treated at primary or comprehensive stroke centers (CSCs) for acute ischemic stroke (AIS).[1-3] Such reports have led to widespread recognition and adoption of the "drip and ship" paradigm as a method to increase the use of IV recombinant tissue plasminogen activator (rt-PA) in AIS patients. Guidelines have been provided to ensure timely recognition and response to neurologic and hemodynamic changes during the IV rt-PA infusion to reduce the risk of adverse events. However, it remains controversial whether adherence to these guidelines is possible within the emergency medical services (EMS) transport. The question becomes relevant because a prominent proportion of drip and ship patients continue to receive IV rt-PA during EMS transport.[3-5] This

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study examines the EMS adherence to guidelines during transport of AIS patients treated with IV rt-PA using the "drip and ship" paradigm while being transferred to CSCs from referring facilities and to determine its effect on outcome upon discharge.

## Methods

All AIS patients treated using the "drip and ship" paradigm who presented at 2 university-affiliated CSCs between June 2009 and July 2011 were identified from a prospective database maintained as part of certification requirements for the Joint Commission supplemented by retrospective chart review. The institutional review board at each institution approved the methodology and design of the database. Patients were transferred from referring facilities that did not have stroke center certification. A review of EMS transport records and assessments performed at transferring and receiving hospitals was performed by one of the investigators (G.A.) to determine the rates of adherence to quality parameters for neurologic and hemodynamic monitoring during EMS transport with ongoing IV rt-PA infusion. A second investigator (A.E.H.) reviewed the documents to independently determine rates of adherence, and high interobserver agreement ($\kappa = 0.6$) was seen between the 2 reviewers. Rates of adherence to the following quality parameters were determined: frequency of blood pressure (BP) monitoring, interventions for elevated BPs, and discontinuation of IV rt-PA in the event of neurologic deterioration. These quality parameters were selected based on current American Heart Association/American Stroke Association (AHA/ASA) guidelines for acute management of ischemic stroke.[6]

We reviewed medical records at the CSCs to ascertain presence of cardiovascular risk factors, including hypertension, diabetes mellitus, atrial fibrillation, coronary artery disease, dyslipidemia, congestive heart failure, cigarette smoking, and previous stroke or transient ischemic attack (Table 1). The severity of neurologic deficit in patients with AIS was determined using the National Institutes of Health Stroke Scale (NIHSS) score at the referring facility; if not available, the NIHSS score was estimated retrospectively based on the neurologic examination that was recorded. Nonadherence was defined as at least 1 BP measurement >180/105 mm Hg without antihypertensive treatment, hemodynamic monitoring less frequent than an average of every 15 minutes, or neurologic deterioration determined by comparing the NIHSS scores documented by the referral facilities and the initial NIHSS scores documented upon presentation at our CSCs. Outcome at time of discharge was assessed using the modified Rankin Scale (mRS) determined using detailed descriptions provided by the vascular neurology service and the rehabilitation team that consists of occupational, speech, and physical therapists. Favorable outcome was defined as a mRS score of ≤1.

We determined the rate of asymptomatic or symptomatic intracerebral hemorrhages (ICHs) within 24 hours of receiving IV rt-PA. The presence of ICH was determined by a review of all computed tomography (CT) scans acquired within 24 hours for each patient by one of the investigators (G.A.). Symptomatic ICH was identified after review of medical records and documented concurrent neurologic deterioration (defined as an increase in the NIHSS score of ≥4) with a focal intraparenchymal hemorrhage causing mass effect.

Statistical analysis was performed using SAS software (version 9.1; SAS Institute, Cary, NC). Descriptive statistics were expressed as means with standard deviation, medians with intraquartile range, and frequency (percentages). The rates of all asymptomatic and symptomatic ICHs and favorable outcome at discharge were compared between 2 patient groups defined by a lack of adherence to any of the 2 interventions that are part of the quality parameters: (1) IV antihypertensive treatment for elevated BP (>180/105 mm Hg); and (2) discontinuation of IV rt-PA in the event of neurologic deterioration. Continuous and categorical variables were compared using analysis of variance and Chi-square tests, respectively.

## Results

Among the 40 patients included in this study (55% men; mean age 71.9 ± 13.9 years), IV rt-PA infusion was continued throughout the entire EMS transport in 21 patients; the infusion was completed before transport in 5 patients and completed during transport in 14 patients. The mean transit time by EMS was 37.7 ± 20.2 minutes. The mean time interval between symptom onset and IV rt-PA initiation for all patients was 136.3 ± 56.1 minutes. Of the 40 patients, 38 patients received BP monitoring at 10- to 20-minute intervals; the other 2 either underwent monitoring at less frequent intervals or did not receive any BP monitoring. Of the 39 patients with BP measurements documented, 7 patients had at least 1 episode of BP above the recommended parameters (>180/105 mm Hg) while being treated with IV rt-PA; only 1 of those was treated with an antihypertensive agent. No neurologic deterioration was reported during transit by EMS, however, 5 of the 40 patients were considered to have neurologic deterioration based on the impression of the vascular neurology team between the outside ED and CSC ED evaluations. The mean systolic BP measured in transit was 143.6 ± 26.9 mm Hg and similar to the mean initial systolic BP measured upon presentation at any of the 2 CSCs of 146.6 ± 23.3 mm Hg.

Seven patients received additional endovascular treatment upon arrival to the CSCs, with a mean time from symptom onset to treatment of 282.7 ± 109.6 minutes. The rates of symptomatic and asymptomatic ICHs were 5% and 10%, respectively. The rate of favorable outcome of patients who had interim neurologic deterioration