The Door to Needle Time Metric Can Be Achieved via Telestroke

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Ganesh Asaithambi, MD¹, Amy L. Castle, RN¹, Michael A. Sperl¹, Jayashree Ravichandran¹, Aditi Gupta¹, Bridget M. Ho, CCRC¹, and Sandra K. Hanson, MD¹

Abstract

The administration of intravenous (IV) alteplase to patients with stroke via telestroke (TS) can be safe and effective. It remains unclear how quickly IV alteplase occurs during TS evaluations. We sought to compare door to needle times (DNTs) between patients receiving IV alteplase who present directly to our comprehensive stroke center (CSC) and those presenting to community hospitals in our TS network. Consecutive patients with acute ischemic stroke (AIS) who presented to emergency departments and received IV alteplase between August 2014 and June 2015 were identified at our CSC and TS network. Median DNTs with interquartile ranges were calculated in each cohort. During the study period, 117 patients with AIS (mean age 71 ± 15 years, 47% women) receiving IV alteplase were included in the analysis (65 CSC and 52 TS). Median DNT at our CSC was significantly shorter compared to TS sites (CSC: 43 [35-55] minutes vs TS: 54 [41-71] minutes, $P < .01$). The proportion of patients receiving IV alteplase ≤ 60 minutes of presentation was significantly higher at our CSC compared to our TS network (CSC 84.6% vs TS 63.5%, $P = .02$). Differences in favorable discharge to home were not significant (CSC 60% vs TS 46%, $P = .14$). Guideline-recommended DNTs ≤ 60 minutes can be achieved in community hospitals with TS guidance. Initiatives are required to better resemble DNTs found at stroke centers.

Keywords

door to needle, stroke, telemedicine, telestroke, thrombolysis

Introduction

Intravenous (IV) alteplase is most effective for patients presenting with acute ischemic stroke (AIS) when administered ≤ 4.5 hours from symptom onset¹; any opportunity to reduce time delays in delivering IV alteplase significantly increases the health benefits of patients.² Current stroke center metrics include the recommendation that eligible patients with AIS receive IV alteplase ≤ 60 minutes from arrival to the emergency department (door to needle time [DNT]).³ National quality improvement measures have successfully increased the proportion of patients with AIS receiving IV alteplase ≤ 60 minutes, but this remains a minority.⁴ Smaller health-care facilities may not have the opportunity to be a part of national quality improvement initiatives such as American Heart Association/American Stroke Association Target: Stroke initiative because they lack the resources or manpower. Instead these smaller facilities may rely on primary or comprehensive stroke centers (CSCs), serving as telestroke (TS) hubs, to guide implementation of stroke measures and quality metrics. Because DNT is an important

metric among patients eligible for alteplase therapy, we elected to compare DNTs of patients presenting to our CSC and TS hospitals in order to identify potential delays in time to treatment.

Methods

From August 2014 to June 2015, consecutive patients with AIS receiving IV alteplase in emergency departments at TS sites and our CSC were identified from a prospective database supplemented by retrospective chart review. All TS patients identified for this study were those treated at spoke sites and then transferred to our CSC for higher level of

¹ United Hospital, Allina Health, St Paul, MN, USA

Corresponding Author:

Ganesh Asaithambi, United Hospital, 225 North Smith Avenue, Suite 500, Mail Route 65500, St Paul, MN 55102, USA.
Email: ganesh785@gmail.com

Table 1. Comparison of Baseline Clinical Characteristics Based on Treatment Site.

	CSC (65)	TS (52)	P Value
Mean age (SE)	69.3 (2)	73.8 (1.8)	.17
No. of men	30 (46%)	33 (64%)	.06
Median admission NIHSS (IQR)	6 (3-14)	7 (3, 11)	.95
Hypertension (%)	40 (62)	41 (79)	.04
Diabetes mellitus (%)	10 (15)	18 (35)	.02
Dyslipidemia (%)	39 (60)	40 (77)	.05
Atrial fibrillation (%)	18 (28)	15 (29)	.89
Coronary artery disease (%)	20 (31)	19 (37)	.51
History of stroke (%)	10 (15)	14 (27)	.12
Tobaccoism (%)	8 (12)	12 (23)	.12

Abbreviations: CSC, comprehensive stroke center; IQR, Interquartile range; NIHSS, National Institutes of Health Stroke Scale Score; SE, standard error; TS, telestroke.

care. This study was approved by our local institutional review board.

We reviewed medical records of patients to determine baseline chronic illnesses and severity of neurological deficit at presentation defined by the National Institutes of Health Stroke Scale Score (NIHSS). The following time metrics were tabulated: (1) door to needle, (2) door to stroke alert activation, (3) door to neurologist evaluation, (4) door to imaging, (5) door to alteplase order, and (6) alteplase order to treatment initiation. Outcomes adjudicated included rates of symptomatic intracerebral hemorrhage (sICH) as defined by NIHSS increase ≥ 4 , in-hospital mortality, and favorable discharge to home.

Our TS practice consists of 4 neurologists who cover 10 hospitals. One TS hospital was excluded because coverage was not provided during the study period. We excluded another TS hospital (a primary stroke center) from analysis because patients do not transfer to our CSC for postalteplase cares, and we did not have access to all outcome variables during the study period. Among the remaining 8 TS hospitals, we conduct quarterly quality reviews with cooperative hub and spoke meetings to address opportunities for process improvement. Components of this process include use of aggressive triage plan for ambulatory arrivals, partnering with emergency medical services for prehospital alerts, specific team member assignments and time goals, and early remote involvement of neurologic expertise.

Statistical analysis was performed using SAS software (version 9.3; SAS Institute, Cary, North Carolina). Statistics were expressed as means with standard error, medians with interquartile ranges, and frequency (percentages). Continuous variables were analyzed by Wilcoxon test; categorical variables were analyzed by χ^2 tests and Fisher exact test if counts < 5 .

Results

During our study period, we identified 117 patients (65 CSC and 52 TS) treated with IV alteplase. Table 1 describes clinical

Table 2. Time Metrics Based on Site of Treatment Initiation.

	CSC (65)	TS (52)	P Value
Median door to stroke alert (IQR, minutes) ^a	0 (−6 to 8.25), n = 60	10 (4.75-17)	<.01
Median door to neurologist evaluation (IQR, minutes) ^a	6.5 (0 to 16), n = 46	16 (11-29)	<.01
Median door to imaging (IQR, minutes)	17 (13 to 23)	16 (3-27)	.43
Median door to alteplase order (IQR, minutes) ^a	27 (19 to 38)	35 (25-45), n = 47	.02
Median alteplase order to treatment initiation (IQR, minutes)	15 (12 to 20)	18 (12-26), n = 47	.1
Median door to needle time (IQR, minutes)	43 (35 to 55)	54 (41-72)	<.01
Median onset to needle time (IQR, minutes)	112 (93 to 161)	134 (81-187)	.66
Percent door to needle time ≤ 60 minutes	84.6%	63.5%	.02
Symptomatic ICH	1 (1.5%)	0	-
In-hospital mortality	1 (1.5%)	2 (3.8%)	.58
Discharge to home	39 (60%)	24 (46%)	.14

Abbreviations: CSC, comprehensive stroke center; IQR, Interquartile range; ICH, intracerebral hemorrhage; TS, telestroke.

^aSome times were missing or could not be confirmed.

characteristics of each cohort. Patients presenting to our TS sites had significantly longer DNTs compared to patients presenting to our CSC (54 [41-70.25] TS vs 43 [35-55] CSC, $P < .01$); a significantly lower proportion of TS patients were treated ≤ 60 minutes compared to CSC patients (63.5% TS vs 84.6% CSC, $P = .02$). Although neither door to imaging ($P = .43$) nor alteplase order to treatment initiation ($P = .1$) times significantly differed between the 2 cohorts, we did identify significant differences in door to stroke alert activation ($P < .01$), door to neurologist evaluation ($P < .01$), and door to alteplase order ($P = .02$) times (Table 2). Only 1 case of sICH occurred among all study patients. There were no significant differences in rates of in-hospital mortality ($P = .58$) and discharge to home ($P = .14$). Differences in time metrics and outcome end points were not affected after adjusting for differences in baseline clinical characteristics.

Discussion

National registry data reported that approximately 41.3% of patients are treated ≤ 60 minutes.⁴ Previous reports of timeliness of IV alteplase therapy within TS practices have been slow with DNT averages well beyond 60 minutes.⁵ The largest barrier identified in these practices was the time elapsed between patient arrival and initiation of TS consultation request, which delayed neurologist evaluation, diagnosis, recommendations, and treatment.⁵ Our current TS model reflects an attempt to minimize delays from the arrival of patient with

AIS at TS emergency departments to TS consultation request. We were able to achieve DNTs ≤ 60 minutes in a majority of our patients with TS. Although outcomes were not significantly different between the 2 cohorts, TS sites still have slower treatment times overall when compared to our CSC largely due to the delay in stroke alert activation and TS neurologist consultation request.

By using time points for patients at our CSC as the "control," we identified that the door to TS consultation request is still the largest barrier in delay to alteplase administration at TS sites. Stroke alert activations at our CSC notify emergency department staff as well as our stroke team simultaneously even if it is a prehospital alert. However, prehospital alert activations at our TS sites do not automatically alert the TS neurologist on call. A typical scenario for prehospital stroke alert activations at TS sites involves the emergency department physician evaluating the patient upon arrival followed by TS consultation request while the patient is completing cranial imaging. This can lead to an approximately 15-minute delay for formal neurological assessment via TS. This initial delay will unavoidably cause delays in alteplase recommendation and treatment initiation.

Rapid stroke team notification has been found to be independently associated with shorter DNTs.⁶ Because we identified a delay in treatment initiation as a result of a delay in TS evaluation, we have encouraged our TS sites to request TS consultations even with prehospital stroke alerts such that there is a simultaneous initial evaluation by both the local emergency department physician and the TS neurologist.

During onboarding within our TS program, we held several team meetings that include spoke hospital staff. We appoint stroke team champions within each section of the spoke hospital, including but not limited to medical provider, emergency department and inpatient nursing, phlebotomy, imaging, therapists, and emergency medical services. In addition, we appoint a stroke coordinator/liaison who collaborates very closely with our own dedicated TS program nurse coordinator in order to address quality and process issues; our dedicated TS nurse coordinator oversees the quality and process improvement opportunities at all of our TS sites. We collaboratively create a protocol designed with resources available at each spoke hospital in mind. Components of these protocols include use of an aggressive triaging plan for patients arriving by private vehicle, partnership with numerous emergency medical services for prehospital stroke alert activations, and creation of specific team member assignments during a stroke alert with time goals. This integrated team approach continues with quarterly quality meetings with cooperative CSC and TS site involvement in order to address barriers and create effective process improvement opportunities. These meetings particularly address the issues that may hinder the timeliness of treatment with IV alteplase, processes that can improve the efficiency of transfers to our CSC for patients eligible for endovascular therapy, and review of

missed treatment opportunities among patients who may present with rare stroke syndromes. We strongly believe that because of the frequent opportunities for feedback between the spoke and hub sites, we were able to accomplish a high proportion of patients receiving IV alteplase ≤ 60 minutes at TS sites.

Our study has important limitations. This study was retrospectively performed. The small sample size and few number of adverse events decrease the power to detect meaningful differences in outcomes. A formalized outcome scale such as the modified Rankin Scale (mRS) was not used because many of our patients with TS do not return to our clinic for formal 3-month outcome assessments due to far distances from home to our CSC. Discharge destination has been used as a surrogate for mRS due to its high predictive value for 3-month mRS scores.⁷

We conclude that a majority of patients with TS can be treated ≤ 60 minutes from arrival to the emergency department, which is better than previously reported data. The ability to achieve our TS DNTs is largely related to the dedicated stroke team champions at each of our TS sites, who are invested in ongoing process improvement and participate regularly in collaborative quality improvement meetings with our CSC team. There are still opportunities to improve treatment times in order to resemble the timeliness of treatment at a CSC; shortening times to TS consultation requests ultimately can help improve DNTs at TS sites.

Authors' Note

M.A.S, J.R, and A.G contributed equally to this study.

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Declaration of Conflicting Interests

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