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Door to Needle Time over Telestroke—A Comprehensive Stroke Center Experience

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Abstract

Background: The implementation of telestroke programs has allowed patients living in rural areas suffering from acute ischemic stroke to receive expert acute stroke consultation and intravenous Alteplase (tPA). The purpose of this study is to compare door to needle (DTN) time when tPA is administered at telestroke sites (spokes) through telestroke consultations compared to tPA administration at the comprehensive stroke center (hub).

Methods: Data on all patients who received intravenous tPA at the hub and spoke hospitals through a large telestroke program between May 2008 and December 2016 were collected. Baseline characteristics were compared between the two groups, and the percentage of patients meeting DTN guidelines was compared between the hub and spoke hospitals during the study period. Comparison of DTN before and after the implementation of a quality improvement project was performed.

Results: A total of 1,665 patients received tPA at either the spoke (n = 1,323) or the hub (n = 342) during the study period. Baseline characteristics were comparable in both treatment groups. Before the intervention, DTN time <60 min was achieved in 88% of the hub patients versus 38% of the spoke patients. This difference between the two groups decreased by 35 percentage points, controlling for year (p = 0.0018) after the interventions.

Conclusion: Overall, DTN is longer at the spoke hospitals compared to the hub hospital. This can be improved by various interventions that target quality, training, education, and improving the comfort level of the staff at partner hospitals when treating acute stroke patients.

Keywords: ischemic stroke, telestroke, telemedicine, tPA, door to needle time

Introduction

The use of intravenous thrombolysis with Alteplase (tPA) remains the cornerstone for acute ischemic stroke.^{1,2} A significant limitation to the use of tPA is the time window during which it can be administered.^{1,2} Pooled data from previous randomized controlled trials of tPA were analyzed and showed that the odds of a favorable functional outcome at 3 months increased as onset to treatment decreased.³ As a result of these findings, the current guidelines recommend initiating tPA within 60 min of patient arrival to the hospital in 75% or more of patients and within 45 min in 50% or more of patients.^{4–8}

Following the implementation of telestroke programs, patients living in rural areas that lack access to acute stroke therapy can now be remotely evaluated by a neurologist and receive intravenous tPA. Little has been reported, however, on door to needle (DTN) time through telestroke consultations.

The purpose of this study is to compare the percentage of patients meeting DTN guidelines through Telestroke at spoke hospitals versus those who receive tPA at the hub comprehensive stroke center. We provide an insight on potential ways to improve DTN times in telestroke spoke hospitals.

Study Sites and Intervention

The Medical University of South Carolina (MUSC) is an academic medical center and comprehensive stroke center, located in Charleston, South Carolina. In 2008, a telestroke consultation network was established to increase access to specialty care for stroke patients located in rural areas of South Carolina. By 2016, 9,566 consultations had been conducted across 24 spoke sites. The reasons for teleconsultation include acute ischemic stroke, hemorrhagic stroke, transient ischemic attack, and other neurological symptoms. Multiple steps were taken to improve DTN over spoke hospitals to meet the guidelines goal of <60 min. The intervention began in 2014, when 4 out of 10 spoke hospitals were able to become Joint Commission accredited Primary Stroke Centers (PSC) because of telestroke support. Next in 2015, the hub employed two telestroke coordinators to actively work with each of the spoke sites to improve care. The coordinators implemented spoke hospital stroke education programs, which included on-site training, webinars, and monthly educational newsletters.

The on-site education included training on how to perform National Institutes of Health Stroke Scale (NIHSS), telepresentation education, medication use protocols, and acute stroke education. The telestroke coordinators were also in charge of communication between the hub and spoke hospitals. A quarterly site visit and quarterly reports were sent to each spoke site by the telestroke coordinators, including consult volume activity and site-level metrics related to DTN times. In addition, a monthly award certificate is sent to the spoke center with the fastest DTN of the month and announced to all spoke partner hospitals. Similar interventions were not implemented at the hub center. The overall design and clinical and operational outcomes of the MUSC Telestroke Program have been described previously.⁹

Materials and Methods

DATA SOURCE

The hub maintains a registry of all patients evaluated within the Telestroke consultation network and includes patient demographic information and DTN times for each patient evaluated. The same data elements for the patients receiving tPA at the hub are collected and reported through the Epic electronic medical records. Exports from the two data sources were merged, and analysis was completed in STATA 14 and SAS 9.4 software systems.

OUTCOMES

We analyze two outcome measures related to compliance with DTN benchmarks. First, we calculate the percentage of patients that have a DTN time of 60 min or less. Next, we conduct a separate analysis of the percentage of patients with a DTN time of 45 min or less. The outcome variables were constructed based on patient DTN time and coded where 1 indicates a DTN meeting the guideline and 0 indicates exceeding the guideline.

ANALYSIS

We examine DTN for all patients who received tPA at the spoke hospitals through the Telestroke network and hub between May 1, 2008 and December 31, 2016. We define the preperiod as those patients who were treated between May 2008 and December 31, 2013. The intervention postperiod is defined as those patients who were treated beginning January 1, 2014. We compared differences between hub and spoke patients for continuous and categorical variables using *t* test and chi-square as applicable. For each outcome, we examined the differences in the percentage of patients meeting the DTN guidelines post-intervention (2014) between the two groups (hub and spokes), controlling for year, using ordinary least squares regression.

The Institutional Review Board of the MUSC approved the study.

Table 1. Patient Characteristics

VARIABLE	PRE (N=695)		POST (N=970)	
	HUB (N=167)	SPOKE (N=528)	HUB (N=175)	SPOKE (N=795)
Age (mean)	64.6	65.5	66.2	66.2
Admission NIHSS				
Mean	11.5**	8.2	10.5	10.1
Median	9**	6	9	8
Sex, n (%)				
Female	81 (48.50)	274 (51.9)	90 (51.4)	360 (45.3)
Male	86 (51.5)	254 (48.1)	85 (48.6)	435 (54.7)
Race, n (%) ^a				
White	84 (50.9)*	322 (61)	94 (55)	452 (57)
Non-White	81 (49.1)	206 (39)	77 (45)	341 (43)
DTN, min, (mean)	62.3**	90.1	46.1**	64.6

* $p < 0.05$, ** $p < 0.001$.

^aSmaller *n* due to missing data.

DTN, door to needle; NIHSS, National Institutes of Health Stroke Scale.

Results

Between May 1, 2008 and December 31, 2016, 1,665 patients received tPA in either the spoke hospitals ($n=1,323$) or in the hub hospital ($n=342$). Patient characteristics across the pre- and postintervention periods are summarized in *Table 1*. There were no significant differences between the two groups' patient age or sex in either time period. In the preintervention period, a lower percentage of white patients were treated in the hub hospital (50.9%) compared to spoke hospitals (61%) ($p<0.05$). However, the differences in race were not significant in the postintervention period. The median and mean NIHSS were significantly higher for hub patients in the preintervention period. However, there was no significant difference in stroke severity postintervention. Finally, DTN times were significantly different between the two groups in both time periods. Preintervention, average DTN times were 62.3 and 90.1 min at hub and spoke sites, respectively ($p<0.001$). Postintervention both the hub and spoke show that average DTN times have improved to 46.1 and 64.6 min, respectively ($p<0.001$).

At the time of implementation of the Telestroke program in 2008, tPA was administered to 24 spoke patients, the number gradually increased to reach 400 patients in 2016 (*Fig. 1*). Patient volumes at the hub hospital remain more consistent and range from 15 to 65 tPA administrations annually.

The percentage of patients with DTN times of less than 60 min has increased both settings since 2008. In 2008, when the MUSC Telestroke program was implemented, 33% (5/15) of hub patients and 13% (3/24) of spoke patients met the 60-min guideline. The gap between the two settings continued to grow through 2013, where the percentage of hub patients meeting the guideline was 52% (87% vs. 35%) higher compared to the spoke patients (*Fig. 2*).

In 2008, no spoke patients and 7% (1/15) of hub patients achieved DTN in less than 45 min. Overall, the percentage of patients meeting the 45-min

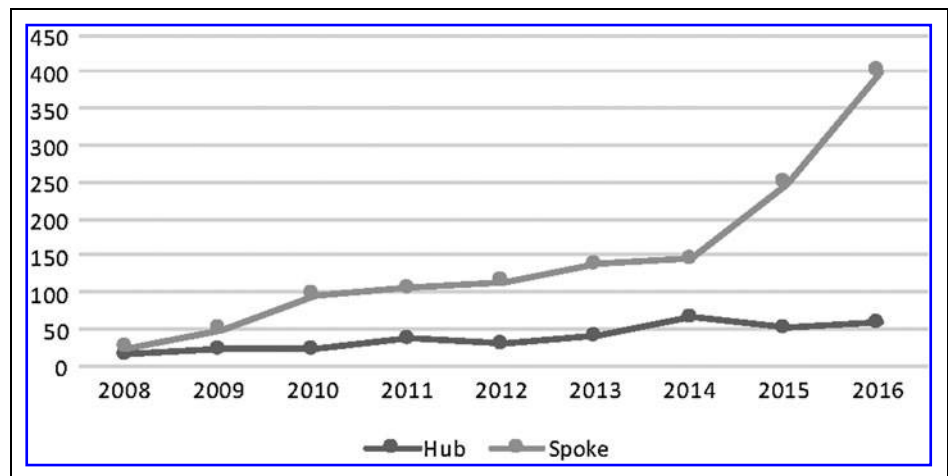


Fig. 1. Alteplase (tPA) administered 2008–2016.

guideline has improved for both spoke and hub patients. The largest disparity was seen in 2013 where the percentage of hub patients meeting the guideline was 61% (68% vs. 7%) higher than the spoke patients. Postintervention (2014), the differences between care in the two settings began to lessen (*Fig. 3*).

Controlling for year, results of the regression analysis showed that the differences in DTN times between the two settings narrowed. Postintervention, the gap between hub and spoke has narrowed by 35 percentage points ($p=0.0018$) for DTN time of 60 min (*Table 2*). The difference in the percentage of patients meeting the 45-min time between the hub and spoke reduced by 36 percentage points ($p=0.0149$) (*Table 3*).

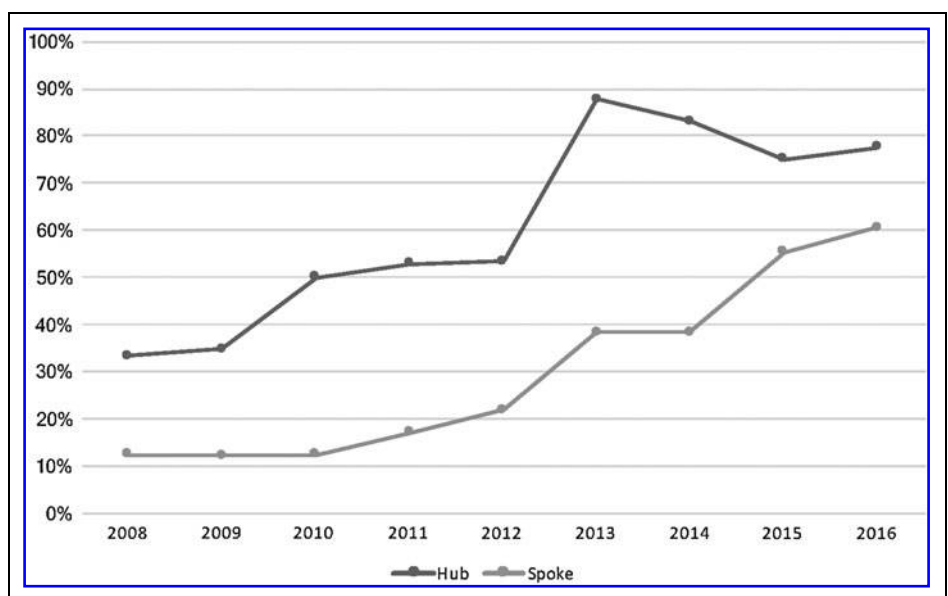


Fig. 2. Percentage of patients meeting the 60-min guideline.

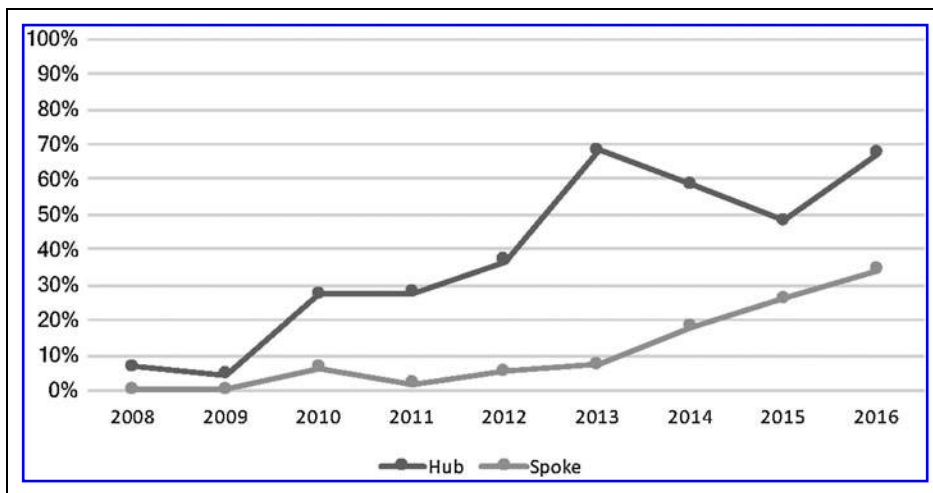


Fig. 3. Percentage of patients meeting the 45-min guideline.

DTN consistently improved over time since 2008; however at the hub, DTN improved from 2008 until 2014 then worsened in 2014 and 2015 at which point it started to improve again.

Discussion

Our study shows that average DTN times for both hub and spoke hospitals have improved since 2008. While the percentage of patients in the spoke sites meeting 60- or 45-min guidelines is lower compared to hub DTN times, the gap between the two locations is narrowing. There is a clear change in trend postintervention in 2014 as the differences in meeting the 60- and 45-min guidelines across the settings narrowed. This is an important finding as a goal of telestroke programs is to increase access to care for patients that may otherwise need to travel long distances.

Our study provides an insight on potential ways to improve DTN time in spoke hospitals of less than 60 min.

Only few previous studies evaluated DTN time over Telestroke and reported a longer time over spoke hospitals compared to the hub hospital administration.¹⁰ Our study confirms this finding and suggests that while telestroke offers access to

stroke patients to receive tPA, there is a delay in administration after they arrive to the spoke hospital. We speculate that potential reasons for this delay include reduced spoke hospital stroke experience and comfort level with tPA administration. In addition, the time taken to perform the telestroke consult and review brain images is theoretically longer than the time it would take for hub cases.¹¹

Our study suggests that DTN time can be improved in spoke hospitals. There are several possible explanations for this improvement. First, our intervention period included additional spoke hospitals becoming PSC certified.

In 2014, 4 out of 10 spoke hospitals became PSC certified, the following year the DTN time of less than 60 min improved from 38% to 58%. In addition, we hypothesize that hiring stroke coordinators who are in charge of spoke hospital education, sending a monthly newsletter, and creating a competitive environment with a monthly certificate award will impact DTN times. Quality improvement theory supports the use of multifaceted interventions and effective interventions often combine more than one type of change.¹¹ However, the multiple components of this telestroke intervention make it difficult to determine if one change had a more significant impact on DTN time than another. Therefore, we cannot speculate if certain aspects of the spoke intervention lead to more significant improvements than others.

This study demonstrates that it is possible to improve the DTN time in spoke hospitals; we believe that there is still room for improvement. This includes efforts to increase the number of PSC certified partners, provision of regular nursing and physician training on the telestroke system, and regular stroke education to improve the ability of medical staff to recognize stroke.

Our study has several limitations. First, we are limited by retrospective observational design. We are unable to

Table 2. Regression Result Difference in Meeting 60-Min Guideline

VARIABLE	PARAMETER ESTIMATES	STANDARD ERROR	P
Postintervention	-35.03	6.621	0.0018
Year	4.16	1.066	0.008

Table 3. Regression Result Difference in Meeting 45-Min Guideline

VARIABLE	PARAMETER ESTIMATES	STANDARD ERROR	P
Postintervention	-36.34	10.769	0.0149
Year	8.12	1.733	0.0034

randomize patients into either the hub or spoke sites and there may be additional factors contributing to achieving the DTN guidelines. Second, there is the possibility of miscoding registry data. Third, multiple improvement interventions were implemented, and we are unable to disentangle the effects of each intervention's component on the DTN times. Finally, there is a national focus on improving DTN times and meeting guidelines. It is possible that other factors contributed to the improvement in DTN times outside of the described telehealth interventions.

Conclusion

The percentage of patients meeting DTN time guidelines is lower in spoke hospitals compared to the hub stroke center. Various interventions that target training, education, and improving the comfort level of the staff at partner hospitals when treating acute stroke patients may improve DTN times in spoke hospitals.

Disclosure Statement

No competing financial interests exist.

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