Neurohospitalists Improve Door-to-Needle Times for Patients With Ischemic Stroke Receiving Intravenous tPA

The Neurohospitalist
2(4) 119-122
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DOI: 10.1177/1941874412445098
<http://nhos.sagepub.com>

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Abstract

Purpose: It is unknown whether neurohospitalist evaluation improves door-to-needle times (DNT) in patients with acute ischemic stroke. The purpose of this study is to determine the impact of neurohospitalist evaluation on DNT for patients with ischemic stroke receiving intravenous tissue plasminogen activator (tPA) presenting within 4.5 hours of symptom onset. **Methods:** We retrospectively identified consecutive patients with ischemic stroke who received tPA between 0 and 4.5 hours. We determined and compared DNT for nonneurohospitalists versus neurohospitalists for a 26-month period from 2009 to 2011. Our main outcome measure was percentage of patients receiving tPA within 60 minutes. **Results:** Overall, out of the 107 consecutive ischemic stroke patients (mean age 67 years) who received intravenous tPA within 4.5 hours, 60 patients were evaluated by nonneurohospitalists (community and locums neurologists) and 47 patients were evaluated by neurohospitalists. Mean $\pm$ standard deviation (SD) DNT with patients treated by nonneurohospitalists (93 ± 24 minutes) were significantly longer than the DNT treated by neurohospitalists (68 ± 18 minutes). Twenty-four patients (51%) treated by neurohospitalists had DNT less than or equal to 60 minutes, while 9 patients (15%) treated by nonneurohospitalists had DNT less than or equal to 60 minutes. Multivariate analysis showed that neurohospitalist evaluation (odds ratio [OR] 5.4, confidence interval [CI] 2.2-13.6, $P = .022$) was the only independent factor associated with patients receiving tPA within 60 minutes. **Conclusion:** Neurohospitalist evaluation is associated with faster DNT in patients with ischemic stroke. Neurohospitalist evaluation could be a part of a multidimensional initiative to improve the timeliness of tPA administration.

Keywords

neurohospitalist, thrombolysis, door to needle, quality, tPA

Introduction

Patients with ischemic stroke benefit from intravenous tissue plasminogen activator (tPA), when given expeditiously.¹ Current best practice strategy identified by American Heart Association/American Stroke Association (AHA/ASA) sponsored Target: Stroke program is to achieve a door-to-needle time (DNT) ≤ 60 minutes for at least 50% of patients with acute ischemic stroke. However, less than one third of patients with acute ischemic stroke who receive tPA are treated within the guideline-recommended 60 minutes.² This program has identified 10 key strategies to improve DNT. These include emergency medical service prenotification, activating the stroke team with a single call, rapid acquisition and interpretation of brain imaging, use of specific protocols and tools, premixing tPA, a team-based approach, and rapid data feedback. Neurohospitalists are inpatient site-specific specialists mainly responsible for managing inpatient neurological conditions.³ Community neurologists, who are chiefly outpatient based

and periodically cover the hospital on call, may not have time or interest to focus on inpatient quality and safety metrics on top giving optimal care to their outpatient population. Neurohospitalist model has been associated with reduced length of stay in patients with ischemic stroke.⁴ Limited data are available regarding whether inpatient neurohospitalist evaluation has an impact on DNT for intravenous thrombolysis in patients with ischemic stroke within 4.5 hours of symptom onset. We know that most inpatient neurologists are vascular neurologists.² But, there is no specific data comparing

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vascular neurologists and community neurologists on the quality of inpatient care. Our aim is to retrospectively compare DNT for intravenous thrombolysis in ischemic stroke between nonneurohospitalists and neurohospitalists at a single institution in the emergency department (ED).

Design/Methods

After Institutional Review Board (IRB) approval, we retrospectively identified consecutive patients with ischemic stroke who received intravenous tPA between 0 and 4.5 hours at Spectrum Health Hospitals in Grand Rapids, Michigan. Patients with ischemic stroke were identified by *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. The DNT for patients evaluated by neurohospitalists were compared to DNT for patients evaluated by nonneurohospitalists (community neurologists and locums neurologists) in the ED for a 26-month period from July 2009 to September 2011. All neurologists were certified by the American Board of Psychiatry and Neurology.

Neurohospitalist service was established in August 2010 at Spectrum Health, which is a tertiary care certified primary stroke center and does not have a neurology residency program. It uses AHA/ASA suggested best practices to reduce DNT. Prior to August 2010, community neurologists (total 4) were responsible for a primary consultative inpatient service maintained by a rotating schedule. They also shared clinical responsibilities that included office hours in outpatient clinics along with inpatient care. Two neurohospitalists (primarily consultative) were hired by the hospital on August 15, 2010 (A.B. who is board certified in vascular neurology and A.S. who is board certified in clinical neurophysiology). Locums neurologists and community neurologists provided occasional weekend coverage. The primary task of the neurohospitalists was to provide care for neurological patients admitted to the hospital or ED at 2 hospitals; Butterworth hospital which has 701 beds and Blodgett hospital which has 280 beds. Patients were not admitted in the stroke unit. The DNT were collected from time of triage to time of intravenous tPA bolus administration, which was expressed in minutes. A multidisciplinary team, which included ED physicians, pharmacists, neurologists, radiologists, were involved in any "code stroke" evaluation in the ED and was responsible for doing the initial evaluation and completing the tPA inclusion/exclusion checklist based on the most current evidence.^{5,6} The on-call neurologist made the final decision regarding administration of tPA within 0 to 4.5 hours of symptom onset. The data that were retrospectively abstracted include demographic data, National Institute of Health Stroke Scale (NIHSS), DNT, door-to-inclusion/exclusion checklist completed time, door-to-computed tomography (CT) brain read by a radiologist time, door-to-laboratories known time and data pertaining to evidence of symptomatic intracranial (presence of intracranial hemorrhage on CT or magnetic resonance imaging with ≥ 3 point NIHSS deterioration within 36 hours), or any other life-threatening hemorrhage within 36 hours of admission,

determined by predefined criteria.⁵ In addition, we also collected data whether the on-call neurologist was physically present in the hospital when code stroke was activated. Data were stored in a computer database. Both A.B. and A.S. gathered the data in a blinded fashion.

The 95% confidence interval was calculated for the mean DNT for patients with ischemic stroke cared for by neurohospitalists and nonneurohospitalists. Continuous variables were compared with the independent samplest test and categorical variables were tested for association with chi-square test statistic. P value of $<.05$ was considered statistically significant. Our main outcome measure was percentage of patients receiving tPA within or equal to 60 minutes. We also compared compliance of AHA/ASA suggested best practice strategy to achieve a DNT ≤ 60 minutes for at least 50% of patients with acute ischemic stroke and rates of symptomatic intracranial or life threatening hemorrhage between the 2 groups. In a multivariate model, factors such as age, sex, door-to-CT brain time, door-to-laboratories known time, door-to-inclusion/exclusion checklist completion time, and whether neurologist was physically present in the hospital when code stroke called were analyzed.

Results

A total of 789 patients were evaluated by nonneurohospitalists and 484 patients by neurohospitalists over a 26-month period. The overall tPA rate is 8.7%. Of the 107 consecutive patients with ischemic stroke (mean age 67 years) who received intravenous tPA within 4.5 hours, 60 patients were evaluated by nonneurohospitalists and 47 patients were evaluated by neurohospitalists. The baseline data are summarized in Table 1. Mean $\pm$ SD DNT with patients treated by nonneurohospitalists (93 ± 24 minutes) were significantly longer ($P = .031$) than the DNT treated by neurohospitalists (68 ± 18 minutes). Twenty-four (51%) patients treated by neurohospitalists had DNT less than or equal to 60 minutes, while 9 patients (15%) patients treated by nonneurohospitalists had DNT less than or equal to 60 minutes. Symptomatic intracranial bleed rate was lower in patients treated by neurohospitalists compared to non-neurohospitalists (2% vs 8%, $P = .061$) but not statistically significant. A total of 4 protocol violations were observed. None of the patients had intracranial or life-threatening bleeds. All violations were pertaining to blood pressure control after tPA administration. One was in the neurohospitalist group and 3 in the nonneurohospitalist group. The differences were not statistically significant ($P = .09$). The in hospital mortality rate for patients receiving tPA was 2% (1 of 47) in the neurohospitalist group and 7% (4 of 60) in the nonneurohospitalist group. The difference was not statistically significant ($P = .07$). Median length of stay for patients receiving tPA in neurohospitalist group was 4.2 ± 1.1 days and 4.5 ± 1.2 days in the nonneurohospitalist group. The difference was not significant statistically. The data pertaining to discharge disposition and thrombectomy and intra-arterial therapy rates are not available. Although not

Table 1. Characteristics I

Demographic Characteristic	Neurohospitalists	Nonneurohospitalists	P Value
Patients, n	47	60	
Mean age, years (range)	69, (40-91)	66, (45-93)	>.05
Female, n (%)	25 (53%)	29 (48%)	>.05
tPA administration rate, n (%)	47/484 (9.7%)	60/745 (7.7%)	= .056
Mean NIHSS	10.8	12.1	>.05
Mean DNT (SD), minutes	68 ± 18	93 ± 24	= .031
Range DNT, minutes	36-91	54-184	
DNT ≤ 60 minutes, n (%)	24 (51%)	9 (15%)	.011
Mean door-to-CT time (SD), minutes	27 ± 5	28 ± 7	>.05
Mean door-to-laboratories known time (SD), minutes	39 ± 8	41 ± 9	>.05
Mean door-to-tPA inclusion–exclusion checklist completed time (SD), minutes	44 ± 6	71 ± 14	= .038
Neurologist present in the hospital when code stroke called, n (%)	38 (80%)	32 (53%)	= .017
Symptomatic ICH, n (%)	1 (2%)	5 (8%)	= .061
Stroke mimics, n (%)	1 (2%)	2 (3%)	>.05

Abbreviations: CT, computed tomography; tPA, tissue plasminogen activator; DNT, door-to-needle time; NIHSS, National Institute of Health Stroke Scale; ICH, intracranial hemorrhage.

Table 2. Multivariate Model

Characteristic	Patients Receiving Intravenous tPA at ≤ 60 minutes DNT	Patients Receiving Intravenous tPA at > 60 minutes DNT	P Value
Patients, n	33	74	
Mean age, years (range)	64 (40-79)	71 (48-93)	>.05
Female, n (%)	17 (51%)	37 (50%)	>.05
Door-to-CT time less than 30 minutes (SD), n (%)	30 (89%)	68 (91%)	>.05
Door-to-laboratories known time ≤ 40 minutes (SD), n (%)	32 (95%)	70 (95%)	>.05
Door-to-tPA inclusion–exclusion checklist completed time ≤ 45 minutes (SD), n (%)	30 (90%)	37 (50%)	OR 6.2, CI 1.7-19.6, P = .03
Neurologist present in the hospital when code stroke called, n (%)	26 (79%)	44 (59%)	OR 5.4, CI 2.2-13.6, P = .022

Abbreviations: CT, computed tomography; tPA, tissue plasminogen activator; DNT, door-to-needle time.

statistically significant, tPA administration rates were not different. Neurohospitalists were more likely to be present in the hospital when code stroke was activated as compared to nonneurohospitalists (80% vs 53%, $P = .017$).

In a multivariate model (Table 2), inpatient neurohospitalist evaluation (odds ratio [OR] 5.4, confidence interval [CI] 2.4-10.1, $P < .022$) and door-to-checklist completion time (OR 6.2, CI 1.7 – 19.6, $p = .03$) were the only independent factors associated with patients receiving tPA within 60 minutes. Mean time to complete the inclusion/exclusion checklist was significantly shorter when neurohospitalist evaluated the patient as compared to a nonneurohospitalist (44 ± 6 vs 74 ± 14 minutes, $P = .038$).

Discussion

Each minute, 1.9 million neurons, 14 billion synapses, and 12 km (7.5 miles) of myelinated fibers are destroyed during an ischemic stroke.⁷ In patients with ischemic stroke,

thrombolytic treatment within 4.5 hours is time sensitive and early treatment with TPA yields better outcomes.¹

In our study, neurohospitalists achieved a significantly higher compliance rate for giving tPA within 60 minutes to a patient with ischemic stroke presenting to the ED. This strategy is recommended by AHA/ASA for at least 50% of patients with acute ischemic stroke.² As neurohospitalists do not have any outpatient responsibilities, they are more prompt and efficient in responding to ED stroke calls.⁸⁻¹⁰

Our research also suggests that neurohospitalists were more likely to be physically present in the hospital when stroke code was called as compared to nonneurohospitalists. Patients who were cared by neurohospitalists had faster tPA checklist completion times. Neurohospitalists were more likely to complete exclusion inclusion tPA checklist within 45 minutes. These findings indicate that neurohospitalists may be more efficient in utilizing “systems of care.”¹¹

Our data also showed no statistically significant differences in tPA rates (9.7% vs 7.6%, $P = .051$) and hemorrhage rates

Table 3. Neurohospitalists^a

	Neurohospitalist— Vascular Neurologist	Neurohospitalist— Nonvascular Neurologist
Total tPAs given	25	22
DNT ≤ 60 minutes, n (%)	16 (64%)	8 (36%)
Symptomatic ICH	0	1(4%)

Abbreviations: ICH, intracranial hemorrhage; tPA, tissue plasminogen activator; DNT, door-to-needle time.

^a Small sample to perform statistical analysis.

(2% vs 8%, $P = .061$) among neurohospitalists as compared to nonneurohospitalists.

Our research study is limited by a small sample size in a single institution and presence of only 2 neurohospitalists. Also, our data lacks long-term outcome data, for example Modified Rankin Scale at 3 months or 1 year. But this study provides real world estimates over a course of a 2-year period, where neurohospitalist evaluation was associated with faster DNT. This emphasizes that large tertiary care stroke centers where community neurologists are overwhelmed by outpatients and inpatient responsibilities should consider establishing neurohospitalist programs. This may be even more important as comprehensive stroke center guidelines emerge.¹² In our study, differences in DNT may be independently impacted by presence of a vascular neurologist (Table 3) as 64% of the tPAs administered by the vascular neurologist were within 60 minutes as compared to 38% by the nonvascular neurologist hospitalist. But we believe this represents a real-world scenario where nonvascular neurologists work as neurohospitalist physicians. The differences in DNT may also reflect generational gap as both neurohospitalists were less than 35 years in age and all community neurologists were more than 35 years, although only 1 community neurologist was more than 50 years of age.

To our knowledge, this is the first study providing evidence that neurohospitalists are more likely to adhere to the guideline recommended 60 minutes for administration of intravenous tPA in patients with ischemic stroke in the ED. Larger studies comparing hospitals systems with different models (neurohospitalist vs nonneurohospitalist) could be performed. If confirmed, neurohospitalist evaluation could be a part of a multipronged effort to improve the timeliness of tPA administration.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Saver JL, Levine SR. Alteplase for ischaemic stroke—much sooner is much better. *Lancet*. 2010. 375(9727):1667-1668.
2. Fonarow GC, Smith EE, Saver JL, et al. Timeliness of tissue-type plasminogen activator therapy in acute ischemic stroke: patient characteristics, hospital factors, and outcomes associated with door-to-needle times within 60 minutes. *Circulation*. 2011. 123(7):750-758.
3. William D. Freeman, Andrew Josephson S. The birth of neurohospitalists. *Neurohospitalist*. 2011;1(1):5-7.
4. Freeman, WD, Brian Dawson, Carol Raper, Kay Thiemann, Andrew Josephson S, Kevin M. Barrett. Neurohospitalists reduce length of stay for patients with ischemic stroke. *Neurohospitalist*. 2011;1(2):67-70.
5. Tissue plasminogen activator for acute ischemic stroke. The national institute of neurological disorders and stroke rt-pa stroke study group. *N Engl J Med*. 1995;333(24):1581-1587.
6. Hacke W, Kaste M, Bluhmki E, et al. Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. *N Engl J Med*. 2008;359(13):1317-1329.
7. Saver JL. Time is brain—quantified. *Stroke*. 2006;37(1):263-266.
8. Barrett KM, Freeman WD. Emerging subspecialties in neurology: Neurohospitalist. *Neurology*. 2010. 74(2):e9-e10.
9. Freeman WD, Gronseth G, Eidelman BH. Invited article: is it time for neurohospitalists? *Neurology*. 2008;70(15):1282-1288.
10. Josephson SA, Engstrom JW, Wachter RM. Neurohospitalists: an emerging model for inpatient neurological care. *Ann Neurol*. 2008;63(2):135-140.
11. Schwamm LH, Pancioli A, Acker JE 3rd, et al. Recommendations for the establishment of stroke systems of care: recommendations from the american stroke association's task force on the development of stroke systems. *Circulation*. 2005;111(8):1078-1091.
12. Leifer D, Bravata DM, Connors JJ 3rd, et al. Metrics for measuring quality of care in comprehensive stroke centers: detailed follow-up to brain attack coalition comprehensive stroke center recommendations: a statement for healthcare professionals from the american heart association/american stroke association. *Stroke*. 2011. 42(3):849-877.