# Novel Use of a Nurse-Led Telemedicine Team in Acute Stroke: A Retrospective Review of the Impact on a Regional Health Care System

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**Contribution to Emergency Nursing Practice**

- The current literature on telemedicine and specialty-trained nurses in stroke indicates that both increase timely administration of recombinant tissue plasminogen activator (rTPA).
- This article contributes to the body of knowledge about telemedicine in emergency stroke care with a focus on specialty-trained nurse stroke responders.
- Key implications for emergency nursing practice found in this article focus on collaboration among team members in the emergency department and telemedicine service.

## Abstract

**Introduction:** Despite the increasing incidence of acute ischemic stroke in the United States, many health care facilities remain unprepared to manage patients with acute stroke, including the administration of intravenous alteplase (recombinant tissue plasminogen activator [rTPA]). This has led to an opportunity for telemedicine systems to facilitate these evaluations and acute medical stroke treatment decisions. However, even telemedicine systems can fail to provide timely evaluation and management of the patient with acute stroke. The purpose of this retrospective study was to compare stroke outcome metrics pre- and postimplementation of a hybrid, local nurse-led "stroke-responder" telemedicine system.

**Methods:** A retrospective chart review was performed on 21 patients at a regional community hospital between the years of 2014 and 2016. Data were collected pre- and postimplementation of a local stroke-responder system. Outcomes obtained included door-to-alert time, door-to-computerized tomography (CT) time, door-to-rtPA order time, and door-to-rtPA bolus dose administration time. Outcomes were compared among years.

**Results:** Between 2014 and 2016, 21 charts were reviewed. Decreased mean times were observed for all metrics. The mean time for door-to-alert decreased from 21.19 to 5.84 minutes ($P = 0.021$), door-to-CT from 29.9 to 12.2 minutes ($P = 0.022$), door-to-rtPA order 88.4 to 53 minutes ($P = 0.021$), and door-to-rtPA administration from 106.94 to 64.65 minutes ($P = 0.001$).

**Conclusion:** In an acute stroke telemedicine system, implementation of a local nurse-led "stroke responder" system resulted in significantly decreased acute stroke metrics for a community hospital within a regional hospital system.

**Key words:** Stroke; Telemedicine; Tissue plasminogen activator; Computerized tomography

## Introduction

Ischemic stroke remains one of the leading causes of morbidity and mortality in the United States.[1] It is the fifth leading cause of death and the leading cause of serious long-term disability.[1] As our population ages, the incidence of ischemic stroke increases, and it is concerning that in younger age populations it appears to be increasing as well.[2]

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| **Education** | **Completion Date** | **Preceptor Initials** |
|---|---|---|
| Stroke CAI in LMS | | |
| NIH Stroke Scale training videos/certification | | |
| Stroke Responder Seminar | | |
| Clinical Practice: Shadow Jennifer &/or live training with a preceptor | | |
| **Protocols & Resources** | **Completion Date** | **Preceptor Initials** |
| Locate Stroke Protocols | | |
| Locate Neurology and Neurovascular call schedules (Amion.com & SWIFT) | | |
| Locate resource book for alerts on Neuroscience Unit | | |
| Locate resource book for alerts in Emergency Department | | |
| Differentiate between Stroke Alert 1 & Stroke Alert 2 | | |
| Locate stroke packets and tools for stroke workup (Exclusion criteria, language exam, etc.) | | |
| **Stroke Alert Level 1 (Work up for IV tPA)** | **Completion Date** | **Preceptor Initials** |
| Respond to location/video ASAP | | |
| Confirm stroke deficits and last known well (start NIHSS) during **"time out"** in ED team: EMS-MD-EDRN-Stroke Responder-Chaplin-Business Office-Lab (MD must clear patient safe for imaging before proceeding to CT) | | |
| Facilitate IV, labs, weight before/during/after CT. limit sticks 5min do not delay CT | | |
| Accompany patient and team to CT | | |
| EDMD or responder order CTA/P if NIHSS 6 or ≤6 with aphasia, vision loss, or cerebellar signs otherwise not explained within 24hr onset and POC creatinine is <3.0 (MRI can be ordered as alternative) | | |
| Notify neurology of alert and patient MR# when CT complete, if they are not present | | |
| Facilitate IVF NS@100 and observe BP <185/110 for IV tPA | | |
| Complete NIHSS if not done | | |
| Review medical history, medications, exclusion criteria, and diagnostic results | | |
| Report findings to neurology if they are not present | | |
| Telemedicine (after hrs and per Neurology request) | | |
| Communicate with pharmacy if premix is requested & when IV tPA is ordered. | | |
| Enter tPA orders ***IV Alteplase Bolus/Infusion***, facilitate pump at bedside | | |
| Complete and document RN Stroke Swallow Screen | | |
| Document Communication order if no IV tPA and document Stroke Alert SBAR | | |

FIGURE
Stroke responder competency.

Ischemic stroke is a time-critical emergency in which expert diagnosis and rapid treatment mobilization is necessary to achieve positive outcomes.[3] Recombinant tissue plasminogen activator (rtPA) is a serine protease enzyme that catalyzes the conversion of plasminogen to plasmin and thus facilitates the degradation of fibrin clots such as those involved in ischemic stroke.[4] Administered within 4.5 hours of onset of symptoms and with expert patient selection, intravenous (IV) rtPA has been shown to increase the odds of favorable outcome following ischemic stroke.

| **Stroke Alert Level 2 (Work up for Endovascular Intervention-Thrombectomy, Stenting, IA tPA)** | **Completion Date** | **Preceptor Initials** |
|---|---|---|
| Eligible for Endovascular Therapy (Neurology to determine)ED MD orders advanced imaging.<br>Onset <24 hrs, wake up stroke, unclear onset<br>NIHSS >6<br>NIHSS ≤6 with aphasia, vision loss, cerebellar signs not otherwise explained<br>CT findings (dense MCA sign)<br>Fluctuating NIHSS | | |
| Activate level 2 per Neurology order via "22" (delegate if needed) | | |
| After hours and weekends call Angio Tech on call ASAP (they have 30min to arrive) | | |
| **Stroke Level 2 from ED (Work up for Endovascular Intervention-Thrombectomy, Stenting, IA tPA)** | **Completion Date** | **Preceptor Initials** |
| Inform EDMD of Level 2, assist ED RN package patient and expedite transfer to 2B on a monitor. Chaplin assist with getting family to 2B waiting room (consent). | | |
| assist RRT/ED RN with pt upon change in condition i.e. pull meds, run for supplies | | |
| CTA/P preferred imaging unless contraindicated MRI. If patient is receiving IV tPA and needs MRI PCA tubing can be used as extension so drip can continue while in MRI. Alaris pump is NOT MRI SAFE | | |
| ED RN and responder handoff to RRT and notify Neurology to contact RRT if you have to leave to attend another stroke alert. Remain with RRT to assist if you don't have another alert until patient is moved to angio table. | | |
| **Stroke Level 2 from outside hospital** | **Completion Date** | **Preceptor Initials** |
| Obtain Report (Neurology or Transfer Center to facilitate) | | |
| Give RRT a heads up, if patient is intubated RT needs to bring a ventilator to 2B | | |
| Order MRI Brain (Stroke Alert), head and neck | | |
| Report to 2B Angio: EMS Handoff, PCC and business office ensure registration | | |
| CCM & RRT evaluate patient | | |
| Confirm stroke deficits, NIHSS | | |
| Assist with transferring to MRI monitor, transfer to MRI stretcher | | |
| Notify Neurology when MRI is complete and they will contact interventionalist | | |
| Hold patient in 2B Angio until decision is made, facilitate transfer to angio table | | |
| Complete swallow screen if procedure not completed Document Stroke SBAR and enter a stroke alert patient identifier | | |

FIGURE
(Continued).

| Treatment & Advanced Diagnostics | Completion Date | Preceptor Initials |
|---|---|---|
| **IV Alteplase (tPA)** | | |
| BP monitoring & management Pre-tPA | | |
| Body Weight in kg | | |
| Order entry | | |
| Dosing 0.9mg/kg (max dose of 90mg)<br>1. 10% given IV push<br>2. Remaining 90% dose infused as a 1hr drip MAX 90mg | | |
| Pharmacy support | | |
| IMED Pump Guardrails Level 1 | | |
| Consent | | |
| Double verification | | |
| Goal to initiate drug (Door To Needle time) | | |
| Monitoring during and after infusion | | |
| MRI extension tubing | | |
| Adverse reactions/complications | | |
| Waste protocol | | |
| Patient placement (ICUX8hrs minimum) | | |
| **CTA** | | |
| Plain CT head to r/o bleed | | |
| iSTAT creatinine ED staff (Cut off 3.0 for contrast) | | |
| Large bore IV in antecubital space for contrast | | |
| CTA resulting takes several minutes >10 | | |
| **MRI** | | |
| Unable to speak or no one to give history for metal- stat CXR and KUB | | |
| Use abbreviated screen only for stroke alert patient | | |
| **Airway** | | |
| If a stroke patient requires airway management the patient will be stabilized in ED before transfer to 2B. If status changes on 2B during level 2, RRT and CCM manage the airway before proceeding to tests or procedure. Notify neurology & interventionalist of change in pt condition if they are not present. Run for meds and equipment as needed to assist in facilitating the stroke alert process. | | |
| Telestroke/Outlying site | | |
| DPH-Polycom | | |
| South Seminole-Polycom | | |
| South Lake-In Touch | | |
| Health Central-Polycom | | |
| Winnie Palmer (WPH)<br>1. ≤23 wks gestation report to hospital until transport to ORMC arranged to facilitate labs and CT(may do CT at ORMC to prevent | | |

FIGURE
(Continued).

However, specialized stroke training is required to achieve expert patient selection, and improper selection, as well as delays in administration, can result in adverse patient outcomes.[3,5] The acute ischemic stroke patient-management timeline is therefore critical and ultimately contributes a large component to final patient outcomes. Core elements of this timeline include (1) activation of the stroke alert, (2) completion and interpretation of the noncontrasted head computerized tomography (CT) scan, (3) physician ordering of rtPA and pharmacy preparation of the medication, and (4) IV administration of the medication.

## Stroke (Nurse) Responders

In 2005, charge nurses, clinical assistant nurse managers, unit educators, and clinical nurse specialists (CNS) were trained to be stroke responders to evaluate patient eligibility for rtPA (n = 15) in the emergency department and inpatient units. Nurses completed the National Institutes of Health Stroke Scale (NIHSS) training module and attended designated classroom education programs. The CNS mentored stroke responders at the point of care when evaluating patients. Two hours of stroke-related education were required annually for all stroke responders. Over a 3.5-year period, stroke responders attended to 1,506 stroke alerts and facilitated administration of rtPA in 73 patients. Peer relationships with physicians continued to grow over the course of time. The Department of Neurology agreed to provide stroke coverage in this structure because they were comfortable with the quality of the neuroscience nurses' assessments and the continuous presence of a competent in-house responder.

Increased volume of stroke alerts necessitated stroke responders removed from staffing in 2012. Stroke responders did not serve dual roles when they were assigned this designated role during their shift. For example, they did not act as charge nurse and stroke responder at the same time.

Evaluation of patient eligibility for comprehensive interventional procedures was added to the stroke responders' responsibilities in 2013, as a result of a change in the stroke protocol. Physicians performing mechanical endovascular revascularization procedures educated the nurses on inclusion and exclusion criteria. A clinical competency was developed (Figure). Clinical assistant nurse managers and the stroke clinical coordinator train and mentor new stroke responders. Competency is maintained through practice and 8 hours of stroke-related education required annually for all stroke responders. Recertification in the NIHSS is done every 1 to 2 years.

## Telemedicine

Telemedicine provides remote consultative support via an interactive encounter including virtual examination, telemedicine assessment, and remote diagnosis and treatment decision making.[6] Telemedicine in stroke care has the been shown to increase use of rtPA and decrease delays in

TABLE 1
**Means and standard deviations**

| Outcome | Year | N | Range (minutes) | Mean | Standard deviation |
|---|---|---|---|---|---|
| Door-to-alert | 2014 | 21 | 3-96 | 21.19 | 20.26 |
| | 2015 | 16 | 1-66 | 16 | 20.27 |
| | 2016 | 19 | 1-25 | 5.84 | 6.40 |
| Door-to-CT | 2014 | 21 | 5-99 | 29.9 | 20.02 |
| | 2015 | 16 | 3-122 | 27.19 | 31.38 |
| | 2016 | 20 | 5-25 | 12.2 | 5.73 |
| Door-to-tPA order | 2014 | 20 | 40-162 | 88.40 | 33.17 |
| | 2015 | 15 | 12-126 | 71.47 | 35.33 |
| | 2016 | 20 | 36-87 | 53 | 13.54 |
| Door-to-needle | 2014 | 21 | 61-179 | 106.95 | 33.98 |
| | 2015 | 16 | 42-149 | 91.06 | 37.27 |
| | 2016 | 20 | 43-102 | 64.65 | 14.44 |

TABLE 2
**Comparative statistics (analysis of variance [ANOVA]) for 2014, 2015, and 2016**

| Outcome | F | Degrees of freedom | *P* value (significant) |
|---|---|---|---|
| Door-to-alert | 4.19 | 2 | 0.021 |
| 2014 compared with 2016 | | | 0.016 |
| Door-to-CT | 4.10 | 2 | 0.022 |
| 2014 compared with 2016 | | | 0.026 |
| Door-to-tPA order | 7.79 | 2 | 0.001 |
| 2014 compared with 2016 | | | 0.001 |
| Door-to-needle | 9.52 | 2 | 0.000 |
| 2014 compared with 2015 | | | 0.032 |
| 2014 compared with 2016 | | | 0.000 |

diagnosis and treatment.[7] Nurses with technical, clinical, and interpretative skills are key members of telemedicine stroke teams. Nurses with specialty training in stroke-evaluation protocols (National Institutes of Health Stroke Scale) have been shown to decrease times from door-to-needle administration of rtPA.[5]

In our regional health care system, before the implementation of a local nurse-led stroke-responder system, the community emergency medical provider would call an on-call specialist with a nationwide network for telemedicine stroke services. The ED personnel would then complete a questionnaire and fax the document to the network. After review by the network specialist, he or she would respond back to staff at the facility with a recommendation to administer tPA or not. Sometimes this process took up to 40 minutes. Following implementation of a stroke-responder system, local on-site nurses responded to all stroke alerts in person at the facility, performed the initial evaluations, and responded via telemedicine. The focus of the nurse responder was to assist with the neurological assessment and facilitation of the acute diagnostic and treatment processes: specifically, to perform the initial NIHSS, report this to the responding neurologist, and facilitate the administration of rtPA if ordered by the neurologist. Their overarching role is to facilitate the process to determine patient eligibility for tPA and comprehensive interventional procedures within a limited timeframe.

## Methods

Local institutional review board approval was obtained before acquisition and analysis of any patient data. One facility in our health care system was chosen for retrospective chart review. Charts were reviewed for 21 stroke patients between January 2014 and December 2016 who presented to this hospital. Inclusion criteria included presentation to the emergency department, complaints of symptoms of acute stroke, activation of a stroke alert, activation of telemedicine, and administration of rtPA. Inpatient stroke alerts were excluded. Variables measured included door-to-stroke alert time, door-to-CT time, door-to-rtPA decision time, and door-to-rtPA bolus-dose time. Discrete statistics were derived for each of these variables as shown in Table 1. A year-based, between-subjects analysis was performed via analysis of variance methods as shown in Table 2.

## Results

Twenty-one patients were included in the data analysis. Over the course of 3 years, the mean times for each metric decreased (Table 1). Specifically, the door-to-alert time decreased from 21.19 minutes to 5.84 minutes ($P = 0.021$), the door-to-CT time decreased from 29.9 minutes to 12.2 minutes ($P = 0.022$), the door-to-rtPA-order time decreased from 88.40 minutes to 53 minutes ($P = 0.001$), and the door-to-rtPA-administration time decreased from 106.95 minutes to 64.65 minutes ($P = 0.001$) (Table 2).

## Discussion

In this retrospective analysis, we observed a significant decrease across all acute stroke metrics over a 3-year period following the implementation of a hybrid stroke-responder telemedicine paradigm compared with a standard stroke telemedicine paradigm. There are several limitations and strengths of this study, the primary being the retrospective nature of the analysis and the small sample size. However, there are several unique limitations.

One confounding component of the data was that of increased staff awareness of stroke symptoms during the study period, due to local campaign efforts. This may be reflected in stroke-alert activation time, during which, statistically, there was no difference between 2014 and 2015; however, a statistically significant difference became apparent between 2014 and 2016. This number may not be due to the change in telemedicine services but rather to increased staff awareness of stroke symptoms and thus an inherently greater exposure to the patient population. The time from door-to-CT scan dramatically decreased to 12.2 minutes in 2016. However, a significant component of this decrease could have been due to fine-tuning of processes related to notification, transport, and reading of images by the radiology department. The time from door-to-rtPA order decreased by approximately 35 minutes between 2014 and 2016 and approximately 17 minutes from 2014 to 2015. Similar to the aforementioned limitations, various multidisciplinary process improvements also may have contributed to the outcomes observed.

Collaboration through telemedicine with stroke responders and staff at outlying facilities builds relationships across the organization. A team approach to delivery of efficient, effective care has been demonstrated in the stroke telemedicine program.

Strengths of the study include the novel concept of a local stroke-responder system in comparison with a traditional stroke telemedicine system and standardized and uniform data acquisition from 1 institution and multiyear follow-up.

## Implications for Emergency Nursing Practice

ED nurses care for acute stroke patients in collaboration with the ED team, radiology staff, neurologists, and nurse stroke responders. This interaction may take place through a telemedicine system. Specialty-trained nursing

staff and neurologists in stroke assessment and management provide support and guidance to the ED team, especially for acute interventions such as administration of rTPA. Emergency nursing practice for patients with acute stroke is enhanced with the use of telemedicine and experts.

## Summary

This study suggests that the presence of local, specialty-trained nursing staff can improve standard ischemic stroke metrics in an acute ischemic stroke telemedicine system and that future study is warranted in this area.

REFERENCES

1. American Heart Association/American Stroke Association. Heart Disease and Stroke Statistics 2017At-aGlance. Retrieved February 15, 2018 from http://www.heart.org/idc/groups/ahamah-public/@wcm/@sop/@smd/documents/downloadable/ucm_491265.pdf.
2. Yannick B, Benoit D, Maurice G. Rising stroke incidence in young adults: More epidemiological evidence, more questions to be answered. *J.Am Heart Assoc*. 2016;5, e003661.
3. Leira C, Ahmed A. Development of an emergency department response to acute stroke ("code stroke"). *Curr Neurol Neurosci Rep*. 2009;9:35-40.
4. Wardlaw JM, Murray V, Berge E, et al. Recombinant tissue plasminogen activator for acute ischaemic stroke: an updated systematic review and meta-analysis. *Lancet*. 2012;379(9834):2364-2372. https://doi.org/10.1016/S0140-6736(12)60738-7.
5. Mainlan S, Stutzman S, Sengupta S, et al. Feasibility and efficacy of nurse-driven acute stroke care. *J Stroke Cerebrovasc Dis*. 2017;26:987-991.
6. Demaerschalk BM, Berg J, Chong BW, et al. American telemedicine association: Telestroke guidelines. *Telemed e-Health*. 2017;23:376-389.
7. Gibson J, Fitzgerald J, Gibson A, et al. Using telemedicine for acute stroke assessment. *Nurs Times*. 2013;109:14-16.