A call for formal telemedicine training during stroke fellowship

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ABSTRACT

During the 20 years since US Food and Drug Administration approval of IV tissue plasminogen activator for acute ischemic stroke, vascular neurology consultation via telemedicine has contributed to an increased frequency of IV tissue plasminogen activator administration and broadened geographic access to the drug. Nevertheless, a growing demand for acute stroke coverage persists, with the greatest disparity found in rural communities underserved by neurologists. To provide efficient and consistent acute care, formal training in telemedicine during neurovascular fellowship is warranted. Herein, we describe our experiences incorporating telestroke into the vascular neurology fellowship curriculum and propose recommendations on integrating formal telemedicine training into the Accreditation Council for Graduate Medical Education vascular neurology fellowship. **Neurology® 2016;86:1827-1833**

GLOSSARY

ACGME = Accreditation Council for Graduate Medical Education; **AIS** = acute ischemic stroke; **CSC** = comprehensive stroke center; **EMTALA** = Emergency Medical Treatment and Labor Act; **NIHSS** = NIH Stroke Scale; **tPA** = tissue plasminogen activator.

ADDRESSING THE GAPS IN ACUTE STROKE CARE WITH TELEMEDICINE Ten years after the 1996 US Food and Drug Administration approval of IV tissue plasminogen activator (tPA) for acute ischemic stroke (AIS), only 2% of all AIS cases and approximately 50% of eligible patients received the drug.^{1,2} Several barriers were identified at that time, including physician uncertainty in diagnosing AIS, unfamiliarity with tPA contraindications, and general hesitation in tPA administration.^{1,3} Telemedicine, a telecommunication model in which a regional stroke center (“hub”) provides a 2-way audio-visual consultancy role to outside hospitals (“spokes”), has addressed many of these barriers.

The rate of IV tPA use for AIS has nearly doubled since the early 2000s.^{4,5} One major driver is undoubtedly the increasing utility and expansion of telemedicine programs. Telestroke has increased the frequency of IV tPA administration and broadened geographic access to the drug.⁶⁻⁹ Providing vascular neurology consultation via telemedicine has increased IV tPA rates in several community hospitals lacking prior stroke specialist coverage.¹⁰⁻¹² Several community hospitals may have never used IV tPA for ischemic stroke before joining a telemedicine network.^{6,7,13}

Managing patients with AIS using the guidance of telemedicine consultation is safe and reliable.¹⁴⁻¹⁶ Several telemedicine programs have reported comparable functional outcome and mortality rates between telemedicine-guided tPA administration at community hospitals and tPA treatment at stroke centers.^{16,17} The TEMPiS group in Bavaria, Germany, found that community hospitals with support from a telemedicine network had a decreased chance of poor outcomes (including death, discharge to institutional care, and disability) when compared to matched community hospitals outside of a telemedicine network.¹⁸ The “drip-and-ship” pathway, in which patients are treated with IV tPA at spoke hospitals via telemedicine and then transferred to a stroke center, has also been shown to have comparable safety and outcomes with patients treated with IV tPA at stroke centers.^{19,20} Establishment of hub-and-spoke networks appears to be cost-effective for community hospitals, based on a 5-year model developed in 2013.²¹

However, telestroke services must expand to meet the growing need for stroke care in the United States. Not only are there a limited number of neurologists available to cover nearly 800,000 stroke cases per year, but also neurologists are increasingly declining to provide acute stroke care.^{22,23} Considering the aging population, and that the incidence of stroke is projected to more than double by 2050, the potential lack of access to acute

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stroke care in the United States is alarming.^{22,23} Rural populations are at the greatest risk of gaps in care: stroke patients presenting to rural hospitals are an estimated 10 times less likely to receive IV tPA than those who present to urban hospitals.²⁴ In Texas, a state with one of the largest rural populations, telemedicine has significantly increased access to acute stroke care; however, 16% of Texans remain more than 60 minutes away from facilities capable of providing acute stroke care.²⁵ To address the limited access to vascular neurology expertise in underserved hospitals, the American Heart Association/American Stroke Association now formally recommends telestroke consultation.²⁶ Pending legislation at the state and national levels also supports telemedicine services and seeks to address various issues, such as licensure, portability, and reimbursement.^{27,28}

At our center, telestroke services were initiated in 2003. Since then, the telemedicine program has grown to provide full-time acute stroke care coverage to 16 spoke sites, averaging a total of 1,500 consults and approximately 250 tPA cases per year. Given the increasing case volumes, the program has expanded to 2 full-time faculty members committed to telestroke and has developed a dedicated call schedule involving vascular neurology attendings and vascular neurology fellows supervised by an attending.

Despite the increasing demand for telestroke coverage across the United States, there are actually no formal training programs, curricula, or milestones to address how to evaluate and manage acute stroke consultations via telemedicine. Responsible health care delivery obligates physicians to be appropriately trained in telemedicine to meet this growing need. Managing acute stroke patients via telemedicine requires familiarity with the capabilities and the limitations of telemedicine equipment, maneuvering the equipment remotely, and proceeding in cases of technical shortcomings in order to continue rapid assessment and treatment. There are also differences in reviewing imaging remotely. Evaluating acute stroke patients via telemedicine requires efficient communication with spoke staff as well as the patient and their family. Discussing risks and benefits of IV tPA with patients and families effectively yet compassionately on telemedicine devices is different than in person. Correspondence with spoke physicians regarding the assessment and treatment plan is an important skill. Potential drip-and-ship pathways are different for each patient depending on neurology coverage at the spoke hospital. Identification and transfer of potential endovascular candidates rely heavily on the ability to expeditiously acquire information remotely including timing of presentation, stroke severity, vessel imaging capability, and estimated transfer time. They also require efficient communication between the spoke hospital and the hub vascular and

endovascular teams. As changes in the complexity in the field of stroke continue, it is important to assure consistency in patient care via telemedicine. In our opinion, delivery of acute stroke care via telemedicine would improve with formal training.

FORMAL TELESTROKE TRAINING IN NEUROVASCULAR FELLOWSHIP IS FEASIBLE

Incorporating telemedicine into vascular neurology fellowship is one way to address the growing demands for telestroke coverage. In 2007, our program recognized this potential and fellows began seeing stroke patients via telemedicine. Initially, patients were evaluated at only one spoke hospital remotely using a stationary device located in the emergency department as part of the fellows' acute care rotation. With time, telemedicine became a separate rotation and fellows could complete consultations on their portable computers. At present, the vascular neurology fellowship at the McGovern Medical School at the University of Texas Health Sciences Center at Houston has incorporated a formal telestroke rotation comprising 8 weeks minimum per year, which does not detract from Accreditation Council for Graduate Medical Education (ACGME) clinical requirements. When fellows start the credentialing process a few months before their start date, they can acquire training in telemedicine throughout the entire 12 months of a 1-year fellowship. In our network, most spoke sites allow fellows to participate in telemedicine if they have a physician-in-training permit. For the remaining sites, a second-year fellow or faculty member with a permanent license covers telemedicine consults. Fellows undergo orientation to the telemedicine network as well as the telehealth platform and documentation system required to complete a telemedicine consultation. Before evaluating patients on their own, fellows shadow stroke attendings for several consultations. When fellows start to see patients independently during the telemedicine rotation, supervision is available by the telemedicine program director and manager, as well as other stroke faculty as needed. In addition, because of a growing number of cases (an average of 33 consults per week in 2014), telestroke has been formally incorporated into didactics, with a case conference once per month dedicated to the topic.

Seven years since first integrating telemedicine into the stroke fellowship curriculum at the McGovern Medical School at The University of Texas Health Sciences Center at Houston, graduates of the vascular neurology program were surveyed regarding their exposure to telemedicine as fellows and how such training has affected their current practice (table 1). Of 21 graduates in the last 10 years who responded to the survey, 90% had telemedicine exposure during fellowship, and 62% use telemedicine in their current

Table 1 Telemedicine survey for former neurovascular fellows

Survey questions	
Did you perform telemedicine consultation during your neurovascular fellowship? (n = 21)	90 (19/2)
Are you currently performing telemedicine consultation in your current practice? (n = 21)	62 (13/8)
Do you think a telemedicine rotation should be necessary for 1-y ACGME neurovascular fellowship training? (n = 21)	81 (17/4)
How many weeks would you recommend for the formalized telemedicine rotation? (n = 21)	3-4 wk: 71 (15/6); >4 wk: 29 (6/15)
In your opinion, how many teleconsultations, if any, does it take to become proficient in telemedicine? (n = 21)	1-30: 71 (15/6); 31-60: 29 (6/15)
Were you involved in starting a telemedicine program at your current practice? (n = 13)	46 (6/13)
5-Point scale questions	
Telemedicine improves access to acute stroke care in your region of practice (n = 20)	4.7 ± 0.5
I felt proficient in performing telemedicine consultations after my neurovascular fellowship (n = 19)	4.7 ± 0.6
Telemedicine experience during neurovascular fellowship was useful in regard to your current practice (n = 17)	4.4 ± 1.1
Telemedicine should be a part of the ACGME requirement for neurovascular fellowship training (n = 21)	4.0 ± 1.0
Telemedicine expands your expertise as a stroke neurologist (n = 21)	4.3 ± 1.0

Abbreviation: ACGME = Accreditation Council for Graduate Medical Education.
Data represent % (yes/no) or mean ± SD.

practice. Those who did not have telemedicine exposure during fellowship stated that they wish they had prior telemedicine training. Prior fellows strongly agreed that telemedicine has improved access to AIS care in their current region of practice. Graduates reported that exposure to telemedicine as fellows led to proficiency in performing telemedicine consultations. Eighty-one percent of prior fellows agreed that telemedicine should be a requirement in a 1-year ACGME-accredited vascular neurology fellowship, including the respondents who did not have telemedicine exposure during fellowship. Regarding the extent of necessary training, 71% of former fellows recommended at least 3 to 4 weeks of a formal telemedicine rotation. Seventy-one percent of fellows felt proficient after 1 to 30 teleconsultations, and 29% felt that a range of 31 to 60 teleconsultations during training was required for proficiency. That 6 of 21 former fellows reported having started a telemedicine program at their current location of practice illustrates the influence of incorporating telemedicine exposure into a vascular neurology fellowship.²⁹

We have investigated the safety of fellows administering IV tPA via telemedicine consultation. In a retrospective chart review of approximately 1 year of telemedicine consultations at University of Texas Houston, neurovascular fellows advised tPA administration in about 35% of 137 acute stroke cases (table 2). There was no significant difference in outcomes between neurovascular fellows and neurovascular attendings (including the following rates: symptomatic intracranial hemorrhage, $p = 1.00$; neuroworsening—defined as increased NIH Stroke Scale [NIHSS] score of ≥ 2 points from any cause, $p = 1.00$; angioedema, p value not reportable; and death, p value not reportable). It was noted, however, that fellows took a

median of 12.5 minutes longer between symptom onset and tPA administration compared to attendings (145.0 vs 132.5 minutes, $p = 0.05$). While this time difference did not result in worse outcomes, it does suggest a measurable difference in experience administering tPA via telemedicine between fellows and attendings.³⁰

While many academic stroke programs offer telemedicine services, not all ACGME accredited vascular neurology fellowships have formally embedded telemedicine into their curriculum, particularly at institutions with smaller stroke programs. However, telemedicine services are increasing, community hospitals are embracing telemedicine to a greater extent, and we believe even smaller programs will need to adapt to the changing health care delivery systems. There is such an increasing need for coverage that academic programs, large and small, can contribute. Consequently, we have observed anecdotally that the number of smaller programs developing a telemedicine network is increasing. In the meantime, fellows at institutions that have not yet established a telestroke network could pursue a specific rotation at programs that do have telemedicine training, akin to neurology residents pursuing an away rotation at another institution or stroke fellows pursuing focused training in neurosonology at another program. The Interstate Medical Licensure Compact, approved in several states and introduced in several others, might allow fellows with a principal license to participate in telemedicine at sites outside of their training state.²⁸ Even for fellowship programs with telemedicine experience, however, there is not a standardized or consistent methodology for training and evaluating competency of fellows in telestroke. With other clinical aspects of stroke care, there are evaluations and

Table 2 Comparison of baseline characteristics and outcomes in patients treated with IV tissue plasminogen activator by fellows and by attendings

Variable	Fellow (n = 48)	Attending (n = 89)	p Value
Baseline characteristics			
Age, y, mean $\pm$ SD	65.5 $\pm$ 13.9	65.9 $\pm$ 14.6	0.89 ^a
Sex, n (%)			0.92 ^b
Male	22 (45.8)	40 (44.9)	
Female	26 (54.2)	49 (55.1)	
NIHSS score on arrival, median (Q1–Q3)	6 (4–14)	8 (5–12)	0.28 ^c
Outcomes			
Symptomatic hemorrhage, n (%)	1 (2.1)	1 (1.1)	1.0 ^d
Hemorrhagic transformation, n (%)	1 (2.1)	4 (4.5)	0.66 ^d
Other hemorrhagic complication, n (%)	3 (6.3)	0 (0)	NR
Neurologic worsening, n (%)	3 (6.3)	6 (6.7)	1.0 ^d
Angioedema, n (%)	0 (0)	1 (1.1)	NR
Death, n (%)	0 (0)	4 (4.5)	NR
Onset to needle times, min, median (Q1–Q3)	n = 43, 145 (123–192)	n = 88, 132.5 (103–168.5)	0.05 ^c
Door to needle times, min, median (Q1–Q3)	n = 39, 82 (56–77)	n = 86, 69.5 (54–92)	0.41 ^c

Abbreviations: NIHSS = NIH Stroke Scale; NR = not reported because of zero cells; Q = quartile.

^aDenotes p values obtained by 2-sample t test.

^bDenotes p values obtained by χ^2 test.

^cDenotes p values obtained by Wilcoxon rank sum test.

^dDenotes p values obtained by Fisher exact test.

milestones. Thus, what would a formal and organized training format for telestroke involve, and what is the appropriate level of supervision?

AN APPROACH TO FORMAL TELESTROKE TRAINING

We propose that fellows receive a formal orientation on the format of their program's telemedicine network and hands-on orientation maneuvering the equipment necessary for telemedicine consultation and documentation. Fellows should shadow a recommended 3 to 5 consultations with an attending before seeing their own consultations, depending on the individual fellow's level of comfort. An attending should precept a minimum of 10 cases. In general, some fellowships require discussion with a stroke attending before treatment with IV tPA and some do not, both of which could be applicable for telemedicine cases. However, in cases that fellows find straightforward, precepting cases with an attending should not delay treatment. Cases can be supervised via 3-way telemedicine viewing depending on the technical capabilities, training philosophy, and available faculty of the program. Based on feedback from our former fellows, we suggest fellows complete at least 30 acute stroke consultations during training, with supervision as needed, including cases involving IV tPA administration and cases requiring identification of patients for transfer to a comprehensive stroke center (CSC) for endovascular therapy. For all

telemedicine cases, attendings should be readily available for any questions fellows may have, just as they are for cases in clinic and in the in-hospital setting.

A formal evaluation of fellows should address the following:

- Technical aspects: Is the fellow able to zoom in and out? To change the field of view? To move robot (when applicable)? To identify connection issues and know whom and when to call for technical help if needed?
- History-taking: Is the fellow able to obtain an adequate yet efficient history to make acute therapy decisions (e.g., relative and absolute contraindications to IV tPA, tPA treatment "window," pertinent vital signs, and labs)?
- Imagery: Is the fellow able to review imaging remotely and sufficiently to make acute therapy decisions? To identify early ischemic changes? To identify other acute stroke findings (e.g., hyperdense sign, hemorrhage)?
- Complicated cases: Does the fellow know what to do in complicated situations such as recent myocardial infarction, or hemorrhagic or ischemic stroke?
- Examination of patient: Is the fellow able to obtain an adequate, quick, and reliable neurologic and stroke examination? To communicate with nursing how to perform complex parts of the NIHSS such as visual fields and extinction?

- Communication with spoke staff: Is the fellow able to communicate with spoke nursing the urgency of any steps during a code stroke? To communicate the plan effectively? To assist in expediting treatment as much as possible (e.g., calculate tPA dosing)?
- Identification of endovascular candidates: Is the fellow able to identify patients who may be eligible for endovascular therapy? To assimilate important factors for potential transfer to hub/CSC including Emergency Medical Treatment and Labor Act (EMTALA) rules, communication with hub/CSC and transfer center? Does the fellow understand and maneuver well within the complexity of the transfer process?
- Communication with spoke physician: Is the fellow able to discuss pertinent findings and the proposed plan with the spoke physician?
- Communication with patient and family: Is the fellow able to clearly discuss the clinical assessment and plan with the patient and family? To obtain consent in a thorough but concise manner?
- Professionalism: Does the fellow develop good rapport with the spoke physician and staff, as well as patient and family?

As competency milestones are integrated into vascular neurology fellowship evaluations, we propose these potential markers for progress in telestroke training:

- Level 1: Performs a complete, organized, and relevant history and examination. Manages acute stroke patients and any acute risk factors remotely via robot.
- Level 2: Performs an efficient, complete, and relevant history and examination. Manages acute stroke patients remotely and identifies potential surgical or endovascular candidates. Identifies patients at high risk of intracranial hemorrhage. Identifies and addresses technical issues, and calls for assistance appropriately.
- Level 3: Performs complete history and examination and incorporates relevant aspects needed to make treatment decisions. Manages acute stroke efficiently via robot and without unnecessary delay. Identifies and facilitates transfer as needed. Communicates efficiently with spoke hospital physicians and staff.
- Level 4: Proficiently obtains history and examination remotely without delay. Efficiently treats and manages acute stroke remotely with the assistance as needed from spoke staff. Discusses case with spoke staff and physician; with patient and family, assessment and plan. Identifies patients who require transfer for higher

level of care, surgical or endovascular procedures, and facilitates transfer with hub team and through transfer center. Demonstrates fluency with EMTALA rules. Displays high level of professionalism in all communications.

- Level 5: Serves as a role model for other trainees in performing telemedicine consultation including efficiently obtaining relevant history and examination, treating AIS and acute risk factors, post-tPA triaging for surgical/endovascular procedures, efficiently coordinating transfers as necessary.

Training milestones for telestroke will likely need to adjust as the field of telestroke evolves. Mobile telemedicine, a prehospital model in which telestroke consultation takes place in the ambulance en route to the emergency department, seeks to identify and triage AIS patients rapidly with the goal of decreasing onset to treatment times. In AIS simulation scenarios, mobile telemedicine has been shown to be both feasible and reliable, with good interrater reliability.^{31,32} Moreover, one pilot study on mobile telestroke found that the NIHSS correlation increased over the course of the study period.³² This finding supports a role for training physicians to evaluate patients via mobile telestroke. Likely, there are aspects unique to evaluating patients via mobile telestroke, compared to conventional methods of telestroke. Formal telestroke training will need to adapt as new avenues for telemedicine consultation arise, just as stroke fellowship training has adapted to the evolving standards of AIS care and poststroke management and evaluation.

The importance of telemedicine training is not limited to stroke, or fellowship. As addressed in the 2013 report from the Telemedicine Work Group of the American Academy of Neurology, more neurology subspecialties have increasingly integrated telemedicine into patient care. Subspecialties have included epilepsy, movement disorders, rehabilitation medicine, and general neurology. The American Academy of Neurology has officially made a statement calling for the use of teleneurology to provide coverage to hospitals without dedicated neurologists. Formal training in telemedicine may benefit not only neurovascular fellows, but also neurology residents, as programs prepare trainees to pursue a field with a long-standing history of physician shortage.³³ Although neurologists have been providing remote specialist patient care for years without formal training, new trainees will need to benefit from the experience of their seniors as they face an increasing demand for teleneurology upon graduation. Formal teleneurology training would help prepare residents for already existing teleconsultation programs such as Specialists On Call, which seek to provide specialist

coverage remotely to hospitals that do not have on-site neurology support.

There is an increasing incidence of acute stroke and a growing need for coverage in areas underserved by vascular neurology, both of which can be addressed with new and expanding telestroke programs. With the increasing demands for vascular neurology coverage and the increasing complexity of treatment options, formal telestroke training in neurovascular fellowship can address the intricacies of evaluating and managing patients remotely. With such training, those of us in the field have the potential to exponentially increase our patient catchment and fill in the daunting gaps in acute stroke coverage. We therefore recommend an approach to formally incorporate telestroke training into ACGME fellowship programs. Training programs will need guidance on offering consistent, high-quality telestroke curricula. An accreditation committee is needed to develop standards of training.

Comment: Telemedicine training during stroke fellowship

In 2009, the American Heart Association recommended the implementation of telemedicine within stroke systems of care.¹ Telestroke services have expanded throughout the United States, and have led to improvements in access to care, recombinant tissue plasminogen activator utilization, and cost-effectiveness. Medical trainees must be educated to utilize these new technologies and health care delivery models. There is limited information on the training of telemedicine providers and what education is necessary. A recent article recommended telemedicine-related enhancements to Accreditation Council for Graduate Medical Education (ACGME) Core Competencies.²

Jagolino et al.³ describe the integration of telestroke services into the curriculum of a vascular neurology (VN) fellowship program. The authors provide evidence of a growing need for telestroke services, address the lack of formal training in the field, and discuss the skills required to provide these services. They describe the feasibility of training and discuss the impact on stroke patients and recent graduates. They propose an educational model with associated ACGME VN milestones that could be incorporated into existing VN fellowship programs. The challenges to incorporating telestroke training into an ACGME VN fellowship program include access, licensure, and an effective educational program. It is unclear how many ACGME VN fellowships have access to telestroke services or could provide this training. Licensure and credentialing of VN fellows within networks may take several months and could affect training. An educational model with measurable learning objectives that address the competencies required to provide telestroke services would also be needed.

Telestroke services will likely expand in the future to address the projected undersupply of neurologists and burden of stroke. We need to prepare our trainees for a changing health care system, including telemedicine. Residency and fellowship programs must continuously update their curricula to address new technologies and changes in health care delivery.²

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Dr. Amanda L. Jagolino contributed to the design and conceptualization of the manuscript, interpretation of the data, and drafting/revising the manuscript for intellectual content. Dr. Judy Jia contributed to the design and conceptualization of the manuscript, analysis and interpretation of the data, and drafting/revising the manuscript for intellectual content. Dr. Kasey Gildersleeve contributed to the design and conceptualization of the manuscript, interpretation of the data, and drafting/revising the manuscript for intellectual content. Christy Ankrom contributed to the design and conceptualization of the manuscript, and drafting/revising the manuscript for intellectual content. Dr. Chunyan Cai contributed to the analysis and interpretation of the data. Dr. Mohammad Rahbar contributed to the analysis and interpretation of the data. Dr. Sean I. Savitz contributed to the design and conceptualization of the manuscript, analysis and interpretation of the data, and drafting/revising the manuscript for intellectual content. Dr. Tzu-Ching Wu contributed to the design and conceptualization of the manuscript, analysis and interpretation of the data, and drafting/revising the manuscript for intellectual content.

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