Telestroke Assessment on the Move
Prehospital Streamlining of Patient Pathways

Leila Eadie, PhD; Luke Regan, FCEM, DRTM; Alasdair Mort, PhD; Helen Shannon, MBChB, DMRD(Ed); Jason Walker, MBChB, BSc(Hons); Ashish MacAden, MD, DNB, PhD; Philip Wilson, DPhil, FRCGP

Thrombolysis as a treatment for ischemic stroke is only indicated within the first 3 to 4.5 hours after onset of symptoms, and is more efficacious the earlier it is given.1,2 Patients must thus seek help, receive a clinical diagnosis, and reach a center of care for imaging and treatment without delay.

The Problem
This is a problem in remote and rural areas, leading to a relative disadvantage for rural dwellers: symptom-to-needle time is nevertheless often too long even for people in major urban centers. In the Scottish Highlands, for example, the total amount of time taken from calling for help, transfer to the nearest diagnostic center, undergoing computed tomography scanning to exclude contraindications to thrombolysis treatment, and then receiving thrombolysis often exceeds the 4.5-hour limit.3 The ambulance service reports that the more rural the patient’s location, the longer their response time is likely to be, reflecting the geography and road network as well as the limited number of vehicles.4 Even among patients with stroke in the Highlands who make it to hospital within the 4.5-hour thrombolysis window, mean times from onset to thrombolysis range from 130 to 210 minutes at the various hospitals audited, and <8% of patients with stroke actually receive the treatment at all.5

Scotland has a telestroke program run by the Scottish Center for Telehealth and Telecare, featuring 5 networks around the country.6 They use videoconferencing from the acute hospital site where local physicians can discuss their patients with specialists many miles away. This service has been running successfully since 2008, and thus the idea of using communications technology in stroke assessment is already in place and being successfully used. However, this service is hospital-based, providing support to smaller institutions rather than in prehospital situations.

Initial code stroke systems were set up within hospitals to organize multidisciplinary rapid–response teams and to expedite diagnosis and treatment in stroke, and these proved successful at reducing time to treatment.7–10 This idea then moved into the prehospital sphere, with paramedics alerting hospitals when they encountered suspected acute stroke,11 and further studies included expert sign-off before a code stroke was activated, to help reduce false-positive cases.12 In the past year, initial feasibility studies have appeared building on the work of the TeleBAT system,13 looking at the use of telemedicine systems in real-time prehospital stroke assessment,14,15 but these have been based in urban areas, using telecommunications networks which generally provide good area coverage. In remote and rural areas, not only are patients subject to lengthy transport times but there is also frequently poor cellular network coverage— with 38% receiving no 2G signal reception and 70% no 3G signal16—which is likely to hamper mobile telemedicine-facilitated assessment.

A Solution
A mobile acute telestroke assessment service could provide crucial information about patients with a suspected stroke while they are being transported to hospital by ambulance. This could allow them to bypass the emergency department and go straight to computed tomography to ensure thrombolysis treatment is appropriate and, if indicated, administered rapidly. This novel audio–visual assessment performed en route could help streamline the patient’s pathway and reduce treatment delays.

This article reports the results of our study investigating the feasibility of mobile telestroke assessment while in transit around the notoriously cellular signal-poor Scottish Highlands.

Methods
Participants were 12 healthy volunteers who took on the role of a patient or responding paramedic, using a script providing details about the suspected stroke patient’s condition. The scripts were chosen at random from a pool describing people with thrombolysable stroke, those with contraindications to thrombolysis, and those with a non-stroke condition (eg, epilepsy and risk of noncompressible hemorrhage). Four experts took part as assessors, following the telestroke checklist prepared by NHS Highland stroke specialists, which incorporates the Recognition of Stroke in the Emergency Room Score, exclusion criteria for thrombolysis, Modified Rankin Scale, and National...
Results

Nineteen mobile and 4 stationary telestroke assessments were completed. None were abandoned because of connectivity or other technical problems and all were correctly categorized as potentially thrombolysable or not. The mean time to reach a conclusion about whether the simulated patient was a candidate for thrombolysis was 11.1±8.7 (1–31) minutes for mobile assessments compared with 9.8±4.9 (4–16) minutes for stationary assessments. Both types of assessment received high ratings when asked whether the A V system allowed adequate diagnosis.

It should be noted that the overall duration of interview and assessment required for the nonthrombolysable scripts was less because of the ability to terminate the checklist at the point when a simulated patient was judged to have a contraindication.

There were occasional breaks or freezes in the transmission (experienced in 47% of the tests), but connection was re-established quickly and only minor delays (eg, several trials reported delays of 2–3 minutes in total during the assessment) were reported. Connectivity data rates ranged from 22 to 1900 kilobits per second (Kbps), with a mean of ≈1250 Kbps. Higher rated AV quality (rated 4/5 or 5/5) was associated with a higher mean upload rate (1021 Kbps, range: 336–839), compared with AV rated 1/5 or 2/5 (553 Kbps, range: 447–1657).

The latency of the transmission was low, at a mean of 300 ms, and this was not considered to be a limitation by the participants at both ends of the communication.

Conclusions

These initial tests have shown that it is feasible to perform telestroke assessments while mobile in rural areas, a service that could be applied when transporting patients the often long distances to hospital. The transmission of live AV feeds in real time to hospital-based experts provided adequate information for a patient to be designated as a candidate for thrombolysis—or not—and this information could help accelerate their path to appropriate treatment on arrival at a center of care. This assessment, because it was done in transit, added no additional time to the patient’s transfer and meant that the usual stationary assessments by paramedics at the scene, on arrival at the hospital, and in the ward or pre-computed tomography scanning were not required. This service could readily be incorporated into stroke care pathways in both rural and urban areas, saving time and potentially improving outcomes by reducing the time to treatment.

AV transmission was performed successfully despite greatly varying levels of connectivity as the vehicle passed in and out of cellular signal areas. The Omni-Hub system is also able to connect to satellite networks in the event of cellular networks being totally unavailable.

| Table 1. Times to Diagnostic Assessment for the Mobile and Static Telestroke Assessments |
|---------------------------------------------|----------------|----------------|
| Time to Diagnostic Assessment              | Mobile         | Stationary     |
| (minutes): Mean±SD (Range)                 | (n=19)         | (n=4)          |
| All assessments                            | 11.1±8.7 (1–31)| 9.8±4.9 (4–16) |
| Thrombolysable scripts                     | 15.0±9.7 (8–31)| 12.5±4.9 (9–16)|
| Nonthrombolysable scripts                  | 8.7±7.5 (1–27) | 7.0±4.2 (4–10) |

| Table 2. Ratings of the Communications Connection for the Mobile and Static Telestroke Assessments by Expert Telestroke Assessors |
|----------------------------------------------------------|----------------|---------------|
| Rating (Range; Scale: 1=Worst; 5=Best)                  | Mobile         | Stationary    |
| (n=19)                                                   | (n=4)          |
| Rating of whether AV allowed adequate diagnosis          | 5 (1–5)        | 5 (5–5)       |
| Rating of AV quality                                     | 3 (1–5)        | 5 (4–5)       |

AV indicates audio and video.
These results compare favorably to Liman et al’s study investigating telestroke ambulances in Berlin, in which over half of the scenarios could not be completed because of technical problems involving poor quality, loss, or absence of AV signal. Similarly, Wu et al’s reported a success rate of 85% without technical complications when performing National Institutes of Health Stroke Scale assessments. This study, performed in rural areas of the Scottish Highlands and including not only the National Institutes of Health Stroke Scale assessment but also the Recognition of Stroke in the Emergency Room Score, Modified Rankin Scale and thrombolysis exclusion criteria, achieved a determination of eligibility for thrombolysis in an average of 11 minutes, which could save considerable time by bypassing these initial checks on arrival at hospital.

Although this enhanced communications system (which also incorporates a portable ultrasound machine) is currently experimental only, to equip an ambulance would cost somewhere in the region of £30K–45K ($48K–72K; €38K–57K), depending on the ultrasound machine chosen. It would require ambulance service approvals to ensure compatibility with operational and power supply factors. The Omni-Hub is of a similar size to a laptop computer, with small dome-shaped aeros that are fitted to the vehicle roof, and portable ultrasound scanners are now little bigger than briefcases. The addition of this equipment to an ambulance would therefore not affect its general usability, but could offer possibilities of remote support for many emergency situations.

Limitations of the study include the use of healthy volunteers to simulate patients: ideally the system should be tested with real patients and their responses to the telestroke checklist, and this would be the next step for the project. The study was not powered for statistical analysis, and so the conclusions reported may be at risk of type I error.

In conclusion, this report shows that a remotely performed full assessment for thrombolysis for stroke is possible from a moving vehicle even in the variable connectivity of rural areas of the Scottish Highlands, and could be incorporated into systems of stroke care.

Acknowledgments

The Satellite Ultrasound for Rural Stroke team thanks all of our volunteers and our telestroke reviewers Laura Nicol and Farihah Tariq for their time and efforts during this study.

Sources of Funding

This project was funded by Highlands and Islands Enterprise; The UK Space and Life Sciences Catapult; dot.rural (The University of Aberdeen’s rural Digital Economy Hub, funded by Research Councils UK); and TAQA Bratani.

Disclosures

None.

References


Key Words: acute ◆ clinical pathways ◆ prehospital emergency care ◆ stroke ◆ transmission ◆ videoconferencing
Telestroke Assessment on the Move: Prehospital Streamlining of Patient Pathways

Stroke. 2015;46:e38-e40; originally published online December 30, 2014;
doi: 10.1161/STROKEAHA.114.007475
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2014 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/46/2/e38

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/