REACH
Clinical Feasibility of a Rural Telestroke Network

David C. Hess, MD; Samuel Wang, MS; William Hamilton, MBA, MHA; Sung Lee, MD; Carol Pardue, RN, MSN; Jennifer L. Waller, PhD; Hartmut Gross, MD; Fenwick Nichols, MD; Christiana Hall, MD; Robert J. Adams, MD

Background and Purpose—Development of stroke networks is critical to bringing guideline-driven stroke care to rural, underserved areas.

Methods—A Web-based telestroke tool, REACH, was developed to provide a foundation for a rural stroke network that delivered acute stroke consults 24 hours per day 7 days per week to 8 rural community hospitals in Georgia.

Results—There were 194 acute stroke consults delivered. Thirty patients were treated with tissue plasminogen activator (tPA). The mean National Institutes of Health Stroke Score (NIHSS) was 15.4, and the median NIHSS was 12.5. The mean onset to treatment time (OTT) was 122 minutes. The OTT dropped from 143 minutes in the first 10 patients treated to 111 minutes in last 20 patients. Of the 30 patients treated with tPA, 23% (7) were treated in ≤90 minutes and 60% (18) were treated within 2 hours. There were no symptomatic intracerebral hemorrhages.

Conclusions—The REACH telestroke system permits the rapid and safe use of tPA in rural community hospitals. Over time, the system became more efficient and OTT decreased. (Stroke. 2005;36:2018-2020.)

Key Words: tissue plasminogen activator ▪ stroke, acute ▪ stroke, ischemic ▪ telemedicine

In rural communities, stroke care often does not adhere to published guidelines, and the use of tissue plasminogen activator (tPA) for stroke is infrequent.1 Poor compliance with tPA treatment guidelines can lead to high rates of symptomatic intracranial hemorrhage and complications.2 Telemedicine, including telephone use, has been used to increase tPA administration rates.3–9 However, the lack of reliable information from the remote site has prevented many stroke specialists from advising tPA treatment over the telephone. Transfer of patients to regional hospitals by helicopter and ground transportation is an option, but critical time can be lost in the transfer process.10 Recent analyses show that the shorter the onset to treatment time (OTT), the better the functional outcome.11

Stroke care is often fragmented in the United States, and there is an urgent need to develop systems of stroke care.12 In rural Georgia, we developed a low-cost telestroke tool that enables a stroke specialist to review patient video, perform an NIHSS, review the computed tomography (CT) scans in real time, interact with local Emergency department (ED) staff with a graphical interface, and to make a recommendation on tPA use via any broadband-connected workstation. This system called REACH has permitted the use of tPA in rural community hospitals where tPA was not used previously.3,13 In this report, we demonstrate that tPA can be administered safely and rapidly using the REACH system with short OTTs.

Methods
Beginning in March 2003, REACH, a rural hospital telestroke network, was developed with a “hub and spoke” organizational model. By February 2005, this network included 8 hospitals, as shown in the Figure (map) and Table. Before the institution of the REACH telestroke system, only 1 of these hospitals had formalized acute stroke care guidelines, and only 2 of these hospitals had tPA available in the pharmacy.

The REACH system hardware and software has been described previously.3,13 All consultants have telestroke privileges at all the 8 hospitals. Medical College of Georgia (MCG) evidence-based stroke pathways and order sets are provided to the rural hospitals along with on-site education. A monthly newsletter is distributed that includes stroke care improvement tips. The rural hospital activates the system if a patient with a suspected stroke arrives within 4 hours of the onset of symptoms. A toll-free call is made to the MCG Emergency Communication Center, which then contacts the stroke specialist on call (D.C.H., R.J.A., F.T.N., H.G., C.H.). The stroke consultant then logs onto the REACH Website via any workstation with broadband Internet access (512 kbp) and completes the consult with 2-way audio and 1-way video. A decision to treat or not to treat with tPA is made and transmitted to the rural facility. In addition, recommendations for diagnostic evaluation and therapy are given as well as recommendations and arrangements for transfer to MCG.

Results
Between March 2003 and May 2005, 194 acute stroke consults were delivered, and 30 patients received tPA. For the tPA-treated patients, the average age was 62 years, 60% (18

References
1. Hess DC, Wang S, Hamilton W, et al. Stroke care is often fragmented in the United States, and there is an urgent need to develop systems of stroke care. 2. Patients with acute stroke often do not receive guideline-driven care. 3. The use of tPA in rural hospitals is infrequent. 4. Telemedicine has been used to increase tPA administration rates. 5. However, the lack of reliable information from the remote site has prevented many stroke specialists from advising tPA treatment over the telephone.

Note: The REACH system hardware and software has been described previously. 3, 13 All consultants have telestroke privileges at all the 8 hospitals. Medical College of Georgia (MCG) evidence-based stroke pathways and order sets are provided to the rural hospitals along with on-site education. A monthly newsletter is distributed that includes stroke care improvement tips. The rural hospital activates the system if a patient with a suspected stroke arrives within 4 hours of the onset of symptoms. A toll-free call is made to the MCG Emergency Communication Center, which then contacts the stroke specialist on call (D.C.H., R.J.A., F.T.N., H.G., C.H.). The stroke consultant then logs onto the REACH Website via any workstation with broadband Internet access (512 kbp) and completes the consult with 2-way audio and 1-way video. A decision to treat or not to treat with tPA is made and transmitted to the rural facility. In addition, recommendations for diagnostic evaluation and therapy are given as well as recommendations and arrangements for transfer to MCG.

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2018
of 30) were women, and 53% (16 of 30) were black. The mean National Institutes of Health Stroke Score (NIHSS) was 15.4, and the median NIHSS was 12.5. The mean OTT was 122 minutes. Of the 31 patients treated with tPA, 7 (23%) were treated in ≤90 minutes less, and 18 (60%) were treated within 2 hours. Imaging by CT scan or MRI was done within 24 to 36 hours after tPA administration. There were no symptomatic intracerebral hemorrhages (ICHs). Rapid improvement defined as a drop of ≥4 points at 24 hours occurred in 18 of 30 patients (60%). The in-hospital mortality rate was 2 of 30 or 7%.

We examined the OTT in the first 10 patients (the first year of operation) treated with tPA and compared with the last 20 treated using a 2-sample pooled t-test. The mean OTT dropped from 143 minutes to 111 minutes (t=2.61; P=0.0144). The reason for this improvement was a significantly shorter door to REACH login time (71 versus 44 minutes; t=3.13; P=0.0040), whereas onset to door (36 versus 34 minutes; t=0.24; P=0.8126) and the login to tPA administration were not significantly different (27 versus 31 minutes; t=−0.94; P=0.3563).

The most common reasons for not treating with tPA included: rapidly improving (31); deficits were too mild with NIHSS <4 (30); beyond the time window (29); intracranial hemorrhage (22); and seizures (9). By reviewing the video, 4 patients were thought to have conversion disorders and were not treated.

**Discussion**

Our preliminary experience with REACH suggests that we can treat patients rapidly, safely, and effectively with tPA in rural community hospitals. Nearly one quarter of the tPA-treated patients were treated within 90 minutes of the onset of symptoms and more than half were treated within 2 hours. This compares favorably to a model urban system of stroke care in which only 28% of the tPA-treated patients were treated in <2 hours. Over time, the OTT became shorter because of a reduction in time from when patient presented to ED to the time the stroke consultant logged on. This was likely because of an educational effort that improved the recognition of stroke and prompted an earlier activation of the system even before the CT scan was completed.

### REACH Rural Hospitals

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Bed Size</th>
<th>ED Volume</th>
<th>Distance From MCG (in miles)</th>
<th>Black % Population in County</th>
</tr>
</thead>
<tbody>
<tr>
<td>McDuffie Regional</td>
<td>47</td>
<td>11225</td>
<td>32</td>
<td>37</td>
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<tr>
<td>Emanuel County</td>
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<td>10104</td>
<td>76</td>
<td>33</td>
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<td>Wills Memorial</td>
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<td>Washington County</td>
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<td>8777</td>
<td>61</td>
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<td>3312</td>
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</tr>
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<td>Morgan County</td>
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<td>6252</td>
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<tr>
<td>Elbert County</td>
<td>52</td>
<td>7377</td>
<td>83</td>
<td>51</td>
</tr>
</tbody>
</table>
Presently, rural residents often experience a “rural penalty” in their stroke care. Moreover, there are urban and suburban hospitals “underserved” for acute stroke care that can benefit from remote evaluation systems. Stroke systems that route all potential stroke patients away from rural community hospitals force patients away from their families and local support systems and may adversely affect the financial health of rural hospitals. Remote systems of care such as REACH have the capacity to deliver the “right health care at the right location by the right doctor.”

The financial investment in REACH by the health system is minimal. These costs are low, consisting of a $6000 telemedicine cart and establishment of adequate information technology to handle Internet connectivity, which currently exists in many instances. The costs to the rural hospital in this system are minimal and only involve maintaining broadband Internet access and a DICOM-compatible CT scanner. REACH provides the rural hospital with a 24-hour stroke team.

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References
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