FAST
Fast Adoption of Significant Technologies

# Detailed Technology Analysis
# Tele-Stroke

## Introduction

Each year, just under 800,000 Americans have a stroke. The most promising treatment for ischemic (closed vessel) strokes, which occur in 87 percent of cases, is a clot-busting drug called a tissue plasminogen activator (tPA). Patients who receive the drug within three hours of stroke onset may have reduced mortality rates and improved long-term speech and motor function.

Unfortunately, the application of tPA is not without challenges; tPA must be administered within three hours of stroke onset and cannot be used for hemorrhagic (open vessel) stroke patients for whom the risk of intracerebral hemorrhage, a serious and sometimes fatal complication, is much higher. As a result, tPA use is normally limited to stroke centers staffed by specialist stroke neurologists.

Stroke centers are generally limited to larger urban and academic medical centers; rural and community hospitals lack comparable staffing and expertise. However, telemedicine technology for stroke, known as "tele-stroke," allows community hospitals to access the expertise of the stroke centers and provide enhanced stroke care, most notably the administration of the critical tPA therapy.

Tele-stroke technology operates on a "hub and spoke" model, in which specialist neurologists at the stroke center "hub" communicate with "spoke" community hospital emergency departments via video-conference link. During the consultation, stroke patients and their doctors communicate with tele-stroke specialists using a battery powered, portable cart with a PC, monitor, webcam and Internet access. Computed tomography (CT) scans and other tests conducted at the spoke facility are shared electronically with the hub-based specialists. Working together, the specialist and the emergency department staff develop a care plan based on established stroke protocols including, if appropriate, the administration of tPA.

### *Stroke center certification*

Generally speaking, stroke centers are located at large academic hospitals, often in urban areas. A task force of stroke care experts convened by the American Stroke Association found that all patients should have access to a primary stroke center and that hospitals should incorporate telemedicine or ground transportation

## Selected Networks

**REACH Call**

- Spoke hospitals use a secure website; no proprietary software required
- Using the website, emergency room physicians in spoke hospitals input patient information, request consultations, and conduct video conferences with the hub
- Website shows real-time consult statistics including treatment times and transfers

**Partners TeleStroke Center**
Massachusetts General Hospital · Brigham and Women's Hospital

- Spoke hospitals use dedicated Internet lines in conjunction with proprietary software
- Computer and video-conference hardware can be purchased by hubs or rented from the network

**Specialists On Call**
*Effective Solutions to the Specialty Physician Shortage*

- Spoke hospitals use a secure website and off-the-shelf computer and video-conference hardware
- Hub provides tele-stroke care as well as consultations for other emergency neurological issues

to facilitate this linkage. The National Institute of Neurological Disorders and Stroke has also endorsed the use of telemedicine to increase the use of acute ischemic stroke therapies. Rural populations that are farther from a stroke center, as well as populations living close to a hospital without stroke expertise, may benefit greatly from tele-stroke technologies.

Some states have established definitions of what constitutes a stroke center. In 2004, the Massachusetts Department of Public Health created a licensing requirement for hospitals that treat stroke patients. A hospital in Massachusetts can be designated as a provider of "primary stroke services" if it provides 24-hour CT scans and has a neurologist on call to determine whether tPA can be administered. Tele-stroke services have allowed many hospitals to achieve this certification without the expense of a full-time neurologist.

As a result of the expansion of stroke center certification, hospitals in Massachusetts have improved the proportion of eligible stroke patients treated with tPA from 27 to 53 percent.[1] The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has established similar criteria for its primary stroke center certification.[2]

## Targeted Medical Conditions

Stroke is currently the third leading cause of death and the leading cause of adult disability in the United States, occurring in 795,000 patients per year. Eighty-seven percent of all strokes are ischemic, the type that is potentially treatable with tPA drugs.[3] As many of the risk factors for stroke, such as diabetes and hypertension, increase the disease's prevalence, tele-stroke technology offers an opportunity to treat a growing number of patients.

The direct and indirect costs of ischemic stroke in the United States, including ambulance services, initial hospitalization, rehabilitation, nursing home costs, outpatient clinic visits, drugs, informal care giving and potential lost earnings, are expected to total $2 trillion between 2005 and 2050.[4] The average annual cost is about $51 billion.

The application of tele-stroke technology could lower these direct and indirect costs of ischemic stroke through the wider application of tPA drugs. In stroke centers currently, around 10-20 percent of ischemic stroke patients are treated with tPA (the 20 percent rate is considered current best practice), while outside these centers the rate of treatment is widely reported to be around 1-2 percent.[5] Data show that the number of patients receiving tPA therapy increases by approximately 10 fold over previous levels when tele-stroke technology is applied.[6]

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[1] Kowalczyk, Liz (2006, October 20). More in Mass Get Drug for Stroke. *Boston Globe*.
[2] Accreditation information is available at http://www.jointcommission.org/CertificationPrograms/PrimaryStrokeCenters/
[3] American Heart Association (2009). Heart Disease and Stroke Statistics—2009 Update. *Circulation*, 119, e21-e181. Accessed May 2009 from http://circ.ahajournals.org/cgi/content/full/119/2/e21.
[4] Brown, Devin, et al (2006). Projected costs of ischemic stroke in the United States. *Neurology*, 67(8),1390-1395. Accessed May 2009 from www.neurology.org.
[5] Ehlers L et al (2008). National Use of Thrombolysis with Alteplase for Acute Ischaemic Stroke via Telemedicine in Denmark : A Model of Budgetary Impact and Cost Effectiveness. *CNS Drugs*, 22, 73-81.
[6] Audebert H et al (2006). Comparison of Tissue Plasminogen Activator Administration Management between Tele-stroke Network Hospitals and Academic Stroke Centers. *Stroke,* 37, 1822.

## Current Availability

Nationally, tele-stroke services are not universally available, and coverage tends to be associated with a small number of regional networks, as shown in Figure I.

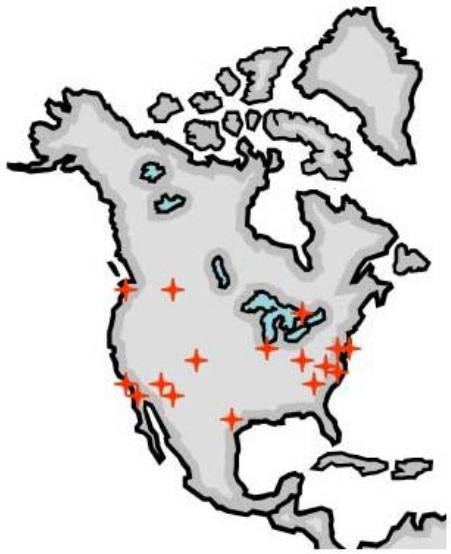
### Figure I: Selected Tele-stroke Networks

**United States**

1. STARR, Mayo Clinic Arizona, Phoenix
2. STRokE DOC, University of California San Diego, San Diego
3. REACH, Medical College of Georgia, Augusta
4. Partners TeleStroke Center, Massachusetts General Hospital, Boston
5. Specialists on Call, Southeastern Massachusetts
6. Maryland Brain Attack and StrokeCenter, University of Maryland, Baltimore
7. Michigan Stroke Network, St. Joseph Mercy Hospital, Detroit
8. University of Texas Health Science Center, Houston
9. University of Pittsburgh Medical Center, Pittsburgh
10. Utah Telehealth Network, University of Utah, Salt Lake City
11. University of California Los Angeles, Los Angeles
12. Renown Institute for Neuroscience, Reno
13. Colorado Neurological Institute Stroke Center, Englewood
14. Virginia Acute Stroke Telehealth Network, University of Virginia, Charlottesville

**Canada**

15. Ontario Telehealth Network Telestroke Program, Toronto
16. Alberta Provincial Stroke Strategy Telestroke Initiative, Calgary & Edmonton
17. British Columbia Provincial Telestroke Initiative, Vancouver



*Source: Mayo Foundation for Medical Education and Research*

In Massachusetts, 77 out of 79 hospitals are currently designated as stroke centers, with 26 hospitals achieving certification through membership in two tele-stroke networks:

- Partners TeleStroke Center: Serves 17 hospitals from hubs at Massachusetts General Hospital and Brigham and Women's Hospital.
- Specialists on Call: Serves nine hospitals with a group of private practice neurologists based in Southeastern Massachusetts.

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## User Satisfaction/Provider Satisfaction

Opinions of tele-stroke have been shown to be extremely favorable among patients and physicians alike.

- Patients consider the tele-stroke consultation "as good as face-to-face" 86 percent of the time, while 100 percent of physicians (both stroke specialist neurologists and emergency physicians) believe tele-stroke improves patient care.[7]
- In Arizona, 90 percent of rural emergency departments surveyed by the Stroke Telemedicine for Arizona Rural Residents Network expressed a willingness to treat patients with acute stroke if a vascular neurologist could provide a telemedicine consultation thorough the state's tele-stroke network.[8]

## Clinical Outcomes

### *Time to treatment*

Tele-stroke technology has been shown to reduce the amount of time it takes to identify and treat a stroke patient with tPA, compared with hospitals without stroke expertise. In one study, the "door-to-needle" time for tPA in community hospitals using tele-stroke was 106 minutes, consistent with the treatment times of many traditional stroke centers.[9]

### *Mortality*

Tele-stroke consultations are approximately as effective as in-person consultations with the stroke specialits who staff stroke centers. A 2006 study showed that patients treated with tPA in hospitals that used tele-stroke technology had similar mortality outcomes as patients in stroke centers. Tele-stroke hospital patients experience intracerebral hemorrhage, the most serious and common side effect of tPA, at a slightly higher rate than stroke center patients but within standards set by the National Institute of Neurological Disorders and Stroke.

### *Long-term morbidity*

Finally, tele-stroke technology produces better long-term patient outcomes. Long-term progress of 1,938 patients with ischemic or hemorrhagic strokes who were admitted to clinics taking part in the TEMPiS (Telemedicine Pilot Project on Integrated Stroke Care) project between July 2003 and March 2005 were compared to 1,122 patients admitted to nearby hospitals not using tele-stroke during the same period. Among stroke patients admitted to TEMPiS hospitals using telemedicine, the probability of a poor outcome (defined here as death, nursing home admittance or lasting disability) 12 months after stroke was 35 percent lower than for non-TEMPiS patients. After 30 months, the risk of a poor outcome was still 18 percent lower for other hospital patients than for patients who were treated at hospitals without telemedicine links.[10]

## Financial Analysis

### *Cost of technology: Capital acquisition*

Infrastructure required for tele-stroke includes an IP/ISDN connection for videoconferencing, a high-speed Internet connection, CT or brain image transfer capability, a videoconferencing device that supports standard protocols and encryption, and a desktop computer. The

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[7] Schwamm LH and Rosenthal ES, et al (2004). Virtual Tele-stroke Support for the Emergency Department Evaluation of Acute Stroke. *Academy of Emergency Medicine*, (11), 1193-1197.
[8] Demaerschalk, BM and Miley ML et al (2009). Stroke Telemedicine. *Mayo Clinic Proceedings*, 84 (1). Accessed May 2009 from http://www.mayoclinicproceedings.com/content/84/1/53.full#F5.
[9] Schwamm LH and Rosenthal ES, et al (2004).
[10] World Stroke Organization Press Release. German Stroke Study: Telemedicine Prevents Disability. Accessed January 2009 from www2.kenes.com/Stroke/Documents/WSC08-PA-Audebert-Telemedicine-E-frei.pdf.

videoconferencing device used by the hub hospitals typically costs about $20,000 to $25,000.[11] Other technology acquisition costs for the hub facilities are proprietary information and not available.

### *Cost of technology: Ongoing operations*

The most important difference among tele-stroke networks is the financial arrangement of the hub in relation to the spokes. The hub can be created with public funds, or it can operate as a private third party. An important source of income for the hub is subsequent treatment referrals from spoke hospitals.[12]

- In a private model (such as Specialists on Call), membership and rental fees allow the hub to recoup both the initial and ongoing costs of operation.
- In a publicly funded model (such as the Arizona Telemedicine Program, described in the sidebar), most infrastructure costs are covered by the government, and a relatively small membership fee covers all or part of the ongoing service costs.

Operations costs, which include network membership fees and training and education for doctors and support staff who interact with stroke patients, vary substantially among networks. In particular, costs vary based on whether a fixed-site or site-independent approach is used. A fixed-site hub uses dedicated Internet lines and remote encrypted private networks to send and receive information from the stroke consultant, who is located at the hub hospital. Site-independent, web-based approaches allow stroke consultants to take calls from anywhere that has broadband access. The REACH system uses this approach and charges spoke hospitals $3,500-$4,500 per month for a neurologist, and $2,000 to $3,000 per month for technical support, for a total cost to the spoke facility of $69,300 to $93,300 per year.[13] Ongoing operational costs for the hub facilities is proprietary information and not available.

## Case Study

The Arizona Telemedicine Program (ATP), established in 1996 and run by the University of Arizona Medical Center, uses an application service provider model to share the costs and services associated with tele-stroke technology. The ATP hub acts as a service provider for spoke hospitals by buying infrastructure at bulk rates (using state funds) and charging client hospitals a comparatively low annual membership fee based on the level of service requested ($1,500 to $5,000). These fees cover 30 percent of ATP's total costs.* This specialized funding scenario points to the potential for public-private partnerships in telemedicine.


* Barker, GP et al (2005). The Arizona Telemedicine business model. *Journal of Telemedicine and Telecare*, 11, 397-402.

It is likely that many tele-stroke networks could be sustained through a combination of public and private funds. Public grants could serve as the seed money needed to fund start-up costs,

[11] Demaerschalk, BM and Miley ML et al. and interview with Garfield Jones, Director of the Eastern Region, REACH; Gregory Young, MD, Western Region Medical Director, State of New York; Anna Colello, Director, Regulatory Compliance/OHSM, State of New York. Conducted 2/10/09.
[12] Cho, S et al. (2007). An Analysis of Business Issues in a Tele-stroke Project. *Journal of Telemedicine and Telecare*, 13.
[13] Ibid.

after which time a hospital's membership fees could be balanced through savings in the cost of care for stroke patients.

### *Costs of the condition treated*

In 2005, the average cost of a hospital stay for ischemic stroke, including both tPA and non-tPA treated patients, calculated using cost-to-charge data from the Centers for Medicare and Medicaid Services (CMS), was $9,100.[14]

That same year, in an effort to remove a financial disincentive to the use of tPA, Medicare began to reimburse tPA-treated patients at a higher rate than conventionally treated patients (new DRG 559 covers reimbursement for the use of tPA at a rate of $11,540, while DRG 014 covers non-tPA stroke services at a rate of $6,417).[15] As a result of this change, the use of tPA has become profitable for many hospitals. By example, one hospital found that, after the change, its cost-reimbursement ratio (ratio of the total cost per patient to the total reimbursement per patient) improved from a four-year average of 1.41 to a four-year average of 0.82, a shift from loss to profit.[16]

### *Return on investment*

In the long run, increasing the use of tPA could save the health care system money through decreases in length of stay, rehabilitation or nursing home costs. Bringing community hospitals up to the level of stroke centers in the use of tPA (to a minimum of 10 percent treated) could result in the administration of tPA to an additional 50,000 patients and, conservatively, save the U.S. health care system approximately $37 million in the first year after stroke.[17]

The existing data regarding the return on investment for the implementation of tele-stroke technology is limited. The best evidence is offered by a study conducted in Denmark where the findings were generally positive. [18] However, the substantial differences in health care system design and payment models between the two countries substantially diminishes the opportunities for direct comparison.

## Barriers to Adoption

There are legal, organizational and economic barriers to the adoption of tele-stroke networks.

### *Legal barriers*

Legal barriers include the uneven application of stroke center regulation and the fact that networks must meet different physician licensure requirements to consult in multiple states.[19] Hospitals across the country or around the world would have the ability to pool resources by expanding tele-stroke network membership if one licensure standard were adopted.

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[14] Russo, CA and Andrews, RM (2008). Hospital Stays for Stroke and Other Cerebrovascular Disease, 2005. Agency for Healthcare Research and Quality.
[15] Payments are current as of August 2005
[16] Demaerschalk, BM and Durocher, DL (2007). How Diagnosis-Related Group 559 Will Change the US Medicare Cost Reimbursement Ratio for Stroke Centers. *Stroke*, 38; 1309-1312.
[17] Demaerschalk, BM & Yip, TR (2005). Economic Benefit of Increasing Utilization of Intravenous Tissue Plasminogen Activator for Acute Ischemic Stroke in the United States. *Stroke,* 36(11), 2500-3.
[18] Ehlers L et al. (2008). p. 79.
[19] Center for Telehealth and E-Health Law (2009). Available at: http://www.telehealthlawcenter.org/?c=118

### *Organizational barriers*

An organizational barrier to tele-stroke networks is the need for a high level of communication and teamwork among all the relevant staff. The hub's staff may include one or more neurologists, an emergency physician, a nurse or physician's assistant, an information technologist, a lawyer, an administrative assistant, a financial analyst, an operations manager and a research coordinator. Staff for the spoke hospital may include a director (emergency physician), a site coordinator, other emergency physicians, an information technologist, a radiology technologist, a credentialing and privileging assistant, a lawyer, a radiologist, and an emergency nurse. Coordination among these staff is key to implementing a successful network, and adds financial and time costs.[20]

### *Economic barriers*

Economic factors are an additional barrier. Tele-stroke networks require upfront capital investments in telemedicine equipment (hardware and software that enable a two-way audio-visual connection) and IT support, as well as clinical and administrative personnel, training and credentialing, and allowances for on-call coverage. For example, participation in the REACH network costs approximately $69,300 to $93,300 per year.[21]

In addition, obtaining reimbursement from private and public sources is difficult. Many private payers have been slow to pay for telemedicine services. For example, under the American Medical Association's Current Procedural Terminology, multiple providers cannot bill for the same procedures for the same patient on the same day, leaving less incentive to form integrated care teams.[22] Medicare will only reimburse teleconsulting fees if there is a two-way video link and the spoke hospital is rural (it must not be located in a metropolitan statistical area or its location must qualify as a rural health professional shortage area). And many telemedicine networks have had to rely on state grants to cover the substantial upfront costs for remote hospitals. These grants tend to be given to rural counties, in effect restricting the types of areas that networks can reach.

However, members of the REACH network in New York State have established reimbursement rates for telemedicine services with the Centers for Medicare & Medicaid Services (CMS) equal to in-person consultations.[23] Further study of the technology's efficacy and cost-effectiveness, which has not yet been conducted in a detailed manner, would facilitate the adoption of a national reimbursement policy.[24]

## Conclusion

Tele-stroke technology enables patients to receive the best possible care for stroke regardless of whether they live near a traditional brick-and-mortar stroke center. The clinical benefits to

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[20] Demaerschalk, BM and Miley ML et al (2009).
[21] Demaerschalk, BM and Miley ML et al. and interview with Garfield Jones, Director of the Eastern Region, REACH; Gregory Young, MD, Western Region Medical Director, State of New York; Anna Colello, Director, Regulatory Compliance/OHSM, State of New York. Conducted 2/10/09.
[22] Bambauer, KZ et al (2006). Reasons Why Few Patients with Acute Stroke Receive Tissue Plasminogen Activator. *Neurological Review*. 63 (5).
[23] Interview with Garfield Jones, Director of the Eastern Region, REACH; Gregory Young, MD, Western Region Medical Director, State of New York; Anna Colello, Director, Regulatory Compliance/OHSM, State of New York. Conducted 2/10/09.
[24] Demaerschalk, BM and Miley ML et al (2009).

patients are substantial and the data, though limited, suggest that tele-stroke care can result in financial benefits, particularly if longer-term patient wellbeing is considered.

In addition to increasing the use of tPA for ischemic stroke, tele-stroke consultations have been shown to support the diagnosis and treatment of other neurological problems in patients that might otherwise have gone undiagnosed. Tele-stroke systems also allow for quality assurance monitoring in remote facilities and generate substantial amounts of data for research activities. Finally, some hospitals find inclusion in a tele-stroke network generates both positive publicity and increased volume from the perception that they provide best-in-class stroke care.

Nationally, tele-stroke adoption is low, limited in large measure by the lack of reimbursement for telemedicine consultations and the relatively high costs of the technology and ongoing service fees.

As noted earlier, Massachusetts has a large tele-stroke penetration rate. In large measure, this is due to the implementation of stroke center regulations in the Commonwealth. As a result, the market for additional tele-stroke implementation in the state is very limited.[25]

Other states, however, do offer the potential for tele-stroke expansion. In Georgia, a 2008 bill created a two-tier stroke center law, with separate designations for JCAHO-certified primary stroke centers and remote treatment stroke centers that utilize tele-stroke technology. Additional state-level activity is progressing, with Florida and New York having passed stroke center certification laws, and Illinois considering legislation.[26]

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[25] Sandrick, Karen (2008). Guidelines Stimulate Explosive Growth of Certified Stroke Centers. *Diagnostic Imaging*. Accessed May 2009 from http://www.ihealthbeat.org/Features/2009/Medicare-Telemedicine-Bill-Could-Change-Landscape.aspx

[26] Graham, Judith (2009, May 20). Right ER may be key after stroke: Illinois legislation would establish network of specialist stroke centers. *Chicago Tribune*.