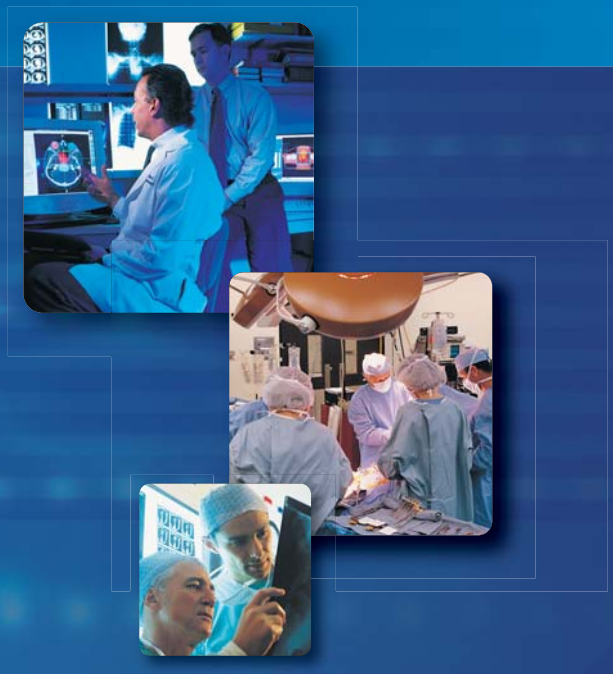
Canadian Agency for Drugs and Technologies in Health

Agence canadienne des médicaments et des technologies de la santé

TECHNOLOGY OVERVIEW

HTA
Issue 37
January 2008

Telehealth for Acute Stroke Management (Telestroke): Systematic Review and Environmental Scan



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Cite as: Deshpande A, Khoja S, McKibbon A, Rizo C, Jadad AR. *Telehealth for Acute Stroke Management (Telestroke): Systematic Review and Environmental Scan* [Technology overview 37]. Ottawa: Canadian Agency for Drugs and Technologies in Health; 2008.

Production of this report is made possible by financial contributions from Health Canada and the governments of Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Nunavut, Ontario, Prince Edward Island, Saskatchewan, and Yukon. The Canadian Agency for Drugs and Technologies in Health takes sole responsibility for the final form and content of this report. The views expressed herein do not necessarily represent the views of Health Canada or any provincial or territorial government.

CADTH is funded by Canadian federal, provincial, and territorial governments.

Legal Deposit – 2008
National Library of Canada
ISSN: 1203-9012 (print)
ISSN: 1481-4501 (online)
O0456 – January 2008

PUBLICATIONS MAIL AGREEMENT NO. 40026386
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Canadian Agency for Drugs and Technologies in Health

Telehealth for Acute Stroke Management (Telestroke): Systematic Review and Environmental Scan

January 2008

We thank Eugenia Palylyk-Colwell for her assistance in creating this overview from a longer report authored by Deshpande *et al*.

This overview is based on the Technology Report commissioned by CADTH: Deshpande A, Khoja S, McKibbon A, Rizo C, Jadad AR. *Telehealth for Acute Stroke Management (Telestroke). Systematic Review of Analytic Studies and Environmental Scan of Relevant Initiatives* [Technology report 99]. Ottawa: Canadian Agency for Drugs and Technologies in Health; 2008

REPORT *IN BRIEF*

January 2008

Telehealth for Acute Stroke Management (Telestroke): Systematic Review of Analytic Studies and Environmental Scan of Relevant Initiatives

Technology

Any modality of telehealth (synchronous or asynchronous) that enables communication between a patient and health care providers, or among health care providers, for the purposes of assessing, treating, or rehabilitating stroke patients.

Issue

There is uncertainty about how telestroke programs can be optimally delivered. There have been several original studies evaluating telestroke services, but no systematic effort summarizing them.

Methods and Results

This systematic review was based on a search of five bibliographic databases completed in mid-December 2006, and a scan of relevant reference lists. It included 22 studies with original data on telestroke modalities assessing health outcomes, cost-effectiveness, patient and provider satisfaction, or process of care, published in English in a peer-review journal. Two independent teams of reviewers screened all articles and extracted data by consensus.

The environmental scan, which identified 15 organizations (two in Canada) providing telestroke services, was based on the articles included in the systematic review, as well as a review of 400 hits from Google.

Implications for Decision Making

- **Telestroke improves access to therapy.** Telestroke improves access to thrombolysis treatment, which may in turn reduce mortality and serious morbidity post-stroke. A high level of patient satisfaction has been documented with this service.
- **Uncertainty remains regarding cost-effectiveness and safety.** Conclusions regarding the economic impact and potential harm from telestroke services compared with face-to-face care could not be drawn from the available evidence.
- **Opportunities for further understanding exist.** The lack of standardized reporting of resources and outcomes precludes comparisons among programs and the determination of best practices. The creation of two programs in Canada opens the door to collaborative efforts that could lead to standardized evaluation frameworks, economies of scale for knowledge transfer, and a better understanding of the safety and resource implications of the services that the two programs offer.

This summary is based on a comprehensive health technology assessment available from CADTH's web site (www.cadth.ca): Deshpande A, Khoja S, McKibbon A, Rizo C, Jadad AR. *Telehealth for acute stroke management (telestroke): systematic review of analytic studies and environmental scan of relevant initiatives.*

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1 Introduction

A stroke is an acute vascular event that is associated with bleeding into the brain or decreased blood flow to part of the brain. Both hemorrhagic and ischemic strokes may be treatable. Hemorrhagic strokes may be amenable to surgery (i.e., to remove blood clots or to clamp bleeding vessels). Ischemic strokes (80% of all cases) occur when there is decreased blood flow to a part of the brain and consequent cell death. The successful treatment of ischemic stroke requires the identification of eligible patients and the administration of thrombolytic agents during a narrow window of time after the onset of symptoms. Meta-analysis and systematic reviews of the clinical evidence show that favourable outcomes are achieved if thrombolysis is administered within 90 minutes of the onset of symptoms and that positive benefits can still be achieved up to 270 minutes after the onset of symptoms.[1,2] The need for rapid intervention has led to the exploration of strategies to deliver timely treatment, such as community education programs, designated stroke centres, emergency room treatment protocols, and telehealth applications or "telestroke."[2-4]

Telestroke is the use of audio, video, or other telecommunications and electronic information processing to transmit data that are relevant to the diagnosis and treatment of acute stroke. Communication can occur between a patient and health care providers or among health care providers. Telestroke can be used to facilitate the remote clinical assessment of patients, measurement of a National Institute of Health Stroke Scale (NIHSS) score, review of radiological investigations, or instruction on the delivery of thrombolytic agents.

Telestroke modalities can range from a telephone discussion to audio-videoconferencing. Videoconferencing can occur via fixed-site or web-based models. In the former, the neurological consultant must be in a videoconferencing facility located at a hub hospital when interacting with a requesting physician. Typically, the dedicated integrated services digital network (ISDN) line that is used transmits 30 frames per second, with two-way full motion, video and audio teleconferencing, and encryption of information at the remote site via virtual private networks.[5] In the web-based model, the neurological consultant interacts with the requesting physician via videoconferencing (i.e., using a web-cam and real-time audio). The interaction could occur from almost any location as long as there is access to an Internet application via a computer or web-enabled device using wireless fidelity (WiFi) or wired broadband. Access to a patient's information is encrypted. The advantages of the web-based model are the avoidance of travel by a consultant to a hub and the convenience of being able to answer a request from anywhere that Internet access is available.

Given the morbidity and socioeconomic costs associated with stroke, efforts have been made to improve treatment and patient care. By facilitating access to health services, telestroke is seen as a potential solution. There is, however, uncertainty about how to optimally deliver telestroke programs. Although telestroke has been the focus of many original studies, there have been no systematic attempts to summarize the data on its effectiveness and potential risks. As a result, a resource that captures the best practices at leading telestroke organizations worldwide would be valuable for decision and policy makers charged with the assessment or implementation of telestroke programs. This report will address the current knowledge gap.

2 Objectives

The objective of this report was to provide a critical evaluation of the available data on the use of telehealth for acute stroke patients. For this report, the term "telestroke" was defined as the use of audio (including the telephone), video, and other telecommunications and electronic information processing technologies for the transmission of information and data relevant to the diagnosis and treatment of acute stroke. A systematic review of the peer-reviewed literature was conducted on the impact of telestroke initiatives on health outcomes, process of care, access to health services, and health resources. An environmental scan was undertaken to synthesize the practices from existing organizations that provide telestroke services of relevance to Canadian policy makers. The research questions were:

- What evidence exists in the peer-reviewed literature to support the use of telestroke in the improvement of health outcomes?
- Does the use of telestroke improve access to health services?
- Does telestroke affect health care resource utilization?
- What is the level of user satisfaction regarding health services delivered through telestroke?
- What organizations and best practices are at the forefront of telestroke delivery?

3 Clinical Review

Methods

Published literature was obtained by searching MEDLINE (from 1966), CINAHL (from 1982), and HealthSTAR (from 1975) databases to mid-December 2006. The Database of Abstracts of Reviews of Effects (DARE) and the Cochrane Library were searched to mid-December 2006. Supplemental searches of the reference lists of eligible reports were also done.

Reviewers independently selected potentially eligible reports if the report evaluated telestroke services; included original data on health outcomes, process of care, patient satisfaction, or resource utilization; and if the report was published since 2000 in English, in a peer-reviewed journal. Reviewers independently extracted data from selected studies. The quality of selected studies was evaluated independently by reviewers using the Jadad scale for randomized controlled trials (RCTs)[6] and the Downs and Black checklist[7] for observational studies and controlled clinical trials (CCTs). Studies (RCTs) were considered to be of high quality if the Jadad score was greater than three points or if the median quality score from the Downs and Black checklist was greater than 14 (qualitative studies and CCTs). Any reviewer differences in study selection, data extraction, or quality assessment were resolved by consensus. The reviewers summarized the results of the studies qualitatively. A meta-analysis was considered to be inappropriate because of heterogeneity in study design, methodological quality, clinical settings, technological interventions, outcome measures, and endpoints.

Results

A total of 863 citations were identified from the original searches. From these, 828 were excluded, resulting in 35 potentially relevant reports, plus one report identified by an external reviewer. In total, 36 reports were retrieved for full-text scrutiny and from these, 14 reports were excluded to yield 22 reports. Study sizes, designs, and quality varied. Details can be found in the full report.

Ten studies originated from the US,[4,8-16] four from Germany,[17-20] two from Canada,[21,22] two from China,[23,24] two from the Netherlands,[25,26] and one each from Italy[27] and Finland.[28] Fourteen studies assessed the impact of telehealth on acute stroke management, and eight reviewed its effect on rehabilitation in post-stroke survivors. There were three RCTs[8,23,25] and one CCT,[29] with the remainder a combination of case series and other forms of observational design (i.e., mostly single prospective cohorts). All studies included adult patients, except one study[21] that included pediatric patients. All 22 studies described the technologies used in telestroke. These included telephone-based interventions (five studies), videophone (one study), or videoconferencing with asynchronous technology to deliver radiological images to the consultant (16 studies). The outcomes that were assessed included clinical effectiveness (11 studies), aspects of resource utilization (six studies), process of care issues (12 studies), and patient satisfaction (three studies).

One[8] RCT, the CCT,[29] and seven[4,5,9,17,19,20,24] of the remaining studies were judged to be of high quality. Low-quality observational studies were uniformly deficient in failing to properly describe the study population or provide adequate detail on the recruitment process. All non-RCTs failed to describe a statistical power calculation.

a) Acute stroke management

Of the 14 studies that assessed telehealth for acute stroke management, four reported data on health outcomes, 12 on process of care, two on resource utilization, and two on patient or provider satisfaction. Studies reporting data on "door-to-needle time" or the time elapsed from the patient's arrival at hospital to the start of thrombolysis were classified under process-of-care outcomes unless specific health outcome data were reported.

Health outcomes: One RCT[15] reported reduced mortality at six months with teleradiology (i.e., telephone call and transfer of images) compared to telephone consultation alone. In the CCT,[29] compared to controls, poor outcomes were reduced after three months in the intervention group. Treatment in network hospitals (those associated with the delivery of telestroke services) was found to independently reduce the probability of a poor outcome. Improved quality of care and rehabilitative services with reduced mortality were also reported. In contrast, one study,[30] based on a population included in a previously published study, found comparable mortality rates between the telehealth group and controls at three and six months. The same study reported comparable functional outcomes at six months using the modified Rankin scale and Barthel Index. Two studies[12,15] reported an absence of complications with tissue plasminogen activator (tPA) administration.

Process of care: The outcomes that were assessed included consultation time, door-to-needle time, and patients' access to thrombolysis as a result of the availability of telestroke. One RCT[23] compared the use of the telephone, teleradiology, or videoconferencing to deliver acute stroke care. Videoconferencing (real-time and transfer of radiology images) resulted in a longer consultation time compared with telephone alone, but this was comparable to the time needed for teleradiology. In another study,[20] telestroke consultation occurred within three hours for 25% of the study group, with a mean time to consultation of 69 minutes and no difference between acute and sub-acute cases. The mean time to interpret one radiological case at a distance was reported to be 40 minutes in one study[28] and the impression was identical to the reference film in 86% of cases.

In one study,[31] door-to-needle time was 76 minutes on average, including 15 minutes for consultation. Similar times were reported in two other studies: 85 minutes (range 27 to 165

minutes)[15] and 106 minutes.[4] Another study[11] reported evaluation times of 62.9 minutes with a door-to-needle time of 104.92 minutes. A drop in mean onset to treatment time from 143 to 111 minutes after 10 patients was reported in one study,[13] with 23% of patients treated within 90 minutes and 60% treated in two hours.

Several studies show that telestroke increases access to thrombolysis. An increase from 10 to 86 patients receiving thrombolysis within one year of starting a telestroke program has been reported.[19] A 72% increase in the number of tPA-treated patients with the use of a telephone-based service was reported in another study,[9] whereas another[4] described how 5.6% of patients received tPA during the intervention compared with none in the two years before the start of the program, despite the availability of tPA. Access to care increased from 0.8% to 4.3% in the 12 months after implementation of a telestroke program in another study.[15]

Satisfaction: Data on satisfaction were sparse. In one study,[4] physicians reported that telestroke improved care in 95% of cases. In another,[12] it was reported that patients and staff viewed positively the reassurance of interacting with a "live" stroke specialist.

Other effects: Telestroke has been associated with an increased diagnosis of neurological conditions and use of CT-MRI, speech therapy, and occupational therapy.[29] The diagnostic accuracy of the telephone-based system was found to be significantly lower than that of teleradiology or video-conferencing.[23] Transfer avoidance has also been associated with telestroke.[4]

b) Post-stroke rehabilitation

Studies of home-based, post-stroke telerehabilitation focused on health outcomes and patient and caregiver satisfaction. No outcomes were reported on resource utilization or process of care.

Health outcomes: Two RCTs[8,25] investigating outreach programs delivered by telephone to the caregivers of stroke survivors reported improved caregiver emotional well-being with the intervention. The first study[8] reported reduced anxiety and improvement in the indicators of social functioning and mental health in caregivers. The second[25] reported reduced levels of depression among caregivers, but no other significant differences. Two reports[24,27] focused on interventions for stroke survivors. One[27]concluded that a lack of the health care practitioner's physical presence did not hamper motor learning. The other[24] noted that a service based on videoconferencing resulted in improved balance, strength, and self-esteem.

Satisfaction: Two studies[16,24] reported patient satisfaction with home-based telerehabilitation. The first[24] reported that patients considered the intervention to be good (63%) or excellent (36%). The second,[16] which investigated behavioural health care, found that patients were less satisfied with videoconferencing versus face-to-face diagnosis by neuropsychologists, but generally were more satisfied when undergoing psychotherapy.

4 Health Services Impact

Methods

An environmental scan was conducted by identifying eligible organizations or initiatives for inclusion through a review of the reports selected for full-text scrutiny from the clinical review and

by a review of the first 200 hits obtained from two Google™ searches. As a result, 400 hits were reviewed out of 297,200 (15,200 hits using the search term "telestroke" and 282,000 hits using the term "stroke telemedicine").

Reviewers independently selected an organization or initiative for inclusion if it stated that one of its objectives was the promotion and use of telestroke services, if it provided information about its services through any means (e.g., web site, telephone, or face-to-face), or if it generated data on the impact of such services. The first Google™ search was done to confirm that the organizations that were identified from the clinical review were involved in the delivery of telestroke services rather than focused on research. The second Google™ search was done to identify additional institutions involved in the delivery of telestroke services. Duplicate organizations were removed. For each organization, information was collected on the program name, contact person, organizational leader (where possible), available telestroke services, publications, and evidence of impact based on the evaluation framework developed by the Oregon Evidence-based Practice Center during a systematic review of telehealth interventions on behalf of the US Agency for Healthcare Research and Quality (AHRQ).[32] Efforts were made to answer the following questions to determine evidence of impact:

- Does telestroke result in comparable diagnostic decisions and recommendations for clinical management?
- Does telestroke result in comparable health outcomes?
- Does the availability of telestroke services improve access?

The Telemedicine Information Exchange (http://tie.telemed.org/default.asp) – a repository of information about telehealth – was used to verify the contact information and program coverage of each eligible organization. All identified institutions were contacted by e-mail, and a template was sent to each so that extracted information could be verified and missing information obtained. A follow-up was done to ensure receipt of the e-mail message and to obtain additional information.

Results

Fifteen organizations providing telestroke services were identified. Two were located in Canada, seven in the US, three in Germany, and one each in Italy, the Netherlands, and China. Most offered a combination of synchronous (real-time) and asynchronous services. Their characteristics appear in the full report. Of the 15 organizations, four had data that matched all the elements of the evaluation framework for telehealth interventions developed on behalf of the AHRQ.[32]

There was variability in the number and type of staff employed by telestroke programs. Most programs had a multidisciplinary team composed of licensed physicians (e.g., neurologists, neurosurgeons, fellows, and residents), nurse practitioners, registered nurses, information technology experts, program coordinators, and managers. Determining the number of staff involved in each organization was difficult because of the nature of the neurology services that support telestroke in the host hospitals and the range of assessed patients. In some instances, there was dedicated staff, whereas in most institutions, staff floated to support telestroke services. In some cases, physicians autonomously supervised the telestroke operation, while in others, services were managed by nurses. There was also difficulty in ascertaining the volume of patients served by the programs. Most often, the lack of data was due to a lack of agreement about the unit of analysis (e.g., number of patients seen via telehealth versus the number of events undertaken to support non-scheduled emergency stroke consultations or the number of events where tPA is administered).

The coverage radius for telestroke services ranged from 160 to 400 kilometers (100 to 250 miles). Coverage limits were based on the number of telestroke centres in the same network and the distance of a satellite telestroke centre from a telestroke hub. The widest coverage was offered by the telestroke initiative in Ontario. Most consultations were performed using videoconferencing and did not require patient transportation for tPA treatment. Some organizations used the telephone to connect with stroke patients. This allows for a coverage area of up to 40 kilometers. Extended coverage can be facilitated by the use of air ambulance services, and the maximum distance for safe air transport is used as a limiting coverage factor by some institutions. Information about the 15 included organizations appears in the full technology report.

5 Economic Analysis

A formal economic analysis was not conducted for this report. Data on cost-effectiveness and impact on resource utilization, however, were collected from studies included in the clinical review. Few studies assessed the impact of telestroke on resource utilization. In one study,[23] higher costs were reported (i.e., expenses directly related to a patient's hospital admission, such as inpatient admission, telehealth, or operating room time) with teleradiology and videoconferencing compared with teleconferencing, although results were not statistically significant. In another,[29] the mean hospital stay was reduced in those institutions that were supported by a telestroke program compared to those without a specialized stroke service. In a third study,[4] transfer avoidance attributed to telestroke was documented. This, in turn, may reduce resource utilization. No cost data, however, were provided.

6 Limitations

There are several limitations to the systematic review. The searches of the medical databases were performed in mid-December 2006 and given the evolution of telehealth, the information included in this report may be dated because new publications since that time will not have been included. Searches were limited to the English language and although large telestroke networks located outside North America (e.g., TEMPiS in eastern Bavaria) have published many papers in English, there may be reports published in other languages that were not included. The exclusion of unpublished studies may have introduced bias, and the pursuit of grey literature was beyond the resources available for this review. Reports on telerehabilitation were identified from the generic search strategy, which focused on acute stroke and because it was broadly defined, some reports may not have been identified. Because of the weak evidence, no conclusions were drawn on telerehabilitation, and it would be prudent to conduct a focused systematic review to determine its effectiveness. Lastly, the quality of approximately two-thirds of the included studies was poor. Nonetheless, the trends that were identified in the high- and low-quality literature were consistent.

7 Conclusions

Stroke is a neurological condition that affects many Canadians and results in socioeconomic costs. The use of thrombolysis that is delivered during a narrow window of time after the presentation of symptoms has been shown to significantly reduce the burden of illness.

The use of telestroke in acute stroke seems to improve access to the administration of thrombolysis, could reduce the number of poor outcomes three and six months post-stroke, and may improve the quality of care in acute stroke management. Two studies assessed patient satisfaction. Both documented high levels of acceptability. It is unclear, however, whether this modality is cost-effective and safe compared with face-to-face care.

The evidence obtained for the use of telestroke in the rehabilitation of post-stroke survivors was not exhaustively reviewed, so no conclusions could be drawn. The few articles that were identified, however, suggest a trend towards improved caregivers' well-being. More research is warranted to determine the impact of telehealth on post-stroke care.

While several organizations have been identified at the forefront of telestroke, the lack of standardized reporting of resources and outcomes precludes comparisons among programs and the determination of best practices. The use of telestroke services seems to reduce inappropriate variations in practice. The recent creation of two programs in Canada opens the door for collaboration that could lead to standardized evaluation frameworks, economies of scale for knowledge transfer, and a better understanding of the safety and resource implications of the services that they offer.

Telestroke, like telehealth in general, transcends distance and geographic boundaries. Canada has made strides in many areas of telehealth. The availability of picture archiving and communication systems (PACS) in almost 20% of Canadian hospitals and free-standing imaging facilities (2005 figures) provides the foundation for telestroke care to play a greater role. The emerging telestroke programs, and their financial and political backers, have an opportunity to join efforts that could place Canada at the forefront of telestroke, while ensuring that Canadians have access to the services that they expect, regardless of where they live.

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