Evaluation of Telemedicine For Stroke

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Prepared For

BC Stroke Strategy

By

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Executive Summary

Background

Telemedicine for stroke (telestroke) is a technology that has emerged within the past decade that allows audio and visual connections amongst health care providers and stroke patients. It also enables transmission of CT or MRI images. Telestroke networks are often established with a stroke centre, or consulting site, at the hub and multiple regional hospitals, or referring sites, are connected to it. A key benefit of telestroke is the improvement of stroke care in rural areas.

Thrombolytic therapy is an important component of stroke care, and an increase in its usage is often an outcome of telestroke programs. Thrombolysis with recombinant tPA is effective in improving patient outcome when administered to an acute ischemic stroke (AIS) patient within 3 hours of symptom onset. However, less than 6% of these patients receive thrombolytic therapy; this is due to presentation of the patient outside of the 3-hour time window, and due to the requirement that AIS is diagnosed by a stroke expert before the therapy is administered.

Because telemedicine is still a relatively new health service delivery platform, it is only in recent years that evaluations of telestroke have been published. There are few comprehensive assessments as yet, though many individual telestroke projects have been studied.

Indicators

Assessment of the effectiveness of a telestroke program requires identification of indicators for measurement. Indicators used in evaluating telemedicine are outlined by the National Initiative for Telehealth (NIFTE) Framework of Guidelines using the categories “evaluation of clinical effectiveness” and “efficiency of telehealth service”. The National Telehealth Outcome Indicators Project (NTOIP) identified 34 telehealth outcome indicators, divided into the categories Quality, Access, Acceptability and Cost and each one described in full detail using a specific framework. Twelve of these indicators constitute a Minimum Indicator Set, determined to be the most relevant and useful.

Indicators used for assessing telestroke in the literature have been divided into three categories: health, process of care, and qualitative assessment. The potential indicators recommended for use in a B.C. telestroke program are outlined below:

Category	Recommended Indicator
Health Outcomes	3-month mortality rate 6-month mortality rate post-consultation intracerebral hemorrhage 3-month modified Rankin Scale and Barthel Index 6-month modified Rankin Scale and Barthel Index
Process of Care	Number of telestroke consults Number of patients receiving thrombolysis % of all telestroke consults % of all stroke patients % of ischemic stroke patients % of ischemic stroke patients arriving at hospital within 2.5 hours of symptom onset % administered within 90 minutes from symptom onset Time intervals Teleconsultation time Door-to-needle time Door-to-CT time Symptom onset to needle time Protocol violations Diagnoses other than stroke Avoidance of patient transfer Technical problems during teleconsultation Number of consult delays Number of consults aborted
Qualitative Assessment	Ratings by physician/nurse Imaging quality Audio quality Sacrifice of time Importance for stroke management Ratings by patient Satisfaction Ease of communication Comparable to face-to-face consultation

Lessons Learned

Throughout the literature, telestroke is determined to be an effective, safe and reliable means of improving the quality of stroke care. Telestroke broadens the use of thrombolytic therapy to rural areas and in general increases the use of this therapy. One of the key factors in the success of telestroke projects is the ongoing education of health practitioners, both in stroke care and in using the telestroke technology. Education of the public with regard to stroke symptoms and pre-hospital stroke care is also an important component of a telestroke program, as this will aid in increasing the use of thrombolytic therapy. A second factor on which the success of a telestroke program is often dependent is the availability of stroke specialists for consultation. A telestroke system that provides 24-hour linkage to specialty consultants is optimal.

Background

Telestroke

Telemedicine for stroke (telestroke) is a health care delivery system that enables communication among patients and health care providers for the purposes of assessing, treating, or rehabilitating stroke patients. Telestroke is an emergency telemedicine application that involves the use of secure networks and videoconferencing to provide real-time video and audio connections and transmission of images such as CT or MRI to a remote health care provider. Telestroke networks have been established in which the hub is usually a stroke centre (**consulting site**) providing support to various regional hospitals or clinics (**referring sites**). The availability of this technology has the potential to positively impact the quality of care that these health care facilities provide to stroke patients, as they often have limited access to specialty resources.

Telestroke allows for consultation with a stroke neurologist, resulting in treatment options such as thrombolysis that were not previously available in the remote hospital. There are numerous other advantages to involvement of stroke care specialists in the management of stroke:

- facilitation of diagnosis of other neurological emergencies
- quantization of neurological deficit with National Institutes of Health Stroke Scale (NIHSS)
- quantifiable identification of neurological deterioration and provision of immediate feedback on therapeutic strategies
- quantifiable identification of patients who had improvement and thus did not require thrombolysis or transfer.[1]

Telemedicine has also been used in the rehabilitation of stroke patients (telerehabilitation), in which professionals such as physiotherapists provide support, assessment, and intervention to patients via videoconferencing.[2] This document will focus on the acute stroke care aspect of telemedicine.

Telestroke programs were first introduced in the mid-1990s, though it is only in recent years that evaluations of telestroke have been published. There are still few comprehensive assessments of existing programs. Many small studies report that telemedicine for stroke is “feasible” or “promising”, but do not have enough data or patients to offer a full analysis.

Because of its importance in telestroke programs, we provide a brief overview of thrombolysis below.

Thrombolysis

The treatment of acute ischemic stroke (AIS) by IV thrombolysis with recombinant tPA has been shown to be efficacious in improving patient outcome when

[1] LaMonte MP, Bahouth MN, Hu P et al. Telemedicine for acute stroke: triumphs and pitfalls. *Stroke.* 2003; 34(3): 725-8.
[2] Lai JC, Woo J, Hui E et al. Telerehabilitation - a new model for community-based stroke rehabilitation. *Journal of Telemedicine and Telecare.* 2004; 10(4): 199-205.

administered within three hours of symptom onset.[3] However, less than 6% of patients with AIS receive this therapy.[4] The major reason for this is presentation of the patient outside of the 3-hour time window. Of patients presenting within 3 hours, many are excluded from thrombolysis because their symptoms are too mild or are rapidly improving.[5] A further complicating factor is that thrombolytic therapy should only be given when a physician with expertise in stroke establishes the diagnosis and a CT scan of the brain is assessed by a physician with expertise in this type of imaging. Many patients present at local community hospitals where such expertise is not available. Access to telestroke has resulted in a significant increase in tPA thrombolysis in studies of regional networks.[6,7,8]

Despite the relatively small number of stroke patients who receive thrombolytic therapy, it is a vital part of the system of stroke care and efforts are being made to increase its appropriate usage through educational activities directed at training of physicians and increasing public awareness of stroke symptoms.[9] At the same time, research is ongoing to increase the benefits of thrombolytic therapy for patients and to further develop this treatment strategy.

A recent study published in the *New England Journal of Medicine* reports that thrombolytic therapy given 3 to 4.5 hours after stroke symptom onset results in a modest but significant improvement in clinical outcome.[10] If the time window for tPA therapy is extended, there is the potential to treat many stroke patients who would otherwise have been excluded. At the same time, there have been reports of a lack of treatment response in patients after administration of tPA, and its potential neurotoxicity is of some concern.[11,12] Thrombolytic strategies under development may combine tPA (or another thrombolytic agent) use with either ultrasound,

[3] Nadeau JO, Shi S, Fang J et al. TPA use for stroke in the Registry of the Canadian Stroke Network. *Canadian Journal of Neurological Sciences.* 2005; 32(4): 433-9.
[4] Nadeau JO, Shi S, Fang J et al. TPA use for stroke in the Registry of the Canadian Stroke Network. *Canadian Journal of Neurological Sciences.* 2005; 32(4): 433-9.
[5] Barber PA, Zhang J, Demchuk AM et al. Why are stroke patients excluded from TPA therapy? An analysis of patient eligibility. *Neurology.* 2001; 56(8): 1015-20.
[6] Audebert HJ, Kukla C, Clarmann von Claranau S et al. Telemedicine for safe and extended use of thrombolysis in stroke: the Telemedic Pilot Project for Integrative Stroke Care (TEMPiS) in Bavaria. *Stroke.* 2005; 36(2): 287-91.
[7] Hess DC, Wang S, Hamilton W et al. REACH: clinical feasibility of a rural telestroke network. *Stroke.* 2005; 36(9): 2018-20.
[8] Waite K, Silver F, Jaigobin C et al. Telestroke: a multi-site, emergency-based telemedicine service in Ontario. *Journal of Telemedicine and Telecare.* 2006; 12(3): 141-5.
[9] Audebert HJ, Kukla C, Vatankhah B et al. Comparison of tissue plasminogen activator administration management between Telestroke Network hospitals and academic stroke centers: the Telemedical Pilot Project for Integrative Stroke Care in Bavaria/Germany. *Stroke.* 2006; 37(7): 1822-7.
[10] Hacke W, Kaste M, Bluhmki E et al. Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. *New England Journal of Medicine.* 2008; 359(13): 1317-29.
[11] Meairs S, Wahlgren N, Dirnagl U et al. Stroke research priorities for the next decade--A representative view of the European scientific community. *Cerebrovascular Diseases.* 2006; 22(2-3): 75-82.
[12] Kaur J, Zhao Z, Klein GM et al. The neurotoxicity of tissue plasminogen activator? *Journal of Cerebral Blood Flow and Metabolism.* 2004; 24(9): 945-63.

pharmacological agents or intra-arterial interventions to enhance the anti-clot activity.[13,14]

This document is divided into two main sections. First, outcome indicators for **telemedicine** in general are outlined. This is then followed by a discussion of indicators for **telestroke** that have been used in the literature.

[13] Tsivgoulis G, Culp WC, Alexandrov AV. Ultrasound enhanced thrombolysis in acute arterial ischemia. *Ultrasonics.* 2008; 48(4): 303-11.
[14] Meairs S, Wahlgren N, Dirnagl U et al. Stroke research priorities for the next decade--A representative view of the European scientific community. *Cerebrovascular Diseases.* 2006; 22(2-3): 75-82.

Indicators Used in Evaluating Telemedicine

In the National Initiative for Telehealth (NIFTE) Framework of Guidelines, the general categories suggested for telehealth **clinical** outcome indicators are "evaluation of clinical effectiveness" and "efficiency of telehealth service".[15] Examples of the former category include: diagnostic accuracy, validation of diagnostics, appropriate health care intervention, and patient/client safety and risks. Those that fall under "efficiency of telehealth service" are similar to some of the NTOIP indicators, which are discussed below.

The National Telehealth Outcome Indicators Project (NTOIP) was designed to build consensus in Canada around defined outcome indicators suitable for use by the telehealth/e-health community. In their report, a total of 34 telehealth outcome indicators are identified and described in full detail using a framework of 16 fundamental components. These include elements such as definition, rationale, potential uses, data sources, and outcome measures.[16] An example of this framework is included in Appendix A for the indicator *Health Status (Individual) – Assessed*.

The indicators are divided into four categories: Quality, Access, Acceptability and Cost. Three indicators from each category are identified as the most relevant and useful. These constitute the Minimum Indicator Set and are outlined in the following table.

[15] National Initiative for Telehealth (NIFTE). *National Initiative for Telehealth (NIFTE) Framework of Guidelines*. 2003. NIFTE. Available at http://www.cst-sct.org/en/index.php?module=library&VV_DocumentManager_op=viewDocument&VV_Document_id=47. Accessed September 2008.

[16] Rush B, Scott RE. *Approved Telehealth Outcome Indicator Guidelines: Quality, Access, Acceptability, and Cost*. 2004. Available at http://www.canarie.ca/funding/ehealth/publications/NTOIP.pdf. Accessed September 2008.

Top Twelve Telehealth Outcome Indicators from the NTOIP		
Indicator	**Definition**	**Rationale**
Quality		
Health Status (Individual) - Assessed	The state of health of an individual as assessed by a health care provider	Positive changes in the health status of an individual as a result of a telehealth intervention provide strong evidence of the effectiveness of telehealth.
Quality of Telehealth Encounter - User	Those relative characteristics that influence the user's telehealth experience	Increased quality of the telehealth encounter that meets or exceeds the user's expectations demonstrates effectiveness of telehealth
Health Status (Individual) - Self Reported	The state of health of an individual, as assessed by himself/herself	Positive changes in the health state of an individual as a result of a telehealth intervention provide strong evidence of the effectiveness of telehealth.
Access		
Utilization - Telehealth Services	For a given user population, the number of telehealth sessions occurring per month	Increased utilization rates for telehealth activities demonstrate increased access to telehealth
Utilization - Health Care Services	For a given user population, the number of traditional health care services occurring per month	This indicator will provide information as the base line comparator for the telehealth interventions
Uptake - Adoption of Telehealth	The number of groups or individuals using telehealth applications	Assessing uptake will provide some evidence needed to sustain funding and research in telehealth
Acceptability		
Knowledge Transfer - Patient	The effective sharing of ideas, knowledge or experience between a healthcare provider(s) and their patient(s). The knowledge can be tangible or intangible.	One primary goal of health care providers is to educate and transfer health knowledge to patients. Telehealth facilitates knowledge transfer by breaking down geo-political, temporal, and spatial boundaries.
Expectations - Telehealth Users	The expectations of users about how products and services will meet their specific needs and requirements	If the telehealth experience met (or exceeded) the user's expectations, then positive uptake may be facilitated
Uptake - Rate of Change in Utilization	For a given user population, the percentage change in utilization of telehealth services month to month	Showing that telehealth services are increasing over time could indicate acceptability of telehealth
Cost		
Transportation - Time & Distance	The cost of resources required to transport something [or someone] from one location to another	One major benefit of telehealth is that it allows for less travel by the user. Less time on the road means less disruption in the lives of users, less greenhouse gas emissions, and possibly fewer accidents on the roads.
Capital - Equipment	Capital equipment costs associated with operating, maintaining and developing telehealth services	Capital investment in telehealth will ensure that this area of health will continue to grow and evolve
Human Resources - Operational	The costs associated with providing the human capital needed to operate and maintain telehealth activities	Human resource investment in telehealth will ensure that this area of health functions efficiently and effectively and will allow it to grow and evolve

Source: http://www.canarie.ca/funding/ehealth/publications/NTOIP.pdf

The remaining 22 indicators identified by the NTOIP are as follows:

Other Telehealth Outcome Indicators from the NTOIP			
Quality	**Access**	**Acceptability**	**Cost**
Quality of Life	Availability - Telehealth Service	Utilization - Health Care Services	Uptake - Industry Investment
Telehealth Integration	Uptake - Rate of Change in Utilization	Utilization - Telehealth Services	Facilities - Space
Quality - Technology Performance	Expectations - Telehealth Users	Uptake - Adoption of Telehealth	Communication - Cost
Health Status (Population) - Self Reported	Uptake - Societal Perceptions	Uptake - Research Funding Sources	Human Resources - Training & Education
Burden of Illness or Injury - Individual	Uptake - Capacity		Facility - Overhead
User Satisfaction			Marketing
			Warranties

Source: http://www.canarie.ca/funding/ehealth/publications/NTOIP.pdf

Indicators Used in Assessing Telestroke

Most of the more complete assessments of telestroke in the literature refer to large-scale networks and pilot projects, including: the Telemedic Pilot Project for Integrative Stroke Care (TEMPiS) in Bavaria;[17] the Telemedicine in Stroke in Swabia (TESS) Project;[18] and the Remote Evaluation for Acute Ischemic Stroke (REACH) program in Georgia.[19] The outcome measurements used in these and other studies are outlined here, in terms of health, process of care, and qualitative assessment. These indicators have been used to compare telemedicine for stroke with telephone-based systems, stroke centres (face-to-face consults), and as components of a before- and-after implementation comparison. Many of the indicators relate to administration of thrombolytic therapy.

Health Outcomes

The following are indicators that have been used in evaluating health outcomes after receiving telemedical care for acute stroke:

- 3-month and 6-month mortality rates or survival rates
- Complications associated with the administration of tPA, such as intracerebral hemorrhage
- Functional outcomes at 90 days and 6 months as measured on the modified Rankin scale (mRS) and Barthel Index (BI)[20]

The TEMPiS project was founded by two comprehensive stroke centres in Munich, Germany in February 2003. These centres provide consultation via telemedicine to 12 regional clinics (referring sites). A long-term follow-up published in 2007 (based on 132 patients receiving tPA in the consulting sites and 170 in the referring sites) indicated that the rate of thrombolysis in the referring sites had increased 10-fold and that the outcomes for patients receiving tPA in the referring sites were comparable to those for patients who received tPA in the consulting sites, as indicated in the following table.[21]

[17] Audebert HJ, Kukla C, Clarmann von Claranau S et al. Telemedicine for safe and extended use of thrombolysis in stroke: the Telemedic Pilot Project for Integrative Stroke Care (TEMPiS) in Bavaria. *Stroke.* 2005; 36(2): 287-91.

[18] Wiborg A, Widder B. Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project. *Stroke.* 2003; 34(12): 2951-6.

[19] Wang S, Gross H, Lee SB et al. Remote evaluation of acute ischemic stroke in rural community hospitals in Georgia. *Stroke.* 2004; 35(7): 1763-8.

[20] These are commonly used scales used for measuring the degree of disability or dependence in the activities of daily living for stroke patients.

[21] Schwab S, Vatankhah B, Kukla C et al. Long-term outcome after thrombolysis in telemedical stroke care. *Neurology.* 2007; 69(9): 898-903.

Favorable Functional Outcome and Mortality after 3 and 6 months				
Indicator	**Referring sites**	**Consulting sites**	**OR (95% CI)**	***p* Value**
3 months				
mRS 0/1 (%)	38.2	33.7	1.2 (0.7-2.0)	0.258
BI 95/100 (%)	45.1	40.1	1.3 (0.8-2.1)	0.197
Survival rate (%)	88.8	88.6	1.0 (0.7-1.4)	0.55
Any cerebral hemorrhage in deceased patients	6/24	3/17	0.6 (0.2-2.6)	0.391
6 months				
mRS 0/1 (%)	39.5	30.9	1.5 (0.9-2.4)	0.095
BI 95/100 (%)	47.1	44.8	1.1 (0.6-1.8)	0.443
Survival rate (%)	85.8	87.1	0.9 (0.5-1.8)	0.448

Source: Schwab et al., *Neurology* , 2007.

Based on these results, the authors concluded that "the safety and effectiveness of systemic thrombolysis by less experienced physicians in community hospitals in a telemedical network under guidance by stroke experts seems to be comparable to that achieved in dedicated stroke centers."[22]

The STRokE DOC project involves the provision of telemedicine from an academic stroke site in San Diego, California to four remote sites located 30 to 350 miles from the academic hub.[23] In a randomised, blinded, prospective study (including 207 patients) published in 2008, the authors assessed whether telemedicine or telephone only was superior for decision making in acute telemedicine consultations. [24] Two groups of acute stroke patients were compared: those who received telemedicine consultation, and those who only received consultation via telephone. The primary outcome measure was to assess whether the decision to give thrombolytic treatment was correct. Secondary outcomes involved 90-day BI and mRS scores, 90-day mortality rates, or post-thrombolytic intracerebral haemorrhages.

The results for both the entire study sample and the sub-group receiving thrombolysis are shown on the following table. Correct treatment decisions were made more often in the telemedicine group (compared to the telephone only group) for both the entire study sample (98% vs. 82%) and those receiving thrombolysis (97% vs. 76%).

[22] Schwab S, Vatankhah B, Kukla C et al. Long-term outcome after thrombolysis in telemedical stroke care. *Neurology.* 2007; 69(9): 898-903.
[23] Meyer BC, Raman R, Hemmen T et al. Efficacy of site-independent telemedicine in the STRokE DOC trial: a randomised, blinded, prospective study. *Lancet Neurology.* 2008; 7(9): 787-95.
[24] Meyer BC, Raman R, Hemmen T et al. Efficacy of site-independent telemedicine in the STRokE DOC trial: a randomised, blinded, prospective study. *Lancet Neurology.* 2008; 7(9): 787-95.

STRokE DOC Trial Outcomes for Telemedicine and Telephone Groups				
Outcome Measure	**Telemedicine**	**Telephone**	**Odds ratio (95% CI)**	**p value**
Overall	n=110	n=111		
Primary outcome: overall correct decision	108 (98%)	91 (82%)	10.9 (2.7-44.6)	0.0009
Overall thrombolytic treatment	31 (28%)	25 (23%)	1.3 (0.7-2.5)	0.42
Overall post-consultation intracerebral hemorrhage	2 (7%)	2 (8%)	0.8 (0.1-6.3)	1
90-day BI score (95-100)	45 (43%)	56 (54%)	0.6 (0.4-1.1)	0.13
90-day mRS score (dichotomised 0-1)	36 (34%)	48 (47%)	0.6 (0.3-1.1)	0.09
Overall mortality	21 (19%)	14 (13%)	1.6 (0.8-3.4)	0.27
Thrombolysis subgroup	n=31	n=25		
Primary outcome: correct decision	30 (97%)	19 (76%)	7.4 (1.0-53.2)	0.05
Post-thrombolytic intracerebral hemorrhage	2 (7%)	2 (8%)	0.8 (0.1-6.3)	1
90-day BI score (95-100)	10 (33%)	12 (48%)	0.5 (0.2-1.6)	0.29
90-day mRS score (dichotomised 0-1)	9 (30%)	8 (32%)	0.9 (0.3-2.9)	1
Subgroup mortality	12 (39%)	3 (12%)	4.6 (1.1-19)	0.03
Mortality adjusted for baseline NIHSS			3.4 (0.6-19)	0.17

Source: Meyer et al.,*The Lancet* , 2008.

The authors note that the apparent lack of outcome benefit for telemedicine may be due to the small sample size (31 thrombolysis patients for telemedicine, 25 for telephone) and to the more severe deficit in the telemedicine group at baseline.

Process of Care

The types of data collected for the purpose of evaluating the process of care for telemedicine in acute stroke vary widely. The most common indicators reported include:

- *Consultation time*. This may be measured as a median duration of teleconsultation, or in terms of the minutes from start of consult to tPA bolus.
- *Door-to-needle time*. This is the time in minutes from presentation of the patient in the emergency department to receiving the tPA bolus. Further time measurements may include time from patient arrival to start of consult; time from symptom onset to patient arrival; and time from symptom onset to tPA bolus. These time intervals are important in answering questions such as: How many patients presented to the emergency department within the 3-hour window of potential tPA use? Did teleconsultation begin within the 3-hour window? Were any patients excluded from tPA treatment due to the length of time required to initiate or complete teleconsultation?

- *Number of patients receiving thrombolysis*. This is an indicator of the patients' access to thrombolysis for acute stroke as a result of telestroke availability. May be expressed as a percentage of all stroke patients, as a percentage of ischemic stroke patients, or as a percentage of ischemic stroke patients arriving at hospital within 2.5 hours of stroke onset. These are indicators used in the Institute for Clinical Evaluative Sciences (ICES) Report on the 2002/03 Ontario Stroke Audit.[25] Although this report was focussed on stroke care in Ontario, and not specifically telestroke, the thrombolysis indicators are still applicable here.

The Ontario Telemedicine Network reported the following data regarding telestroke consultations and tPA administration[26]:

Ontario Telestroke tPA Administration			
	2003-04	2004-05	2005-06
Telestroke consults	22	50	114
Telestroke patients administered tPA	5	17	32
tPA as percentage of all telestroke consults	23%	34%	28%

Source: Integrated Stroke Care in Ontario Stroke Evaluation Report 2006, 2007.

The number of telestroke consults more than doubled each year; the number of telestroke patients administered tPA also increased, though at a slower rate between 04/05 and 05/06, resulting in a decrease in tPA as a percentage of all telestroke consults during this time period.

Some of the evaluation times measured in the STRokE DOC trial are outlined in the table below:

STRokE DOC Evaluation Times			
Stroke timepoint	Telemedicine (mean time, min)	Telephone (mean time, min)	*p* value
Onset to door	163.2, n=77	155.5, n=70	0.35
Onset to decision	258, n=107	230.6, n=109	0.07
Onset to thrombolysis	157.2, n=30	143, n=25	0.14
Door to reading of CT	84.3, n=69	85.4, n=50	0.67
Door to decision	99.8, n=77	95.5, n=69	0.2
Consent to decision	32.0, n=107	22.9, n=107	0.0001
Decision to thrombolysis	10, n=30	15.6, n=24	0.02

Source: Meyer et al.,*The Lancet* , 2008.

Time from consent (written, informed consent for participation in the clinical trial) to decision (recommendation for or against thrombolytic treatment) is essentially the consultation time. Telemedicine consultations took longer than telephone because the patient history was taken, an examination performed, and images reviewed. The authors note that the 10 minute time difference may be justified by the improved decision making of telemedicine compared with telephone consultation.[27] The

[25] Kapral MK, Lindsay MP, Silver FL et al. *Report on the 2002/03 Ontario Stroke Audit*. 2006. Institute for Clinical Evaluative Sciences. Available at http://www.ices.on.ca/file/Stroke_report_June_2006_prelim_baseline.pdf. Accessed October 2008.
[26] Stroke Evaluation Advisory Committee. *Integrated Stroke Care in Ontario Stroke Evaluation Report 2006*. 2007. Heart & Stroke Foundation of Ontario. Available at http://www.strokestrategyseo.ca/pdf_docs/SEAC%20Report%202006.pdf. Accessed October 2008.
[27] Meyer BC, Raman R, Hemmen T et al. Efficacy of site-independent telemedicine in the STRokE DOC trial: a randomised, blinded, prospective study. *Lancet Neurology*. 2008; 7(9): 787-95.

decision to thrombolysis time was shorter for telemedicine, suggesting that "telemedicine might help to quantitatively lessen neuronal loss."[28]

In the TEMPiS study, various time intervals in the process of tPA management were measured, as well as outcomes after tPA treatment for the community hospitals (referring sites) and the stroke centers (consulting sites). A selection of these are summarized in the following table:

Time Intervals and Outcomes for tPA Management in TEMPiS

	Referring sites	Consulting sites	
Time interval	Mean time, min (SD)		*p* Value
Onset to admission	64 (26)	74 (31)	<0.01
Admission to CT time	17 (9)	27 (16)	<0.01
CT to treatment time	51 (22)	34 (22)	<0.01
Admission to treatment time	68 (23)	61 (23)	0.03
Onset to treatment	134 (30)	135 (38)	0.81
Outcome measure	*n=115*	*n=110*	
Mortality within 7 days, n (%; 95% CI)	4 (3.5; 1.0-8.7)	1 (0.9; 0.0-5.0)	0.37
In-hospital mortality, n (%; 95% CI)	4 (3.5; 1.0-8.7)	5 (4.5; 1.5-10.3)	0.74

Source: Audebert et al., *Stroke* , 2006.

The onset to admission time interval is shorter in community hospitals, despite often greater distances to travel in rural areas. The Admission to CT time is shorter in the referring sites, though the CT to treatment time is approximately 17 minutes longer, which the authors note is the average duration of teleconsultations. Overall, the data indicates that the quality of tPA management was similar in the two sites. The low in-hospital mortality rate of 3.5% in referring sites indicates that patients who have received tPA administration are safely managed in these locations, as this is much lower than previously reported mortality rates in German hospitals.[29]

Other indicators that may be used are as follows:

- Percentage of tPA administered within 90 (or 120) minutes from symptom onset
- Protocol violations
- Diagnoses other than stroke
- Avoidance of patient transfer
- Technical problems during consultation

In the TESS project, a total of 153 stroke patients were examined using teleconsultation in seven rural hospitals in southern Germany. The purpose of the

[28] Meyer BC, Raman R, Hemmen T et al. Efficacy of site-independent telemedicine in the STRokE DOC trial: a randomised, blinded, prospective study. *Lancet Neurology.* 2008; 7(9): 787-95.
[29] Audebert HJ, Kukla C, Vatankhah B et al. Comparison of tissue plasminogen activator administration management between Telestroke Network hospitals and academic stroke centers: the Telemedical Pilot Project for Integrative Stroke Care in Bavaria/Germany. *Stroke.* 2006; 37(7): 1822-7.

project was to determine whether telemedicine is feasible in routine stroke management, and whether it could improve stroke care in rural areas. When the emergency physician suspected stroke, teleconsultation was carried out; 26% of patients had diagnoses other than stroke.[30] This indicates how crucial telemedicine can be for neurological assessment of patients and for ensuring they receive appropriate treatment.

Schwamm et al., in a small pilot study of TeleStroke, reported avoidance of patient transfer as a result of teleconsultation in 11 of 24 patients.[31] In this 27-month study, two-way videoconferencing was used by emergency physicians to consult with stroke neurologists in the evaluation of patients with possible acute stroke, and eligibility for tPA treatment was determined.

Technical problems, when reported in the literature, were rare. In the STRokE DOC trial, only one of 111 telemedicine consultations was aborted due to technical failure.[32] However, it is important in evaluating a telemedicine program to track how often technical problems occur, and whether the teleconsultation was delayed or aborted due to these issues.

Qualitative Assessment

Some studies of telemedicine for stroke have included qualitative assessments, often via interviews or questionnaires given to both physician and patient. Areas the physician may be asked to rate are as follows:

- Imaging quality of the patient
- Imaging quality of CT scan
- Audio quality
- Sacrifice of time
- Importance of the teleconsultation for stroke management

Wiborg et al., as part of the TESS project, had both the stroke neurologist and local physician complete a "teleform" (see Appendix B), in which they were asked to give reasons why teleconsultation was not used or why it was delayed. They were also asked to indicate the relevance of the telemedicine contribution to clinical, CT, and ultrasound assessment and to the therapeutic procedures. These results are summarized in the table below.

[30] Wiborg A, Widder B. Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project. *Stroke.* 2003; 34(12): 2951-6.
[31] Schwamm LH, Rosenthal ES, Hirshberg A et al. Virtual TeleStroke support for the emergency department evaluation of acute stroke. *Academic Emergency Medicine.* 2004; 11(11): 1193-7.
[32] Meyer BC, Raman R, Hemmen T et al. Efficacy of site-independent telemedicine in the STRokE DOC trial: a randomised, blinded, prospective study. *Lancet Neurology.* 2008; 7(9): 787-95.

Ratings of Relevance of the Contribution of Teleconsultation to Stroke Management		
	Relevant	
Stroke management category	Neurologist, n (%)	Local physician, n (%)
*Diagnostic work-up**	*135 (88)*	*95 (93)*
Neurological examination	121 (79)	82 (80)
Differential diagnosis	57 (37)	42 (41)
Stroke localization	65 (42)	51 (50)
Additional diagnostic measures	92 (60)	68 (67)
Others	11 (7)	23 (23)
*CT assessment**	*116 (76)*	*78 (76)*
Ischemia vs hemorrhage	48 (31)	48 (47)
Cause of hemorrhage	9 (6)	21 (21)
Cause of ischemia	74 (48)	38 (37)
Early signs	31 (20)	23 (23)
Elevated intracranial pressure	19 (12)	27 (26)
Others	28 (18)	19 (19)
*Therapeutic decisions**	*134 (88)*	*82 (80)*
Thrombolysis	11 (7)	12 (12)
Anticoagulation	106 (69)	58 (57)
Antihypotensive treatment	33 (22)	14 (14)
Antihypertensive treatment	26 (17)	25 (25)
ICU	6 (4)	6 (6)
Transfer stroke center	8 (5)	11 (11)
Neurosurgery	12 (8)	12 (12)
Vascular surgery	1 (1)	1 (1)
Others	24 (16)	11 (11)

*At least once rated "relevant" throughout the category.

Source: Wiborg et al., *Stroke* , 2003.

In most cases, ratings of relevance by the neurologist and the physician were similar. If the ratings were different, it was usually the local physician who found some relevance in the teleconsultation, while the neurologist did not. The physicians and neurologists also rated the imaging and audio quality, the time required for telemedicine, and the patient's satisfaction. Both the neurologists and the local physicians rated the contribution of the teleconsultation as important for stroke management in the majority of cases.[33]

Questions for the patient may include:

- How content were you with the examination?
- How easy was it for you to speak with the doctor on the screen?

[33] Wiborg A, Widder B. Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project. *Stroke.* 2003; 34(12): 2951-6.

- Was it on a par with a face-to-face consultation?

In the BC Telehealth Program Final Evaluation Report, attitudes and perspectives of patients and family members towards the use of video-conferencing in clinical consults were surveyed.[34] There were 27 phone interviews conducted using a standardized set of questions (refer to Appendix C). Interview respondents had received teleconsultation for various clinical applications, including oncology follow-up, foetal ultrasound, and cardiology. They were asked to rate their satisfaction with the video-conference experience, whether they would repeat the experience, and how it compared to a face-to-face consult. A series of questions were also posed related to travel avoidance and associated costs. In the largest subset of interviewees – oncology follow-up – the 13 clients ranged in age from 7-22 years. Males aged 13 and older (4 interviewees) consistently had the lowest satisfaction rating, citing the impersonal feeling of the telehealth session as well as privacy concerns. All but two of the 13 clients, however, indicated that they would choose to repeat the experience. In other interviewee subsets, the avoidance of potentially expensive travel was considered a key benefit to the telehealth consult, as well as receiving diagnostic information earlier than would have been possible otherwise.

Lamonte et al. reported that all patients who participated in their telemedicine consultations expressed positive statements regarding the technology, and that the picture of the "live" stroke specialist was reassuring during the critical phase of treatment.[35] The TESS Project found that patient satisfaction was good or very good in all cases.[36]

[34] *BC Telehealth Program Final Evaluation Report*. 2003. Available at http://hinf.uvic.ca/archives/t_health.pdf. Accessed August 2008.
[35] LaMonte MP, Bahouth MN, Hu P et al. Telemedicine for acute stroke: triumphs and pitfalls. *Stroke.* 2003; 34(3): 725-8.
[36] Wiborg A, Widder B. Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project. *Stroke.* 2003; 34(12): 2951-6.

Lessons Learned

Within the studies discussed in this document, and indeed throughout the literature on telemedicine, there is a consensus that telemedicine for stroke is a safe, effective, and time-saving means of providing quality care to the stroke patient. In many studies, the use of thrombolytic therapy was increased as a result of telestroke, and broadened to rural areas that otherwise would not have had access to it. Increasing the proportion of patients receiving this therapy is an objective common to most telestroke networks.

There are several factors to which the success of telestroke projects is often attributed. A recurring theme in many of these projects is the importance of ongoing stroke education for physicians in both the referring and consulting sites. High employee turnover in the emergency department was also noted, highlighting the need for refresher courses and orientation for new staff in order to maintain competencies with telestroke technology. Another facet to the education theme is the need to increase public awareness of stroke symptoms and pre-hospital stroke care; this is an essential component of strategies for increasing the proportion of patients receiving thrombolytic therapy.

A second factor in the success of telestroke programs is the commitment of neurologists/specialty consultants to using the technology, and their immediate response when they are called upon to consult. The lack of 24-hour availability of neurologists was cited as a downfall to one telestroke program, and it was suggested that real-time linkage of the referring site to these specialists at any location (home or hospital) would be optimal.

Summary and Recommendations

The fundamental importance of prompt therapy for stroke has led to the exploration of strategies for the optimization of patient outcomes. These include community-based education programs, designated stroke centres, and telemedicine for stroke (telestroke). The primary benefit of telestroke is the provision of specialty resources not available at a community hospital. It allows for early identification of stroke patients, optimization of initial medical management, and early evaluation of symptoms.

Assessment of the effectiveness of a telestroke program requires identification of indicators for measurement. NTOIP outcome indicators and NIFTE clinical outcome indicators for telemedicine are presented in this document. For the purposes of summarizing studies of telestroke in the literature, indicators were categorized under Health Outcomes, Process of Care, and Qualitative Assessment. The following are potential indicators recommended for use in evaluating a B.C. telestroke program:

Category	Recommended Indicator
Health Outcomes	3-month mortality rate 6-month mortality rate post-consultation intracerebral hemorrhage 3-month modified Rankin Scale and Barthel Index 6-month modified Rankin Scale and Barthel Index
Process of Care	Number of telestroke consults Number of patients receiving thrombolysis % of all telestroke consults % of all stroke patients % of ischemic stroke patients % of ischemic stroke patients arriving at hospital within 2.5 hours of symptom onset % administered within 90 minutes from symptom onset Time intervals Teleconsultation time Door-to-needle time Door-to-CT time Symptom onset to needle time Protocol violations Diagnoses other than stroke Avoidance of patient transfer Technical problems during teleconsultation Number of consult delays Number of consults aborted
Qualitative Assessment	Ratings by physician/nurse Imaging quality Audio quality Sacrifice of time Importance for stroke management Ratings by patient Satisfaction Ease of communication Comparable to face-to-face consultation

Appendices

Appendix A: NTOIP Framework Example

Q2: Health Status (Individual) - Assessed		
#	**Element**	**Description**
1	Indicator	Health Status (Individual) - Assessed
2	Purpose of Indicator	To objectively assess the state of health of an individual by a health care professional.
3	Characteristics Specificity Perspective Time Frame Outcome Relationship	 Generic Health care professional Cross sectional or Longitudinal Distal, Direct
4	Definition	The state of health of an individual as assessed by a health care professional
5	Rationale	Positive changes in the health state of an individual as a result of a telehealth intervention provide strong devidence of the effectiveness of telehealth.
6	Potential Uses	1. This indicator has not been identifed to have value in other NTOIP themes and therefore has only one use in QUALITY 2. National, Provincial, Territorial or Regional policy makers; Decision makers (Health Care Managers and Clinicians) 3. 'Health Status (individual) - Assessed' may be used in conjunction with, or as an alternative to 'Health Status (individual) - Self reported'.
7	Possible Confounders	Health behaviour of patients; age
8	Data Sources	1. Survey assessment at the time of the encounter 2. Survey assessment at the discrete and appropriate time after the encounter.
9	Data Quality	Both subjective and objective measures will be of value.
10	Outcome Measures	1. Number of sick days
11	Outcome Tool	1. Physical Global Health Assessment
12	Comments	• CREAM: clinical, research, education • This indicator provides the opportunity to extrapolate individual data to a larger study group. • Conceptually, health status is the proper outcome measure for the effectiveness of a specific population's medical care system, although attempts to relate effects of available medical care to variations in health status have proved difficult[1].
13	Conclusion	
14	Further Work Required	Clear identification and description of suitable measures and tools is highly desirable.
15	Priority for Implementation	High priority
16	Additional Resources	1. http://www.academyhealth.org/publications/glossary.htm

Appendix B: Teleform from the TESS Project

To be filled out immediately after teleconsultation, or after admission of stroke patients if teleconsultation was not performed.

Category	Items	Possible Ratings	Filled Out By
No immediate teleconsultation because of….	• Clear diagnostic situation • Clear CT scan • No additional therapeutic consequences because of patient's state • No time for teleconsultation • Others	Multiple choice (multiple reasons possible)	Local physician
Teleconsultation at a later time point because of….	• Secondary worsening • Wish to clarify further procedure • Technical problems • Patient in too bad a state on admission • Others	Multiple choice (multiple reasons possible)	Local physician
Questions to teleconsultation			
Diagnostic work-up	• Assessment of neurological status; differential diagnostic considerations; stroke localization (anterior or posterior circulation); discussion of additional diagnostic procedures; others	"Relevant" or "moderately relevant" or "not relevant" for each item	Local physician and stroke expert
CT assessment	• Differentiation ischemia-hemorrhage; differentiation cause of hemorrhage; differentiation ischemia (territorial, lacunar, hemodynamic); early signs; elevated intracranial pressure?; others		
Ultrasound assessment	• Extracranial stenosis/occlusion; intracranial stenosis/occlusion; others		
Therapeutic procedures	• Thrombolysis; anticoagulation, antiplatelets; anti-hypotensive treatment; anti-hypertensive treatment; intensive care unit necessary; transport to stroke unit; neurosurgery; vascular surgery; others		
Rating of teleconsultation quality	1. Imaging quality of the patient 2. Imaging quality of CT scan 3. Audio quality 4. Sacrifice of time *For patients only (if possible):* 1. How content have you been with the examination? 2. How easy was it for you to speak to the doctor on the screen?	From 1=very good to 5=very bad	1 & 2: only stroke expert 3 & 4: stroke expert and local physician
Source: Wiborg et al., *Stroke*, 2003.			

Appendix C: Client/Family Interview Questions from the BC Telehealth Program Final Evaluation Report

Telephone interviews with Maternal/Child/Palliative care patients were conducted by a member of the evaluation team to obtain their attitudes and perspectives toward the use of video-conferencing in clinical consults. [37]

1. How did you hear about the possibility of using the telehealth video-conferencing system?
2. What was the nature of your video-conferencing session?

   Clinical Consultation, Family Visit, Other
3. Who suggested the idea of a consultation by video-conference?
4. If the consult was of a clinical nature, is this a newly diagnosed condition?
5. What options would have been available to you if the telehealth video-conferencing service was not available?

   Travel to another location, Other
6. What would have been the personal and social costs attached to the alternatives?

   If travel:

   - Destination of travel
   - Mode of transport
   - Who would travel
   - Length and means of stay
   - Approximate cost of stay
   - Special arrangements needed at home to accommodate the travel
   - Special arrangements regarding employment
   - Extraneous/Other costs
7. What is your overall level of satisfaction with the video-conferencing session (1 – low; 5 – high)?
8. Were you given adequate information at the start of the session to understand the process/flow of the session?
9. During the video-conference could you adequately hear and see the off-site participants?
10. Did you feel uncomfortable with any aspects of the video-conferencing experience?
11. How did the video-conference compare to a face-to-face consultation?
12. Did it impact your waiting time for relevant/appropriate information?
13. What aspects of the video-conference did you particularly dislike or enjoy?
14. Would you choose to repeat the video-conferencing experience?
15. How could your video-conferencing experience have been made better?

[37] *BC Telehealth Program Final Evaluation Report*. 2003. Available at http://hinf.uvic.ca/archives/t_health.pdf. Accessed August 2008.