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Canadian Stroke Best Practice Recommendations: Telestroke Best Practice Guidelines Update 2017

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Abstract

Every year, approximately 62,000 people with stroke and transient ischemic attack are treated in Canadian hospitals. The 2016 update of the Canadian Stroke Best Practice Recommendations *Telestroke* guideline is a comprehensive summary of current evidence-based and consensus-based recommendations appropriate for use by all healthcare providers and system planners who organize and provide care to patients following stroke across a broad range of settings. These recommendations focus on the use of telemedicine technologies to rapidly identify and treat appropriate patients with acute thrombolytic therapies in hospitals without stroke specialized expertise; select patients who require to immediate transfer to stroke centers for Endovascular Therapy; and for the patients who remain in community hospitals to facilitate their care on a stroke unit and provide remote access to stroke prevention and rehabilitation services. While these latter areas of Telestroke application are newer, they are rapidly developing, with new opportunities that are yet unrealized. Virtual rehabilitation therapies offer patients the opportunity to participate in rehabilitation therapies, supervised by physical and occupational therapists. While not without its limitations (e.g., access to telecommunications in remote areas, fragmentation of care), the evidence-to-date sets the foundation for improving access to care and management for patients during both the acute phase and now through post stroke recovery.

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Introduction

Telemedicine, a method of healthcare delivery and support using telecommunication technologies, is becoming increasingly popular across a wide range of health conditions. Telemedicine adapts a variety of technologies and tactics, such as videoconferencing and mobile phone applications, to deliver virtual medical, health, and educational services. In Canada, the number of telemedicine visits increased by 46% between 2010 and 2014 across a wide range of services, most notably among mental health, neurology, oncology, pediatrics, and rehabilitation services.[1]

The benefits of telemedicine may best be captured in the area of stroke, where radiological interpretation and complex therapies must be initiated shortly after stroke onset to avoid potentially disabling or fatal outcomes. The specialized expertise required to provide advanced stroke care is generally limited to larger communities and urban areas, and patients living outside these boundaries in the past did not have access to this care. In Canada, issues of access are especially challenging due to the low population density of many regions. Accordingly, Telestroke becomes especially important in the many communities without neurologists or other physicians with expertise in stroke care including stroke rehabilitation and recovery. In the area of stroke, telemedicine is intended to support equal and timely access to optimal stroke services across the care continuum and across geographic regions. This includes providing guidance and support for the administration of thrombolysis, rehabilitation therapies, secondary prevention support, and monitoring, and has been used to support the provision of homecare.

The use of remote telecommunications in stroke care, referred as *Telestroke*, was initially viewed as a means to increase access to a time-sensitive acute thrombolysis treatment that was only available in specialized facilities in large, urban hospitals. Telestroke offers the ability to link rural hospitals and those with lower numbers of stroke admissions with regional acute stroke centers. With the recent emergence of acute endovascular treatment for large vessel occlusion, the value and essential role of Telestroke in the first hours of stroke has been amplified. In the past 20 years, the use of Telestroke has grown, in part, due to improvement in telecommunications capacity (speed and coverage) and has become more mainstream. Consequently, Telestroke has grown beyond its initial use as a means to increase access to hyperacute thrombolytic therapy. Improved quality and availability of technology has made the delivery of cross-continuum services possible within a variety of facilities and practice settings throughout Canada. This technology has been a major driver and opportunity for bridging the gap in access to equitable stroke services regardless of geographic location. The current challenge is to expand the use of this technology, given that it is significantly under-utilized in the management of patients who have experienced a stroke and their family members.

The 2017 update of the Canadian Stroke Best Practice Recommendations *Telestroke* guidelines includes a comprehensive summary of current evidence-based recommendations appropriate for use by healthcare professionals across all disciplines that provide care to patients following stroke across a broad range of settings. They also support health system planners and decision-makers in building systems that ensure timely accessibility to evidence-based care. The focus of these recommendations is on the use of Telestroke systems to increase access to acute thrombolysis for patients who may not live close to a specialized stroke center, decision-making support for potential acute endovascular treatment candidates, and the use of Telestroke to support stroke prevention and rehabilitation services. The evidence related to the use of Telestroke systems was reviewed and a previously developed set of clinical practice recommendations was updated in this sixth iteration by the *Canadian Stroke Best Practices Telestroke* writing group. Additional supporting information on creating a Telestroke program (preparation and readiness, infrastructure development, implementation and evaluation, rationale, and implications for system planning) and the Telestroke Resource Toolkit may be found at www.strokebestpractices.ca. As this is an area that is rapidly evolving, the literature in this area is continually monitored and these guidelines will be updated again in three years' time.

Guideline development methodology

The *Canadian Stroke Best Practice Recommendations* development and update process follows a rigorous framework adapted from the Practice Guideline Evaluation and Adaptation Cycle and current guideline update methods.[2,3] An interprofessional group of experts was convened to review, draft, and update all

recommendation statements. Members with extensive experience in telestroke were selected as were those who are considered leaders and experts in their field, having been involved in research on the topics addressed in this module. Persons with experience in the review and appraisal of research evidence and individuals (or family members of individuals) who had experienced a stroke were also included either as group members or external reviewers in the development process. The interprofessional writing group and external reviewers include stroke neurologists, nurses, family physicians, emergency department clinicians, Telestroke technical experts, epidemiologists, care coordinators, and health system planners. These experts work in a wide range of healthcare settings. This interprofessional approach ensured that the perspectives and nuances of all relevant health disciplines and care settings were considered in the development of the recommendations, and mitigated the risk of potential or real conflicts of interest from individual members.

A comprehensive systematic literature search was conducted to identify research evidence on the establishment of Telestroke systems and use of Telestroke across the continuum. The literature searches were conducted by an author (NF) with expertise performing systematic literature reviews, who was not directly involved in active research within any of the identified topic areas to promote objective identification and selection of evidence. Literature searches include set time frames which overlap the search time frames associated with the previous revision of the best practice recommendations by six months to ensure high catchment of key articles within that time frame. The literature for this module is updated to August 2016.

The writing group was provided with comprehensive evidence tables that included summaries of all high-quality evidence identified through the literature searches. Systematic reviews, meta-analyses, randomized controlled trials, and observational studies were included, where available. The writing group discussed and debated the value of the evidence and, through consensus, developed a set of proposed recommendations. Through their discussions, additional research may have been identified and added to the evidence tables, if consensus on the value of the research was achieved.

All recommendations are assigned a level of evidence ranging from A to C, according to the criteria defined in Table 1.[4,5] When developing and including "C-Level" recommendations, consensus was obtained within the writing group and validated through the internal and external review process. This level of evidence is used cautiously and only when there is a lack of stronger evidence for topics considered important system drivers for stroke care (e.g., protocol development for Telestroke systems). Telestroke is still an emerging area; many topics that were considered important to provide a comprehensive and useful guide to implementing Telestroke lack substantial evidence and therefore relied on expert opinion and the consensus of the writing group and external reviewers. In some sections, additional information was identified as important to include, even though it did not meet the evidence criteria for a "recommendation." This information has been included as "clinical considerations" intended to provide additional guidance or clarity in the absence of evidence.[4]

After completion of the draft update to the recommendations, the module underwent an internal review by the Canadian Stroke Best Practices Advisory Committee and an external review by experts who were not involved in any aspects of the guideline development. All feedback was reviewed and addressed by the writing group members and the advisory committee to ensure a balanced approach to addressing suggested edits.

Table 1. Summary of criteria for levels of evidence reported in the *Canadian Stroke Best Practice Recommendations* (Update 2017).[5]

Level of evidence	Criteria
A	Evidence from a meta-analysis of randomized controlled trials or consistent findings from two or more randomized controlled trials. Desirable effects clearly outweigh undesirable effects or undesirable effects clearly outweigh desirable effects.
B	Evidence from a single randomized controlled trial or consistent findings from two or more well-designed non-randomized and/or non-controlled trials, and large observational studies. Desirable effects outweigh or are closely balanced with undesirable effects or undesirable effects outweigh or are closely balanced with desirable effects.
C	Writing group consensus and/or supported by limited research evidence. Desirable effects outweigh or are closely balanced with undesirable effects or undesirable effects outweigh or are closely balanced with desirable effects, as determined by writing group consensus. Recommendations assigned a Level-C evidence may be key system drivers supporting other recommendations, and some may be expert opinion based on common, new or emerging evidence or practice patterns.

All recommendations are accompanied by additional supporting information, including a rationale for inclusion of the topics, system implications to ensure the structural elements and resources are available to achieve recommended levels of care, performance measures to monitor care delivery and patient outcomes, as well as implementation resources and a summary of the evidence on which the recommendations were based. The evidence tables are available as well. All of this additional supporting information for the recommendations included in this publication can be found at http://www.strokebestpractices.ca/index.php/Telestroke/

For a more detailed description of the methodology on development and dissemination please refer to the *Canadian Stroke Best Practice Recommendations* Overview and Methodology documentation available on the Canadian stroke best practices website at http://www.strokebestpractices.ca/wp-content/uploads/2014/08/CSBPR2014_ Overview_Methodology_ENG.pdf[4]

Canadian Stroke Best Practice Recommendations: Telestroke best practice guidelines update 2017

The following sections provide detailed recommendations associated with the organization of Telestroke systems, for both the hyperacute phase of stroke and for ongoing stroke assessment and management, as well as staff training and ongoing education. All recommendations are assigned a level of evidence which reflects the strength and quality of the evidence available to support the recommendations as determined through consensus of the writing group and validated through the external review process.

Section 1: Organization of Telestroke services for hyperacute stroke management

Telestroke is used in the emergency department to increase access to acute thrombolytic treatment at facilities that lack 24 h, 7 days a week onsite stroke expertise, using 2-way audiovisual equipment to carry out a detailed stroke examination, combined with a system to reliably transmit Computerized Tomography (CT) scan results.[6] The safety, feasibility, and efficacy of the traditional ''spoke and hub'' model, which connects a tertiary stroke center (the spoke) to one or more distant primary care centers (the hub), has been established in many studies conducted in Europe and North America.[7–12] The use of Telestroke systems enables improved communication and better networking to increase access to stroke expertise, regardless of the physical location of the treating hospital (facility) and the patient's location. In the hyperacute setting, the short therapeutic time window for initiating thrombolytic therapy for acute ischemic stroke patients does not allow them to be transported long distances to regional stroke centers. Debate continues as to whether the outcomes of patients who are treated with thrombolytic therapy at hub hospitals are similar to patients treated with the same therapy via Telestroke at ''spoke'' hospitals.[13,14] There is also debate whether outcomes could be improved in patients receiving thrombolytic therapy at ''spoke'' hospitals should stay (drip and stay) or be immediately transferred, after commencing therapy, to the comprehensive or regional stroke center (drip and ship). Many spoke hospitals using Telestroke do not have a formalized acute stroke unit, whereas hub hospitals all do, and there is strong evidence that care in a stroke unit has a significant positive impact on outcomes.[15] Patients assessed by a stroke expert through a Telestroke system who are not candidates for thrombolytic therapy still benefit from the stroke specialist's assessment and recommendations regarding appropriate investigations and treatment, which include early triage and management of transient ischemic attack and minor stroke patients.

As Telestroke systems have expanded over the past decade, there is evidence to suggest that they have become more efficient.[16,17] The improvements in process times reported in one study[17] were attributed in part, to better communication, regional expertise engagement, and staff experience. More recently, another approach has been the development of mobile stroke units, which are ambulances equipped with point-of-care blood tests and CT imaging and staffed with specially trained nurses, paramedics, and physicians. The results from several studies indicate that the time from symptom onset to treatment with intravenous thrombolytic agents is significantly shorter compared with patients arriving by regular ambulance.[18,19] This strategy is only feasible in large urban centers where there are high volumes of patients and it is not an option for rural communities. In Canada, the first mobile stroke unit, located in Edmonton, Alberta, was launched in February 2017.

In 2015, the results of five randomized controlled trials demonstrated the effectiveness of mechanical thrombectomy in the management of acute ischemic stroke for a subgroup of patients with large proximal arterial occlusions.[20] Mechanical thrombectomy or Endovascular Therapy (EVT) is the new standard of care for these patients. EVT is generally only available in comprehensive stroke centers, further limiting access to optimal care for acute stroke care. Telestroke will have a pivotal role in the selection of patients who may benefit from EVT and require rapid transfer to a comprehensive stroke center by providing the

Telestroke physician the ability to remotely review both the patient and their imaging to aid decision-making.

Challenges related to the adoption of Telestroke systems for hyperacute management include issues related to staffing and reimbursement. The results from several studies suggest that while Telestroke systems may be cost-effective from the perspective of hospital who are requesting assistance (i.e., the spoke centers) for the hub hospital (those providing the specialized services remotely), the system is not cost-effective. In Canada, with a single-payer health insurance system, Telestroke may represent a cost-effective tool to support health systems in closing the urban/rural and tertiary/primary care gap.

Section 1. Recommendations:

Organization of Telestroke services for hyperacute stroke management

Telestroke care delivery modalities should be integrated into stroke care planning and service delivery across the continuum to ensure equitable access to care across geographic regions in Canada (Evidence Level C).

(i) Telestroke networks should be implemented to provide access to stroke expert consultations for hyperacute and acute stroke assessment, diagnosis, and treatment, including acute thrombolytic therapy with tissue plasminogen activator (tPA) and decision-making for endovascular therapy (Evidence Level B).
   a. Telestroke modalities including video-conferencing and teleradiology systems may be considered to support screening and decision-making regarding candidacy for endovascular therapy in appropriate cases and to facilitate transfer to endovascular-enabled stroke centers (Evidence Level B).
   b. Consulting and referring sites require processes in place to ensure access to stroke experts through Telestroke modalities, available 24 h a day, seven days a week to provide equitable access to stroke care across geographic regions in Canada (Evidence Level B).

(ii) Standardized, time-driven protocols are required for a coordinated and efficient approach to Telestroke service delivery in the hyperacute phase of stroke to facilitate delivery of advanced stroke therapies in referring sites (Evidence Level B). Refer to Telestroke Resource Toolkit (online supplementary material) for additional details at http://www.strokebestpractices.ca/index.php/telestroke/.

(iii) Clearly defined criteria and protocols are required at referring sites to guide the Telestroke consultation process (Evidence Level B). This referral system should be part of a coordinated system of stroke care. Refer to Telestroke Resource Toolkit (online supplementary material) for additional details and examples.

(iv) The consultant should be a physician with specialized training in hyperacute stroke management, and must have timely access to diagnostic-quality neurovascular (e.g., brain CT, CTA) images during the Telestroke consultation (Evidence Level A). Refer to Telestroke Resource Toolkit Technical section (online supplementary material) for additional details.
Note: The decision to use acute stroke therapies in emergency management requires imaging to rule out hemorrhage. Refer to CSBPR Hyperacute Stroke Care module for additional information regarding imaging and t-PA administration.

(v) Real-time two-way audiovisual communication should be in place to enable remote clinical assessment of the patient by the consulting stroke expert (Evidence Level B).
   a. The benefits of telephone consultation without video are not well-established (Evidence Level C).

(vi) All laboratory and diagnostic results required by the consultant should be made readily available during the Telestroke consultation (Evidence Level B).

(vii) Referring physicians should follow an established protocol or algorithm which describes the critical steps and inclusion/exclusion criteria for recanalization therapies, which are agreed upon by both referring and consulting sites (Evidence Level A). *Refer to CSBPR Hyperacute Stroke Care module recommendations 3 and 4 for additional information.*

(viii) Referring physician and nursing staff who may be involved in acute Telestroke consultations should ideally be trained in administration of the National Institute of Health Stroke Scale (NIHSS), to efficiently and competently assist the Telestroke consultant with the remote video neurological examination (Evidence Level B).

(ix) The most responsible physician remains the attending physician at the referring site. Decision-making is a consensus process that is achieved in consultation with the attending medical staff at the referring site, the patient and family, and the consulting physician with stroke expertise (Evidence Level C).

(x) A consulting physician may be required to provide ongoing guidance to the referring site following initial consultation and should be accessible (Evidence Level C).

(xi) Protocols should be in place to define patient transfer criteria to a more advanced stroke care facility when clinically indicated (e.g., endovascular (if available) and neurosurgical intervention) (Evidence Level C).

a. The Telestroke system should identify the stroke centers that are able to provide endovascular and neurosurgical care (Evidence Level C).
b. For patients who are deemed eligible for endovascular treatment or neurosurgical interventions, protocols should be in place to define the process for patient transfer (Evidence Level C).

(xii) Standardized documentation should be considered for both the referring site and the consulting site (in accordance to hospital processes, jurisdictional legislation, and regulatory bodies) (Evidence Level C). This may include:
a. A consultation note provided by the consulting physician to the referring site at the completion of the consultation to be included in the patient medical record (Evidence Level C).
b. A discharge summary sent by the referring site to the consulting Telestroke physician to provide feedback about the patient's outcome (Evidence Level C).
c. Data related to the Telestroke consultation and outcome captured and collected by the Telestroke program for continuing quality improvement (Evidence Level C).
d. For patients that are transferred to another hospital (e.g., "drip and ship"), a discharge summary from the receiving hospital to the referring physician and the Telestroke physician (Evidence Level C).

Section 2: Organization of Telestroke services for ongoing stroke assessment and management

While Telestroke, until now, has offered the greatest opportunities for emergent acute stroke management, these technologies can also be used to facilitate stroke rehabilitation therapies, secondary prevention, and home-based monitoring. All of these areas experience significant access issues due to both geographic factors and availability of appropriate expertise. The largest body of evidence is related to the use of telemedicine for rehabilitation. The feasibility and effectiveness of Telestroke in the context of rehabilitation therapy is often referred to as "telerehabilitation" or "telerehab." Interventions examined in these studies were those designed to improve mobility, balance, and upper extremity motor function. The results of these yielded ambiguous results.[21–25] In particular, the results from two systematic reviews,[24,25] which were both negative, may be problematic to interpret largely due to the variability in treatment contrasts. Interventions provided in the included studies, 7 and 10, respectively, were delivered by virtual reality, phone, and internet-based therapies. Although the authors of the Cochrane review[24] reported no significant differences between groups in upper limb function or performance in activities of daily living, they concluded that there was insufficient evidence to support or refute the effectiveness of telerehabilitation following stroke. Chumbler et al.[26,27] evaluated the effectiveness of a Stroke Telerehabilitation program, which focused on improvement of functional mobility. At six months post intervention, there were no significant differences in measures of disability and frequency of falls, between groups; however, there was a significant difference in the mean Stroke-specific Patient Satisfaction with Care Scale (hospital care sub score), favoring the Stroke Telerehabilitation program group. The feasibility of a self-management program, Moving On after Stroke, was evaluated, which used videoconferencing to link rurally based participants and their caregivers with facilitators located at an urban site.[28] There were a few technical difficulties, which were resolved quickly. Participants in both groups reported satisfaction with the program.

There is a paucity of evidence related to telemedicine for secondary prevention of stroke, although in Canada and in other regions, access to stroke prevention through Telestroke technology has significantly increased access to ongoing prevention monitoring and management for patients living in more rural and remote areas (e.g., in Saskatchewan). These programs have yielded high ratings of both patient and provider satisfaction.

Section 2. Recommendations:

Organization of Telestroke services for ongoing stroke assessment and management

(i) Telestroke services should be part of an integrated stroke services delivery plan that addresses hyperacute stroke care, acute stroke care, stroke prevention, rehabilitation, home-based, and ambulatory care to support optimal patient recovery and family support regardless of geographic location (Evidence Level C).

(ii) Telehealth enabling technologies, including real-time two-way video-conferencing with or without medical peripheral devices and potentially asynchronous (store-forward) tools, such as an e-referral system for non-urgent consultations and remote patient monitoring devices, can be used to enable consultations and/or service delivery regarding:

a. Optimal in-hospital stroke care (virtual stroke unit) including medical decision making and rehabilitation treatment (Evidence Level C).
b. Stroke rehabilitation services (Telestroke-rehabilitation), where all rehabilitation disciplines should consider the use of telemedicine technology for patient assessment and clinical therapies (e.g., exercise monitoring and intensity adjustments, speech therapies for aphasia) (Evidence Level C).
c. Secondary prevention consultation and follow-up services (virtual neurovascular clinic or stroke prevention clinic) in communities where these services do not exist (Evidence Level A).
d. Home-based patient monitoring through web-based applications may be considered as an alternative to face-to-face clinic visits in instances where frequent patient monitoring is necessary, such as for out-patient rehabilitation services (Evidence Level C).
e. Patients with reduced mobility in long-term care facilities, or those living at a prohibitive distance from the clinic/hospital (Evidence Level C).

(iii) Clearly defined criteria and protocols or algorithms should be available for referring sites to determine when and how to access these rehabilitation, prevention, and ambulatory services for stroke patients (Evidence Level B).
(iv) The consulting healthcare provider may provide documentation to the referring site to be included in the patient medical record, regarding patient progress, treatment plans, plans for ongoing follow-up, and discharge recommendations (in accordance with clinical care processes, organizational requirements, jurisdictional legislation, and regulatory bodies) (Evidence Level C).

Section 3: Staff training and ongoing education

While the need for staff training and development for acute stroke and use of Telestroke technologies are recognized in several guideline statements, evidence in support of the recommendation is lacking. A scientific statement from the American Heart Association/American Stroke Association[6] indicates that investments in staff training and education may be helpful in increasing the use of intravenous tPA at community hospitals without access to adequate onsite stroke expertise. The *iTREAT* study[29] included 27 simulations in which actors portrayed four scripted stroke scenarios in two settings (in hospital bed and remotely in Telestroke-equipped ambulance) and were assessed by two neurologists who completed NIHSS. The intraclass correlation for all simulations combined was excellent (0.96, 95% CI 0.92–0.98). Despite the paucity of evidence evaluating the impact of staff training and ongoing education related to telemedicine, utilization of Telestroke should occur in combination with continuous staff training and education.

Section 3. Recommendations:

Staff training and ongoing education

(i) It is recommended that Telestroke care providers attain and maintain the necessary competencies required in telemedicine in order to provide safe, competent care and to create a satisfactory telehealth encounter for both the patient and the healthcare provider (Evidence Level C).
(ii) Referring and consulting service providers should be trained in using the Telestroke system and understand their roles and responsibilities for technical and clinical aspects of a Telestroke consultation (Evidence Level C).
(iii) Training should include physicians, nurses, therapists, and any support staff (such as members of technology department), who may be involved in any Telestroke consultation or therapy appointment (Evidence Level C).
(iv) Ongoing Telestroke training and education with a regular update cycle is useful to ensure competency of providers (Evidence Level C). Refer to Telestroke Resource Toolkit Technical section (online supplementary material) for additional information and resources for staff training.
(v) Consulting physicians and other healthcare professionals involved in Telestroke consults should have expertise and experience in managing stroke patients (Evidence Level C).
(vi) Continuing education in online and face-to-face formats is useful to ensure remote-based practitioners have access to ongoing education (Evidence Level C).
(vii) Mock patients simulations may be helpful, especially for hyperacute Telestroke care for new sites, and where the ongoing number of cases is low (Evidence Level C).

Clinical considerations

There were several issues raised by the writing group that lacked evidence to be included in the recommendations section. Some of these issues were deemed important in the development and successful implementation of Telestroke systems, and were therefore included in a new section for 2017 entitled Clinical Considerations. Ensuring the equipment is accessible, straightforward to use without extensive training, and always in working order are drivers of successful Telestroke encounters. In addition, protection of personal health information is paramount in any clinical setting, and lack of secured systems for transmitting patient information has been another barrier to adoption and success of Telestroke services.

recommendations for optimal investigations and treatment. This includes early triage and management of transient ischemic attack and minor stroke patients. With the emergence of acute EVT, a further important role for Telestroke is the ability of the Telestroke physician to select appropriate patients that can be transferred for EVT. Barriers to Telestroke include reimbursement agreements, infrastructure, staffing, training, partnership development, fragmentation of care and lack of coordination,[30] and limited internet access for some people living in rural areas (digital divide). Whether the use of Telestroke for the purposes of providing hyperacute care can reduce costs is an ongoing debate. All stroke systems should consider Telestroke services across the continuum of care when planning and improving patient access and outcomes.

Clinical considerations (New for 2017)

(i) Routine checks of Telestroke equipment (both video-conferencing and imaging systems such as PACS) ensure that in an emergency situation, the equipment is functioning well. This may be done as part of routine checks on other emergency equipment (such as crash carts). Some systems may have a back-up system or alarms for abnormal functioning equipment, but this varies by sites.

(ii) Where electronic health records are available, health information sharing regulations should be developed to allow sharing of an individual patient's record at both sending and receiving facilities in ways that comply with provincial/federal privacy legislation.

(iii) Efforts should be made to ensure that the telestroke technology is designed with ease of use and simplicity of operation in mind to facilitate adoption of the technology and to decrease the time required to meet educational requirements.

Summary

The 2017 update of the *Canadian Telestroke Best Practice Recommendations* provide a common set of guiding principles for establishing, implementing, and monitoring Telestroke services. The recommendations continue to be a work in progress and are regularly updated every two to three years in order to integrate newly released data to help maximize patient outcomes from this disabling disease.

Telestroke enables improved communication and better networking to increase access to stroke expertise, regardless of the physical location of the treating hospital (facility) and the patient's location. In the hyperacute setting, the short therapeutic time window for initiating thrombolytic therapy for acute ischemic stroke patients does not allow them to be transported long distances to regional stroke centers. Telestroke brings an experienced stroke consultant into the local emergency department "virtually." Patients assessed by a stroke expert through the Telestroke system who are not deemed to be candidates for tPA or acute EVT may still benefit from the stroke specialist's assessment and

Author Contributions

Dylan Blacquiere (first author) and Frank L Silver (senior author) co-chaired the *Telestroke* expert writing group and are lead authors contributing to all aspects of the development, data analysis, writing, editing, and final approval of this manuscript; M Patrice Lindsay is corresponding author, and senior editor of the Canadian Stroke Best Practice Guidelines and this manuscript, and writer of supplementary documentation. Norine Foley and Sanjit Bhogal conducted the evidence searches and completed the evidence tables and evidence summaries supporting this guideline update, and contributed to the writing and editing of this manuscript. Colleen Taralson, Susan Alcock, Catherine Balg, Julie Cole, Marsha Eustace, Patricia Gallagher, Antoinette Ghanem, Alexander Hoechsmann, Gary Hunter, Khurshid Khan, Alier Marrero, Brian Moses, Kelley Rayner, Andrew Samis, and Marilyn Vibe are all members of the *Telestroke* expert writing group and contributed by reviewing, analyzing, and discussing the evidence and collectively finalizing the wording of all the recommendations; Dar Dowlatshahi and Gord Gubitz are senior advisors to the writing group and contributed significantly to the methodology and recommendation development and provided review and edits to this manuscript. Stephen Phillips provided extensive review and edits to early drafts of the

guideline development content. Elisabeth Smitko provided coordination and editorial support to the writing group and contributed to the development of supplementary materials.

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References

1. Canadian Telehealth Report, https://www.lecsct.ca/wp-content/uploads/2012/10/2015-TeleHealth-Public-eBook-Final-10-9-15-secured.pdf (2015, accessed Janurary 11, 2017).
2. Graham ID, Harrison MB, Brouwers M, Davies BL and Dunn S. Facilitating the use of evidence in practice: evaluating and adapting clinical practice guidelines for local use by health care organizations. *J Obstet Gynecol Neonatal Nurs* 2002; 31: 599–611.
3. Vernooij RW, Alonso-Coello P, Brouwers M and Martinez Garcia L. Reporting items for updated clinical guidelines: checklist for the reporting of updated guidelines (CheckUp). *PLoS Med* 2017; 14: e1002207.
4. Lindsay MP GG, Bayley M, Phillips S and Smith EE. *Canadian stroke best practice recommendations overview and methodology. On behalf of the Canadian Stroke Best Practices Advisory Committee and Writing Groups*. Ottawa, ON: Heart and Stroke Foundation, www.strokebestpractices.ca/wp-content/uploads/2010/10/CSBPR-2014_Overview-and-Methodology_Fifth-Edition-Final.pdf (2014, accessed January 11, 2017).
5. Guyatt GH, Cook DJ, Jaeschke R, Pauker SG and Schunemann HJ. Grades of recommendation for antithrombotic agents: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). *Chest* 2008; 133: 123s–131s.
6. Schwamm LH, Holloway RG, Amarenco P, et al. A review of the evidence for the use of telemedicine within stroke systems of care: a scientific statement from the American Heart Association/American Stroke Association. *Stroke* 2009; 40: 2616–2634.
7. LaMonte MP, Bahouth MN, Hu P, et al. Telemedicine for acute stroke: triumphs and pitfalls. *Stroke* 2003; 34: 725–728.
8. Wiborg A and Widder B. Teleneurology to improve stroke care in rural areas: the Telemedicine in Stroke in Swabia (TESS) Project. *Stroke* 2003; 34: 2951–2956.
9. Schwamm LH, Rosenthal ES, Hirshberg A, et al. Virtual TeleStroke support for the emergency department evaluation of acute stroke. *Acad Emerg Med* 2004; 11: 1193–1197.
10. 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: 287–291.
11. Waite K, Silver F, Jaigobin C, et al. Telestroke: a multisite, emergency-based telemedicine service in Ontario. *J Telemed Telecare* 2006; 12: 141–145.
12. Vaishnav AG, Pettigrew LC and Ryan S. Telephonic guidance of systemic thrombolysis in acute ischemic stroke: safety outcome in rural hospitals. *Clin Neurol Neurosurg* 2008; 110: 451–454.
13. Heffner DL, Thirumala PD, Pokharna P, Chang YF and Wechsler L. Outcomes of spoke-retained telestroke patients versus hub-treated patients after intravenous thrombolysis: Telestroke patient outcomes after thrombolysis. *Stroke* 2015; 46: 3161–3167.
14. Yaghi S, Harik SI, Hinduja A, Bianchi N, Johnson DM and Keyrouz SG. Post t-PA transfer to hub improves outcome of moderate to severe ischemic stroke patients. *J Telemed Telecare* 2015; 21: 396–399.
15. Organised inpatient (stroke unit) care for stroke. *Cochrane Database Syst Rev* 2013; 9: CD000197. doi: 10.1002/14651858.CD000197.pub3.

16. Muller-Barna P, Hubert GJ, Boy S, et al. TeleStroke units serving as a model of care in rural areas: 10-year experience of the TeleMedical project for integrative stroke care. *Stroke* 2014; 45: 2739–2744.
17. Sanders KA, Patel R, Kiely JM, Gwynn MW and Johnston LH. Improving Telestroke treatment times in an expanding network of hospitals. *J Stroke Cerebrovasc Dis* 2016; 25: 288–291.
18. Walter S, Kostopoulos P, Haass A, et al. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: a randomised controlled trial. *Lancet Neurol* 2012; 11: 397–404.
19. Kunz A, Ebinger M, Geisler F, et al. Functional outcomes of pre-hospital thrombolysis in a mobile stroke treatment unit compared with conventional care: an observational registry study. *Lancet Neurol* 2016; 15: 1035–1043.
20. Goyal M, Menon BK, Van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. *Lancet* 2016; 387: 1723–1731.
21. Lai JC, Woo J, Hui E and Chan WM. Telerehabilitation – a new model for community-based stroke rehabilitation. *J Telemed Telecare* 2004; 10: 199–205.
22. Piron L, Turolla A, Agostini M, et al. Exercises for paretic upper limb after stroke: a combined virtual-reality and telemedicine approach. *J Rehabil Med* 2009; 41: 1016–1102.
23. Huijgen BC, Vollenbroek-Hutten MM, Zampolini M, et al. Feasibility of a home-based telerehabilitation system compared to usual care: arm/hand function in patients with stroke, traumatic brain injury and multiple sclerosis. *J Telemed Telecare* 2008; 14: 249–256.
24. Laver KE, Schoene D, Crotty M, George S, Lannin NA and Sherrington C. Telerehabilitation services for stroke. *Cochrane Database Syst Rev* 2013; 12: CD010255. doi: 10.1002/14651858.CD010255.pub2.
25. Chen J, Jin W, Zhang X-X, Xu W, Liu X-N and Ren C-C. Telerehabilitation approaches for stroke patients: systematic review and meta-analysis of randomized controlled trials. *J Stroke Cerebrovasc Dis* 2015; 24: 2660–2668.
26. Chumbler NR, Quigley P, Li X, et al. Effects of telerehabilitation on physical function and disability for stroke patients a randomized, controlled trial. *Stroke* 2012; 43: 2168–2174.
27. Chumbler NR, Li X, Quigley P, et al. A randomized controlled trial on stroke telerehabilitation: the effects on falls self-efficacy and satisfaction with care. *J Telemed Telecare* 2015; 21: 139–143.
28. Taylor DM, Cameron JI, Walsh L, et al. Exploring the feasibility of videoconference delivery of a self-management program to rural participants with stroke. *Telemed e-Health* 2009; 15: 646–654.
29. Smith SNC, Govindarajan P, Padrick MM, et al. A low-cost, tablet-based option for prehospital neurologic assessment: the iTREAT study. *Neurol* 2016; 87: 19–26.
30. Dorsey ER and Topol EJ. State of telehealth. *N Engl J Med* 2016; 375: 154–156.