Canadian Stroke Best Practice Recommendations: Hyperacute Stroke Care Guidelines, Update 2015

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The 2015 update of the *Canadian Stroke Best Practice Recommendations* Hyperacute Stroke Care guideline highlights key elements involved in the initial assessment, stabilization, and treatment of patients with transient ischemic attack (TIA), ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, and acute venous sinus thrombosis. The most notable change in this 5th edition is the addition of new recommendations for the use of endovascular therapy for patients with acute ischemic stroke and proximal intracranial arterial occlusion. This includes an overview of the infrastructure and resources required for stroke centers that will provide endovascular therapy as well as regional structures needed to ensure that all patients with acute ischemic stroke that are eligible for endovascular therapy will be able to access this newly approved therapy; recommendations for hyperacute brain and enhanced vascular imaging using computed tomography angiography and computed tomography perfusion; patient selection criteria based on the five trials of endovascular therapy published in early 2015, and performance metric targets for important time-points involved in endovascular therapy, including computed tomography-to-groin puncture and computed tomography-to-reperfusion times. Other updates in this guideline include recommendations for improved time efficiencies for all aspects of hyperacute stroke care with a movement toward a new median target door-to-needle time of 30 min, with the 90th percentile being 60 min. A stronger emphasis is placed on increasing public awareness of stroke with the recent launch of the Heart and Stroke Foundation of Canada FAST signs of stroke campaign; reinforcing the public need to seek immediate medical attention by calling 911; further engagement of paramedics in the prehospital phase with prehospital notification to the receiving emergency department, as well as the stroke team, including neuroradiology; updates to the triage and same-day assessment

of patients with transient ischemic attack; updates to blood pressure recommendations for the hyperacute phase of care for ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage. The goal of these recommendations and supporting materials is to improve efficiencies and minimize the absolute time lapse between stroke symptom onset and reperfusion therapy, which in turn leads to better outcomes and potentially shorter recovery times.

Key words: endovascular therapy, guidelines, hyperacute stroke care, neurovascular imaging, thrombolysis

Introduction

Stroke is a burden across the globe; in Canadian hospitals, one patient is treated every nine-minutes for a stroke or a transient ischemic attack (TIA) (1). Stroke is also the third cause of death in Canada and a leading cause of disability (2).

The *Canadian Stroke Best Practice Recommendations (CSBPR)* are evidence-based guidelines that are updated and released every two-years (or more frequently as necessary) (2). They address the continuum of stroke care from stroke symptom onset through the hyperacute period to rehabilitation and longer-term recovery. The target audience for the *CSBPRs* includes all healthcare professionals involved in the care of patients with stroke or TIA across that continuum. The present publication addresses the hyperacute period for stroke and is intended for all members of the interdisciplinary healthcare team who care for stroke patients and their families throughout this stage of care.

Hyperacute stroke care specifically refers to the key interventions involved in the assessment, stabilization and treatment in the first hours after symptom onset. This represents all prehospital and initial emergency care for TIA, ischemic stroke, intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), and acute venous sinus thrombosis. This includes assessment, diagnosis with the support of early neurovascular imaging, thrombolysis or endovascular interventions for acute ischemic stroke, emergency neurosurgical procedures, and same-day TIA risk stratification and diagnostic evaluation.

Hyperacute care is time sensitive by nature, minutes for disabling stroke and hours for TIA, but specific interventions are associated with their own individual treatment windows. Broadly speaking, 'hyperacute' refers to care offered in the first 24 h after stroke (ischemic and hemorrhagic) and the first 48 h after TIA. The prognosis of stroke is indeed very time dependent, especially in the hyperacute period: 'Time is Brain'. It is estimated that for every minute delay in treating an ischemic stroke, 1·9 million brain cells die, 13·8 billion synapses, and 12 km of axonal fibers are lost (3). Each hour without treatment, the brain loses as many neurons as it does in almost 3·6 years of normal aging (3). The principal aim of this phase of care is therefore to diagnose the stroke type, to coordinate and execute the treatment plan as rapidly as possible, within a coordinated system of seamless workflows.

The 2015 update of the *CSBPR* Hyperacute Stroke module includes many new additions, the most important one being the use of endovascular therapy for patients with acute ischemic stroke and proximal arterial occlusion. The update addresses brain and vascular imaging including computed tomography angiography (CTA) and computed tomography perfusion (CTP) as well as patient selection for endovascular therapy.

The present publication summarizes the recommendations for the hyperacute period. Other up-to-date and comprehensive *CSBPR* for all stages of stroke care and recovery are freely available at www.strokebestpractices.ca (2) and in a recent publication of the Prevention of Stroke recommendations in this journal (4). Recommendations, detailed rationales, supporting evidence, system implications, performance measures, as well as patient and professional education resources are detailed on our website.

What's new in 2015

In the 2015 update of the Hyperacute Stroke Care module, there are several notable updates. The theme of this update is Working Together, and so there is a strong focus on the interprofessional teams of healthcare workers involved in the hyperacute care of people with stroke, including paramedics, emergency department (ED) teams, stroke teams, and radiology (including neurointerventionalists), emphasizing each healthcare professional's responsibilities in the hyperacute care period.

There are two time phases that are noted in the recommendations: phase 1 includes prehospital care by paramedics and other Emergency Medical Services (EMS) personnel; phase 2 includes ED care. There is an updated recommendation for prehospital notification of the ED care team by paramedics/EMS personnel that includes detailed patient-specific information that must be relayed in this prehospital time phase (section 2). Prenotification is imperative to ensure that stroke teams are available when an acute stroke patient arrives in the ED to initiate patient triage and registration, time-sensitive investigations and treatments. An important and bold update in this edition of the Hyperacute Stroke Care Best Practice Recommendations is a recommendation for a shorter target door-to-needle time for medical thrombolysis with tissue plasminogen activator (tPA) – with a new target median time of 30 min, with the 90th percentile being 60 min (5). This change arose after a review of published quality improvement studies that have demonstrated improvements in the door-to-needle time in many stroke centers internationally.

The most significant update to the 5th edition of the *CSBPR* Hyperacute Stroke Care module is the addition of new recommendations on the use of endovascular therapy with mechanical thrombectomy in patients with acute ischemic stroke (section 4.3). Since late 2014, five randomized controlled trials have been published, showing improved outcomes in patients with acute ischemic stroke treated with endovascular therapy in addition to tPA thrombolysis (or without tPA thrombolysis in patients in which it is contraindicated) compared with the standard of care, which mainly included tPA thrombolysis alone. In these recommendations, there is a detailed description of the infrastructure and human resources required for all stroke centers that will be providing endovascular therapy services; this includes the training criteria and minimal annual experience required by neurointerventionalists who perform these procedures. Additionally, brain imaging with CT and vascular imaging with computed tomography angiography (CTA), with or without computed

tomography perfusion (CTP), is now recommended for all acute stroke patients presenting within the treatment time windows (sections 3.2 and 4.1). For endovascular therapy, all eligible patients should be treated within a six-hour time window from the time of stroke symptom onset (or the time the patient was last known to be well), with select patients being treated within a 12-hour time window if they meet imaging and clinical criteria (section 4.3, Appendices S2 and S3). There are important system implications related to endovascular therapy and the need for screening patients with CT brain and advanced imaging with CTA/CTP that are noted in the Recommendations (see www.strokebestpractices.ca). With these recommendations, it should be recognized that the literature supporting endovascular therapy is evolving and that further studies, including a planned meta-analysis of the major recent trials, will guide further understanding of this treatment strategy for acute ischemic stroke patients.

Guideline development methodology

The CSBPR has been developed and undergo routine review and updates using a rigorous and transparent methodology which is described in the CSBPR Methodology Manual (6), and available online at www.strokebestpractices.ca. The *CSBPR* development and update process follows a framework adapted from the Practice Guideline Evaluation and Adaptation Cycle (7). An interprofessional group of stroke experts was convened to participate in reviewing, drafting, and revising all recommendation statements. These experts have extensive experience in the topic areas covered in this hyperacute module, are considered leaders and experts in their field, have been involved in clinical trials or publications on the topics addressed in this module, and have experience appraising the quality of research evidence. People who have experienced a stroke or their family members are also included as group members and/or external reviewers. The interprofessional writing group and reviewers included stroke neurologists, ED physicians, neurosurgeons, radiologists, family physicians, paramedics, nurses, stroke program managers, physiotherapists, occupational therapists, a speech language pathologist, a social worker, and a stroke survivor. This interprofessional approach ensures that the perspectives and nuances of all relevant health disciplines are considered in the development of the recommendations, and mitigate the risk of potential or real conflicts of interest from individual members. Other experts outside the writing group were consulted for very specific issues such as neuroimaging.

A systematic literature search was conducted to identify research evidence for each topic area addressed in the Hyperacute Stroke Care module. All literature searches are conducted by individuals with expertise performing systematic literature reviews that are not directly involved in active research or the writing group to ensure objective selection of evidence. Literature searches include set time frames which overlap the previous search time frame by six-months to ensure high catchment of key articles within that time frame. The literature searches included all published literature up to April 15, 2015.

The writing group was provided with comprehensive evidence tables that include summaries of all high-quality evidence identified through the literature search and appraisal process. The writing group discussed and debated the value of the evidence and through consensus developed a final set of proposed recommendations. Through their discussions, additional research had been identified and added to the evidence tables if consensus on the value of the research was achieved. All recommendations were assigned a level of evidence ranging from A to C, according to the criteria defined in Table 1. When developing and including 'C-Level' recommendations, consensus was obtained among 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. transport using ambulance services or some screening practices). Recommendations with this level of evidence may also be made in response to requests from a range of healthcare professionals who seek guidance and direction from the experts in the absence of strong evidence on certain topics that are faced on a regular basis. In some sections, the expert writing group felt there was additional information that should be included within the documentation, but these statements did not meet the criteria to be stated as recommendations, and therefore were included as clinical considerations with the goal of providing additional guidance or clarity in the absence of evidence.

After completion of the draft update of the recommendations, the Hyperacute Stroke Care module underwent an internal review by the Canadian Stroke Best Practices Advisory Committee, and an external review by 10 Canadian and international experts in hyperacute stroke care who were not involved in any aspects of

Table 1 Summary of criteria for levels of evidence reported in the *Canadian Best Practice Recommendations for Stroke Care* (update 2015)

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 nonrandomized and/or noncontrolled 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.

*Adapted from Guyatt *et al.* (8).

the guideline development. All feedbacks were reviewed and addressed by the writing group members and the advisory committee to ensure a balanced approach to addressing suggested edits. 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 the recommended levels of care, performance measures to monitor care delivery and patient outcomes, implementation resources and a summary of the evidence to which the recommendations were based. The detailed evidence tables are also available online. This additional supporting information for the recommendations included in this publication can be found at http://www.strokebestpractices.ca/index.php/hyperacute-stroke-management.

A unique situation presented itself as the writing group worked through the final stages of review for these hyperacute stroke recommendations. The results of four anticipated randomized clinical trials investigating the use of endovascular therapy for large ischemic stroke were released simultaneously in February 2015 (9–12), and a fifth trial in April 2015 (13). These clinical trials all had similar positive findings, resulting in strong evidence to support the use of endovascular thrombectomy for people experiencing large vessel ischemic stroke (section 4.3). An additional multistep guideline development and review process was undertaken to be able to confidently include recommendations related to endovascular treatment in this edition of the CSBPR hyperacute stroke guidelines. A subgroup of the hyperacute writing group was convened along with representation from the ESCAPE Canadian trial leadership and several physician members of the Canadian Stroke Best Practices advisory committee and the Canadian Stroke Consortium. This group thoroughly reviewed and discussed the recent endovascular trials, and compared and contrasted differences in methodology, clinical process steps including imaging, thrombus retrieval techniques, and patient outcomes. A draft set of recommendations were developed that impacted section 2 (Emergency Medical System Management of Stroke), section 3 (Emergency Department Initial Assessment and Treatment), and section 4 (Acute Ischemic Stroke Therapies). The group went through eight rounds of review to achieve a final consensus-based set of draft recommendations. This draft was then sent to the larger hyperacute stroke writing group for review and input, and subsequently to the principal investigators of all four other trials to ensure that the recommendations reflected an accurate interpretation of their individual trial findings, and to seek their input on the wording of the recommendations. Feedback was reviewed and a final draft resulted. The final draft of the entire hyperacute module was then sent to the external international reviewers. Feedback from all stages of review was considered and final edits were made based on consensus between the Hyperacute Writing Group and the Advisory Committee, as is our normal process.

For a more detailed description of the methodology on the development and dissemination of the *CSBPRs*, please refer to the *CSBPR* 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 (6).

CSBPR: Hyperacute Stroke Care Update 2015

This section provides detailed recommendations for several aspects of hyperacute stroke care. These include outpatient assessment, triage and management of mild nondisabling stroke; EMS care of stroke patients in the prehospital phase; initial assessment and management in the ED; acute stroke treatments, including thrombolysis and endovascular therapy (new for 2015); acute aspirin therapy; initial management of patients with ICH; initial management of patients with SAH; and initial evaluation of patients for hemicraniectomy. All recommendations are assigned a level of evidence which reflects the strength and quality of the evidence available to support the recommendations as of April 15, 2015. For more details on the rationale for the recommendations, health system implications, suggested performance measures, implementation resources and detailed evidence summaries and evidence tables, please visit http://www.strokebestpractices.ca/index.php/hyperacute-stroke-management. For full French translation of this manuscript and the recommendations, refer to Appendix S1.

Section 1: Outpatient Management of Nondisabling Stroke and TIA

There is clear evidence that TIAs or minor ischemic strokes are unstable conditions that warn of high risk of future stroke, other vascular events, or death. The risk of recurrent stroke among patients presenting with TIA or minor stroke is as high as 10% within the first week of symptom onset. A systematic review by Rothwell *et al*. (14) pooled the results from 18 studies published between 1997 and 2007 to obtain estimates of risk. Overall, the reported risk of stroke at days 2 and 7 were 3·1% and 5·2%; however, the rates of recurrence were highly variable. Timely initiation of secondary prevention medical therapy and carotid endarterectomy has been shown to significantly reduce the risk of major stroke after an initial TIA or nondisabling stroke. The goal of outpatient management of TIA and nondisabling (minor) ischemic stroke is rapid assessment and management to reduce the risk of a recurrent, possibly more serious, event.

Management of nondisabling stroke and TIA best practice recommendations 2015

1.0 Patients with stroke and TIA who present to an ambulatory setting (such as primary care or other ambulatory care setting) or to a hospital should undergo clinical evaluation by a healthcare professional with expertise in stroke care to determine risk for recurrent stroke and initiate appropriate investigations and management strategies.

Note: These recommendations (Section 1) pertain to patients with TIA or subacute, nondisabling ischemic stroke patients who are not candidates for hyperacute treatment with tPA thrombolysis or endovascular therapy. For patients with suspected acute stroke that warrant hyperacute investigations to determine eligibility for thrombolysis/endovascular therapy, refer to Hyperacute Stroke Care Module, Section 3 (including Section 3.2 for Neuroimaging).

1.1 Timing of initial assessment

1.1.1. HIGHEST risk for stroke recurrence

i. Patients who present **within 48 h** of a suspected transient ischemic attack or nondisabling ischemic stroke **and** with transient, fluctuating, and/or persistent unilateral weakness (face, arm, and/or leg), or speech disturbance **are considered at highest risk** of recurrent stroke [Evidence Level B].

a. These highest risk patients should be ***immediately*** sent to an ED with capacity for advanced stroke care (such as brain and vascular imaging on site, and ideally access to tPA) [Evidence Level C].

b. Urgent brain imaging [computed tomography (CT) or magnetic resonance imaging (MRI)] and noninvasive vascular imaging [CTA or magnetic resonance angiography (MRA) from arch to vertex] should be completed without delay [Evidence Level B].

c. An electrocardiogram should be completed without delay [Evidence Level B].

ii. Patients who **present within 48 h** of a suspected transient ischemic attack or nondisabling ischemic stroke with transient, fluctuating, or persistent symptoms **without motor weakness or speech disturbance** (e.g. with symptoms such as hemibody sensory loss, or acute monocular visual loss, or binocular diplopia or hemivisual loss or dysmetria) **may be considered at high risk** of recurrent stroke [Evidence Level C].

a. These patients should be referred for ***same-day*** assessment at the closest stroke prevention clinic or ED with capacity for advanced stroke care [Evidence Level B].

1.1.2. INCREASED risk for recurrent stroke

i. Patients who **present between 48 h and two-weeks** from onset with symptoms of transient, fluctuating, or persistent unilateral weakness (face, arm, and/or leg), or speech disturbance symptoms **are considered at increased risk** for recurrent stroke [Evidence Level B].These patients should receive a comprehensive clinical evaluation and investigations by a healthcare professional with stroke expertise as soon as possible, **at most within 24 h** of first contact with the healthcare system [Evidence Level B] (see section 1.2).

ii. Patients who **present between 48 h and two-weeks** of a suspected transient ischemic attack or nondisabling ischemic stroke with transient, fluctuating, or persistent symptoms **without motor weakness or speech disturbance** (**e.g. with symptoms such** as hemibody sensory loss, or acute monocular visual loss, or binocular diplopia or hemivisual loss or dysmetria) **remain at increased risk** of recurrent stroke [Evidence Level C].

a. These patients should receive a comprehensive clinical evaluation and investigations by a healthcare professional with stroke expertise as soon as possible, **at most within two-weeks** of first contact with the healthcare system [Evidence Level B] (see section 1.2).

1.1.3. LOWER risk for recurrent stroke

i. Patients presenting more than two-weeks following a suspected transient ischemic attack or nondisabling ischemic stroke, may be considered as being less urgent, and should be seen by a neurologist or stroke specialist for evaluation as soon as possible, generally within one-month of symptom onset [Evidence Level C].

ii. Patients experiencing atypical sensory symptoms (such as patchy numbness and/or tingling) are generally considered as less urgent, and may be seen by a healthcare professional with stroke expertise as required [Evidence Level C].

1.2 Clinical investigations for patients with TIA who are not being considered for acute thrombolytic or endovascular therapy

i. All patients with suspected transient ischemic attack or nondisabling ischemic stroke should undergo an initial assessment that includes: brain imaging and noninvasive vascular imaging of the carotid arteries [Evidence Level B].

a. Extracranial vascular imaging is recommended to identify extracranial carotid stenosis for which patients should be referred for possible carotid revascularization [Evidence Level A].

b. CT angiography should be performed at the time of brain CT to asses both the extracranial and intracranial circulation [Evidence Level B].

c. When performing CTA or MRA, we recommend including extracranial and intracranial vasculature ('aortic arch-to-vertex') [Evidence level C].

d. Carotid ultrasound (for extracranial vascular imaging) and MR angiography are alternatives to CTA, and selection should be based on immediate availability, patient characteristics [Evidence level C].

e. CTA is recommended to allow visualization of the intracranial circulation, posterior circulation, and the aortic arch to identify stroke etiology. A detailed understanding of the neurovasculature guides management decisions [Evidence level C].

ii. The following laboratory investigations should be undertaken routinely for patients with suspected TIA or nondisabling ischemic stroke as part of the initial evaluation: hematology (complete blood count), electrolytes, coagulation [activated partial thromboplastin time (aPTT), international normalized ratio (INR)], renal function (creatinine, e-glomerular filtration rate), capillary glucose level [Evidence Level C]. *(Table of Recommended laboratory tests available online at* www.strokebestpractcies.ca).

iii. All patients with suspected TIA or nondisabling ischemic stroke should undergo an electrocardiogram (ECG) to assess baseline cardiac rhythm, and to provide information regarding evidence of structural heart disease (i.e. previous myocardial infarction, left ventricular hypertrophy) [Evidence Level C].

iv. In cases where the ECG or initial cardiac rhythm monitoring (e.g. 24 or 48 h ECG monitoring) does not show atrial fibrillation but a cardioembolic mechanism is suspected, prolonged ECG monitoring, up to 30 days duration, is recommended in selected patients for detection of paroxysmal atrial fibrillation. [Evidence Level B].

v. Echocardiogram may be considered in cases where the stroke mechanism has not been identified [Evidence Level C].

vi. Patients with clinical evidence of ischemic stroke who are not admitted to hospital should be assessed for functional impairment when appropriate (e.g., cognitive evaluation, screening for depression, screening of fitness to drive, and functional assessments for potential rehabilitation treatment) [Evidence Level B].

Section 2: Prehospital Emergency Medical Services Management of Acute Stroke

Approximately two-thirds of all patients who seek acute care for stroke in Canada arrive at the ED by ambulance. Transport by paramedics is safer and enables patients to be triaged to appropriate hospitals that provide specialized stroke services without delays. The current estimated target for transport to hospital by paramedics is in the range of 80% of cases (15). Hyperacute stroke is a medical emergency and optimizing out-of-hospital care improves patient outcomes. EMS plays a critical role in out-of-hospital (prehospital) assessment and management of suspected stroke patients. Acute interventions such as thrombolytic therapy are time sensitive and therefore strategies such as redirecting ambulances to stroke centers to facilitate earlier assessment, diagnosis, and treatment may result in better outcomes.

Emergency medical services management best practice recommendations 2015

2.0 Out-of-hospital patient management should be optimized to meet the needs of suspected acute stroke patients, including recognition, management, and transport, usually done concurrently [Evidence Level C].

2.1 ACCESS to EMS

i. Immediate contact with EMS (e.g. 911) by patients or other members of the public is strongly recommended [Evidence Level B].

ii. *EMS Communications Centre:* All regions should implement a dispatch process through the EMS communications center to recognize the probable stroke signs (such as FAST – Face, Arms, Speech, Time), potential stroke diagnosis, and need for priority response to the scene and transport to a hospital capable of providing services for the rapid diagnosis and treatment of stroke [Evidence Level C].

iii. After dispatching the ambulance, the personnel at the EMS communications center should provide pre-arrival instructions (such as unlock door, move pets, determine stroke symptom onset time, determine current medications) to the patient or person reporting the stroke, in order to expedite and optimize prehospital care [Evidence Level C].

iv. The personnel at the EMS communications center should convey relevant information (such as symptom onset time or time last known well, and availability of an alternate decision-maker) to the responding paramedics while they are en route [Evidence Level C].

2.2 Paramedic on-scene management

Note: On-scene goal is to ***'recognize and mobilize'*** *– it is of the utmost importance to proceed rapidly and safely to transport these patients as on-scene management for stroke patients is limited.*

i. EMS personnel should use a standardized acute stroke out-of-hospital diagnostic screening tool as part of on-scene assessment [Evidence Level B]. (*Table 2 Canadian Stroke Best Practices Table of Standardized Acute Stroke Out-of-Hospital Diagnostic Screening Tools is available online at* www.strokebestpractices.ca).

ii. EMS personnel should obtain information from the patient, family members, or other witnesses about the suspected stroke event (presenting symptoms, time of onset or time of symptom recognition or time last known well, and sequence of events), comorbid conditions, current medications, and any formal or informal advance directives that may influence care by EMS and in the ED [Evidence Level C].

iii. On-scene time with suspected stroke patients should be as short as possible; ideally 20 min or less* for patients who present within the 4.5-hour treatment time window [Evidence level C]. *(* Target of 20 min based on median EMS on-scene time data from across provinces contained in HSF Stroke Report 2015) (16).*

iv. Initial care provided by paramedics on-scene should include blood glucose measurement [Evidence Level B].

v. Prior to transport, EMS personnel should provide instructions to the patients' family, including recommending that the family/decision-maker accompany the patient to hospital or be accessible by phone for decision-making, as well as confirming time last known well, and providing required information about existing health conditions, current medications, and other information as needed [Evidence Level C].

2.3 Transport of suspected stroke patents

i. Direct transport protocols must be in place to facilitate the transfer of suspected acute stroke patients who are potentially eligible for thrombolytic or endovascular therapy to the closest and most appropriate acute care hospital capable of providing services for the diagnosis and hyperacute treatment of stroke [Evidence Level C].

ii. Direct transport protocol criteria should be based on:

a. an EMS system set up to categorize patients exhibiting signs and symptoms of an acute stroke as a high priority for evaluation, response, and transport [Evidence Level C];

b. the medical stability of the patient;

c. other acute care needs of the patient;

d. the prehospital phase, including symptom duration and anticipated transport time being 3·5 h or less for medical thrombolytic therapy (for the 4·5 h treatment time window) and for most patients being considered for endovascular therapy, five-hours or less (for a six-hour

treatment time window for most patients), though select patients may be considered for endovascular therapy up to 12 h based on local stroke center protocols;

e. the ED's ability to provide acute stroke services within a target 90th percentile for door-to-needle (i.e. arrival to treatment) time of 60 min (upper limit) and a target median door-to-needle time of 30 min or less (5).

iii. Patients with suspected stroke should be triaged by EMS personnel as Canadian Triage Acuity Scale (CTAS) Level 2 in most cases and as a CTAS Level 1 for patients with compromised airway, breathing, or cardiovascular function [Evidence Level B].

a. For pediatric stroke cases, patients with suspected stroke should be triaged by EMS personnel as Pediatric Canadian Triage Acuity Scale (P-CTAS) Level 2 in most cases, and as a P-CTAS Level 1 for patients presenting with severe symptoms or compromised airway, breathing, or cardiovascular function [Evidence Level C].

iv. While en route to the receiving hospital with acute stroke services, paramedics should notify the ED of the incoming suspected acute stroke patient, providing sufficient details such that a 'Code Stroke' can be activated at that time [Evidence Level B].

a. Information required includes: time of stroke onset or time of symptom recognition or time when last known well (as accurate as possible), total symptom duration at anticipated arrival in the ED, presenting signs and symptoms of stroke, Glasgow Coma Scale (GCS) score, CTAS triage score (or P-CTAS), patient age, and expected time of arrival at the receiving hospital.

v. Patients who are considered ineligible for time-sensitive thrombolytic therapy or endovascular therapy should still be transported urgently (either directly or indirectly) to the closest hospital capable of providing services for the diagnosis and treatment of stroke (ED, access to neurovascular imaging, stroke unit, and stroke expertise on site or through Telestroke modalities) [Evidence Level C].

2.4 Hospital arrival and EMS handover to ED Staff

i. Transfer of care from paramedics to receiving hospital personnel should occur with minimal delay; patients with suspected hyperacute stroke who are potentially eligible for thrombolytic therapy or endovascular therapy should receive the highest priority in the ED triage queue [Evidence Level B]. *Refer to Hyperacute Stroke Care Module, Section 3.1 for more information*.

ii. Paramedics should provide the receiving hospital with the following information on hospital arrival: time of stroke onset or time of symptom recognition or time when last known well (as accurate as possible), total symptom duration at arrival in the ED, GCS score, CTAS triage score (or P-CTAS), patient age, comorbidities, current medications and medication allergies, and vital signs (including capillary glucose) [Evidence Level C].

a. Paramedics should ensure all information noted above is documented on the patient's EMS record and provided to the receiving hospital during transport with prenotification and upon arrival to the hospital [Evidence Level B].

Clinical considerations:

• Screening for potential stroke should be done early in the on-scene assessment. If the stroke screen is positive, all actions on-scene from that point should be directed at moving to the ambulance and beginning transport. All treatments not immediately required (IVs, etc.) should wait until the patient is en route to the hospital. Scene time is an important variable that paramedics can control and needs to be monitored very closely. Time lost due to inefficient scene care cannot be made up during subsequent transport to hospital, regardless of the use of lights and sirens.

• The term 'eligible' for acute stroke therapies is usually defined within regional jurisdictions. Generally it refers to acute stroke patients within the 4·5 h time window for medical thrombolytic therapy; however, local definitions should be clarified during implementation of these recommendations. For endovascular therapy, the strongest evidence for benefit is when treatment is received within six-hours of stroke symptom onset (in some cases, without the use of medical thrombolytic therapy). However, select patients may be considered for endovascular therapy up to 12 h from symptom onset, as defined by imaging criteria and within regional jurisdictions.

• In some stroke centers, the tPA treatment time window may extend beyond 4·5 t under the directive of a research protocol. These factors should be taken into consideration during transport and agreements should be in place between the provincial/regional EMS system and the receiving hospitals.

• In regions with a specialized pediatric hospital, every attempt should be made to transport children with symptoms of stroke to that specialized paediatric hospital.

Section 3: Emergency Department Evaluation and Management of Acute Stroke

Time is Brain! The goal of ED management is rapid assessment of all patients with a suspected acute stroke.

Patients who present to hospital with suspected stroke often also have significant physiological abnormalities and comorbidities. These can complicate the management of stroke. Signs and symptoms that may explain the cause of the stroke or predict later complications (such as space-occupying infarction, bleeding, or recurrent stroke) and medical conditions such as hypertension or the presence of a coagulopathy, will have an impact on treatment decisions. An efficient and focused assessment is required to understand the needs of each patient.

For patients who may be eligible for acute stroke treatments including intravenous tPA or newer endovascular therapies, the target is to complete rapid assessment and initiate treatment as soon as possible. Section 3.1 identifies the aspects of assessment and investigations that are recommended for all patients; it further identifies which investigations can wait until thrombolysis decisions are made and acted upon for eligible patients in order to optimize time from stroke symptom onset to acute treatment where possible. Particularly, ECG and chest X-ray should not be performed before imaging or acute stroke treatments unless there

is an acute medical condition warranting them being done sooner. Also in Section 3.1, blood work is recommended as part of the initial evaluation. However, awaiting results should not delay acute stroke treatment decisions and treatment initiation, unless there is a specific clinical reason (e.g. for a patient on warfarin, an INR level is required). Awaiting results of renal function blood tests [Cr and estimated glomerular filtration rate (eGFR)] should not delay imaging with CTA in most patients with disabling acute stroke symptoms, given consideration for 'neurons over nephrons'. However, in certain patients with known renal impairment, awaiting results of renal function blood tests should be weighed against the benefit of immediate CTA to identify patients that are eligible for acute stroke treatments, including endovascular therapy.

Initial management of elevated blood pressure in acute stroke patients remains controversial due to the lack of evidence to clearly guide practice. At the same time, this is an area where clinicians often seek guidance from stroke specialists. The recommendations for this area emphasize caution and diligence in monitoring and treating extremely high blood pressure in the first hours after stroke onset.

ED evaluation and management best practice recommendations 2015

3.0 ED evaluation and management

i. All patients presenting to an ED with suspected acute stroke must have an immediate clinical evaluation and investigations to establish a diagnosis, rule out stroke mimics, determine eligibility for thrombolytic therapy and endovascular therapy, and develop a plan for further management, including goals for care [Evidence Level B].

ii. Patients presenting with stroke or transient ischemic attack should not be discharged from the ED without diagnostic evaluations, consideration of functional impairments, initiation or modification of secondary prevention therapies, and a plan for ongoing management [Evidence Level B].

3.1 Initial evaluation

i. Patients with suspected acute stroke should have a rapid initial evaluation for airway, breathing, and circulation [Evidence Level B].

ii. A neurological examination should be conducted to determine focal neurological deficits and assess stroke severity [Evidence Level B]. A standardized stroke scale should be used, such as the National Institutes of Health Stroke Scale (NIHSS) or the Canadian Neurological Scale (CNS) (Table 3.1: Screening and Assessment Tools for Acute Stroke is available online at www.strokebestpractices.ca).

iii. Assessment in the acute phase should include heart rate and rhythm, blood pressure, temperature, oxygen saturation, hydration status, and presence of seizure activity [Evidence Level B].

iv. Acute **blood work** should be conducted as part of the initial evaluation [Evidence Level B]. Initial blood work should include: electrolytes, glucose, hematology (CBC), coagulation (INR, aPTT), creatinine, eGFR, and troponin. (Table 3.2: Recommended Laboratory Investigations for Acute Stroke and Transient Ischemic Attack are available online at www.strokebestpractices.ca).

v. **An electrocardiogram** should be completed [Evidence Level B].

a. Unless a patient is hemodynamically unstable, ECG should not delay assessment for thrombolysis and endovascular therapy and can be deferred until after a decision regarding acute treatment is made [Evidence Level C].

vi. **A chest X-ray** should be completed when the patient has evidence of acute heart disease or pulmonary disease [Evidence Level B].

a. Unless a patient is hemodynamically unstable, chest X-ray can be deferred until after a decision regarding acute treatment [Evidence Level C]. It should not delay assessment for thrombolysis and endovascular therapy.

vii. Patient **swallowing screen** should be completed as early as possible by a practitioner trained to use a validated swallowing screening tool as part of initial assessment, but should not delay decision-making regarding eligibility for acute stroke treatments [Evidence level A]. Ideally, swallow screening should be done within 24 h of hospital arrival, including patients that receive acute stroke treatments (intravenous tPA and endovascular therapy) [Evidence Level C].

a. Patients should remain NPO (nil per os – no oral intake) until swallowing screen is completed for patient safety [Evidence Level B];

b. Oral medications should not be administered until swallowing screen, using a validated tool, has been completed and found normal [Evidence Level B]; alternate routes such as intravenous and rectal administration should be considered while a patient is NPO;

c. A patient's clinical status can change in the first hours following a stroke or TIA; therefore, patients should be closely monitored for changes in swallowing ability following initial screening [Evidence level C];

d. Patients found to have abnormal swallowing ability on screening should be referred to a healthcare professional with expertise in swallowing assessments for an in-depth swallowing assessment [Evidence Level B].

viii. **Seizure Assessment:** New-onset seizures at the time of an acute stroke, occurring either immediately before or within 24 h of the stroke onset, should be treated using appropriate short-acting medications (e.g. lorazepam IV) if they are not self-limited [Evidence Level C]. Treatment may be required before completing hyperacute investigations for stroke, including imaging.

a. A single, self-limiting seizure occurring at the onset, or within 24 h after an acute stroke (considered an 'immediate' poststroke seizure) should not be treated with long-term anticonvulsant medications [Evidence Level C].

b. Patients that have an immediate poststroke seizure should be monitored for recurrent seizure activity during routine monitoring of vital signs and

neurological status. Recurrent seizures in patients with ischemic stroke should be treated as per treatment recommendations for seizures in other neurological conditions [Evidence Level C].

- Seizures are a common presentation with stroke in neonates and children. Consider enhanced or increased seizure monitoring in at-risk populations such as neonates, children with stroke, and adults with otherwise unexplained reduced level of consciousness [Evidence Level C];
- Electroencephalogram (EEG) monitoring may be appropriate in patients at high risk of seizures, such as neonates and children [Evidence Level C].

c. Patients with one or more seizures in the early (defined as occurring up to four-weeks postindex stroke) or late (occurring beyond four-weeks) poststroke period should be treated as per treatment recommendations for seizures in other neurological conditions [Evidence Level C]. An EEG and other tests to rule out precipitating factors of seizures (e.g. infections) may be warranted in these patients [Evidence Level C].

d. Prophylactic use of anticonvulsant medications in patients with acute stroke is not recommended [Evidence Level C]. There is no evidence to support the prophylactic use of anticonvulsant medications in patients with acute stroke and there is some evidence to suggest possible harm with negative effects on neural recovery.

3.2 Neurovascular (brain and vascular) imaging

i. All patients with suspected acute stroke (i.e. presenting within acute stroke treatment time windows) must undergo immediate noncontrast brain CT imaging, and vascular imaging with CTA including extracranial and intracranial arteries to guide hyperacute care [Evidence Level A].

ii. For patients with ischemic stroke that are clinically eligible for acute stroke treatments, advanced CT imaging including CTP (to assess cerebral blood flow) and multiphase or dynamic CTA (to assess pial collateral vessels) should be considered as part of initial imaging; however, this must not substantially delay decision and treatment with tPA thrombolysis or endovascular therapy [Evidence Level B]. *Note: if there are signs of hemorrhage on initial CT images, there is no need to proceed to CTP imaging as part of initial imaging and CTA should be completed based on the clinical judgment of the treating physician.*

iii. Additional imaging (brain magnetic resonance imaging (MRI or MRA) may be considered; however, this must not delay decision and treatment with tPA thrombolysis or endovascular therapy [Evidence Level C].

3.3 Cardiovascular investigations

i. All patients with suspected TIA or ischemic stroke should undergo an ECG to assess baseline cardiac rhythm, and to provide information regarding evidence of structural heart disease (i.e. previous myocardial infarction, left ventricular hypertrophy) [Evidence Level C].

a. Unless a patient is hemodynamically unstable, ECG should not delay assessment for thrombolysis and endovascular therapy and can be deferred until after a decision regarding acute treatment is made [Evidence Level C].

ii. In cases where the ECG or initial cardiac rhythm (e.g. 24- or 48-h ECG) does not show atrial fibrillation but a cardioembolic mechanism is suspected, prolonged ECG monitoring, up to 30 days duration, is recommended in selected patients for detection of paroxysmal atrial fibrillation [Evidence Level B].

iii. Perform an echocardiogram in patients where a cardiac cause of stroke is suspected, including in young adults and children who present with stroke, and when infectious endocarditis is suspected [Evidence Level C].

3.4 Acute blood pressure management

i. The ideal level of blood pressure to target in the hyperacute phase is unknown at this time. Pharmacological agents and routes of administration should be chosen to avoid precipitous falls in blood pressure [Evidence Level C].

ii. Ischemic stroke patients eligible for thrombolytic therapy: Very high blood pressure should be treated in patients receiving thrombolytic therapy for acute ischemic stroke as this may reduce the risk of secondary intracranial hemorrhage (to a target of below 180/105 mmHg) [Evidence Level B].

iii. Ischemic stroke patients not eligible for thrombolytic therapy: Treatment of hypertension in the setting of acute ischemic stroke should not be routinely undertaken [Evidence Level C].

iv. Extreme blood pressure elevation (e.g. systolic greater than 220 or diastolic greater than 120 mmHg) should be treated to reduce the blood pressure by approximately 15%, and not more than 25%, over the first 24 h, with further gradual reduction thereafter to targets for long-term secondary stroke prevention [Evidence Level C].

v. Avoid rapid or excessive lowering of blood pressure as this may exacerbate existing ischemia or may induce ischemia, particularly in the setting of intracranial arterial occlusion or extracranial carotid or vertebral artery occlusion [Evidence Level C].

3.5 Blood glucose abnormalities

i. All patients with suspected acute stroke should have their blood glucose concentration checked upon arrival to the ED (*Note: For patients arriving by EMS, the capillary glucose measured by EMS should be reviewed by the ED team for any immediate management required)* [Evidence Level B]. *(Table 3.2: Recommended Laboratory Investigations for Patients with Acute Stroke or Transient Ischemic Attack is* available online at www.strokebestpractices.ca).

ii. Hypoglycemia should be corrected immediately [Evidence Level B].

3.6 Additional management considerations in the ED

i. Supplemental oxygen should be provided for patients with oxygen saturation below 95% or to maintain an oxygen saturation level above 92% [Evidence Level C].

a. Supplemental oxygen is not required for patients with normal oxygen saturation levels.

ii. The use of indwelling urethral catheters should be avoided due to the risk of urinary tract infections [Evidence Level A].

a. If used, indwelling catheters should be assessed daily and removed as soon as possible [Evidence Level A].

b. Fluid status and urinary retention should be assessed as part of vital sign assessments [Evidence Level C].

c. Excellent pericare and infection prevention strategies should be implemented to minimize risk of infections [Evidence Level C].

iii. Temperature should be routinely monitored and treated if above 37·5°C [Evidence Level B].

iv. For some patients, based on clinical presentation and medical history (e.g. vasculitis), additional investigations should be considered to guide management decisions [Evidence Level B].

Section 4: Acute Ischemic Stroke Therapy

The weight of evidence from many large, international trials over a time frame of 20 years suggests that treatment with intravenous tPA can reduce the risk of death or disability following ischemic stroke at three to six-months posttreatment. Since the fall of 2014, five major clinical trials of endovascular therapy with mechanical thrombectomy were completed, with results demonstrating significant improvement in patient outcomes after large artery occlusions based on the modified Rankin scale score at 90 days posttreatment (9–13), with one trial also demonstrating decreased mortality with endovascular therapy (10). Endovascular therapy is included as a major update in the 2015 Hyperacute Stroke Care module, with its profound impact on patients who suffer the most devastating ischemic strokes; patients who, if left untreated, result in a more significant burden on the healthcare system and family caregivers. Endovascular therapy should be provided within comprehensive and some advanced stroke centers which, by definition, have advanced neuroimaging capability, coordinated stroke care, specialized stroke teams, and a stroke unit to provide appropriate care and recovery after the hyperacute period. *See Appendix S2 for Criteria for Centers Providing Acute Stroke Therapy*.

Acute ischemic stroke therapy best practice recommendations 2015

4.0 Patient selection

i. All patients with *disabling* acute ischemic stroke must be screened *without delay* by a physician with stroke expertise (either on-site or by telemedicine/telestroke consultation) to determine their eligibility for both medical treatment with intravenous tPA (within 4·5 h from stroke symptom onset) and interventional treatment with endovascular therapy (within a six-hour window from stroke symptom onset) [Evidence Level A].

ii. There is limited evidence indicating that select patients with stroke noted upon wakening or with disabling stroke within 12 h of stroke symptom onset (or the time since last seen well) may benefit from endovascular therapy, depending upon clinical and imaging criteria (as defined in Appendix S5) [Evidence Level B].

4.1 Imaging criteria

i. Initial brain CT should be assessed using the Alberta Stroke Program Early CT Score [ASPECTS] to identify patients with a small-to-moderate ischemic core, represented by an ASPECTS score of 6 or higher [Evidence Level B]. *Refer to* www.aspectsinstroke.com.

a. In patients with brain CT scans showing early signs of more extensive infarction, represented by an ASPECTS of less than 6, the decision to treat or not treat with tPA or endovascular therapy should be made based on the clinical judgment of the treating physician [Evidence Level B].

b. If CT or MR perfusion is used, it should demonstrate a perfusion mismatch of at least 20% and a small-to-moderate ischemic core using ASPECTS of 6 or higher. *See Appendix S5 for definitions of CT collateral score and CT perfusion imaging criteria*.

ii. For Endovascular therapy, patients should have a proximal occlusion in the anterior circulation [Evidence Level A].

a. In addition to a proximal occlusion, it is strongly recommended that patients have either moderate-to-good pial collaterals on CTA, or CT perfusion mismatch between the size of the penumbra and the size of the ischemic core [Evidence Level B]. *See Appendix S4 for define inclusion/exclusion for endovascular therapy*.

4.2 Intravenous thrombolysis

i. Eligible patients are those who can receive intravenous tPA within 4·5 h of the onset of stroke symptoms [(17), ECASS III] in accordance with criteria adapted from National Institute of Neurological Disorders and Stroke (NINDS) tPA Stroke Study (18) [Evidence Level A]. *Refer to Appendix S3 for inclusion and exclusion criteria for intravenous tPA eligibility*.

a. When it is unclear whether or not a patient should be treated with tPA, urgently consult with a stroke specialist within the institution or through telestroke services [Evidence Level C].

b. If there is uncertainty regarding CT imaging interpretation, consult a radiologist in your institution [Evidence Level C].

ii. All eligible patients should receive intravenous tPA as soon as possible after hospital arrival [Evidence Level A], with a target door-to-needle time of less than 60 min in 90% of treated patients and a median door-to-needle time of 30 min [Evidence Level B]. Treatment should be initiated as soon as possible after patient arrival and CT scan; every effort should be made to ensure door-to-needle times are routinely monitored and improved.

a. Administration of tPA should follow the American Stroke Association guidelines using a dose of 0·9 mg/kg to a maximum of 90 mg total dose, with 10% (0·09 mg/kg) given as an intravenous bolus over one-minute and the remaining 90% (0·81 mg/kg) given as an intravenous infusion over 60 min [Evidence Level A].

iii. There remain situations in which clinical trial data to support the use of intravenous thrombolytic therapy are more limited. In these situations, urgent consultation with a stroke expert is recommended alongside the clinical judgment of the treating physician and discussion with the patient or substitute decision maker [Evidence Level C].

a. This can apply to: pediatric stroke (newborn to age 18 years); and pregnant women with stroke.

iv. **Hospital inpatients** that present with a sudden onset of new stroke symptoms should be rapidly evaluated by a specialist team and provided with access to appropriate acute stroke treatments (including thrombolysis and endovascular therapy) [Evidence Level B]. Management of complications from tPA administration:

a. There is insufficient evidence to support the routine use of fresh frozen plasma, prothrombin complex concentrates, or platelet transfusions for tPA-associated bleeding [Evidence Level C].

b. For tPA-induced angioedema, discontinue the tPA infusion if it is still running, obtain assistance for airway management if required, and give intravenous hydrocortisone 100 mg, diphenhydramine 50 mg, and ranitidine 50 mg. The use of racemic epinephrine by nebulizer should be weighed against the risk of sudden hypertension and the risk of intracranial hemorrhage [Evidence Level C].

4.3 Endovascular therapy

i. Endovascular therapy should be offered within a coordinated system of care including agreements with EMS; access to rapid neurovascular (brain and vascular) imaging; coordination between the ED, the stroke team and radiology; local expertise in neurointervention; and access to a stroke unit for ongoing management [Evidence Level A].

ii. Endovascular therapy is indicated in patients based upon imaging selection with noncontrast CT head and CTA (including extracranial and intracranial arteries) [Evidence Level A]. *See Appendix S4 for Inclusion Criteria for endovascular therapy*.

iii. Eligible patients who can be treated within six-hours (*i.e.* whose groin can be punctured within six-hours of symptom onset) should receive endovascular therapy [Evidence Level A]. *Refer to Appendix S4 for Inclusion Criteria for endovascular therapy*.

a. Select patients with disabling stroke presenting between 6 and 12 h of stroke symptom onset, including those with stroke symptoms upon awakening, who meet clinical and imaging criteria, may be considered for endovascular therapy [Evidence Level B], in accordance with local protocols.

b. Time from CT (first slice of the noncontrast CT) to groin puncture should be as fast as possible, ideally less than 60 min [Evidence Level C].

iv. Endovascular therapy is indicated in patients who have received intravenous tPA and those who are not eligible for intravenous tPA [Evidence Level A]. Patients eligible for intravenous tPA as well as endovascular therapy should also be treated with intravenous tPA, which can be initiated while simultaneously preparing the angiography suite for endovascular therapy [Evidence Level A].

v. Device selection: Retrievable stents are recommended as the first-choice endovascular device [Evidence Level A].

a. Other interventional devices (e.g. thrombus aspiration devices) may be used based on local protocols and expertise [Evidence Level C].

vi. Endovascular procedures should not be performed using elective general anesthesia and intubation in most patients. General anesthesia and intubation should only be used if medically indicated (e.g. for airway compromise, respiratory distress, depressed level of consciousness, severe agitation, or any other indication determined by the treating physician), and in such cases, excessive and prolonged hypotension should be avoided [Evidence Level B].

Clinical considerations for acute ischemic stroke therapies:

- Intravenous tPA is considered the standard of care and is currently the only approved thrombolytic agent for acute ischemic stroke treatment. There are other drugs being investigated; however, at this time they are not approved for use in stroke patients.
- The 2012 IST3 trial (19) suggests that in some patients, it is safe to administer intravenous tPA up to six-hours from time last known well. At this time, the evidence is not strong enough to extend recommended treatment times for tPA beyond 4·5 h for intravenous therapy.
- tPA administration for patients on direct oral anticoagulants (DOACs): until such time when there is a commercially available and validated assessment tool for DOAC levels, and until such time as it is reliably known what these levels mean clinically, tPA should not routinely be administered to patients on DOACs presenting with acute ischemic stroke. Endovascular therapy may be considered in such patients.
- Large artery occlusions in the posterior circulation (e.g. basilar artery occlusion) may be considered for endovascular therapy based on the clinical judgment of a treating physician with stroke or neurointerventional expertise. It should be noted that these patients were excluded from recent trials of endovascular therapy.

Section 5: Acute Aspirin Therapy

Acute-phase aspirin therapy reduces the risk of early recurrent ischemic stroke (20). Long-term aspirin therapy reduces the risk of ischemic stroke, myocardial infarction, and vascular death. There is a paucity of data from randomized controlled trials to support the use of other antiplatelet regimes in acute stroke patients. In clinical trials for tPA, antithrombotic drugs (including aspirin) were avoided until after the 24-hour post-thrombolysis scan had excluded intracranial hemorrhage.

Acute aspirin therapy best practice recommendations 2015

All acute stroke patients not already on an antiplatelet agent and not receiving tPA therapy should be given at least 160 mg of acetylsalicylic acid (ASA) immediately as a one-time loading dose after brain imaging has excluded intracranial hemorrhage and after dysphagia screening has been performed and passed [Evidence Level A].

i. In patients treated with tPA, acetylsalicylic acid (ASA) should be delayed until after the 24-hour post-thrombolysis scan has excluded intracranial hemorrhage [Evidence Level B].

ii. ASA (81 to 325 mg daily) should then be continued indefinitely or until an alternative antithrombotic regime is started [Evidence Level A]. *Refer to Canadian Stroke Best Practice Recommendations Prevention of Stroke Module Sections 6 and 7 for additional information*.

iii. In dysphagic patients, ASA may be given by enteral tube (80 mg daily) or by rectal suppository (325 mg daily) [Evidence Level A].

iv. In pediatric patients, initial treatment with anticoagulation (heparin) or aspirin at established pediatric dosing should be considered and continued until cervical artery dissection and intracardiac thrombus is excluded. If neither is present, switch to acute aspirin therapy at dose of 1–5 mg/kg [Evidence Level B] (21).

v. In patients already on ASA prior to ischemic stroke or transient ischemic attack, clopidogrel may be considered as an alternative [Evidence Level B]. If rapid action is required, then a loading dose of 300 mg of clopidogrel could be considered, followed by a maintenance dose of 75 mg once a day [Evidence Level B].

Section 6: Acute Subarachnoid Hemorrhage

SAH is a catastrophic neurosurgical emergency that is prevalent in approximately 7% of adults with stroke (1), and also in children, and accounts for prolonged hospital lengths of stay. Recent mortality rates in Canada for patients with SAH are just over 40% within 30 days of the event. Over the past decade, several advances have been made in early treatment of SAH, including endovascular techniques. Prompt recognition and access to expert medical professionals may reduce mortality and morbidity and improve long-term outcomes. These recommendations focus on diagnosis and early management of SAH patients in the first hours after symptom onset. Blood pressure management, temperature, risk of venous thromboembolism and vasospasm should all be addressed in caring for patients with SAH.

Acute SAH best practice recommendations 2015

6.0 Patients with aneurysmal SAH should be treated as a medical emergency and evaluated immediately by physicians with expertise in stroke management [Evidence Level B].

6.1 Consultation with neurosurgery for patients with SAH

i. There is a high early risk for rebleeding in SAH patients; therefore they should be assessed without delay [Evidence Level B].Patients with SAH should have an urgent consultation with a neurosurgeon [Evidence Level B].

ii. Patients should be managed in centers with neurosurgical expertise that treat aneurysms regularly using endovascular and surgical techniques [Evidence Level C].

6.2 Initial clinical assessment of a patient with SAH

i. Patients with suspected SAH should have a noncontrast CT scan ***immediately*** on arrival to hospital to confirm the diagnosis [Evidence Level B].

ii. In patients with a new acute headache suspicious of SAH, a third-generation or higher* CT scan performed within six-hours of onset of headache and read as normal by a neuroradiologist; a lumbar puncture is not required [Evidence Level B].

a. If there is a high clinical index of suspicion of SAH and no availability of an experienced neuroradiologist to review the CT imaging, then a lumbar puncture and cerebral spinal fluid (CSF) analysis should be performed [Evidence Level C].

iii. If a lower generation CT scan is done and read as normal, and the clinical suspicion of SAH is high, or if the CT is performed after six-hours, or is not read by an experienced radiologist or the patient is in an altered state of consciousness, a lumbar puncture should be performed.

a. Xanthochromia evaluation may be more sensitive after a minimum delay of 12 h from onset of headache, but such a delay may not be practical or clinically appropriate [Evidence Level B].

iv. Patients with SAH should undergo vascular imaging of the brain to investigate the cause of the hemorrhage. High-quality CTA may be initially preferable to catheter angiography [Evidence Level B], but catheter angiography should still be considered as the 'gold standard' when initial CTA is negative.

v. The severity of SAH patients should be determined using a validated scale [Evidence Level B].

vi. Recommended assessment tools may include: World Federation of Neurological Surgeons (WFNS), GCS, Hunt and Hess scale (H&H), NIHSS, and the Fisher Scale. Other tools may be considered as appropriate to individual patients.

6.3 Interventions for patients with SAH

i. Once a SAH is confirmed, patients initially seen in non-comprehensive stroke centers should be transferred to a tertiary center for ongoing management [Evidence Level C].

ii. Patients with SAH and negative noninvasive vascular imaging should be considered for further imaging with catheter angiography [Evidence Level C].

iii. Patients who present within 96 h of a SAH and have an adequate blood pressure should immediately be started on nimodipine for 14 to 21 days [Evidence Level A]. Refer to local protocols for usual dosing schedules.

iv. Patients with an aneurysmal SAH should have the aneurysm secured urgently by endovascular coiling or microsurgical clipping, ideally within 24 to 48 h [Evidence Level B].

v. Patients with aneurysmal SAH and CT evidence of hydrocephalus that is clinically symptomatic should undergo urgent placement of an external ventricular drain (EVD) [Evidence Level B].

vi. For SAH patients with decreased level of consciousness (LOC) and large intraparenchymal extension at the time the aneurysm is secured, urgent evacuation of the hematoma should be considered [Evidence Level C].

vii. For most patients with SAH who are technically eligible for endovascular or microsurgery treatment, an endovascular approach is preferred (ISAT trial) [Evidence Level A].

a. Decisions regarding modality of treatment should be based on patient-specific characteristics, which include consideration of patient age, clinical grade, size, location

and morphology of the aneurysm, medical comorbidity, and institutional experience and resources [Evidence Level B].

viii. In the absence of seizures, routine use of prophylactic anti-convulsants is not recommended [Evidence Level B].

6.4 Blood pressure management

i. Patients with an unsecured aneurysm in a SAH should have their blood pressure closely monitored and maintained as normotensive [Evidence Level B].

ii. Treatment for high blood pressure should be initiated while the aneurysm is unsecured to reduce the risk of hypertension-induced rebleeding and maintain cerebral perfusion pressure [Evidence Level B].

6.5 Additional aspects of clinical management

i. Neurological assessment should be conducted as part of regular vital signs, using standardized assessment tools throughout the course of stay to monitor changes, and ideally every one to four-hours until patient is stable as per local protocols [Evidence Level C].

a. Frequency of neurological assessment should be adjusted according to patient's condition (e.g. frequency may increase during episodes of vasospasm);

ii. Patients with SAH should have the head of their bed elevated 30 degrees for at least the first 24 to 48 h [Evidence Level B].

iii. Elevated temperature should be treated to achieve normothermia in SAH patients [Evidence Level B]. Refer to Canadian Stroke Best Practice Recommendations *Acute Inpatient Stroke Care* module section 4.2 for additional information.

iv. Patients with SAH should receive venous thromboembolism prophylaxis [Evidence Level A]. Refer to Canadian Stroke Best Practice Recommendations *Acute Inpatient Stroke Care* module section 2.2 for additional information.

a. Sequential compression devices are recommended in the early stages prior to having the aneurysm secured [Evidence Level B]. Refer to Canadian Stroke Best Practice Recommendations *Acute Inpatient Stroke Care* module section 2.2 for additional information.

v. For patients with poor prognosis for neurological recovery, an initial course of supportive nonsurgical management may be appropriate [Evidence Level B].

a. Goals of care should be established early after patient arrival at hospital, with patient and/or designated substitute decision-maker [Evidence Level B];

b. Patients who are given Do Not Resuscitate (DNR) status at any point should receive all other appropriate medical and surgical interventions unless otherwise explicitly indicated. Preexisting DNR orders should be considered where appropriate [Evidence Level C].

vi. There is insufficient evidence to support routine administration of high-dose magnesium during the acute stage of SAH [Evidence Level C].

vii. Patients with SAH should not be routinely started on statin therapy during the acute stage if not already on a statin prior to admission [Evidence Level A].

6.6 Vasospasm: symptomatic vasospasm is an acute ischemic event that requires acute treatment. *Note: Vasospasm most commonly occurs after the hyperacute period, but is addressed here as part of comprehensive coverage of issues related to SAH.*

i. Hypovolemia should be avoided after SAH [Evidence Level B].

ii. The maintenance of euvolemia, instead of hypervolemia, is recommended to prevent or treat symptomatic vasospasm [Evidence Level B].

iii. Prophylactic treatment of vasospasm with hyperdynamic therapy or balloon angioplasty is not recommended [Evidence Level B].

iv. With the absence of cardiac contraindication and after the treatment of the ruptured aneurysm, patients with symptomatic vasospasm should first be treated with induced hypertension (blood pressure target according to neurological response). [Evidence Level C].

v. Mechanical or chemical endovascular treatment can be used in patients with symptomatic vasospasm having contraindication or being refractory to induced hypertension [Evidence Level C].

Section 7: Acute Intracerebral Hemorrhage

ICH is the most fatal form of stroke and carries the poorest prognosis for survival and functional recovery. ICH commonly occurs in about 12–15% of all stroke patients admitted to Canadian hospitals (1), and is associated with high rates of early mortality – 25–50% in the first 30 days (1). Patients who survive an ICH are often left with moderate to severe persistent functional deficits which place a significant burden on families and the healthcare system. Therefore, this condition requires prompt recognition and action. Efficient clinical assessment, blood pressure and coagulopathy management, and access to neurosurgery are all important aspects of hyperacute care. While baseline hematoma volume is a strong predictor of outcome, it is not a modifiable risk factor. In addition, 30–40% of patients will continue to bleed and experience hematoma expansion, which is also a predictor of poor outcome. Risk factors for hematoma expansion may include the presence of a 'spot sign' (i.e. contrast extravasation), early presentation to medical attention, anticoagulation use, and initial hematoma volume (22). These recommendations are for patients with primary spontaneous ICH, not hemorrhagic conversion of an ischemic infarction, and apply to the initial assessment in the ED within the first few hours of patient arrival. *Ongoing treatment and management of hemorrhagic stroke patients beyond the initial hyperacute period is outside the scope of these recommendations.*

Acute ICH best practice recommendations 2015

7.0 Patients with ICH must be treated as a medical emergency. ICH should be promptly recognized and patients evaluated immediately by physicians with expertise in hyperacute stroke management.

7.1 Initial clinical assessment of an ICH patient

i. An NIHSS should be conducted on awake or drowsy patients, or a GCS on patients who are obtunded, semi or fully comatose, as part of initial assessment to determine

baseline severity of neurological impairments [Evidence Level B]. This has been found to be a strong predictor of outcomes following ICH.

ii. Patients with suspected ICH should undergo a CT or MRI immediately to confirm diagnosis, location, and extent of hemorrhage [Evidence Level A].

iii. In patients with confirmed acute ICH, CT angiography, MR angiography, or catheter angiography is recommended for most patients to exclude an underlying lesion such as an aneurysm or arteriovenous malformation [Evidence Level B].

iv. Evaluation of patients with acute ICH should include questions about anticoagulant therapy, measurement of platelet count, partial thromboplastin time (PTT), and INR [Evidence Level A], and medication history [Evidence Level C].

v. Patients should be assessed for clinical signs of increased intracranial pressure [Evidence Level B].

vi. A validated neurological scale, such as CNS score, should be conducted (usually by nurses) at baseline and repeated at least hourly for the first 24 h, depending on stability of patient [Evidence Level C].

7.2 Blood pressure management

i. Blood pressure should be assessed on initial arrival to the ED and every 15 min thereafter until it has stabilized [Evidence Level C].

ii. Blood pressure targets in ICH patients may be challenging to achieve and require careful monitoring, and in some cases aggressive repeated dosing or intravenous infusion of antihypertensive medications [Evidence Level C].

iii. Close blood pressure monitoring (e.g. every 30 to 60 min, or more frequently if above target) should continue for at least the first 24 to 48 h [Evidence Level B].

iv. There is presently insufficient evidence to demonstrate that lower blood pressure targets are associated with better clinical outcomes, and research is ongoing in this area. However, there is evidence to support safety for a target systolic blood pressure less than 140 mmHg [Evidence Level B].

v. Labetalol is recommended as a first-line treatment for acute blood pressure management if there are no contraindications [Evidence Level B].

vi. After the first 24 h following the onset of an ICH, further blood pressure lowering should be continued with the initiation of parenteral or oral antihypertensive medications (depending on swallowing ability), to achieve individualized blood pressure targets that will optimize secondary stroke prevention [Evidence Level B].

7.3 Management of anticoagulation

i. Patients with acute ICH and an established coagulopathy or a history of anticoagulation medications should be promptly assessed with laboratory tests (INR/PTT) and have a medical treatment plan to control bleeding [Evidence Level B].

ii. Warfarin use with an elevated INR should be treated appropriately to reverse the coagulopathy with prothrombin complex concentrate (PCC) and vitamin K. PCC is preferred because the onset of action is fast, but fresh-frozen plasma and vitamin K could be used as alternative if PCC is not available [Evidence Level B].

iii. Antiplatelet agents (e.g. ASA, clopidogrel, dipyridamole/ASA) should be stopped immediately in patients who present who are routinely on these agents [Evidence Level C].

iv. DOAC use requires urgent consultation with a hematologist regarding use and availability of reversal agents [Evidence Level C].

v. If there is a persisting strong indication for anticoagulation (e.g. atrial fibrillation, mechanical heart valve), the decision about when to restart anticoagulant therapy should be made on a case-by-case basis [Evidence Level C].

vi. The evidence is unclear regarding timing to restart anticoagulation. Consultation with a stroke expert, cardiologist, hematologist/thrombosis expert may be considered to optimize individual patient care [Evidence Level C].

7.4 Consultation with neurosurgery

i. Patients with cerebellar hemorrhage should be referred for urgent neurosurgical consultation, particularly in the setting of altered level of consciousness or new brainstem symptoms [Evidence Level C].

ii. Patients with new onset of acute hydrocephalus requiring placement of EVD should be referred for urgent neurosurgical consultation [Evidence Level C].

iii. Surgical intervention has not been shown to be superior to conservative management to improve outcomes in most patients with supratentorial ICH [Evidence Level B]. In select patients with a higher level of consciousness (especially GCS score 9–12), early surgical intervention may be considered [Evidence Level B].

iv. Early consultation with a neurosurgeon is recommended in cases where decompressive craniectomy is considered [Evidence Level C]. Refer to Section 8 on Hemicraniectomy for additional information.

7.5 Initial interventions for ICH patients

i. Medically stable patients with an acute ICH should be admitted to a stroke unit or neuro-intensive care unit [Evidence Level B], and undergo interprofessional stroke team assessment to determine their rehabilitation and other care needs.

ii. Administration of recombinant Factor VIIa (NiaStase) prevents hematoma growth, but increases the risk of arterial thromboembolic phenomena and does not provide a clinical benefit for survival or outcome. It is not recommended for use outside of clinical trials at this time, and clinical trials are currently ongoing to address this issue [Evidence Level A].

iii. Statin therapy is not indicated for prevention of ICH. For ICH patients who have a clear concomitant indication for cholesterol lowering treatment, statin therapy should be individualized and should take into account the patient's overall thrombotic risk as well as the possibility of increased risk of ICH on statin therapy [Evidence Level B].

iv. Beyond the acutely symptomatic period, patients with ICH should be managed similarly to those with ischemic stroke, except for avoidance of antithrombotic medications

[Evidence Level B]. Refer to recommendation 7.3 for additional information.

v. Goals of care should be established with patient and/or designated substitute decision-maker [Evidence Level B].

vi. For most patients, decisions related to DNR orders or palliative care should be deferred for 24 to 48 h after stroke onset, to allow time to see if there is a significant response to medical therapy or if there is worsening [Evidence Level C].

a. Exceptions may include patients with preexisting wishes to avoid invasive life-sustaining therapies because of comorbidities (e.g. dementia) or based on their own previously expressed values [Evidence Level C].

vii. Patients who are given DNR status at any point should receive all other appropriate medical and surgical interventions unless otherwise explicitly indicated. Preexisting DNR orders should also be reassessed after 24 to 48 h [Evidence Level C].

viii. Currently there is no role for prophylactic anti-convulsant treatment [Evidence Level C]. If a patient were to present with or proceed to have a seizure, anti-convulsants should be initiated.

Section 8: Early Management of Patients Considered for Hemicraniectomy

The morbidity and mortality for the routine care of patients with malignant hemispheric strokes is higher than other stroke subgroups and there is evidence to support that, in selected cases, hemicraniectomy may significantly reduce mortality and lead to improvement in patient outcomes. Consideration for hemicraniectomy must be individualized; there is a strong need for careful clinical consideration and patient selection. Decisions regarding hemicraniectomy involve several members of the interprofessional team, including neurology, neurosurgery, intensive care, and nursing through a collaborative and coordinated system of care. The benefit of decompressive hemicraniectomy (vs. standard medical treatment) early following malignant middle cerebral artery (MCA) infarction in patients <60 years has been evaluated in three major randomized controlled trials, all of which had comparable inclusion criteria and primary outcome measures (23–25). Timing of surgical intervention is also an important consideration when deciding whether to perform decompressive hemicraniectomy. Taken together, these findings suggest that the appropriate time interval to perform decompressive hemicraniectomy may be within 48 h of stroke symptom onset; further research is needed to determine if earlier treatment (e.g. within 24 h) is associated with superior outcomes.

Early management of patients considered for hemicraniectomy best practice recommendations 2015

8.0 Hemicraniectomy should be considered in younger patients in the early stages of extensive (malignant) MCA territory ischemic stroke [Evidence Level A].

8.1 Patient selection

i. Patients who meet the following criteria alone or in combination should be considered for hemicraniectomy [Evidence Level A]:

a. Patients over the age of 18;

b. Children under 18 years with progressive extensive (malignant) MCA syndrome [Evidence Level C];

c. Extensive (malignant) MCA territory ischemic stroke with evidence of edema/mass effect;

d. Infarction size greater than 50% MCA territory on visual inspection, or an ischemic lesion volume greater than 150 cm^3;

e. Worsening NIHSS score, CNS score, GCS, or the Pediatric NIHSS scores, or imaging indications of worsening edema at any time from presentation.

ii. If patient location is initially outside a comprehensive stroke center, patient should have expedited transfer to a tertiary or quaternary center where advanced stroke care and neurosurgical services are available [Evidence Level C].

8.2 Initial clinical evaluation

i. Urgent consultation with a stroke specialist for assessment and for determination to involve neurosurgery [Evidence Level C]

ii. For patients who meet criteria for potential hemicraniectomy during initial assessment, an urgent neurosurgical consultation should be initiated, either in-person or via telemedicine (Telestroke services) [Evidence Level C].

iii. Initiate a discussion with patient, family members, and legal decision-maker regarding a potential hemicraniectomy [Evidence Level C].

a. Key issues to be discussed with decision-makers include: stroke diagnosis and prognosis untreated, the risks of surgery, the possible and likely outcomes following surgery, and the patient's previously expressed wishes concerning treatment in the event of catastrophic illness.

8.3 Patient management prior to hemicraniectomy surgery

i. Once decision for hemicraniectomy has been confirmed, surgery should take place within 48 h of initial presentation [Evidence Level A], and surgery should take place before major midline shift occurs [Evidence Level C].

ii. Patients should be transferred to an intensive care unit or neuro step-down unit for close and frequent monitoring of neurological status prior to surgery [Evidence Level B].

a. Monitoring should include assessments of level of consciousness (e.g. CNS score), worsening symptom severity, and blood pressure at least hourly; more frequently as the individual patient condition requires [Evidence Level C].

b. If changes in status occur, the stroke team and neurosurgeon should be notified immediately for reevaluation of the patient [Evidence Level C]. Change in status may include increasing level of drowsiness/consciousness, drop in CNS score by 1 point, or increase in NIHSS score by 4 points.

c. Repeat CT scans are recommended for patients when deterioration in neurological status occurs [Evidence Level C].

iii. Determine need for acute blood pressure treatment for high blood pressure [Evidence Level B]. Refer to Recommendation 3.4 in this Module for additional information.

iv. Hyperosmotic therapy with 20% mannitol or 3% hypertonic saline may be used in the perioperative period if required [Evidence Level C].

v. The head of the patient's bed should be elevated 30° [Evidence Level C], and patient and family members should be educated about proper head positioning [Evidence Level C].

vi. In general, hyperventilation should be avoided prior to surgery [Evidence Level C].

vii. All antiplatelets and anticoagulants should be withheld prior to hemicraniectomy [Evidence Level B].

viii. Corticosteroids are not recommended as a management strategy for increased intracranial pressure for patients awaiting hemicraniectomy [Evidence Level A].

ix. If hydrocephalus occurs, it may be managed by an EVD placed by a neurosurgeon [Evidence Level C].

Summary

The 2015 update of the *Canadian Stroke Best Practice Hyperacute Stroke Care Recommendations* provide a common set of guiding principles and evidence-based actions from the first signs of stroke onset through to the end of ED care. The quality of recovery and outcomes for people with acute stroke is highly dependent on this hyperacute period. There is an absolute need for prompt recognition of stroke signs, contact with EMS, and access to care by specialized stroke teams with advanced imaging and intervention capability. Access to this care is challenging in a country such as Canada, with a vast geography and with a larger proportion of rural and remote communities. Coordinated systems of care have been established in many provinces which include bypass protocols for paramedics and the use of Telestroke modalities to access specialists at large urban centers for consultation and to support intravenous tPA administration. The strong evidence that has emerged for endovascular therapy to treat patients with large artery occlusions will necessitate a review of the existing stroke systems to ensure that endovascular centers are established to service as many regions as possible. This will take time; however, the magnitude of effect that these therapies have on the recovery of patients who would otherwise likely die or be more severely disabled and requiring intensive levels of long-term care, makes access to these therapies an imperative.

The *CSBPRs* are developed and presented within a continuous improvement model and are written for health system planners, funders, administrators, and healthcare professionals, all of whom have important roles in the optimization of stroke prevention and care and who are accountable for results. Several implementation tools are provided to facilitate uptake into practice (available at www.strokebestpractices.ca), and are used in combination with active professional development programs. By monitoring performance, the impact of adherence to best practices is assessed and results are then used to direct ongoing improvement. Tracking the uptake and outcomes of the newer endovascular therapies will require consensus on case definitions, intervention codes, and key indicators such as treatment times and primary outcomes. Recent stroke quality monitoring activities have shown compelling results with a relative decrease in 30-day in-hospital mortality of over 30% in the past decade (2), which continues to support the value of adopting evidence-based best practices in organizing and delivering stroke care in Canada.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Appendix S1. *Recommandations canadiennes pour les pratiques optimales de soins de l'AVC*: Lignes directrices sur les soins de l'AVC en phase hyperaiguë, mise à jour 2015.

Appendix S2. Criteria for centers providing acute ischemic stroke therapy.

Appendix S3. Inclusion criteria for acute thrombolytic therapy.

Appendix S4. Inclusion criteria for endovascular therapy.

Appendix S5. Endovascular imaging selection criteria.