INTRODUCTION

A stroke is an interruption of blood supply to a region of the brain. This may be due to blockage of an artery (embolic or thrombotic) causing ischemia, or rupture of a vessel resulting in hemorrhage. 80% of strokes are due to ischemia while the remaining 20% are hemorrhagic. At the cellular level, injury is caused by many factors that result in dysfunction and possibly even death of the cell. The ischemic cascade begins within minutes of the loss of glucose and oxygen supply to the neurons in the brain. As the ischemia continues, resulting edema causes further injury to the surrounding areas, collectively known as the ischemic penumbra. This tissue is dependent on collateral circulation and may still be viable for several hours because of this marginal perfusion.

With acute stroke, time is brain. For instance, with every minute that goes by with a middle cerebral artery stroke 1.9 million neurons and 14 billion synapses are lost. This equates to approximately 3 weeks of life lost – every minute! Prehospital care clinicians play a critical role in the early recognition of signs and symptoms, priority transport to the appropriate hospital, and helping to facilitate rapid diagnosis and treatment.

Acute stroke interventions such as IV thrombolytic therapy are time sensitive, therefore systems of care allowing for earlier assessment, diagnosis, and treatment lead to better patient outcomes. In more recent years, the introduction of **endovascular thrombectomy (EVT)** has demonstrated improved outcomes for a subset of stroke patients with large vessel occlusion. EVT is performed by inserting a small catheter into an artery, advancing the tip from within the vasculature to the affected vessel in the brain, and the blood clot causing the stroke is then either removed or liquefied. EVT now extends the treatment window by several hours for a subset of stroke patients; however, similar to IV thrombolytic therapy the earlier treatment is provided the better. Appropriate patients who have received thrombolytic may also undergo EVT as well during the same course of care.

Transient ischemic attacks (TIA) occur as a result of a temporary blockage of the neurons' blood supply by an embolus or a thrombus. While the signs and symptoms are similar to ischemic stroke, they tend to subside and improve within a few minutes or hours. Though the signs and symptoms may have improved, a TIA is an important warning sign that indicates high risk of having a stroke. The risk of stroke is highest in the first 48 hours following a TIA, therefore emergency department (ED) assessment and optimization of risk factor management is critical.

SAFETY

Patients with possible stroke should receive nothing by mouth as swallowing may be impaired. Patients with motor or balance deficits should not ambulate for safety reasons. When extricating these patients consider the proper equipment and extra resources that may be required to do so safely.

ASSESSMENT

A focused medical assessment should be performed expediently. Identify possible risk factors for stroke, as well as history and physical exam findings that will guide treatment and transport decisions. Clinicians should obtain information from the patient, family members, or other witnesses with regards to the presenting symptoms and onset, including the last time they were seen normal.

Past medical history, current medications, allergies, and advance directives may influence care. Any history of recent trauma or head injury is important as well, as traumatic brain injuries may also present with stroke-like symptoms, and recent serious trauma may be a contraindication for thrombolysis. Obtain an up to date list of medications or the medication bottles themselves. Note any anti-coagulants, as these are a relative contraindication to thrombolytic and therefore important for the receiving physician to be made aware of. The presence of terminal illness or advanced dementia are also important findings as these are contraindications to both thrombolysis and EVT.

Risk Factors

Risk factors for stroke include: previous stroke or TIA, atherosclerotic disease, hypertension, high cholesterol, atrial fibrillation, and coronary artery disease. Other risk factors such as diabetes, tobacco use, increased weight, lack of exercise and alcohol consumption may also be considered.

6288.06: STROKE

Last Seen Normal

It is critical to determine the time the patient was last seen normal (LSN). This time stamp is now used to mark the beginning of the **reperfusion interval (RI)**. The RI refers to the time from LSN until thrombolysis or EVT is provided. The prehospital phase of the RI refers to the time from LSN until arrival at a **designated acute stroke hospital (DASH)** is possible. In the past we employed alternative language such as symptom onset and symptom recognition, LSN now replaces both of these. For instance, the patient who wakes up in the morning with new stroke-like symptoms would have a LSN time stamp of the time they went to bed. Time of LSN is now the critical time point from which decisions are made, rather than the time at which the symptoms were noted or recognized.

Signs and Symptoms

The signs and symptoms of stroke vary depending on the area of the brain being affected, and may include:

- Altered level of consciousness (ALOC)
- Dysarthria
- Aphasia
- Unilateral facial droop
- Unilateral extremity weakness or numbness
- Dizziness/vertigo/ataxia
- Headache
- Vision disturbance (monocular blindness, diplopia)
- Nausea/vomiting
- Confusion
- Seizure
- Neglect (ignoring one side when both sides touched simultaneously)
- Eyes gazing to one side (generally the unaffected side)

In hemorrhagic stroke, headache, nausea/vomiting, and ALOC are more common than with ischemic stroke.

Dysarthria refers to slurred speech that occurs when the muscles of the mouth/throat that produce speech become weak. **Aphasia** is a disorder of communication that can also affect speech, and occurs as a result of damage to the language areas of the brain. Aphasia may be *receptive* (also known as *fluent* or *Wernicke's aphasia*) in which the patient will have language comprehension difficulty and may not be able to follow commands or answer questions appropriately. They are able to produce clear speech, but the words may not belong together or make sense. This is sometimes referred to as "word salad". The patient is often unaware of their language deficits. Aphasia may also be *expressive* (also known as *non-fluent* or *Broca's aphasia*), in which the patient understands language, but cannot speak normally. These patients will follow commands, and they know what they would like to say, but have difficulty uttering their chosen words. Patients with expressive aphasia are typically aware of their communication deficits, and this is often a significant source of frustration for the patient.

It can be difficult to discern between the above communication disorders and actual confusion/delirium. The onset of delirium is typically more insidious/gradual vs. the acute onset of communication deficits with stroke. Information from family/bystanders may be helpful when deciphering these findings.

Physical Exam

The physical exam should include:

- A full set of vital signs, including blood glucose (**PEP 2 neutral**)
- Neurologic exam should be very focused and include LOC, pupils, speech, facial asymmetry, motor or sensory changes, and balance/gait instability.
- Assess for signs of trauma.
- 12 lead ECG (**PEP 3 supportive**)
- Serial GCS assessments

A focused neurologic exam is preferred as it allows for more timely decision making. While en route to hospital, if time allows, more detailed findings may be explored.

Screening tools, such as the **Cincinnati Prehospital Stroke Scale (CPSS)** (**PEP 2 supportive**) uses the components of the FAST (Face, Arm, Speech, Time) mnemonic to quickly screen for signs of stroke. This particular tool evaluates three major physical exam findings:

- Unilateral facial droop
- Unilateral limb weakness
- Speech abnormalities

If a patient presents acutely with **any one** of these three findings there is a 72% probability of an ischemic stroke as the underlying cause, and paramedics should consider this a positive screen. All three findings present increases the probability of an acute stroke to more than 85%.

Once a CPSS screen is noted to be positive the prehospital phase of the RI should be calculated and the charge physician at the nearest DASH consulted when appropriate as outlined below. Patients who are outside the reperfusion interval for thrombolytic but within the longer reperfusion interval for EVT will require additional physical exam testing for what is called large vessel occlusion (LVO). LVO is detected by examining the patient for visual gaze abnormalities, aphasia, or neglect (VAN assessment). The Nova Scotia provincial stroke strategy indicates it will be the charge physician at the nearest DASH who performs this additional screen when indicated. The charge physician may also direct the prehospital clinician in assessing for these findings over the radio. This screen helps detect the subset of CPSS positive patients who are EVT candidates.

Clinicians should also be aware of the signs and symptoms of increasing intracranial pressure (ICP) in the setting of hemorrhagic stroke. Decreasing level of consciousness with associated vomiting may occur, requiring supportive care of ABCs. Evidence of increasing ICP can be observed with Cushing's Reflex which includes:

- Bradycardia
- Irregular or decreasing respirations
- Widening pulse pressure

Differential Diagnosis

The differential diagnosis for acute stroke-like symptoms includes both hypoglycemia and hyperglycemia, therefore a blood glucose must be checked in all such patients. Other "stroke mimics" include complex migraine, Todd's paralysis following a seizure, conversion disorder, as well as other toxic, metabolic, and central nervous system disorders. Possible traumatic causes should also be explored. **Once hypoglycemia is ruled out, the patient should be treated as though their symptoms are due to acute stroke until established otherwise in hospital.**

CTAS

Patients with suspected stroke should be assigned a CTAS score of 2 in most cases. CTAS 1 would be appropriate for patients with compromised airway, breathing or cardiovascular function.

Posterior Circulation Stroke

A posterior circulation stroke involves the posterior brain circulation and anatomy (the cerebellum, brainstem, cranial nerves, and occipital lobes). 20% of all ischemic strokes involve the posterior circulation. Strokes affecting this region may present with motor and sensory deficits, but more commonly present with symptoms referred to as "the 5 D's": dizziness/vertigo, diplopia, dysphagia, dysarthria, and dystaxia. Headache, nausea, and vomiting can also occur. It is important to consider this diagnosis in the setting of the above symptoms, even when non-specific (e.g. dizziness and headache). It can also be difficult to distinguish central (brain) related causes of dizziness/vertigo from peripheral (inner ear) causes, and for this reason ED assessment is essential.

It is important to note that while patients with posterior circulation strokes may be missed by the CPSS, they may still be candidates for thrombolysis or EVT. A patient presenting with abrupt onset of any of the above symptoms within the RIs outlined below should prompt a consult with the Charge MD at the nearest DASH.

MANAGEMENT

Oxygenation and Ventilation

The goal of oxygen therapy is to prevent hypoxia and minimize the ischemic penumbra. Oxygen should be provided to maintain SpO2 of 92-99%. Hyperoxia in the setting of stroke has shown to be detrimental. If manual ventilation is required, care should be taken to avoid hyperventilation as it can cause excessive drops in arterial CO_2, causing vasoconstriction and decreased blood flow to the brain. Monitoring $EtCO_2$ will assist in providing appropriate ventilatory support. $EtCO_2$ should be maintained between 35-45 mmHg.

Vascular Access

Patients with suspected stroke who are being transported to a facility where the stroke team has been activated should have two 18 gauge IVs, including one in the right antecubital vein. These IVs are used at the receiving facility for the purpose of CT angiography and thrombolytic administration. It is important that IV insertion does not delay scene time and can ideally be done en route to the facility.

Fluid Management

IV fluids should only be provided in the setting of hypotension **(PEP white)** in accordance with the shock guideline, or in the setting of hyperglycemia (see below).

Glucose Management

Patients with a blood glucose of less than 4mmol/L may present with stroke-like symptoms and their hypoglycemia should be treated (**PEP 2 neutral**).
Patients with acute stroke may also suffer coexisting hypoglycemia, also mandating treatment. The risk of administering glucose to a stroke patient does not outweigh the benefits of treating hypoglycemia, as hypoglycemia is detrimental to the ischemic penumbra.

Patients with stroke-like symptoms with very high glucose readings should be managed with fluid administration (i.e. initiate a 20 mL/kg fluid bolus, with frequent reassessments). The patient's symptoms may be due to hyperglycemia, but a coexisting acute stroke cannot be ruled out until assessed in the ED.

Seizure Management

Seizure activity is possible in patients with stroke, and should be treated as per the seizure clinical practice guideline.

Trip Destination

Paramedics should recognize the time sensitive nature of acute stroke. Proper trip destination decisions are critical, as time to treatment has a major impact on outcome (**PEP 1 supportive**).

Transport destination in the presence of acute stroke symptoms is dependent on the patient's eligibility to receive either IV thrombolytic therapy or EVT. This eligibility is based on symptom criteria/positive CPSS, the anticipated prehospital phase of the RI (time from LSN until arrival at DASH), and the absence of contraindications (advanced dementia or terminal illness). All patients with potential eligibility for these therapies are discussed with the charge physician at the nearest DASH. See Figure 1 for a list of Nova Scotia DASH locations.

In Nova Scotia, the total time from LSN to the anticipated arrival at the nearest DASH represents the prehospital phase of the RI. If the anticipated prehospital phase of the RI is less than 3.5 hours, the patient may be a candidate for ED administered thrombolytic therapy. Clinicians should contact the charge physician at the nearest DASH to discuss potential eligibility for thrombolytic therapy. If the anticipated prehospital phase of the RI is less than 11 hours, clinicians should contact the charge physician at the nearest DASH to discuss potential eligibility for EVT.

This consult should occur before departing scene, as the charge physician at the nearest DASH will advise whether to bypass smaller non-DASH centers. While most DASH province-wide are regional hospitals, in the central region the Halifax Infirmary is considered the DASH. A **regional DASH should not be bypassed in order to transport directly to the Halifax Infirmary**. Although EVT is presently only available at the Halifax Infirmary, initial trip destination will always be the nearest DASH (even for potential EVT candidates). These patients require further clinical screening as well as CT imaging before the decision

is made regarding inter-facility transfer for possible EVT. The charge physician at the regional DASH will review the clinical findings, CT, and RI with the Neurologist at the Halifax Infirmary to discuss whether the patient is an EVT candidate. The Medical Communications Centre (MCC) is then contacted by the Neurologist to discuss transfer options if the patient is deemed an EVT candidate.

If a patient is approximately equidistant from the nearest regional DASH and the Halifax Infirmary, the charge physician at the Halifax Infirmary is the most appropriate person to contact for stroke care consultation regarding trip destination. If the patient is approximately equidistant from 2 regional DASH EDs, the charge physician at the DASH closer to the Halifax Infirmary is the most appropriate person to contact for stroke care consultation regarding trip destination.

See Figure 2 for Acute Stroke Protocol flow diagram.

Patients presenting with stroke-like symptoms who are outside the RI for thrombolytic therapy and EVT should be transported to the nearest most appropriate ED, which may be a non-DASH.

If the patient qualifies for destination bypass to a DASH, but requires ongoing resuscitation (e.g. airway management, cardiovascular support), paramedics should consider transport to the closest ED if additional resuscitative resources are required.

Prior to transport, clinicians should ask the patient's family and/or substitute decision maker (SDM) to accompany the patient to the hospital or to ensure they are accessible by phone if needed to assist with treatment decision-making.

Early Notification
When presented with a suspected stroke, early notification of the receiving facility by the paramedics is imperative to providing adequate time for the ED to make the necessary arrangements to receive the patient (**PEP 1 supportive**).

Key information to share during notification include patient age, symptoms present, time LSN, current use of blood thinners, CTAS, vital signs, and arrival time.

Acute stroke is one of the time-sensitive emergencies which allows for provision of patient demographic information (e.g. name, date of birth, and health card number) over the radio if asked for by facility staff.

Ensuring early hospital pre-notification and identification has demonstrated shorter door-to-imaging, door-to-needle, and stroke onset-to needle time.

Interfacility Transport for EVT (**PEP 2 supportive**)
As per the provincial stroke strategy, the regional DASH physician in collaboration with Neurology will arrange interfacility transfer via the MCC for acute stroke patients going to the Halifax Infirmary for EVT. Transport will occur with the fastest available and most appropriate approach as per the provincial strategy. This may be via LifeFlight or urgent ground transfer. The complication rate is very low in patients thrombolized for acute stroke (approximately 5%). These complications include intracranial hemorrhage, major systemic hemorrhage, and angioedema. Stroke patients who have received or are receiving thrombolytic should be monitored for these complications throughout the course of care, and additional support may be sought as required.

TRANSFER OF CARE

When presenting a patient with a suspected stroke to the ED staff all relevant information should be provided, including:

- Patient age
- Symptoms present, including findings of stroke screening/CPSS
- Time LSN
- Vital signs, including BGL
- GCS
- CTAS
- Comorbidities
- Current medications (note blood thinners)
- Medication allergies
- Treatment provided and response

CHARTING

In addition to the mandatory fields, it is important to document the time of consult with the DASH facility and the information stated in the Transfer of Care section above.

Key Points – Stroke

Identify a positive CPSS early

Use time LSN to calculate the prehospital reperfusion interval (RI)

Consult nearest DASH ASAP if +CPSS and RI criteria met

Identify possible posterior circulation strokes

Never bypass the nearest DASH

Bring family/SDM or their contact info

Early notification and treatment improves outcomes

KNOWLEDGE GAPS

More research is needed regarding potential for administering stroke-specific treatments earlier in the prehospital setting, such as hypertension therapy, anti-platelet therapy and hyperglycemia therapy.

Investigation into the feasibility and effectiveness of the use of mobile stroke units in large urban centres is ongoing. This evidence may not be generalizable to the Nova Scotia setting.

According to Stroke Best Practice Guidelines, patients who demonstrate any signs of stroke (e.g. using the CPSS) should then have a second screen done to assess stroke severity in more detail, or the likelihood of large vessel occlusion. There are several of these screens described [e.g. Vision, Aphasia, Neglect (VAN)] and they are used to identify possible EVT candidates with more specificity than the CPSS on its own. However, this screen takes extra time and is only necessary in a subset of the stroke population that is outside the RI for thrombolytic. For this reason, among others, in Nova Scotia this screen will be done by the charge physician at the DASH. There may be instances in which the physician may ask you to assess for these additional screening findings over the radio, to provide them with further information required for determining EVT candidacy.

Currently, there is less available evidence on the screening and treatment for posterior circulation strokes. The focus for EHS clinicians is to recognize symptoms of a possible posterior stroke and identify this to the receiving facility. Expert opinion advises that the charge physician at the nearest DASH be consulted when suspecting a posterior circulation stroke within the RI for thrombolytic or EVT.

EDUCATION

The focus of stroke education should be on screening, early recognition and notification, and trip destination decisions.

The collaboration between prehospital care clinicians, ED staff, and Neurology colleagues is essential to achieving the overall management goals of stroke treatment in Canada, according to the Canadian Best Practice Recommendations. Continuing to learn and work together across disciplines will be essential in order to improve outcomes.

QUALITY IMPROVEMENT

Important elements are: [1] documentation of time LSN, [2] completion of stroke scale, [3] early notification, and [4] appropriate destination decision.

REFERENCES

Heart and Stroke Foundation of Canada. *Canadian Stroke Best Practices Recommendations.* http://www.strokebestpractices.ca

http://www.heartandstroke.ns.ca

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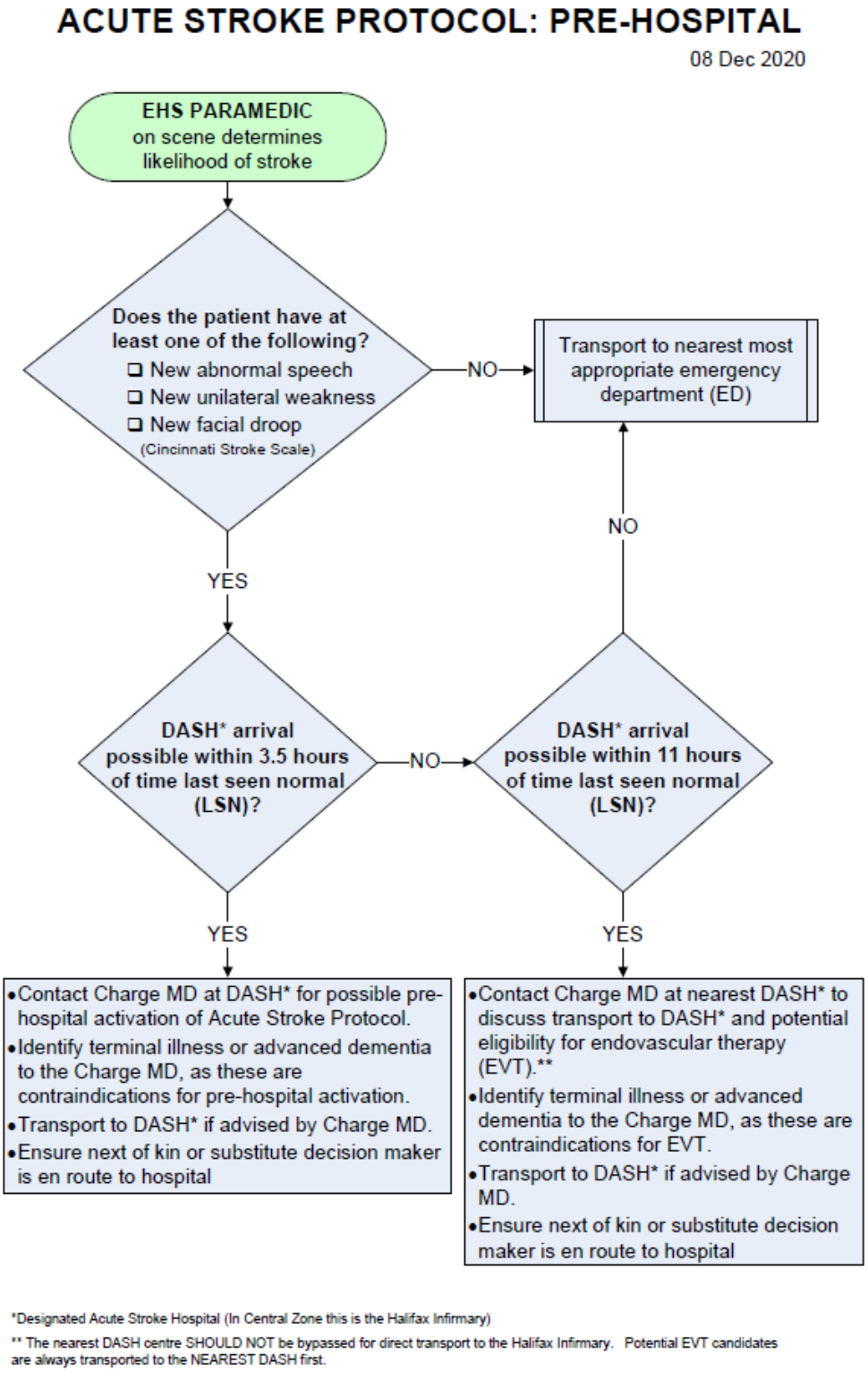
Figure 1: Nova Scotia DASH Locations

- Aberdeen Hospital
- Cape Breton Regional Hospital
- Colchester East Hants Health Centre
- Cumberland Regional Health Care Centre
- Inverness Consolidated Memorial Hospital* (not a DASH facility, but has an acute stroke protocol established and suitable as transport destination)
- Izaak Walton Killam Health Centre
- QEII Health Sciences Centre, Halifax Infirmary
- St Martha's Regional Hospital
- South Shore Regional Hospital
- Valley Regional Hospital
- Yarmouth Regional Hospital

Figure 2: Ground Ambulance Provincial Acute Stroke Protocol



PEP 3x3 TABLES for STROKE

Throughout the EHS Guidelines, you will see notations after clinical interventions (e.g.: **PEP 2 neutral**). PEP stands for: Canadian **P**rehospital **E**vidence-based **P**ractice.

The number indicates the Strength of cumulative evidence for the intervention:
1 = strong evidence exists, usually from randomized controlled trials;
2 = fair evidence exists, usually from non-randomized studies with a comparison group; and
3 = weak evidence exists, usually from studies without a comparison group, or from simulation or animal studies.

The coloured word indicates the direction of the evidence for the intervention:
Green = the evidence is supportive for the use of the intervention; **Yellow = the evidence is neutral**; **Red = the evidence opposes** use of the intervention;
White = there is no evidence available for the intervention, or located evidence is currently under review.

PEP Recommendations for stroke Interventions, as of 2021/01/27. PEP is continuously updated. See: https://emspep.cdha.nshealth.ca/ for latest recommendations, and for individual appraised articles.

Stroke-CVA-TIA

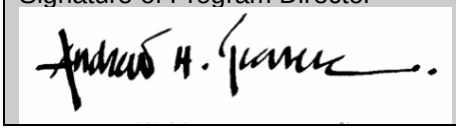
Date Last Search Run: Nov 12, 2019
Table last updated: Dec 19, 2019
Data last added: Jan 26, 2021

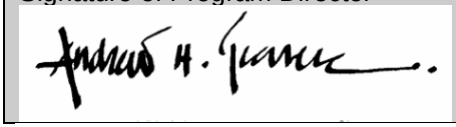
Recommendation		RECOMMENDATION FOR INTERVENTION			
		SUPPORTIVE (Green)	NEUTRAL (Yellow)	AGAINST (Red)	NOT YET GRADED (White)
STRENGTH OF EVIDENCE FOR INTERVENTION	1 (strong evidence exists)	• Advanced Notice/ Optimal Trip Destination • Mobile Stroke unit	• ASA/Aspirin • Magnesium		• Hypotension Control • Oxygen
	2 (fair evidence exists)	• Drip and ship • HEMS • Stroke Diagnosis Scales (any) • Stroke scale: CPSS • Stroke scale: LAMS • Stroke scale: RACE	• Blood Glucose Control • Hypertension Control		
	3 (weak evidence exists)	• 12-Lead ECG			

6288.06: STROKE

Program Document Number Management System

PDN: 6288.06	**Title:** Stroke	**Type:** CPG
Effective Date: February 22 2013	**Revision Date:** June 24 2021	
Approval Date: February 15 2013	**Revision Date:**	
Review Date: November 28 2012	**Revision Date:**	
Replaces: 6288.04, 6288.05	**Revision Date:**	
Signature of Program Director 	Signature of Program Document Coordinator *Electronically signed to expedite information transfer: Tanya Fraser*	

PDN: 6288.99.01.01	**Title:** Stroke Destination	**Type:** Field Guide
Effective Date: February 22 2013	Revision Date:	
Approval Date: February 15, 2013	Revision Date:	
Review Date: November 28, 2012	Revision Date:	
Replaces: 6288.06	Revision Date:	
Signature of Program Director 	Signature of program Document Coordinator *Electronically signed to expedite information transfer: Tanya Fraser*	

PDN: 6288.99.01.01	**Title:** Stroke Management	**Type:** Field Guide
Effective Date: February 22 2013	Revision Date:	
Approval Date: February 15, 2013	Revision Date:	
Review Date: November 28, 2012	Revision Date:	
Replaces: 6288.04	Revision Date:	
Signature of Program Director 	Signature of program Document Coordinator *Electronically signed to expedite information transfer: Tanya Fraser*	