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Continuous Core Content

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C3: Stroke

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* *Drug doses are a guide only, always check a second source and follow local practice guidelines*

Take Home Points:

- Stroke care is systems-based; it cannot be done well without a well functioning team within an organized system
- Although an immediate priority is to get the patient with acute stroke to the CT scanner, it is critical not to overlook the basics: airway, breathing and circulation
- If the initial CT reveals intracranial hemorrhage, treatment focuses on prevention of further bleeding, control of BP and possible neurosurgical intervention
- If the initial CT does not reveal hemorrhage, focus turns to the timely administration of tPA in eligible patients within a 3 hour (in some cases 4.5) window following the onset of symptoms
- Attention to good basic medical and nursing care, as well as a multidisciplinary team of providers, is essential for good patient outcomes

Introduction

In this episode of C3, we review the management of the patient with acute stroke. Although cerebrovascular disease is a leading cause of death worldwide, advances in acute stroke care have been overshadowed to some degree by advances in cardiovascular care. After years of slow and difficult progress, the battle against stroke is picking up steam. Advances in imaging allow us to more precisely define the various stroke syndromes and new interventional techniques now the hold promise of more effective targeted treatments.

When most providers refer to stroke they are referring to an ischemic stroke - an infarction of brain tissue caused by an arterial occlusion in the brain. But stroke is actually a broader term encompassing any injury to central nervous system (CNS) tissue caused by vascular pathology. This includes hemorrhagic strokes of different types, subarachnoid hemorrhage (SAH) and also venous occlusions (central venous thrombosis).

In many respects, there are common principles that unify the management of these various stroke syndromes. Attention to airway management and prevention of secondary brain injury due to fever or hypoglycemia, for example, are important objectives in the treatment of all strokes. In other respects, however, current treatment recommendations differ depending on the syndrome. Blood pressure management is one of the most obvious examples of this, with very different goals in patients with ischemic versus hemorrhagic stroke.

Immediate Considerations

- **Primary Survey**
  - It is important not to let the excitement of a "Code Stroke" (as it is called in many institutions) interfere with the primary survey
    - Airway, breathing and circulation come first!
  - After the primary survey and brief initial assessment, the priority is to obtain imaging - this should be within 25 minutes of arrival or less
  - Elevate the head of the bed 30 degrees
    - Apart from as necessary during the initial imaging, elevation of the head of bed decreases passive regurgitation and aspiration
    - It also decreases intracranial pressure and improved venous drainage of the injured brain
  - Maintain O_2 sat >94%
    - There is a trend in critical care to avoid excessive oxygenation due to the poorer clinical outcomes seen in brain injured patients
    - However, in patients with acute CNS injury the need to avoid secondary hypoxic injury leads to a higher O_2 sat goal
  - Avoid hypotension
    - Similar to hypoxia, even transient decreases in blood pressure have been associated with poor outcomes in CNS injury
    - Hypotension should be scrupulously avoided, utilizing vasopressors if necessary

- **Critical Initial Assessment**
  - Time of onset
    - It is critical to establish the time on onset of symptoms to guide management
    - The clock is ticking once the patient arrives and therapy is time dependent - each minute counts
    - What to do with a wake up stroke?
      - Imaging may allow you to bend the rules with time if edema is minimal and there is a favorable perfusion/diffusion ratio on advanced imaging
  - Cursory physical examination
    - The National Institutes of Health Stroke Scale (NIHSS) serves as a standard in the evaluation of stroke severity and is used to measure the patient's degree of deficit
      - The NIHSS can be performed by any trained provider
      - Measurement of the NIHSS can be performed as the patient is being prepared for CT or even on the CT table
      - The NIHSS score ranges from 0-42, with higher numbers indicating more severe stroke
      - The NIHSS is not perfect, for example, it underestimates strokes in the posterior circulation (brainstem and cerebellum)
  - Blood pressure
    - Blood pressure can be very labile in the setting of acute stroke and high blood pressures are very common in the initial presentation

- Unless pressure is extremely elevated (>220/120) it is appropriate to obtain the initial CT and recheck BP
  - The presence or absence of bleeding will guide the subsequent BP management
  - If the pressure is >220/120, an initial dose of IV antihypertensive such as labetalol (10-20 mg) on the way to CT is appropriate
- Labs and tests
  - **Blood glucose** is the most important initial lab test
    - Both hypo- and hyperglycemia are stroke mimics
    - Blood glucose control is important to clinical outcomes
  - Other important and routine blood tests include complete blood count (CBC), electrolytes and coagulation studies
  - Troponin testing is appropriate
    - Acute coronary or aortic disease can lead to stroke
    - Cardiac ischemia may complicate stroke, which generally results in a hyperadrenergic state
- ECG
  - Electrocardiography (ECG) or the cardiac monitor may detect arrhythmias
  - Atrial fibrillation (AF) suggests a possible embolus from the heart as a cause for the stroke
- CXR
  - Chest x-ray is appropriate when there is suspicion of concurrent cardiopulmonary and is generally obtained

- **Imaging**
  - The immediate priority is to obtain a **non-contrast CT Head**
    - The first important "branch" in the management is to determine the presence or absence of bleeding in the brain
  - In cases where stroke appears clinically obvious, CT angiography while the patient is still on the CT table can be extremely helpful
    - If hemorrhage is seen, angiography can identify a source of the bleeding (e.g. an aneurysm or arteriovenous malformation)
    - If no hemorrhage is seen, the patient may be a candidate for fibrinolytic treatment
  - Some specialized centers have imaging protocols that involve magnetic resonance (MR) imaging and MR angiography
    - MR gives more precise detail but:
      - is more time consuming
      - is actually less sensitive for the presence of acute bleeding
      - may be contraindicated in patients who are critically ill if it compromises the ability to resuscitate and safely monitor the patient
    - MR angiography, unlike CT angiography, does not necessarily require contrast dye

Managing Hemorrhagic Stroke

- Once bleeding is identified on CT other potential diagnoses that might have explained the patient's presentation are less likely
- Types of hemorrhagic stroke
  - Not all bleeding in the brain is the same: it is important to identify the specific syndrome to guide initial therapy
  - **Subarachnoid hemorrhage**
    - Usually due to the rupture of an aneurysm or AVM
    - Blood is seen around the base of the brain and/or in the sulci
  - **Intracerebral (hypertensive) hemorrhage**
    - Usually due to the rupture of small, deep perforating vessels in the brain damaged by chronic hypertension and vascular disease
    - Blood is seen unilaterally in one of four typical sites:
      - Basal ganglia
      - Thalamus
      - Cerebellum
      - Pons
    - Blood sometimes dissects into one of the ventricles
  - **Hemorrhagic transformation of ischemic stroke**
    - Due to the spontaneous bleeding of ischemic and infarcted brain tissue
    - Blood is found in and around the vascular distribution of the vessel occluded (e.g. typically a unilateral wedge on the CT)
    - The risk of hemorrhage is proportional to the size of infarcted territory and is thought to occur with reperfusion
- Treatment
  - BP control (BP<160/90 or lower)
    - This continues to be controversial
    - *EMRAP Paper Chase February 2017* - Brain Bleeds and Blood Pressure
      - No difference in outcomes between a target systolic BP of 140 vs 180
    - This may involve prothrombin complex concentrate (PCC), fresh frozen plasma (FFP), vitamin K, and specific reversal agents for patients on anticoagulants
    - This may involve platelets or DDAVP for patients with low or dysfunctional platelets but recent evidence suggests that patients on antiplatelet therapy may actually do worse with platelet transfusion
      - *EMA September 2016 Abstract 10* - Platelet transfusion versus standard care after acute stroke due to spontaneous cerebral hemorrhage associated with antiplatelet therapy
    - Treatment of secondary hemorrhage after tPA may include cryoprecipitate, aminocaproic acid and tranexamic acid, in addition to all of the agents listed above

- Prevention of vasospasm and seizure
  - Nimodipine, a unique calcium channel blocker, is given in SAH to prevent secondary vasospasm and stroke
    - This can be administered po or by NG tube to prevent
  - In patients with blood surrounding the cerebral cortex, antiepileptic drugs are indicated
    - Levetiracetam and phenytoin are commonly used and can be administered by IV infusion
    - Most patients with deep sites of bleeding (e.g., ICH) do not require AEDs unless a seizure has actually occurred
- Neurosurgical care
  - SAH
    - Early surgery to clip or interventional radiological techniques to "coil" aneurysms
  - ICH
    - Some patients may be candidates for surgical decompression and evacuation of the hematoma
    - Cerebellar hemorrhage is a surgical emergency
  - Ventriculostomy
    - Patients with blood in the ventricles and hydrocephalus may benefit from the insertion of an external ventricular drain (EVD) by a neurosurgeon

Managing Ischemic Stroke

- Once bleeding has been ruled out on CT, management moves in a very different direction
  - The clock is ticking on both IV tPA and interventional therapies
- In early ischemic stroke the CT may appear normal
  - Because signs of stroke on CT only develop with time, this is a promising sign, because the risk of bleeding with tPA increases with time
  - Signs of ischemic stroke are generally related to edema, at first a blurring of the margin of the white and grey matter in the infarcted area, followed by hypodensity and mass effect due to the swelling
- In the event that the CT is normal, one should consider the possibility of a stroke mimic
  - Stroke mimics
    - Most stroke mimics can be identified history, physical examination, by the initial CT and a few simple tests
    - Ischemic stroke is suggested by neurological deficits in the distribution of a vascular territory
      - e.g., right sided arm weakness and facial droop plus difficulty with language suggest a stroke in the territory of the left middle cerebral artery
      - There are a great many stroke syndromes - knowledge of these is extremely helpful in ruling out mimics
    - Common stroke mimics include complex migraine and seizure disorder
      - Migraine syndromes may include neurological deficits that mimic a stroke, these are typically self-limited and resolve

- Seizures may mimic a stroke by resulting in a post-ictal (post-seizure) paralysis; this is called Todd's paralysis
- Deficits that are post-ictal or migraine-related are usually self limited, resolving within hours

- Other important mimics
  - Structural (should be picked up on CT)
    - Subdural hematoma
    - Tumor
  - Glucose/Electrolyte derangements
    - Glucose - hypo- and severe hyperglycemia
    - Sodium - hypo- and hypernatremia
    - Calcium - hypo- and hypercalcemia
  - Peripheral neuropathy
    - Bell's palsy (cranial nerve VII)
    - Peripheral vertigo (cranial nerve VIII)
  - Other neurological syndromes
    - Guillain-Barre syndrome
    - Multiple sclerosis (MS)
    - Spinal cord lesions
  - Dementias
    - Wernicke's encephalopathy
    - Movement disorders
  - Medication related
    - Anticonvulsants
    - Sedative/hypnotic
    - Movement disorder drugs
  - Functional (psychiatric) disorders
    - Conversion disorder
- tPA is sometimes given to patients with stroke mimics
  - *EMRAP Dec 2015 Paper Chase Chapter 17* - Lytics for Stroke Mimics

- IV tPA
  - IV tPA is indicated within 3 hours of the onset of stroke
    - This time frame may extend to 4.5 hours in local protocols for selected patients

- The risk of hemorrhagic conversion increases markedly in patients with severe stroke (NIHSS >25) and signs of a large territory infarction on CT (>⅓ of cortical territory on affected side)
- Patients with small strokes, even with a NIHSS of 0, may benefit from tPA if the deficit is disabling (e.g. deafness or blindness)
  - *EMRAP October 2017 Chapter 12 Low NIHSS stroke patients*

- IV tPA should be administered according to a protocol that involves:
  - informed consent whenever possible
  - A systematic check (using a checklist) for contraindications
  - A pharmacist if possible to help ensure accurate weight-based administration
  - Careful control of blood pressure using IV titratable agents to keep BP <180/105 prior to and after administration
    - Titration of IV labetalol boluses are appropriate until titratable drip can be set up (nicardipine is an excellent choice in the brain injured patient)
  - Ongoing observation in an intensive care setting for any deterioration suggestive of hemorrhagic or other complications such as:
    - New onset of headache, vomiting
    - Worsening neurologic status
    - Gastrointestinal or other systemic bleeding
    - Angioedema (this is a possible complication of tPA and may require airway intervention)
      - In the event of suspected intracranial bleeding, the tPA infusion should be stopped and a repeat CT (without contrast) obtained

- BP management
  - If tPA is not administered, BP management is different
  - Permissive hypertension
    - Unless the blood pressure is extremely high (BP >220/120), it should not be lowered aggressively with IV agents
    - The BP is allowed to remain higher if tPA is not given because the higher cerebral perfusion pressure may improve perfusion of “at-risk” tissue surrounding the infarction
    - Slow, gradual reduction in blood pressure over many hours and days is currently recommended
      - *EMRAP August 2017 Blood Pressure Control in Acute Stroke*
- Aspirin (ASA)
  - ASA is indicated (160-325 mg) unless tPA is given
- Nothing by mouth (NPO)
  - Aspiration pneumonia is the leading cause of death in stroke
  - Patients should have a formal swallowing assessment before any is given by mouth
- Interventional therapy

- At present, emergent interventional therapy (e.g., a thrombectomy in the interventional neuroradiology suite) is considered in patients:
  - Outside the 3 hour window for tPA (up to 12-24 hours in some cases)
  - With large vessel occlusions (seen on imaging)
  - With large areas of "at risk" brain tissue as determined by perfusion scanning (either using MR or CT techniques)
- Thrombectomy can also be performed subsequent to tPA administration
  - *EMA October 2017 Abstract 10 - Combined Thrombolysis and Thrombectomy for Acute Ischemic Stroke*

Prevention Of Complications

- Regardless of stroke subtype, key causes of mortality in stroke can be prevented and mitigated with specialized nursing and protocolized medical care:
  - Aspiration pneumonia
    - NPO, head positioning, suctioning, formal swallowing assessment
  - Urinary tract infection
    - Remove unnecessary indwelling catheters
  - Deep vein thrombosis/pulmonary embolism
    - Mechanical devices such as leg squeezers
    - Low dose heparin
  - Trauma from falls
    - Fall precautions are critical
  - Pressure sores
    - Patients must be turned regularly
- Maintenance of euthermia, euvolemia, euglycemia to prevent secondary brain injury
- If patients remain in the Emergency Department past the initial resuscitative phase, attention to all of the above issues becomes extremely important to a good overall outcome

Disposition

- In general, patients in the acute phase of stroke should be admitted to a monitored bed in a unit with expertise in the care of stroke patients
  - The importance of high-quality specialized nursing care cannot be underestimated as it is the principal determinant of clinical outcome
- Transfer to a center with specialized stroke care is appropriate for both emergent advanced interventions as well as ongoing multidisciplinary inpatient care

References

Hemphill JC, Lam A. Emergency Neurological Life Support: Intracerebral Hemorrhage. Neurocrit Care (2017) 27(Suppl 1): 89. PMID: 28913708

Khandelwal K, Yavagal DR, Sacco RL. Acute Ischemic Stroke Intervention. J Am Coll Cardiol 2016;67:2631–44. PMID: 27256835

Rabinstein AA. Treatment of Acute Ischemic Stroke. Continuum (Minneap Minn) 2017;23(1):62–81. PMID: 28157744

Southerland AM. Clinical Evaluation of the Patient With Acute Stroke. Continuum (Minneap Minn) 2017;23(1):40–61. PMID: 28157743

Cantrill SV, Brown MD, Brecher D, et al. Clinical policy: use of intravenous tissue plasminogen activator for the management of acute ischemic stroke in the emergency department. Annals of emergency medicine. 2015 Sep 1;66(3):322-33. PMID: 26304253

Lai S, Kalantari A, Mason J, et al. When Anticoagulants Become a Bloody Mess. Annals of Emergency Medicine. 2017 Dec 31;70(6):949-52.

Hemphill JC, Lam A. Emergency Neurological Life Support: Intracerebral Hemorrhage. Neurocritical Care. 2017 Sep 1;27(1):89-101. PMID: 26438461

Jauch EC, Saver JL, Adams HP, et al. Guidelines for the early management of patients with acute ischemic stroke. Stroke. 2013 Mar 1;44(3):870-947. PMID: 23370205

Kerr G, Ray G, Wu O, et al. Elevated troponin after stroke: a systematic review. Cerebrovascular diseases. 2009;28(3):220-6. PMID: 19571535