Hemorrhagic Stroke: Considerations for Treatment via Telemedicine

PRESENTED BY:
Alexander M. Mason, MD, FAANS - Assistant Professor, Department of Neurosurgery, Emory Healthcare
REACH Enterprise Telemedicine Platform
Audience Polling Question #1
Hemorrhagic Stroke: Considerations for Treatment via Telemedicine

Diagnosis, Management and Treatment

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EMORY UNIVERSITY
Disclosures

• Consultant for Specialist TeleMed
Case 1:

- 70 year old male
- Sudden onset, severe headache
- Took ASA for relief
- Collapsed
- Decreasing Mental Status
- Wife called 911; taken to your hospital
Physical Exam

- T-98.7  P-69  BP-198/97  RR-18
- Pupils-equal, sluggish, reactive
- CV-NS without murmur
- Skin-Bruise on forehead
- Neurological exam:
  - no gag reflex, withdraws to pain, +4 DTR
- GCS
  - Eyes-0
  - Verbal-0
  - Motor-4
NIH stroke scale

<table>
<thead>
<tr>
<th>Category</th>
<th>Score/Description</th>
<th>Date/Time</th>
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<td>1a. Level of Consciousness</td>
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<td>2 = Confused</td>
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<td>3 = Coma</td>
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<td>3 = Unanswerable</td>
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<td>1c. LOC Comas (Coma, eye, cran)</td>
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<td>2. Vestibular</td>
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<td>(Eye open - patient follows</td>
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<td>direction in head)</td>
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<td>3. Visual Fields</td>
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<td>pre-beat field quadrants)</td>
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<td>4. Facial Paralysis</td>
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<td>5. Motor Arm - Left</td>
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<td>3 = No effort against gravity</td>
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<td>6. Motor Leg - Left</td>
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<td>7. Loss Ataxia</td>
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<td>0 = No ataxia</td>
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<td>2 = Can't keep body</td>
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<td>8. Sensory</td>
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<td>leg, and other senses)</td>
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<td>1 = Partial sensation</td>
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<td>2 = Severe loss</td>
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<td>9. Body Temperature</td>
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<td>and sound)</td>
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<td>1 = Partially moderate alexia</td>
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<td>2 = Moderately moderate alexia</td>
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<td>3 = Severe alexia</td>
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<td>10. Verbal Detox</td>
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<td>(Evaluate speech clarity by</td>
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<td>patient responding (read words)</td>
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<td>0 = Normal</td>
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<td>1 = Partial retention</td>
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<td>2 = Severe retention</td>
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<td>11. Extensive and Isolation</td>
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<td>(Use information from prior test</td>
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<td>to identify, neglect in double</td>
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<td>simultaneous arm test)</td>
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<td>0 = No neglect</td>
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<td>1 = Partial neglect</td>
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<td>2 = Complete neglect</td>
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<td><strong>TOTAL SCORE</strong></td>
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Stroke scale score: 38
CT

Diagnosis:
• Hemorrhagic stroke (ICH)
• Large, Midline shift
Management: Intracerebral Hemorrhage (ICH)

- Initial Medical?
- Surgical?
- Disposition?
- Prognosis?
Case 2

• 67 y/o dropping off dry cleaning with worst headache of her life
• Taken by EMS to your hospital
Physical Exam

- T-98.7  P-104  BP-188/97  RR-18
- Pupils-equal, reactive
- CV-NS without murmur
- Neurological exam:
  - A0x3
  - CN 2-12 intact
  - Moves all extremities; non-focal
- GCS
  - Eyes-4
  - Verbal-5
  - Motor-6
CT

Diagnosis:
- Subarachnoid hemorrhage
- Ruptured aneurysm
Management: Aneurysmal Subarachnoid Hemorrhage

Initial Medical?
Surgical?
Disposition?
Prognosis?
Case 3:

- 23 y/o involved in minor unrestrained MVC
- No LOC
- Airbag deployment
Physical Exam

- T-97.5 P-60 BP-122/67 RR-20
- Pupils-equal, reactive
- CV-NS
- Skin-Bruise on forearm and sternum
- Neurological exam:
  - Normal
- GCS
  - Eye-4
  - Verbal-5
  - Motor-6
CT

Diagnosis:
• Traumatic subarachnoid hemorrhage (tSAH)
Management: Traumatic subarachnoid hemorrhage (tSAH)

- Initial Medical?
- Surgical?
- Disposition?
- Prognosis?
Case 4

• 75 y/o retired banker with right-sided weakness upon awakening
• No headache
• Does not clear after morning cup of coffee; drives himself to your hospital
• History of HTN and DMII
Physical Exam

• T-98.2 P-92 BP-176/87 RR-18
• Pupils-equal, reactive
• CV-NS without murmur
• Neurological exam:
  • AOx3
  • CN 2-12 intact
  • LUE/LLE 5/5; RUE/RLE 3/5
• GCS
  • Eyes-4
  • Verbal-5
  • Motor-6
<table>
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<tr>
<th>Category</th>
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<tbody>
<tr>
<td>1a. Level of Consciousness (Alert, drowsy, etc.)</td>
<td>0 = Alert 1 = Drowsy 2 = Drowsy 3 = Coma</td>
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<td>1b. LOC Questions (b) (Corrected) (Corrected) (Corrected) (Corrected) (Corrected)</td>
<td>0 = Answers both correctly 1 = Answers one correctly 2 = Incomprehensible</td>
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<td>1c. LOC Commands (Corrected, correct, make fast let go)</td>
<td>0 = obey both correctly 1 = obey one correctly 2 = disobey</td>
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<td>2. Best Gaze (Eyes open; patient follows examiner’s finger or eyes)</td>
<td>Normal 1 = Partial gaze asymmetry 2 = Forced Deviation</td>
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<td>3. Visual Fields (Introduce visual stimuli; threat to pick visual field quadrants)</td>
<td>No visual loss 1 = Partial hemianopsia 2 = Complete hemianopsia 3 = Bilateral hemianopsia (blind)</td>
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<td>4. Facial Paralysis (Show teeth, raise eyebrows and squeeze eyes shut)</td>
<td>Normal 1 = Minor 2 = Partial 3 = Complete</td>
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<td>5a. Motor Arm - Left 5b. Motor Arm - Right (Elevate arm to 90° if patient is sitting, 45° if supine)</td>
<td>0 = No drift 1 = Drift 2 = Can’t resist gravity 3 = No effort against gravity 4 = No movement 5 = Intensifies (plant flexion or limb arm)</td>
<td>Left</td>
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<tr>
<td>6a. Motor Leg - Left 6b. Motor Leg - Right (Begin leg 30° with patient supine)</td>
<td>0 = No drift 1 = Drift 2 = Can’t resist gravity 3 = No effort against gravity 4 = No movement 5 = Intensifies (plant flexion or limb arm)</td>
<td>Left</td>
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<td>7. Limb Ataxia (Finger-nose, heel-down Hess)</td>
<td>0 = No ataxia 1 = Present in one limb 2 = Present in two limbs</td>
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<td>8. Sensory (Pin prick to face, arm, trunk, and leg - compare side to side)</td>
<td>Normal 1 = Partial loss 2 = Severe loss</td>
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<td>9. Best Language (Name item, describe a picture and read sentences)</td>
<td>0 = aphasia 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = None</td>
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<td>10. Dysarthria (Evaluate speech clarity by patient repeating/read words)</td>
<td>Normal articulation 1 = Mild to moderate slurring of words 2 = Near to unintelligible or worse 3 = Inarticulate or other physical barrier</td>
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<td>11. Extinction and Inattention (Low information from prior testing to identify neglect or double simultaneous stimuli testing)</td>
<td>0 = no neglect 1 = Partial neglect 2 = Complete neglect</td>
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**NIHSS score: 5**
CT

Diagnosis:
- Intracerebral hemorrhage (ICH)
- Small, no midline shift
Management: Intracerebral hemorrhage (ICH)

Initial Medical?
Surgical?
Disposition?
Prognosis?
Stroke Epidemiology: Ischemic vs Hemorrhagic

Ischemic Stroke 80-85%

Hemorrhagic Stroke 15-20%

Intracerebral Hemorrhage 2/3

Subarachnoid Hemorrhage 1/3

Primary Causes

- Hypertension
- Cerebral amyloid angiopathy
- Anticoagulant use
- Antiplatelet use
- Drugs
  - Amphetamines
  - Cocaine
- Bleeding disorders

Secondary Causes

- Hemorrhagic transformation of a cerebral infarction
- Vascular malformations
  - Aneurysms
  - Vascular Abnormalities
- Tumors
- Trauma
- Venous infarction
Hemorrhagic Stroke Epidemiology

15-20% of all strokes
Highest mortality of all strokes

Epidemiologic Risk factors:
- Age 55+
- Male
- Alcohol use
- Smoking
- Drug use

Increased incidence in African Americans, Japanese, and Hispanic populations
Hemorrhagic Stroke Epidemiology

30 day mortality: 35-52%
  • 50% of these in first 48 hours

10% independent at 1 month

One-fifth of survivors are independent at 6 months

7000 operations annually in US to remove blood

Broderick: Guidelines for the Management of Spontaneous Intracerebral Hemorrhage; Stroke 199;30: 905-915
Hemorrhagic Stroke Presentation: Location Dependent

Basal ganglia (50%)
  • Contralateral hemiparesis, sensory loss, conjugate gaze

Lobar regions (20-50%)
  • Contralateral hemiparesis or sensory loss, aphasia, neglect, or confusion

Thalamus (10-15%)
  • Contralateral hemiparesis, sensory loss, gaze paresis

Pons (5-12%)
  • Quadriparesis, facial weakness, decreased level consciousness

Cerebellum (1-5%)
  • Ataxia, miosis, vertigo, gaze paresis

Acute Evaluation and Management of Intracerebral Hemorrhage; Stroke 1996
Hemorrhagic Stroke Presentation

Hypertension (90%)

Altered mental status (50%)
  • Early decrease in level of consciousness seen about 50% patients
  • Uncommon finding in patients with ischemic stroke

Vomiting (46%)
  • 2% Ischemic stroke

Headache (40%)
  • 17% with ischemic stroke

Seizures (6-7%)

Broderick: Guidelines for the Management of Spontaneous Intracerebral Hemorrhage ;Stroke 1999;30: 905-915
Initial Assessment/Management: Hemorrhagic Stroke

General Measures
• Initial Evaluation and Management (ABC’s)
• Medical history/comorbidities/medications
  • Coagulopathy (warfarin, ASA, plavix, etc.)
  • History of Hypertension
• Assess Neurologic Function
  • GCS
  • NIHSS
  • Neurologic Exam
• Obtain initial imaging (CT/CTA)
  • Ideally within 45 minutes of arrival
• Medical vs Surgical management options
• Additional consultations
  • Varies depending upon hospital and available expertise
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Hemorrhagic Stroke: Airway/Breathing/Circulation

- Patients with ICH generally have higher presenting BP than patients with ischemic stroke
  - Elevated BP may result in greater risk for hematoma expansion

- For ICH patients presenting with SBP between 150 and 220 mm Hg and without contraindication to acute BP treatment,
  - *Acute lowering of SBP to 140 mm Hg is safe* (Class I) and can be effective for improving functional outcome (Class IIa). (Revised from the previous guideline)
  - INTERACT2 (n=2839)
Hemorrhagic Stroke: Airway/Breathing/Circulation

- Initial management in ICU or dedicated unit* (Class 1, Level C (opinion))
  - Clinical course can be quite dynamic first 24-48 hours
  - Frequent neuro checks (q1-q2)
  - Patient and facility dependent
- Normal saline should be initial fluid of choice
- Both hyperglycemia and hypoglycemia should be avoided (Class 1, level C (opinion))
- Involve neurosurgery early
- Prevent or treat fever
- Treat clinical seizures; no prophylaxis (Class 1, Level A)
Hemorrhagic Stroke: Airway/Breathing/Circulation

Incidence of seizures after ICH range 4.2 ~ 30%%
• Most common with lobar hemorrhages
• Unusual with deep basal ganglia hemorrhages
• Prophylactic treatment with anticonvulsants is not recommended

The importance of initiating management in the ED prior to transfer to definitive bed improves outcomes.
• Involvement of Critical Care while in ED improves outcomes
• Consideration of utilization of Critical Care Telemedicine and/or Neurosurgical Telemedicine would allow for early intervention.
• Pathways (e.g. Neurocritical Care Society) can integrate care effectively
Patients with a severe coagulation factor deficiency or severe thrombocytopenia should receive appropriate factor replacement therapy or platelets, respectively (Class I; Level C (opinion)).

All antiplatelet or anticoagulation management should be stopped

No clear role for antiplatelet reversal
  • Platelet transfusions do not improve outcome
  • DDAVP in ICH has not been studied
Initial Assessment/Management: Hemorrhagic Stroke

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Hemorrhagic Stroke: Medical History/Comorbidities/Medications

Anticoagulation should be assessed and reversed if possible

Pre-existing pharmacy protocols for:
- Warfarin
- 10a Inhibitors – Xarelto, Eliquis
- Direct Thrombin Inhibitor – Pradaxa

Possible hemodialysis considerations
Hemorrhagic Stroke: Medical History/Comorbidities/Medications

- Hemostatic agents such as recombinant factor VIIa (rFVIIa)
  - Subsequent phase 3 study failed to showed:
    - Trend towards improved outcome
    - Decreased enlargement of hematoma
    - Increased rate of thrombotic complications
    - Further studies needed to see if certain groups of patients would

- **Routine use not recommended**

- **Occasional, patient specific use can be considered**
Hemorrhagic Stroke: Medical History/Comorbidities/Medications

Let's complicate things...

- No clear data on when to *restart* anticoagulant therapy
- Subcutaneous low molecular weight heparin drugs for VTE appears safe after 3-4 days, if hematoma is stable
- Neurosurgery can be helpful with individual patient recommendations for restarting medications
Initial Assessment/Management: Hemorrhagic Stroke

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Hemorrhagic Stroke: Assess Neurologic Function

Prehospital evaluation

• Primary: Stabilize ABCs and transfer to closest facility prepared to care for stroke patients
• Secondary: Focused history including last normal
• GCS and preliminary physical exam; report these findings to hospital enroute
  • Shorten Door to CT time upon arrival
  • Increase efficiency of consultant availability in person or by Telemedicine

Glasgow Coma Scale (GCS)

• Excellent prehospital tool
• 20% demonstrate a decrease between prehospital to initial hospital eval (2 or more points)
• 15-23% of patients will demonstrate further worsening within the first hours after hospital arrival
Hemorrhagic Stroke: Assess Neurologic Function

A baseline severity score (NIHSS) should be performed as part of the initial evaluation of patients with ICH (Class I; Level B).

- Used to determine whether degree of disability merits use of thrombolytic therapy, and to follow course/treatment of stroke.

- **Equivalent bedside evaluation vs. Telemedicine evaluation** (Class I, Level A)
  
  “The NIHSS-telestroke examination, when administered by a stroke specialist using HQ-VTC, is recommended when an NIHSS-bedside assessment by a stroke specialist is not immediately available for patients in the acute stroke setting, and this assessment is comparable to an NIHSS-bedside assessment.”

- Document Pre-existing neurological dysfunction
- Last normal time documented
- NIHSS has diminished usefulness in ICH patients
Hemorrhagic Stroke: Assess Neurologic Function - Non NIHSS
Hemorrhagic Stroke: Assess Neurologic Function

• The ideal situation is a specialist at bedside for evaluation and assistance in the management and treatment.

• Paucity of specialists in many hospitals and geographic areas

• Telemedicine
  • Provides access to specialists
  • Improves quality of care and resources of ED and hospital based physicians

• The importance of high quality technology in limited physician access areas: Telemedicine allows:
  • Ability to perform detailed neurological assessment
  • Integration of EMR, data and labs, PACS
  • Integration of care pathways and protocols
  • Analogous care to bedside care is the goal
Initial Assessment/Management: Hemorrhagic Stroke

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Audience Polling Question #2
Initial imaging (CT/CTA)

• Rapid neuroimaging with CT or MRI is recommended to distinguish ischemic stroke from hemorrhagic stroke (Class I; Level A)

• Initial diagnosis of ischemic vs hemorrhagic stroke is made
  • CT considered the ‘Gold Standard’ for identifying acute hemorrhage
  • MRI (gradient echo and T2) have analogous sensitivities but time, cost, patient tolerance, clinical status and availability limit use

• 28-38%* of patients will have hematoma volume expansion on follow-up CT

• CTA required for subarachnoid that is not considered to be traumatic (vascular origin)
Initial imaging (CT/CTA)

- CT evaluation should include:
  - Location - correlation with symptoms
  - Volume – LxWXH/2 (volume of an ellipse)
  - Extension (ventricle) – independent risk factor for poor prognosis
  - Midline shift – poorer prognosis
  - Preexisting atrophy - a good thing?

- CTA sensitive for vascular abnormalities for initial evaluation
  - Risk factors for underlying vascular abnormalities include: age <65 years, female sex, nonsmoker, lobar ICH, intraventricular extension, and absence of a history of hypertension or coagulopathy
  - All subarachnoid hemorrhage patients (traumatic) should have CTA

- All non-traumatic SAH should be transferred to a regional cerebrovascular center
  - ICH accompanied by significant amounts of SAH
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Hemorrhagic Stroke: Conservative Management

Minimally symptomatic patients*

Patients with High ICH score*
  • Massive ICH *
  • Low GCS
  • IVH
  • AGE > 75

Those with significant comorbidities

* Potential Telemedicine patients with TeleNeurosurgery or Tele CriticalCare
Hemorrhagic Stroke: Surgical Management

Early surgical intervention can be considered in those >4 cm or GCS < 13 before rapid decline in function:

- Age, co-morbidities, location, patient/family wishes heavily influence decisions
- EVD in those with hydrocephalus
- Surgical intervention indications expanding
  - Emory multicenter MIS evacuation study

Moderate size ICH 10-35cc:

- <10cc often not symptomatic
- >30cc not good outcome with traditional techniques
- MIS studies are expanding indications (35-80cc?) [Emory University leading study]

Favorable locations:

- Lobar, Non-dominant hemisphere, Cerebellar

Rapid deterioration or young patient under 50
Early surgery versus initial conservative treatment in patients with spontaneous supratentorial lobar intracerebral hematomas (STICH II): a randomized trial

A David Mendelow, FRCS[SN], Dr Barbara A Gregson, PhD, Elise N Rowan, PhD, Prof Gordon D Murray, PhD, Anil Gholkar, FRCR, Patrick M Mitchell, FRCS, for the STICH II Investigators

Lancet 2013; 382: 397–408
Hemorrhagic Stroke: Surgical Management: STICH II Trial

601 patients from 78 centers in 27 countries were randomized
Divided into early surgery group versus conservative group

Results:
• 174 (59%) of surgery patients had an unfavorable outcome
• 178 (62%) in the initial conservative treatment group had an unfavorable outcome

The STICH II results confirm that early surgery does not increase the rate of death or disability at 6 months and may have a small but clinically relevant survival advantage for patients with spontaneous superficial intracerebral hemorrhage without intraventricular hemorrhage.

Lancet 2013; 382: 397–408
Hemorrhagic Stroke: Surgical Management - Special Circumstances

Cerebellar Hematoma
- Often cause direct brainstem compression and/or hydrocephalus.
- Can conservatively manage those <4 cm or GCS > 14 with appropriate neurosurgical consultation.
  - Not all hematomas are the same.
  - *Early* neurosurgery involvement and/or consideration for transfer to tertiary care facility

Patients with cerebellar hemorrhage who are deteriorating neurologically, or brainstem compression and/or hydrocephalus should undergo surgical removal of the hemorrhage as soon as possible
- Level 1, class B evidence
Spontaneous hemorrhagic stroke in those <45 or <55 without a history of hypertension require further workup.

• Needs further work-up

• Necessary to r/o all types of vascular lesions
  • AVM?
  • Vascular fistula?
Initial Assessment/Management: Hemorrhagic Stroke

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Hemorrhagic Stroke Initial Assessment/Management: Additional Consultations

- Emergency Medicine evaluation
  - Initial evaluation and management of stroke patients
  - Identification of ischemic vs hemorrhagic stroke vs other causes

- Neurology Consultation Local or Telemedicine (Multiple Providers)
  - Intimate role in the assistance in management for Ischemic stroke.
    - Emergency medicine physicians may consider evaluation and tPA treatment without c/s
  - Role in both ischemic and hemorrhagic stroke for stroke prevention
  - Telemedicine presence and availability well established
Hemorrhagic Stroke Initial Assessment/Management: Additional Consultations

Neurosurgery Consultation – Local or Telemedicine (Specialist TeleMed)
- Intimate role in the assistance and management for hemorrhagic stroke
- Identify surgical vs conservative management patients
- Telemedicine neurosurgical consultation for non-operative patients
  - Allow patient retention, increased hospital revenue and completion of care spectrum locally in selected patients
  - Provide reasonable expectations and treatment recommendations regarding management

Critical Care consultation optimizes care and outcomes
- Class 1, Leve B evidence
- The importance of weighing patient management and what is best for the patient globally
Final Thoughts: Secondary Management

Care pathways Improve Outcomes
  • Hemorrhagic stroke vs Ischemic Stroke

Assume dysphagia and aspiration risk
  • Swallow evaluation by nursing or speech therapy

Prevent venous thromboembolic events (VTE)
  • Higher degree of VTE in higher stroke scores
  • Intermittent compression devices (SCD’s)
  • Low molecular weight heparins or Lovenox
Final Thoughts: Secondary Management

Adequate long-term control of blood pressure
  • Single most important factor at preventing repeat ICH
  • Goal BP < 140/90
    • Ongoing management of BP as an outpatient

Smoking cessation

Stop heavy alcohol use
  • Light alcohol use potentially preventative?
Final Thoughts: Prognosis

Predictions of mortality and major morbidity may influence management

- Elderly
- Significant pre-existing co-morbidity

Identification and counseling to patients and families with regard to prognosis can be meaningful

- Increase patient dignity
- Reduce costs

FUNC SCORE
- A validated scoring system for predicting prognosis
Final Thoughts: Prognosis - FUNC Score

N= 629

Predictors of functional independence at 90 days were

• Independent risk factors include:
  • Age, Glasgow Coma Scale, ICH location, volume and pre-ICH cognitive impairment

Functional “independence” defined as GOS >/= to 4

May be a valid tool for prognostic guidance.

• Use needs to be weighed on individual patient basis
Conclusion

- Stroke is prevalent
  - Prevention is single best management technique

- Hypertension is the primary etiology of spontaneous hemorrhagic stroke

- The importance of initial BP reduction upon arrival to the ED
  - SBP<140 is goal.

- Importance of neurosurgery for initial management and treatment in hemorrhagic stroke, and neurology for primary and secondary management and stroke prevention

- Medical management is the mainstay of treatment, surgical treatment in certain patients

- There are reasonably reliable predictors of outcome
Back to the Cases...
Management: Intracerebral Hemorrhage (ICH)

Initial Medical?
Surgical?
Disposition?
Prognosis?
Management: Aneurysmal Subarachnoid Hemorrhage

Initial Medical?
Surgical?
Disposition?
Prognosis?
Management: Intracerebral hemorrhage (ICH)

Initial Medical?
Surgical?
Disposition?
Prognosis?
Management: Traumatic subarachnoid hemorrhage (tSAH)

Initial Medical?
Surgical?
Disposition?
Prognosis?
Thanks to:

Slides and presentation content referenced

Thanks to

- American Stroke Association: Stoke protocols and guidelines.
- Marc Goldman, MD & Seth John Stankus, DO presentation “Intracerebral Hemorrhage”
Audience Polling Question #3
Additional Information and Questions:

Dr. Alexander Mason:

alexander@specialisttelemed.com
Up-Coming Webinar:
Wake-Up Stroke: A New Treatment Protocol

Tuesday, 8/23 at 3pm EDT

Wake-up stroke (WUS) occurs when patients present with stroke symptoms upon awakening. WUS accounts for approximately 25% of acute ischemic strokes. In an effort to rapidly identify WUS patients who might benefit from endovascular stroke therapies, the team at St. Dominic Comprehensive Stroke Center boldly developed a standardized protocol involving advanced imaging and rapid interpretation.

bit.ly/WUSWebinar
Two-Minute Telemedicine Survey

Which Telemedicine Capabilities are Most Important to you and your Organization?

This survey, designed to take less than two minutes of your time, will help clinicians identify current state-of-the-art telemedicine capabilities and technology direction.

bit.ly/2MINsurvey
On-Demand Webinars

1. *Improving the Continuum of Stroke Care*
   A Practical Model for Post-Acute Treatment

2. *Acute Ischemic Stroke and tPA*
   Understanding and Mitigating the Legal Liabilities

3. *Telestroke Bedside Best Practices*
   Optimizing Collaboration between ED Staff and Remote Neurologists

4. *Building and Sustaining a Telestroke Network*
   It’s More than Technology

reachhealth.com/resources/telemedicine-webinars
Educational Whitepapers

1. **Telestroke Best Practices: Reducing Time to Treatment**  
   *Practical Advice for Minimizing Door-to-Needle and Door-to-Puncture Times*

2. **Best Practices for Establishing a Telemedicine Network**

3. **Executive Guide to Selecting a Telemedicine Platform**  
   *How to Choose Pragmatically for Today and Prepare Strategically for Tomorrow*

4. **Telestroke ROI Case Study**

reachhealth.com/telemedicine-whitepapers