HEMORRHAGIC STROKE: THE GOLDEN HOUR

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DISCLOSURES: NONE

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ENTERPRISE STROKE PROGRAM MANAGER: CLEVELAND CLINIC HEALTH SYSTEM
DISCLOSURES: NONE
HEMORRHAGIC STROKE: OBJECTIVES

OBJECTIVES
- Discuss the 2 types of hemorrhagic stroke: intracerebral and subarachnoid
- Review cerebral anatomy
- Discuss acute treatment of hemorrhagic stroke
- Discuss transfers considerations

HEMORRHAGIC STROKE: TYPES

PATHOLOGICAL ACCUMULATION OF BLOOD WITHIN THE CRANIAL VAULT
- Intracranial hemorrhage
  - May occur within brain parenchyma or surrounding meningeal spaces
  - May extend into the ventricles (IVH)
- Subarachnoid hemorrhage
  - Aneurysmal rupture
  - AVM rupture
HEMORRHAGIC STROKE: LOCATIONS

INTRACEREBRAL HEMORRHAGE

**MOST COMMON CAUSE: BLOOD VESSEL WALL DAMAGE DUE TO HYPERTENSION - 60% OF CASES**

**OTHER CAUSES:**
- Autoregulatory dysfunction (re-perfusion injury, hemorrhagic transformation)
- Arteriopathy (amyloid angiopathy, moyamoya)
- Altered hemostasis (thrombolysis, anticoagulation)
- Hemorrhagic necrosis (tumor, infection)
- Venous outflow obstruction (cerebral venous thrombosis)
- Sympathomimetic drugs (cocaine, methamphetamine)
ICH: MORBIDITY/MORTALITY

20,000 DEATH ANNUALLY IN US

30 DAY OVERALL MORTALITY RATE OF 44%

- 75% at 24 hours with pontine/brainstem hemorrhages

ICH: PATHOPHYSIOLOGY

ICH is a dynamic and complex process

- Vascular Rupture 1-10 sec
- Hematoma Formation <1 hr
- Hematoma Expansion 1-24 hr
- Edema Formation 24-72 hr

ICH: EARLY DETERIORATION

EARLY DETERIORATION IS COMMON
GREATER THAN 20% WILL EXPERIENCE DECREASE IN GCS OF 2 OR MORE POINTS BETWEEN EMS ASSESSMENT AND ED INITIAL EVALUATION
15%–23% DEMONSTRATE CONTINUED DETERIORATION WITHIN THE 1ST FEW HOURS AFTER HOSPITAL ARRIVAL

ICH: HEMATOMA EXPANSION

RELATED TO ACTIVE BLEEDING THAT MAY PROCEED FOR HOURS AFTER SYMPTOM ONSET
TENDS TO OCCUR EARLY
INCREASES RISK OF POOR FUNCTIONAL OUTCOME AND DEATH
28%–38% HAVE HEMATOMA EXPANSION OF GREATER THAN 1/3 OF THE INITIAL HEMATOMA VOLUME ON FOLLOW UP CT
PATIENT PRESENTATION: HEMORRHAGIC STROKE

SUDDEN FOCAL NEUROLOGICAL DEFICIT
HEADACHE – 40%
NAUSEA AND VOMITING – 40%-50%
  • Common with posterior fossa stroke
DECREASED LEVEL OF CONSCIOUSNESS – 50%
  • Not as common with ischemic stroke
ELEVATED BLOOD PRESSURE – 90%
SEIZURES – 6-7%


ED MANAGEMENT: THE GOLDEN HOUR

• PERFORM A RAPID NEUROLOGICAL EX
• ABC’S/STABILIZE
• DIAGNOSE
  • Calculate the ICH score if possible
• CLASSIFY
• CORRECT COAGULAPATHY
• MANAGE BP
• COMMUNICATE WITH TEAM
• GET PATIENT TO THE RIGHT PLACE
**ED MANAGEMENT: THE GOLDEN HOUR**

**ED MANAGEMENT: THE GOLDEN HOUR**

**Checklist for the 1st hour**

- Complete blood count with platelet count, PT, PTT, INR
- Head imaging results: hematoma size, location, presence of intraventricular hemorrhage
- Glasgow Coma Scale (GCS) score
- Calculate ICH Score

**Interventions**

- Coagulopathy reversal (goal INR < 1.4)
- Blood pressure lowering (goal SBP 140-180)
- Surgical hematoma evacuation (if indicated)
- Airway/ventilation management
ED MANAGEMENT: THE GOLDEN HOUR

INITIAL FOCUS ON ARRIVAL:
• Life support (A-B-C)
• Make sure patient is safe to go to CT
  • Can they protect their airway?
  • Hypoxia?
  • Avoid hyperventilation

GOLD STANDARD FOR DIAGNOSIS OF ICH:
NON-CONTRAST HEAD CT
ICH: SPOT SIGN

Photo Courtesy: ENLS Version 3.0 - ICH

CALCULATING ICH SCORE-

SUPRATENTORIAL ORIGIN L TEMPORAL LOBE MILD IVH

Volume = ABC/2

A = largest diameter = 4.2 cm
B = perpendicular = 2.8 cm
C = clot thickness = 2.5 cm (0.25 cm slices x 10 slices (9 full and 2 half))

ABC/2 = (4.2 x 2.8 x 2.5)/2 = 14.7 cc

ICH score is required for CSCs-
Not required for PSC/TSC or ASR
CALCULATING ICH SCORE

<table>
<thead>
<tr>
<th>Component</th>
<th>ICH Score Points</th>
</tr>
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<tbody>
<tr>
<td>GCS Score</td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>2</td>
</tr>
<tr>
<td>5-12</td>
<td>1</td>
</tr>
<tr>
<td>13-15</td>
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<tr>
<td>ICH Volume (cc)</td>
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<tr>
<td>&gt; 30</td>
<td>1</td>
</tr>
<tr>
<td>&lt; 30</td>
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<tr>
<td>Intraventricular</td>
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<tr>
<td>Hemorrhage</td>
<td></td>
</tr>
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<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Infratentorial Origin</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Age (years)</td>
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</tr>
<tr>
<td>≥ 80</td>
<td>1</td>
</tr>
<tr>
<td>&lt; 80</td>
<td>0</td>
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<tr>
<td><strong>Total ICH Score</strong></td>
<td><strong>1</strong></td>
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</table>

ICH SCORE - WHY?

- Each point increase in the ICH Score is associated with an increased risk of mortality and a decreased likelihood of good functional outcome.
- It should not be used for prognosis; use it as a method for communicating disease severity.

<table>
<thead>
<tr>
<th>GCS</th>
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<tbody>
<tr>
<td>3-4</td>
<td>2 pts</td>
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<tr>
<td>5-12</td>
<td>1 pt</td>
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<tr>
<td>13-15</td>
<td>0 pts</td>
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<table>
<thead>
<tr>
<th>ICH volume</th>
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<tbody>
<tr>
<td>&gt; 30 cm³</td>
<td>1 pt</td>
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<tr>
<td>&lt; 30 cm³</td>
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<tr>
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<tbody>
<tr>
<td>Yes</td>
<td>1 pt</td>
</tr>
<tr>
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<td>0 pts</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Infratentorial</td>
<td>1 pt</td>
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<tr>
<td>Supratentorial</td>
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</table>

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<tr>
<td>≥ 80 yrs</td>
<td>1 pt</td>
</tr>
<tr>
<td>&lt; 80 yrs</td>
<td>0 pts</td>
</tr>
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</table>
ICH

Edema
Hemorrhage
Midline Shift

SITES OF SPONTANEOUS ICH

Lobar Subcortical Hemorrhage (24%)
Putaminal Hemorrhage (34%)

Thalamic Hemorrhage (20%)
Pontine Hemorrhage (6%)
Cerebellar Hemorrhage (7%)

A=cortical branches of anterior, middle, or posterior cerebral arteries;
B=basal ganglia from middle cerebral artery;
C=thalamus;
D=pontine;
E=cerebellum.

CASE STUDY: PT PRESENTATION

45 YR OLD MALE

PRESENTS TO ED VIA AMBULANCE AT 2153 WITH C/O:
• Disorientation, slurred speech, facial droop, right sided weakness

STROKE TRIAGE
• Last normal/Onset time: 1830-1900
• Exam: drowsy, follows commands, weak on right, speech slurred, right facial droop, confused, GCS 14
• Finger stick glucose: 109

CASE STUDY: ICH PRESENTATION

VS: BP 198/100; HR 83; RR 18; SAO2 98%
IV START
LAB DRAW
• CBC, PT, INR, aPTT, BMP, type & screen
BEGIN COLLECTING FOCUSED HISTORY
• HTN, hyperlipidemia, obesity, sleep apnea, recently started on coumadin for AF; no trauma, surgeries, stroke, ICH
CT SCAN
EKG AT SOME POINT
CHEST XRAY IF INDICATED *Don’t delay CT for EKG/Chest X-ray; Hold off on labs if difficult stick*
CASE STUDY: ICH - DIAGNOSE AND CLASSIFY

LG ACUTE INTRAPARENCHYMAL HEMORRHAGE
LEFT BASAL GANGLIA
3.2 X 1.5 CM’S
RUPTURED INTO LEFT LATERAL VENTRICLE
SMALL AMOUNT OF BLOOD IN RIGHT LATERAL VENTRICLE AND 3RD VENTRICLE

CASE STUDY: ICH - LABS

<table>
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<tr>
<th>WBC</th>
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<tbody>
<tr>
<td>HGB</td>
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<tr>
<td>HCT</td>
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<td>INR</td>
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<td>APTT</td>
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<tr>
<td>GLU</td>
<td>109</td>
</tr>
<tr>
<td>BUN</td>
<td>11</td>
</tr>
<tr>
<td>CR</td>
<td>.96</td>
</tr>
<tr>
<td>NA</td>
<td>141</td>
</tr>
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</table>

K       | 3.3  |
CL      | 119  |
CO2     | 17   |
CA      | 8.3  |
ALB     | 2.1  |
ALT     | 40   |
AST     | 38   |
ALK PHOS| 92   |
T BILI  | 0.2  |
ICH: THE GOLDEN HOUR: WHAT CAN GO WRONG???

• What Can Go Wrong (or Is Going Wrong)?
  • Herniation and brain(stem) compression
  • Airway compromise
  • Hematoma expansion
  • Elevated intracranial pressure
  • Secondary brain injury
    » Seizures
    » Fever
    » Hyperglycemia

ICH: THE GOLDEN HOUR: FOCUS

1. Stabilization and reassessment of the patient’s airway, breathing, circulation
2. Rapid and accurate diagnosis using neuroimaging
3. Concise clinical assessment regarding ICH characteristics and patient condition
4. Targeted assessment for potential early interventions:
   Control of elevated blood pressure
   Correction of coagulopathy
   Need for early surgical intervention
5. Anticipation of specific patient care needs such as:
   Specific treatment related to underlying ICH cause
   Risk for early clinical deterioration and hematoma expansion
   Need for intracranial pressure (ICP) or other monitoring
   Patient disposition from the emergency department
CASE STUDY: ICH- BP MANAGEMENT

- FOR ICH PATIENTS PRESENTING WITH SBP BETWEEN 150 AND 220 MM HG AND W/O CONTRAINDICATIONS TO ACUTE BP TREATMENT, ACUTE LOWERING OF SBP TO 140 MMHG IS SAFE (CLASS 1, LEVEL A) AND CAN BE EFFECTIVE FOR IMPROVING FUNCTIONAL OUTCOME (CLASS IIA; LEVEL B)

- FOR ICH PATIENTS PRESENTING WITH SBP >220 MMHG, IT MAY BE REASONABLE TO CONSIDER AGGRESSIVE REDUCTION OF BP WITH A CONTINUOUS IV INFUSION AND FREQUENT BP MONITORING (CLASS ILB, LEVEL C)


CASE STUDY: ICH – BP CONTROL

COMMON MEDICATIONS

LABETALOL (NORMODYNE)
- Labetalol 10-20 mg IV over 1-2 mins, may repeat or double every 10 mins for max of 300mg

NICARDIPENE (CARDENE)
- Nicardipine 5mg/hr IV infusion as initial dose; titrate to desired effect by increasing 2.5mg/hr every 5 mins to max of 15mg/hr
CORRECTION OF COAGS: BASED ON MEDICATION

WARFARIN (COUMADIN) ASSOCIATED
• K Centra: 4 factor Prothrombin complex concentrate (PCC)
• Profil 9: 3 factor PCC – use instead of K Centra if heparin allergy
• Vitamin K 5–1–mg IV

PRADAXA (DABIGATRAN)
• Reversal agent – Praxbind (Idarucizumab)
  • Dose = 5 grams
    • 2 vials, 2.5 grams/50 mls each
    • Draw up and administer IV push, one after the other (no more than 15 mins apart)

FACTOR XA INHIBITORS (HOT OFF THE PRESS...)
• Andexanet alfa (Andexxa)
• Only approved for Rivaroxiban and Apixaban

JOINT COMMISSION UPDATE ON ANTICOAGULANT NATIONAL PATIENT SAFETY GOAL (NPSG)

DID YOU KNOW THAT ALL TJC-ACCREDITED HOSPITALS, CRITICAL ACCESS HOSPITALS, NURSING CARE CENTERS AND MEDICAL CENTERS ARE REQUIRED TO HAVE ANTICOAGULANT REVERSAL PROTOCOLS???

STARTING JULY 1, 2019: NPSG 03.05.01 HAS 8 NEW/REVISED ELEMENTS OF PERFORMANCE (EPS).
• EP 1- PROTOCOLS FOR STARTING AND CONTINUING ANTICOAGULANT TREATMENT MUST BE EVIDENCE BASED.
• EP 2- ANTICOAGULATION REVERSAL AND BLEEDING MANAGEMENT PROTOCOLS MUST BE EVIDENCE-BASED.
• EP 3- PERIOPERATIVE MANAGEMENT PROTOCOLS FOR ORAL ANTICOAGULANTS MUST BE EVIDENCE BASED.
• EP 4- HAVE A WRITTEN POLICY ON THE NEED FOR LABORATORY TESTS TO ADJUST AND MONITOR ANTICOAGULANT THERAPY
• EP 5- ESTABLISH A PROCESS TO RESPOND TO ADVERSE DRUG EVENTS AND EVALUATE AND IMPROVE ANTICOAGULATION SAFETY PRACTICES
• EP 6- PROVIDE EDUCATION TO PATIENT AND FAMILIES ON THEIR ANTICOAGULANT TREATMENT
• EP 7- IF AVAILABLE, FACILITIES SHOULD ONLY USE PRE-FILLED SYRINGES, PREMIXED INFUSION BAGS, OR ORAL UNIT-DOSE PRODUCTS
• EP 8- USE PROGRAMMABLE PUMPS WHEN ADMINISTRATING HEPARIN INTRAVENOUSLY AND CONTINUOUSLY

HTTPS://WWW.PSQH.COM/NEWS/JOINT-COMMISSION-UPDATES-ANTICOAGULANT-NPSG/
DIRECT ORAL ANTICOAGULANTS: AKA NOACS

Direct thrombin inhibitor
• Pradaxa (Dabigatran)

FACTOR XA INHIBITORS
• Xarelto (Rivaroxiban)
• Eliquis (Apixaban)
• Savaysa (Edoxaban)

CORRECTION OF COAGULOPATHY

USEFULNESS OF PLATELET TRANSFUSIONS ICH
PATIENTS WITH HISTORY OF ANTIPLATELET USE IS
UNCERTAIN (CLASS IIB, LEVEL C)

2018 SYSTEMATIC REVIEW:
• No benefit, may be harmful
CASE STUDY: ICH - WHAT NEXT

22:17 - CHANGE IN NEURO STATUS IS NOTED: SPEECH INCOMPREHENSIBLE, INCREASED DROWSINESS

22:33 - RAPID SEQUENCE INTUBATION TO PROTECT AIRWAY

23:00 - REPEAT CT

GROWN CONSIDERABLY IN SIZE OVER 1 HOUR

3.2 X 1.5 → 4.5 X 3.6 CM’S
• Hematoma volume = ~45 cc’s

BLOOD IN ALL VENTRICLES

VENTRICLES ALREADY ENLARGING

8MM MIDLINE SHIFT

VASOGENIC EDEMA

CASE STUDY: ICH - CONSIDER SURGERY

Location Surgery urgently:

<table>
<thead>
<tr>
<th>Location</th>
<th>Surgery urgently:</th>
</tr>
</thead>
</table>
| Cerebellum | • Declining neuro exam  
• Size > 3 cm, or  
• Compressive effects brainstem, or  
• Hydrocephalus |
| Lobar | ICH causing mass effect/herniation in severely affected but salvageable patient and as a life-saving measure |

209 - Location Surgery urgently: Cerebellum  
• Declining neuro exam  
• Size > 3 cm, or  
• Compressive effects brainstem, or  
• Hydrocephalus

Lobar ICH causing mass effect/herniation in severely affected but salvageable patient and as a life-saving measure
CASE STUDY: ICH - CONSIDER EVD

ICP MAY BE ELEVATED
PATIENTS WITH IVH ARE AT RISK FOR HYDROCEPHALUS AND ELEVATED ICP
EVD RECOMMENDED IN:
- GCS < 9
- LARGE MASS EFFECT
- HYDROCEPHALUS

OTHER CONSIDERATIONS: SEIZURES

CLINICAL SEIZURES SHOULD BE TREATED WITH AED’S

DEPRESSED MENTAL STATUS OUT OF PROPORTION TO DEGREE BRAIN INJURY IS AN INDICATION FOR EEG MONITORING

ELECTROGRAPHIC SEIZURES ON EEG SHOULD BE TREATED WITH AED’S

PROPHYLACTIC ANTICONVULSANT MEDICATION SHOULD NOT BE USED (CLASS III)
SEIZURE TREATMENT: ANTICONVULSANTS

LEVITERACITAM (KEPPRA)
FOSPHENYTOIN (CEREBYX)
PHENYTOIN (DILANTIN)

Ativan is usually given IV for emergency treatment – followed by loading dose of any of the above AED’s

OTHER CONSIDERATIONS: NAUSEA

ZOFRAN
PHENERGAN
• Not a preferred agent
• Causes drowsiness or confusion – compromises neuro exam
OTHER CONSIDERATIONS: CEREBRAL EDEMA

**MANNITOL – OSMOTIC DIURETIC**
- Typically, Mannitol 20% IV 0.25g/kg to 1g/kg over 2-10 minutes
- Calculation:
  - # grams ordered X pt’s wt in kg’s = desired dose
  - Desired dose X 100 = #cc’s to give
- Increases intravascular osmotic pressure by drawing water from the extracellular space, thus decreasing brain mass

**Hypertonic Saline – Osmotic Diuretic**
- Given as small bolus or continuous infusion
- Watch sodium levels!

TREATMENT

INCLUDES MOSTLY MEDICAL MANAGEMENT/SUPPORTIVE CARE

NEURO-ICU

SURGERY INDICATED ONLY FOR PLACEMENT OF EVD, CEREBELLAR HEMORRHAGE OR RELIEF OF ICP WITH HEMICRANIECTOMY
RESEARCH

MISTIE III
• Minimally invasive surgery plus Rt-PA for ICH Evacuation Phase III
• Missed primary endpoint- but there were encouraging results
• For those that had their hematoma reduced to a volume of 15mL or less, there was a 10.5% difference in the likelihood of achieving a good functional outcome.

ENRICH
• Early Minimally-invasive Removal of IntraCerebral Hemorrhage
• No preliminary data, however, they have started excluding anterior basal ganglia hemorrhages

ANEURYSMAL SUBARACHNOID HEMORRHAGE

BLEEDING INTO THE SPACE BETWEEN THE ARACHNOID MEMBRANE AND THE PIA MATER

ACCOUNTS FOR 6%-8% OF ALL STROKES

ASAH
SAH: MORBIDITY AND MORTALITY

LOW INCIDENCE: 10/100,000 PEOPLE PER YEAR

• 11% DIE BEFORE REACHING MEDICAL ATTENTION
• 40% DIE WITHIN 4 WEEKS AFTER ADMISSION TO HOSPITAL
• 30% OF SURVIVORS HAVE SIGNIFICANT MORBIDITY AND ARE DEPENDENT FOR ADLS
• NEARLY 50% OF SURVIVORS DEVELOP COGNITIVE DYSFUNCTIONS


PRESENTATION: SAH

• SUDDEN, SEVERE, GENERALIZED HEADACHE
  • “Thunder-clap headache”
  • “The worst headache of my life” 97%

• 30-60% - SENTINEL HEMORRHAGE OR WARNING HEADACHES IN THE WEEKS BEFORE SAH
• TRANSIENT LOSS OF CONSCIOUSNESS
• NAUSEA/VOMITING, BLURRED VISION
• PHOTOPHOBIA
• SEIZURES
PRESENTATION: SAH

<table>
<thead>
<tr>
<th>CLASSIC</th>
<th>NOT-SO-CLASSIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrupt onset of severe headache (HA), i.e. thunderclap</td>
<td>HA is not reported as abrupt (patient may not remember event well)</td>
</tr>
<tr>
<td>NEW, QUALITATIVELY DIFFERENT HA</td>
<td>HA responds well to non-narcotic analgesics</td>
</tr>
<tr>
<td>May have nausea, vomiting and neck pain</td>
<td>HA resolves on its own in few hours</td>
</tr>
<tr>
<td>May transiently lose consciousness, present in coma, or have focal deficits</td>
<td>40% patients with aneurysmal SAH will have normal neuro exam without meningismus</td>
</tr>
<tr>
<td>Nature of HA onset distinguishes from other forms of stroke</td>
<td>Do not necessarily appear acutely ill</td>
</tr>
</tbody>
</table>

ED MANAGEMENT: SAH THE GOLDEN HOUR

- ABC’S/STABILIZE
- DIAGNOSE
- CLASSIFY
- CORRECT COAGULAPATHY
- MANAGE BP
- COMMUNICATE WITH TEAM
- GET PATIENT TO THE RIGHT PLACE
ED MANAGEMENT: SAH THE GOLDEN HOUR

SAH CHECKLIST

**Checklist**

- Brain Imaging
- Labs: PT/PTT, CBC, electrolytes, BUN, Cr, troponin, toxicology screen
- 12 lead ECG
- Blood pressure goal established
- Consult neurosurgery
- Address hydrocephalus
ED MANAGEMENT: THE GOLDEN HOUR

INITIAL FOCUS ON ARRIVAL:
- Life support (A-B-C)
- Make sure patient is safe to go to CT
  - Can they protect their airway?
  - Hypoxia?
  - Avoid hyperventilation

CLINICAL SEVERITY OF SAH

<table>
<thead>
<tr>
<th>Grade</th>
<th>Criteria</th>
<th>Grade</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>1</td>
<td>Asymptomatic, mild headache, slight nuchal rigidity</td>
<td>1</td>
<td>GCS 15</td>
</tr>
<tr>
<td>2</td>
<td>Moderate to severe headache, nuchal rigidity, no neurologic deficit other than cranial nerve palsy</td>
<td>2</td>
<td>GCS 13-14, without neurological deficit</td>
</tr>
<tr>
<td>3</td>
<td>Drowsiness / confusion, mild focal neurologic deficit</td>
<td>3</td>
<td>GCS 13-14, with neurological deficit</td>
</tr>
<tr>
<td>4</td>
<td>Stupor, moderate-severe hemiparesis</td>
<td>4</td>
<td>GCS 7-12</td>
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<tr>
<td>5</td>
<td>Coma, decerebrate posturing</td>
<td>5</td>
<td>GCS 3-6</td>
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</table>
DIAGNOSIS OF SAH

- HISTORY AND NEURO EXAM RESULTS
- CT SCAN W/O CONTRAST
  - Within 48 hrs blood appears white
  - Will detect in 95% or more of cases
- NEGATIVE CT → LUMBAR PUNCTURE USED IN SELECTED CASES (CONTRAINDICATED IF INCREASED ICP IS SUSPECTED)
  - Need cell count on all tubes sent to lab
- CEREBRAL ANGIOGRAPHY – GOLD STANDARD
  - Prepare for trip to OR


ED MANAGEMENT: THE GOLDEN HOUR- IMAGING

- Non-contrast CT imaging of the brain is the gold-standard for identifying SAH with sensitivity of 95-100% if:
  - Classic presentation with thunderclap HA
  - CT completed within six hours of HA onset
  - The patient is completely neurologically intact
  - The CT is read by an attending radiologist
- Sensitivity of CT decreases with time
- Falsely negative CT: time, anemia (HCT <30) low volume SAH, and a technically poor scan

Sensitivity CT for SAH

<table>
<thead>
<tr>
<th>Time Since Headache Onset</th>
<th>Sensitivity</th>
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<tbody>
<tr>
<td>3 days</td>
<td>100%</td>
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<tr>
<td>1 week</td>
<td>90%</td>
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<tr>
<td>2 weeks</td>
<td>60%</td>
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ED MANAGEMENT: THE GOLDEN HOUR- LUMBAR PUNCTURE

- Must perform LP if CT is negative and history suggests SAH
- Rationale for LP is to confirm xanthochromia- staining of CSF by heme breakdown products
- Presence of xanthochromia is time dependent- takes several hours to develop

### SAH- GOLDEN HOUR- LUMBAR PUNCTURE

<table>
<thead>
<tr>
<th>Typical LP Findings</th>
<th>Atypical or Inconclusive</th>
<th>Not suggestive of SAH</th>
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</thead>
<tbody>
<tr>
<td>↑ RBCs, No clearing from tube 1→4</td>
<td>Clearing of RBCs from tube 1→4</td>
<td>CSF clear of RBCs</td>
</tr>
<tr>
<td>&lt; 5 WBC, WBC:RBC ratio 1:700</td>
<td>↑ WBC:RBC ratio suggest another process, meningitis or encephalitis</td>
<td>Occasionally, rapidly expanding unruptured aneurysm may present with HA, recommend urgent consultation</td>
</tr>
<tr>
<td>Xanthochromia present</td>
<td>Xanthochromia absent</td>
<td>Xanthochromia absent</td>
</tr>
<tr>
<td>(However if CSF Protein &gt;100mg/dL may be false positive)</td>
<td>(Assuming LP is done more than 12 hours following headache onset).</td>
<td></td>
</tr>
<tr>
<td>Opening pressure elevated (~2/3 patients)</td>
<td>OP normal</td>
<td>OP normal</td>
</tr>
</tbody>
</table>
**SAH: INITIAL MANAGEMENT**

Once SAH is diagnosed, take these first steps:
- Bed rest
- Obtain pre-intervention labs: CBC, Platelets, PT/PTT, INR, electrolytes, BUN, Cr, cardiac enzymes
- 12-lead ECG
- Cardiac telemetry
- Nimodipine 60 mg po/ng (watch for hypotension)
- AED until aneurysm secured
- Consult Neurosurgery

**BP MANAGEMENT: ACUTE SAH**

Between symptom onset and aneurysm obliteration BP should be controlled with a titratable agent to balance risk of stroke, HTN related rebleeding and maintenance of CPP (CLASS I, LEVEL B).

Magnitude of BP control not established, but decrease in SBP to <160 mmHg is reasonable (CLASS IIA, LEVEL C).

- Precise guidelines for BP management in SAH unfortunately do not exist
- Retrospective data suggest higher rates of re-bleeding with SBP > 160 mmHg
- Over treatment of BP can potentially lead to brain ischemia - especially if hydrocephalus or vasospasm is present.
- Pre-morbid BP should be taken into considerations
- Experts recommend to aim for SBP < 160 mmHg, or MAP < 110 mmHg, keeping principles above in mind
- Use short acting, titratable intravenous medications such as beta blockers or nicardipine.
- Avoid long-term nitroprusside due to concern of raising ICP
EARLY COMPLICATIONS: HYDROCEPHALUS

COMMUNICATING

• Problem with absorption of CSF; blood in CSF plugs the arachnoid villi

DIAGNOSED BY CT – DILATED VENTRICLES

SEVERITY RELATED TO SIZE OF BLEED

• Arachnoid villi unable to reabsorb CSF, laden with byproducts of blood breakdown

MAY REQUIRE EMERGENT INSERTION OF EXTRA-VENTRICULAR DRAIN

ASTUTE NEUROLOGICAL ASSESSMENTS

• WILL BECOME SLEEPIER…SLOWER TO RESPOND
• OVERALL DECREASE IN LOC

The following CT scan shows hydrocephalus. Note the enlargement of the ventricles with CSF, as denoted in black.

OTHER CONSIDERATIONS: SEIZURES

• DIFFERENCE FOR ASAH:
• ROUTINE USE OF PHENYTOIN NOT RECOMMENDED (LOW QUALITY EVIDENCE; STRONG RECOMMENDATION)
• ROUTINE USE OF OTHER ANTICONVULSANTS FOR PROPHYLAXIS MAY BE CONSIDERED (VERY LOW QUALITY EVIDENCE; WEAK RECOMMENDATION)
• IF ANTICONVULSANT PROPHYLAXIS USED, A SHORT COURSE IS RECOMMENDED (3-7-DAYS) (LOW QUALITY EVIDENCE; WEAK RECOMMENDATION)


ANEURYSM TREATMENT

• Neuro ICU care
• Stay generally around 21 days depending on complications
• Specific management to treat complications (vasospasm, hydrocephalus, electrolyte imbalances)

http://surgicalunits.com/aneurysm-clip-311.html
STROKE OUTPATIENT MEASURES

STK-OP-1 DOOR TO TRANSFER TO ANOTHER HOSPITAL

• Hemorrhagic stroke
  • Will need to track door in door out times when transferring all hemorrhagic stroke patients
  • No benchmark at this time

• Transfer consideration
  • Hospice– keep the patient locally if able

PACKAGING FOR TRANSFER

ADEQUATE AIRWAY PROTECTION?

• If not intubated – is this patient going to be able to manage their airway for transport?

BLOOD PRESSURE MANAGEMENT

• Is the blood pressure within recommended guideline or per MD recommendations from receiving center?

DISTANCE (CRITICAL CARE TRANSPORT)

• Air vs ground transport
• ACLS with paramedic

IMAGING RESULTS

• Do you have some kind of cloud service or sharing capability with receiving center?
• If not, will need a disc to go with patient

ANY NECESSARY CHART COPIES
PACKAGING FOR TRANSFER

COMMUNICATION

- Obtain cell phone number for family
  - Provide them with information about transfer facility if available
- Obtain contact number to call report to receiving facility ICU
  - History, any treatments done at your ED/facility
  - BP meds, seizure meds, nausea meds, etc...
  - Imaging done
  - Last neuro exam at your facility (be specific – terms like obtunded, stuporous, or unresponsive are not helpful)

QUESTIONS

CONTACT INFORMATION

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WENDY SMITH: SMITHW@CCF.ORG

REVERSAL PROTOCOLS START ON THE NEXT SLIDE!!!!
Factor Xa Inhibitor Reversal

Rivaroxaban (Xarelto), apixaban (Eliquis), edoxaban (Savaysa)

- Definitions Used for Reversal Situations
- Enoxaban (Savaysa) 10 to 14 hours
- Apixaban (Eliquis) 8 to 15 hours
- Assessed by anti-Xa

Agent Elimination Half-life Reversal Recommendation

<table>
<thead>
<tr>
<th>Agent</th>
<th>Urgent without bleeding</th>
<th>Emergency (procedure &gt;7 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivaroxaban (Xarelto), apixaban (Eliquis), edoxaban (Savaysa)</td>
<td>Urgent without bleeding: reversal needed within hours</td>
<td></td>
</tr>
</tbody>
</table>

- Discontinue factor Xa inhibitor

Pharmacological reversal should be guided primarily by bleeding (major or intracranial) and not primarily by laboratory testing.

- Obtain information on the time elapsed since last dose and possible med interactions
- Activated charcoal (50g) may be given if present within 2 hours of ingestion of an oral

HASHTI

1. Investigate the bleeding source
2. Transfuse (red cells, PLT, FFP as indicated)
3. Antifibrinolytic agents (aminocaproic acid, tranexamic acid)
4. Hemostatic measures (compression, packing, escharotomy)
5. Transfusion
6. Other measures (transplantation, surgery)

KCENTRA—Four Factor Prothrombin Complex Concentrate

- 4 Factor-FCC
- Contains vitamin K-dependent factors II, IX, X, and XI, as well as antithrombin, protein C, and S. Kcentra also contains a small amount of heparin.
- Approved for reversal of acute major bleeding due to vitamin K deficiency.
- Black Box warning: Use with underlying risk of or diagnosed thromboembolic disease/state. Administration of FCC may predispose the patient to a thromboembolic event. Benefits of reversal should be weighed against potential risk.

Indications:

- If any of the following criteria must be present before reversal agents can be administered:
  - Patient is currently taking rivaroxaban, apixaban, or edoxaban.
  - Life-threatening hemorrhage defined as any of the following: symptomatic intracranial hemorrhage or hemorrhage decreases greater than 4 in intracranial pressure for >4 hours requiring revasopressor.
  - Patient has hepatic failure, renal failure, or heparin allergy.
  - If present, use Kcentra FCC (Praxbind).
  - If present, use 4 Factor PCC (Profilnine).

Dosing:

- Consider administering 25 units/kg for a total dose of 250 units and with the option of giving an additional dose if deemed clinically necessary. Maximum dose of 50 units/kg is 50 units.
- Risk of thrombosis should be considered when selecting dose.
- Dose based on actual body weight. Round dose to nearest 9 units.

Contraindications to administration:

- INR levels are acceptable, from 1 to 1.5.

Administration:

- If adverse reaction occurs, discontinue administration and administer anti-fibrinolytic agents (aminocaproic acid, tranexamic acid).
- Hemoglobin decrease greater than 4 or transfusion greater than 4 or hypotension requiring vasopressors

Monitoring:

- APTT or PT should not be used to monitor hemorrhage prevention.

Dabigatran (Pradaxa) Reversal

Non-Urgent Reversal

- Hold dabigatran dose
- Consider longer term for major surgery, placement of spinal or epidural catheter or port.
- COX-2 inhibitors
- Dose by height
- 75 mg: 6 feet or greater
- 50 mg: 6 feet or less
- Half-life: 12–17 hours

Urgent/Emergent Life-Threatening Reversal

- Dose based on coagulation tests
- Normal APTT, INR, PT = suboptimal dose is contributing to bleeding
- Prolonged APTT, INR, PT = dabigatran present and may be contributing to bleeding
- Activated partial thromboplastin time of >1.5
- Activated thromboplastin time of >2.5

Hashti

1. Investigate the bleeding source
2. Transfuse (red cells, PLT, FFP as indicated)
3. Antifibrinolytic agents (aminocaproic acid, tranexamic acid)
4. Hemostatic measures (compression, packing, escharotomy)
5. Transfusion
6. Other measures (transplantation, surgery)

Direct Factor Xa Inhibitor Reversal

Idarucizumab (Praxbind)

- Description and Indications
  - Idarucizumab is a humanized monoclonal antibody directed against dabigatran etexilate and is indicated for the reversal of dabigatran etexilate in patients with life-threatening or uncontrolled bleeding who are receiving dabigatran. The recommended dose of idarucizumab is 5 g, provided as two separate vials each containing 2.5 g/50 mL.
  - Dosing and Administration
  - For emergency surgery or urgent procedures
  - Dose may be considered if dabigatran is contributing to bleeding

KCENTRA and PCC if meets criteria

- Activated charcoal if recent ingestion: less than 2 hours since last dabigatran dose
- Hold further doses of dabigatran
- Urgent/Emergent/Life-threatening Reversal
  - In life-threatening or uncontrolled bleeding
  - For emergency surgery/urgent procedures

Life-threatening hemorrhage (defined as one of the following: symptomatic intracranial hemorrhage or hemorrhage decreases greater than 4 in intracranial pressure for >4 hours requiring revasopressor)
- Life-threatening or uncontrolled bleeding
- Patient has hepatic failure, renal failure, or heparin allergy

Activated charcoal may be used if present within 2 hours of ingestion of an oral

Heparin Allergy Focused

- Infuse no faster than 200 units/min in dedicated line
- Monitor for allergic reaction
- Signs/symptoms of bleeding or thromboembolic events or infusion reactions

Infuse no faster than 200 units/min in dedicated line
- Patient does not have heparin induced thrombocytopenia (HIT) or heparin allergy
- If present, use Kcentra FCC (Praxbind)
- If present, use 4 Factor PCC (Profilnine)

KCENTRA has not been studied.

American Stroke Association.
A division of the American Heart Association.

Norton Health
ADMINISTRATION
- Each 2.5 g/50 mL vial can be drawn up in a 60 mL syringe and given via IV push, one after the other no more than 15 minutes apart.
- Administration should begin within 1 hour of removing the solution from the vial.
- Before administration, the line must be flushed with normal saline.
- No other intravenous medication is permitted via the same intravenous access.

Storage/Dispensing
- Stable at room temperature (77°F) or up to 48 hours if stored in the original package in order to protect from light.
- In limited number of patients, between 12 and 24 hours after administration of 5 g Idarucizumab, elevated coagulation parameters (e.g., aPTT or ECT) have been observed.

Additional Info
- An interim analysis of the RE-VERSE AD trial, an ongoing single cohort case series trial, included data for 123 patients. Results of central laboratory evaluations were available for a subset of 90 patients (51 in Group A, 39 in Group B).
- Among the 90 patients with available data, the median maximum reversal of the pharmacodynamic anticoagulant effect as measured by ECT or aPTT in the first 4 hours after administration of 5 g Idarucizumab was 100%, with most patients (>89%) achieving complete reversal. Reversal of the prothrombin complex effect was also observed. Idarucizumab was effective in the reversal of bleeding in patients with symptomatic intracranial hemorrhage who received Idarucizumab in the context of hematologic reversal. The time to reversal was shorter in patients with bleeding, especially intracranial hemorrhage.

ADVERSE EFFECTS
- Most frequently reported adverse events in >5% of healthy volunteers were headache and in >5% of patients were hypokalemia, delirium, constipation, pyrexia, and pneumonia.
- Low potential for immune reactions—4% of volunteers had low levels of possibly persisting treatment-emergent antibodies (low titers).

WARNINGS
- Thromboembolic Risk: Reversing dabigatran therapy exposes patients to the thrombotic risk of their underlying disease. Resume anticoagulant therapy as soon as medically appropriate.
- Hypersensitivity reactions: Discontinue administration and evaluate.
- Patients with hereditary fructose intolerance may be at risk of adverse reactions.

Formulary Status
- Norton Healthcare Pharmacy and Therapeutics Committee and Medical Executive Committee has designated Idarucizumab formulary restricted to patients currently taking dabigatran AND experiencing a life threatening hemorrhage (defined as one of the following: symptomatic intracranial hemorrhage or hemoglobin decrease >4 g/dL or transfusion greater than 4 units of blood or hypotension requiring vasopressors).

References:
1. Praxbind® Prescribing Information and Patient Information Leaflet. 2015.
**Cleveland Clinic**

**CC MAIN CAMPUS GUIDELINE for Reversal of Oral Anticoagulant Induced Coagulopathy With Intracranial Hemorrhage**

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify clinical situation.</td>
</tr>
<tr>
<td>2</td>
<td>Perform standardized safety assessment.</td>
</tr>
<tr>
<td>3</td>
<td>Prepare reversal agent(s) based on situation.</td>
</tr>
<tr>
<td>4</td>
<td>Administer reversal agent(s) as per protocol.</td>
</tr>
<tr>
<td>5</td>
<td>Monitor patient for signs of improvement.</td>
</tr>
</tbody>
</table>

**References**

1. Anderson, C. 
   Coagulation Factor Xa Inhibition, Reversal, and Prophylaxis. 
   *Pallister Pharmaceuticals, Inc.* South San Francisco, CA 2015.

2. Bakris, J. L., Remick, M. P., Schreiner, J., Hoff, J. T. 
   Use of factor Xa inhibitors in atrial fibrillation. 
   *Neurology* 76, 1161-1165, 2010.

   et al. Analysis of the efficacy and safety of dabigatran in patients with atrial fibrillation. 
   *NEJM* 365, 426-433, 2011.

4. ITER Group. 
   Results of the International coagulopathy in atrial fibrillation (ICARIA) study. 
   *NEJM* 373, 932-943, 2015.

5. Krumholz, H. M., Chen, S., Chen, N., Chen, X., 
   et al. The impact of dabigatran on outcomes in patients with atrial fibrillation. 
   *NEJM* 373, 1270-1279, 2015.


   A randomized trial of oral anticoagulant reversal in atrial fibrillation patients. 

8. Stroke Coordinator Boot Camp. 
   Guide to the American Stroke Association Boot Camp. 
   Cleveland Clinic, 2017.

**Special Notes:**

- Dabigatran: 150 mg twice daily, administered by stomach tube.
- Low-molecular-weight heparin: 5000 units subcutaneously, every 12 hours.
- Warfarin: 5 mg, administered orally.
- Direct oral anticoagulants: Dabigatran, rivaroxaban, apixaban, edoxaban.
- Monitor for signs of hemorrhage and adjust dose accordingly.