

## Intracerebral Hemorrhage Decisions and Management

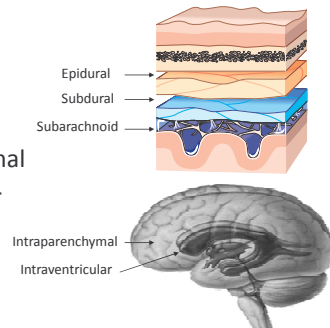
Linda Littlejohns MSN RN CNRN FAAN

## Disclosures

- President – Integra Foundation
- Corporate Clinical Development – Integra
- President elect - AANN

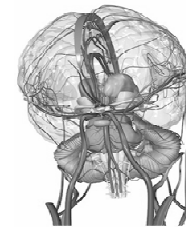
## What's in a Name – ICH ...

- Epidural
- Subdural
- Subarachnoid
- Intraparenchymal
- Intraventricular



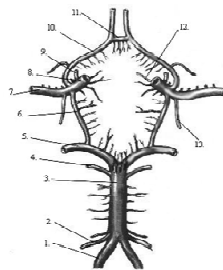
## Vascular Anatomy Review

- Anterior supply
  - Carotids
- Posterior supply
  - Vertebrals



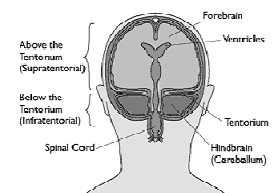
## Vascular Anatomy Review

- Circle of Willis
  - Middle Cerebral Arteries (7)
  - Anterior Cerebral Arteries (10)
  - Anterior Communicating (11)
  - Posterior Communicating (6)
  - Posterior Cerebral (5)



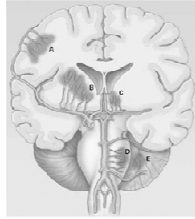
## Location, location, location ...

- Location determines the presentation
  - Supratentorial
  - Infratentorial



## Hemorrhagic Stroke

- Most commonly MCA
- Hypertension
- Lowest incidence – 16%
- Highest mortality – 35-50%
- Worst functional outcome



## Hemorrhagic Stroke

- Space occupying
- Bleeding into the brain caused by a vessel rupture
- Usually unexpected and during activity
- Presentation depends on the location and extent of the bleed

## Hemorrhagic Stroke

- Management options
  - Surgical management
  - Hemostatic therapy
  - Stereotactic aspiration/evacuation

## Surgical Removal

- Lobar clots within 1cm of the surface
  - Standard craniotomy evacuation (class III)
- Surgery for supratentorial ICH within 96 hours is not recommended
- Surgery ASAP for cerebellar hemorrhage >3cm and neuro deterioration or brain stem compression and/or hydrocephalus (class I)

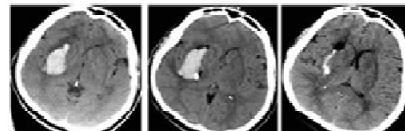
(Stroke 2010)

## Hemostatic Agents - rFVIIa

- Treatment with rFVIIa within 3-4 hours has shown promise in moderate size phase II trial
- Must be confirmed in phase III before recommendation
- Risk of thromboembolism (Stroke 2007)
- There was a reduction of hematoma growth, but no improvement in outcome or survival.

## Clot Aspiration

- Vespa et al found a 77% reduction in ICH volume at 48 hours with no bleeding
- Saline irrigation and aspiration after 1mg rtPA q8 hours



- Uncertain and considered investigational

(2010 ICH Guidelines)

## ICH Aspiration

- CLEAR-IVH Trial
  - “instillation of intraventricular rtPA in ICH suggested low complication rate but efficacy and safety are uncertain and this treatment is still considered investigational  
(Stroke 2010)

## Arteriovenous Malformation - AVM

- Abnormal network of arteries and veins
- Mostly an absence of normal intervening capillaries
- Nidus/tangle of vessels at center

## AVM Epidemiology

- Difficult to establish incidence
  - Unreported/unruptured?
  - 0.14% prevalence
  - Slight male>female
  - 32-40 y/o
- Grading (Spetzler-Martin)
  - Size, venous drainage pattern
  - Eloquence of adjacent brain

## AVM Presentation

- 50% Hemorrhage
  - Intraventricular if deep
  - SAH if superficial
- Seizures
  - Secondary to “steal”
  - Secondary to hemorrhage
- Headache
  - Pulsatile tinnitus

## AVM Management

- Craniotomy
  - Depends on age and symptoms
  - Coagulation of the fistula and removal
  - Can recur in some cases
  - Post-op cautious blood pressure management
- Endovascular
  - Presurgical embolization on large AVMs to decrease flow
- Stereotactic Radiation
  - Nidus must be <3 cm
  - Deep lesions
  - Takes 1-3 years to take effect so patient is still at risk for hemorrhage during this time

## Intracranial Aneurysm

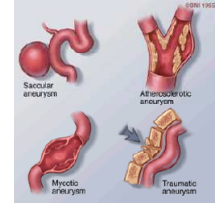
- Historic belief
  - Small thin walled ballooning of an artery associated with defect in the vessel wall
  - However, thin walled vessels are present in most of the population and rupture does not occur along those areas of the vessel...

## Aneurysm - Pathophysiology

- Current belief
  - Local thickening of intimal layer causes inelasticity
  - Places additional stress on area which *will* stretch
  - Increase in pressure and shear stress also exacerbate the problem
  - Rupture frequently occurs at bifurcation of a vessel

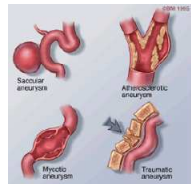
## Aneurysm Types

- Fusiform
  - irregular, dilated
- Mycotic (old term)
  - septic emboli
- Traumatic
  - dissecting
  - often carotid



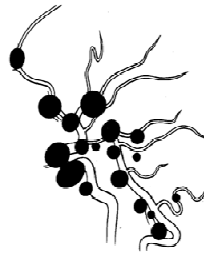
## Aneurysm Types

- Saccular
  - Berry
    - has neck/stem
  - Giant
    - berry larger than 3cm



## Aneurysm Location

Anterior circulation 85%



## Presentation

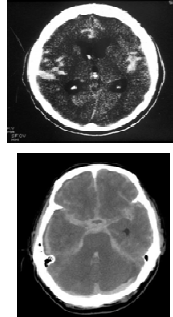
- Classic headache – patient describes “the worst headache of my life”
- Altered LOC, unresponsive
- Vomiting , photophobia, visual changes
- Dizziness
- Seizure
- Hypertension
- Degree of neuro deficit
  - depends on site & extent

## Neurodiagnostic Measures

- CT      Computerized Tomography
- CTA      CT Angiography
- DSA      Angiography
- MRI      Magnetic Resonance Imaging
- LP      Lumbar puncture
- TCD      Transcranial Doppler

### Computerized Tomography CT Scan

- First line of diagnosis
- Detects focal and diffuse hemorrhage
- Identifies ventricular involvement
- Demonstrates structural change (shift, lesions etc)



### CT Angiography

- Provides a 3D reconstruction



### Digital Subtraction Angiography

- Gold Standard for diagnosis
- Localizes aneurysms
- Demonstrates vasospasm
- Endovascular treatment of spasm
  - angioplasty
  - infusion of papavarine
  - t-PA



### Lumbar Puncture

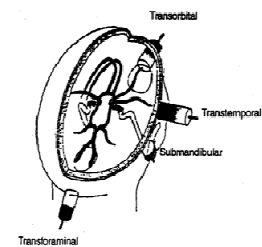
- Must have a CT scan first to avoid herniation
- CSF yellow tinged with old blood byproducts
  - Distinguishes from traumatic puncture
  - The three test tube test is unreliable
  - If CSF is clear then further evaluation is necessary

### Transcranial Doppler

- Measurement of blood flow velocity
- Increased velocity indicates a decrease in arterial diameter or spasm

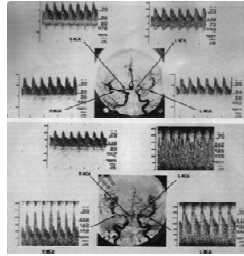
### Windows for Measurement

- Transtemporal
  - MCA, ACA, PCA, Basilar
- Transorbital
  - Carotid syphon, ophthalmic, contralateral ACA
- Suboccipital
  - Basilar trunk, distal vertebral
- Submandibular
  - Retromandibular ICA



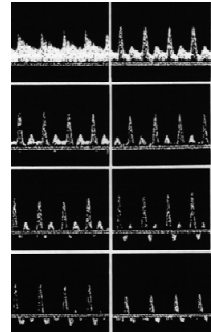
## Normal Flow Velocities

- MCA > ACA > PCA
- MCA 44 +/- 12
- ACA 50 +/- 11
- PCA 44 +/- 9
- ICA 61 +/- 16



## Vasospasm Diagnosis

- Timing - day 3 through 21  
– peak day 5 through 14
- Exam, Monitoring, TCD, CT perfusion, angiogram and/or combination



## Grading Scales for SAH

- Hunt and Hess – Clinical Condition
- WFNN – Clinical Condition
- Fisher – Amount of blood on CT scan

## Hunt and Hess Scale

- 0 Unruptured
- 1 Normal, minimal HA
- 2 HA, nuchal rigidity, no deficits
- 3 Drowsiness, with or without minor deficits
- 4 Stuporous, with major deficit, hemiplegia
- 5 Comatose, decerebrate

## Fisher Scale

- 0 Unruptured
- 1 No blood detected
- 2 Diffuse or vertical layers < 1 mm thick
- 3 Clot or vertical layers > 1 mm thick
- 4 Intracerebral/intraventricular clot



## Prognostic Indicators in Ruptured Aneurysm

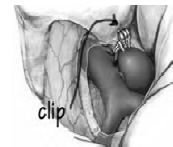
- Patient clinical condition on admission is the most important
- Amount of blood on initial CT scan
- Hunt and Hess Score
- Age

### Timing of Intervention

- Early 48-96 hours
- Eliminates rebleed risk
- Can treat vasospasm aggressively
- Overall mortality lower
- Late >10 – 14 days
- Poor medical condition
- Hunt & Hess >4
- Significant edema on CT
- Active vasospasm
- Use monitoring
  - ICP, LICOX

### What are the options for the patient...

- Surgical management remains the mainstay of therapy ...
- Clipping
- Coiling
- Pharmacology

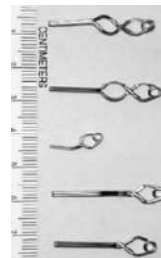


### Interventional Neuroradiology

- Endovascular Options
  - Embolization
    - Agents penetrate nidus of lesion
    - Proximal occlusion of vessels
      - Balloons
      - Coils
      - Stents
      - Combination therapy
  - Angiography
    - Balloon angioplasty for spasm



### Surgical Clipping



- Surgical craniotomy
- Secures the aneurysm with one or more clips

### Arrival of the Patient at a Stroke Center

- Rapid screen for stroke
- Rapid diagnostic workup
- Rapid interventions

### SAH Management on admission

- Maintain ABC's
- Treat BP if over pre-SAH level
- Neurosurgery consult
- Begin Nimodipine
- Anticonvulsant therapy for seizures
- Give analgesics & sedatives as needed
- CT scan and Angiography
- Hemodynamic monitoring & surgery

### Pre-op Management of Aneurysm

- Assess neuro status for subtle changes (pronator drift)
- Arrhythmias
- Fluid overload and neurogenic pulmonary edema
- Assist with bathing, toileting
- Private darkened room, limited visitors and noise

### Post-operative and Post-procedure Management

- Assessment
  - Neuro Assessment
  - Vasospasm
  - Increased ICP
  - Fluid and Electrolytes
  - Cardiovascular and pulmonary

### Complications of SAH

- Bleeding
  - Lethal complication - 11% risk
  - 2nd leading cause of increased morbidity and mortality
  - Greatest risk in first 24 hours
  - Secondary to anticoagulation
  - Increased with conservative therapy
  - Fatal in up to 70% of patients
  - Reduce risk by keeping SBP < 150 mmHg

### SAH Guidelines

- Newly published by NCCS
- Expert international conference
- Literature review and recommendations

Journal of Neurological Care (2011) 15(2) 1-24  
DOI: 10.1097/12020-01-9600-9

**REVIEW**

#### Critical Care Management of Patients Following Aneurysmal Subarachnoid Hemorrhage: Recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference

Michael W. Deringer · Thomas P. Bleck · J. Charles Hemphill III · David Meyers · Levi Srinivas · Paul Vespa · Nilsen Brander · E. Sandro Cassady Jr. · Giuseppe Colletto · David Green · Daniel Heugge · Brian L. Hoh · Giuseppe Lanzetta · Peter Le Roux · Alejandro Robinson · Erick Schmittler · Nino Storchelli · Jose S. Suarez · Miriam Truglieri · Ming-Yuan Tseng · Mervyn D. L. Vergara · Stefan Wolf · Gregory Zigfil

### SAH Assessment

- What scale should we be using
  - NIH
  - GCS
  - Other
  - Comatose versus awake patient

### SAH Complications

- Vasospasm
- Intracranial Hypertension – increased ICP
- Hydrocephalus
- Fluid and Electrolyte disorders
  - SIADH, DI, Cerebral Salt Wasting
- Cardiac rhythm alterations
- Seizures

## Vasospasm

- May occur in 50% of survivors (day 5-14)
- Occurs more commonly in Grade III-V bleeds
- Grades IV-V have poor CBF

## Vasospasm

- Narrowing of cerebral arteries around Circle of Willis
  - Causes an increase in velocities of arteries
  - Decreases blood delivery to cerebral tissue
- Clot encases cerebral arteries
  - Cellular changes in vessel wall are related to substances released by degrading blood
  - Erythrocytes disintegrate releasing oxyhemoglobin
    - Vasospastic effect
  - Collagen increases in cell wall, then tissue thickness increases

## Vasospasm

- Signs/symptoms
  - Assessment in awake patient
    - Global: headache & increasing lethargy
    - Localizing: hemiparesis, aphasia in dominant hemisphere, loss of spatial awareness (non-dominant hemisphere)
- Technological evaluation in Comatose patient
  - ICP, TCD, CBF, Licox, Cerebral Angiogram
- Balloon angioplasty with intra-arterial Rx

## Triple H Therapy???

- Euvolemia
- Isotonic crystalloid

### Recommendations

- Intravascular volume management should target euvolemia and avoid prophylactic hypervolemic therapy. In contrast, there is evidence for harm from aggressive administration of fluid aimed at achieving hypervolemia (high quality evidence; strong recommendation).
- Isotonic crystalloid is the preferred agent for volume replacement (Moderate quality evidence; weak recommendation).
- In patients with a persistent negative fluid balance, use of fludrocortisone or hydrocortisone may be considered (moderate quality evidence; weak recommendation).

Neurocrit Care (2011) 15:211–240

## Glucose Management

- Careful glucose management
  - Above 80 mg/dl
  - Below 200 mg/dl

### Recommendations

- Hypoglycemia (serum glucose <80 mg/dl) should be avoided (High quality evidence strong recommendation).
- Serum glucose should be maintained below 200 mg/dl (Moderate quality evidence-strong recommendation).
- If microdialysis is being used, serum glucose may be adjusted to avoid low cerebral glucose (Very low quality evidence-weak recommendation).

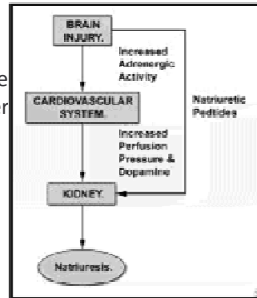
Neurocrit Care (2011) 15:211–240

## Pharmacological Management

- Calcium channel blockers
  - Do not prevent spasm, but decrease severity of ischemia.
  - Dilate secondary arteries
  - Nimotop 60mg PO q4h for 21 days
    - Watch for PO dosing problems
  - Several articles support the use of Nimodipine
  - Others indicate evidence of hypotension that may cause ischemia

### Neuro Endocrine Dysfunction

- Hyponatremia
  - Most common electrolyte imbalance (34%) in higher grade SAH (Grade III- V)



### SIADH and CSWS Chart

Parameter	SIADH	CSWS
BP	Normal	Low or normal
HR	Slow or normal	Tachycardia or normal
Hematocrit	Normal	Elevated
GFR	Increased	Decreased
Urea or creatinine	Normal or low	Normal or high
Urine volume	Normal or low	Normal or high
Urine concentration	High	Dilute
Blood volume	Increased or normal	Decreased
Hydration	Well hydrated	Decreased
Urine Na <sup>+</sup> excretion	Normal	High
Average day starts	8 <sup>th</sup>	4-5 <sup>th</sup>

DI	SIADH	CSWS
<ul style="list-style-type: none"> <li>• Hyponatremia (&gt;145)</li> <li>• Hyperosmolarity (&gt; 295)</li> <li>• Urine osmolarity (&lt; 300)</li> <li>• Specific gravity &lt; 1.005</li> <li>• Dehydration</li> </ul>	<ul style="list-style-type: none"> <li>• Hyponatremia (dilutional)</li> <li>• ↑ extracellular fluid</li> <li>• Serum hypo-osmolarity (&lt;280)</li> <li>• ↑ plasma volume</li> <li>• ↑ body weight</li> <li>• Low BUN</li> <li>• Not necessarily a negative salt balance</li> <li>• Urine osmolarity is inappropriately concentrated as compared to serum osmolarity</li> </ul>	<ul style="list-style-type: none"> <li>• Hyponatremia (primary)</li> <li>• ↓ extracellular fluid</li> <li>• Serum hypo-osmolarity (&lt;280)</li> <li>• ↓ plasma volume</li> <li>• ↓ body weight</li> <li>• High BUN</li> <li>• Excessive natriuresis</li> <li>• Negative salt balance (primary loss of sodium)</li> </ul>

### Cardiac Complications

- Neurogenic cardiac changes
  - Cardiopulmonary changes seen in 33% of patients over the next six months
  - 30% cardiac and pulmonary (U Pitt, 2004)
  - EKG changes for 72 hrs (usually benign)
  - Troponin levels >10
  - Monitor MB isoenzymes and CPK
    - treat as necessary if MI present

### Hydrocephalus and SAH

- Hydrocephalus with or without IVH
  - Ventriculostomy
  - If blood in ventricles, clearing clot with tPA
  - Shunting – usually ventriculoperitoneal
- Specific management related to area

### High Volume Centers

- Patients should be treated at high volume centers

## Residual Impairment

- OT, PT, Speech and Psych as needed
- 50% can't walk
- 62% can't prepare their own meals
- 70% can't read
- Impact on lifestyle, depression
- Ensure caregivers get rest, nutrition

## Questions ...

