

## Hemorrhagic Stroke

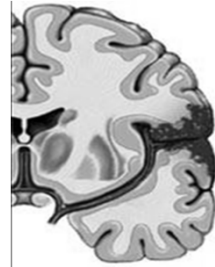
Rosemarie Girardeau RN CCRN CNRN CSRN

## Etiology of Stroke

Ischemic (84%)



Hemorrhagic (16%)



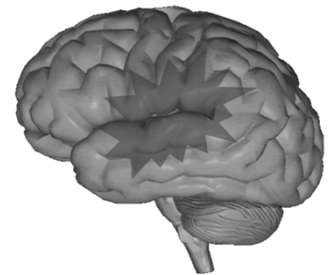
## My focus for this hour...



**Hemorrhagic  
Stroke  
16%**

## Intracerebral Hemorrhage

Bleeding into  
the brain tissue  
caused by a  
rupture of a  
small vessel



## Intracerebral Hemorrhage



Characterized by sudden loss of consciousness,  
usually without warning while the person is active

## Intracerebral Hemorrhage

Hypertension!  
Hypertension!  
Hypertension!

...is the most important  
risk factor!

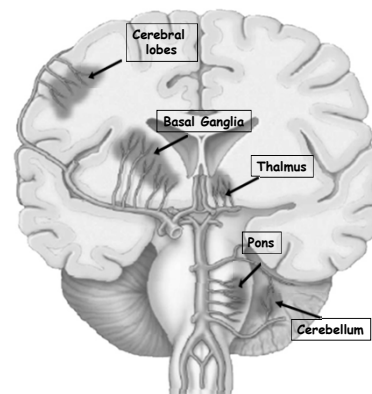


### Other causes:

- Coagulopathies
- Anticoagulation therapy
- Cocaine abuse
- Methamphetamine
- AVM\*\*\*
- Vasculitis
- Tumors
- Trauma



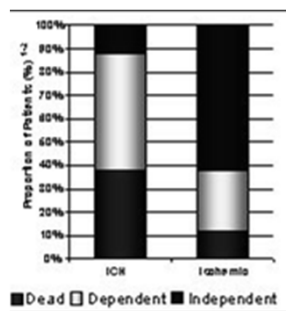
### Common Sites of ICH



Qureshi AI et al. *N Engl J Med*. 2001;344:1450-1460.

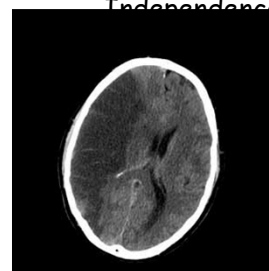
### ICH Epidemiology

- Most devastating form of stroke
- Highest mortality rate (35%-52%)
- Worst functional outcome than any other stroke type

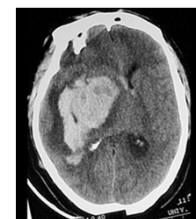


### ICH Epidemiology

Independence @ 6 months



60%



20%

## Stroke

JOURNAL OF THE AMERICAN HEART ASSOCIATION

Guidelines for the Management of Spontaneous Intracerebral Hemorrhage in Adults. 2015 update

American Stroke Association

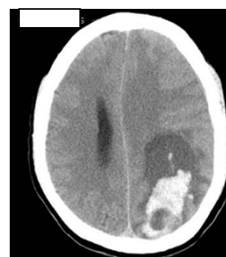
A Division of American Heart Association

### Why?

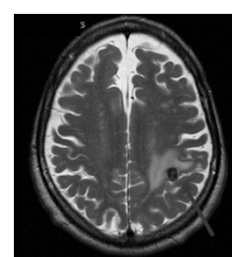
- Improve level of care
- Standardized treatment
- Reduce mortality and morbidity

### Diagnostic Imaging

CT scan



T2 weighted MRI



## ICH Acute Treatment

- ABC's
- Minimize expansion of hematoma (hemostatic therapy)
  - FFP
  - Prothrombin complex concentrate (PCC's)
  - Vitamin K
  - Platelets
  - rFVIIa
- BP control

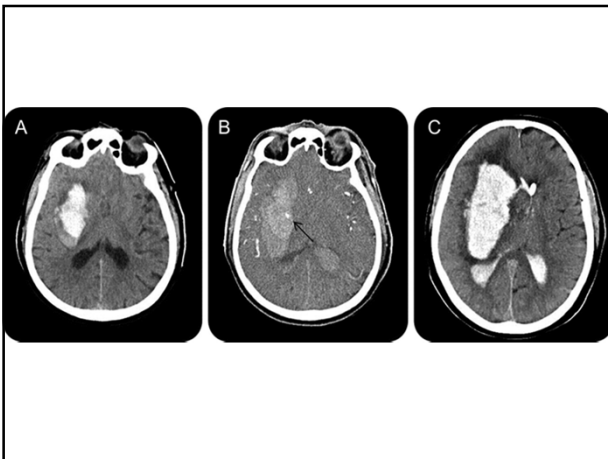


## Identify those at risk...

"Spot sign" - presence of contrast within the hematoma



Predicts hematoma expansion



## BP Control

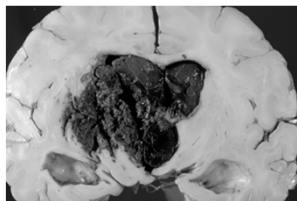


HTN may contribute to hematoma expansion, perihematoma edema and rebleeding

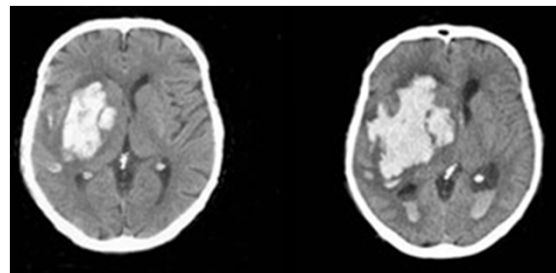
Acute lowering of SBP <140 (if not contraindicated)

## ICH - Treatment

- Hemostatic therapy
- Surgery
- Stereotactic aspiration



## Hemostatic Therapy



2 hours after onset

6 hours after onset



## rfVIIa

- Normalizes INR rapidly
- Does not replenish all the Vitamin K-dependent factors
- Does not restore thrombin generation as effectively as PCC's
- rfVIIa is NOT currently recommended for routine use in warfarin reversal



Stroke, 2015

## Newer Anticoagulant Medications

dabigatran

rivaroxaban

apixaban

No reversal agents  
Half life = 5-15 hours

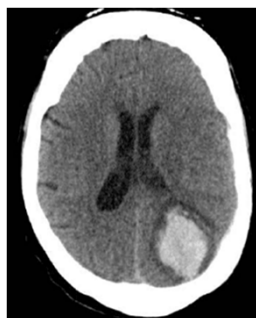
## Surgical Removal



## Supratentorial ICH

"For most patients the usefulness of surgery is **NOT** well established"

(Stroke 2015)



Class IIB, Level of Evidence A

## Cerebellar Hemorrhage

Patients deteriorating neurologically or who have brainstem compression and/or hydrocephalus should undergo surgical removal ASAP!



Class I, Level of Evidence B

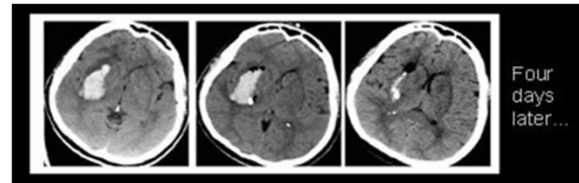


## Stereotactic ICH Aspiration



## Stereotactic ICH Aspiration

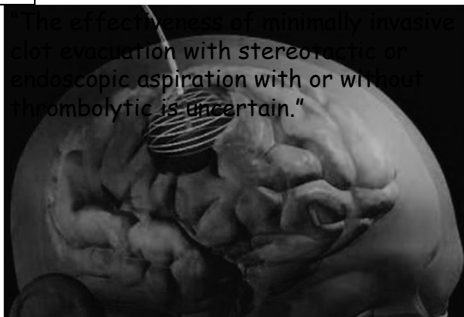
Saline irrigation and aspiration after 1 mg  
rtPA q 8 hours



77% reduction in ICH volume at 48 hours with no bleeding

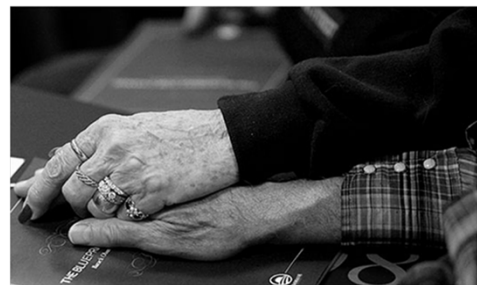
Vespa et al, *Neurocritical Care* 2005

"The effectiveness of minimally invasive clot evacuation with stereotactic or endoscopic aspiration with or without thrombolytic is uncertain."



(Stroke, 2015)

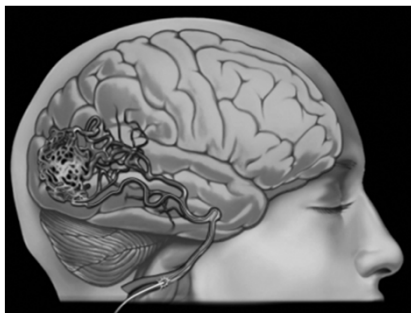
## DNR Recommendation-ICH



DNR should be made only after 2<sup>nd</sup> full day of hospitalization

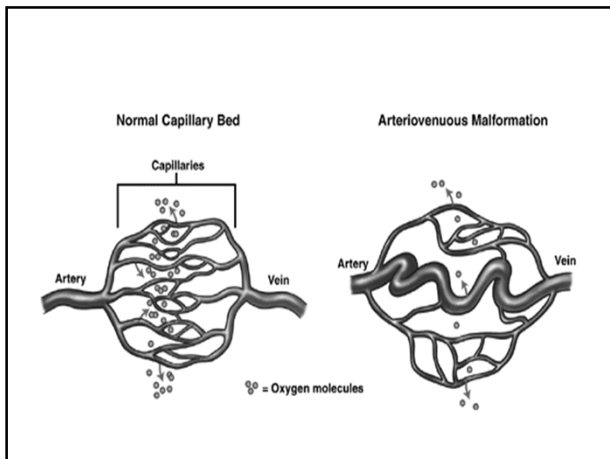
(Stroke, 2010)

## Arteriovenous Malformation



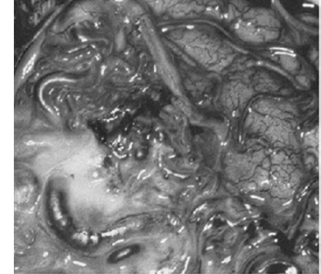
## Arteriovenous Malformation

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



## AVM - Risk of Bleeding

10 years ---33.5%  
 20 years ---55.8%  
 30 years ---70.6%  
 40 years ---80.3%  
 50 years ---86.8%



With age...risk increases

## AVM Presentation

50% hemorrhage

...intraventricular if deep

...SAH if superficial

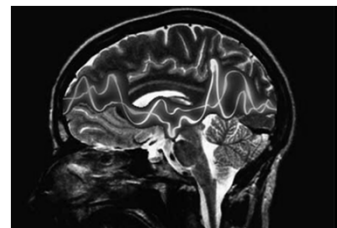


## AVM Presentation

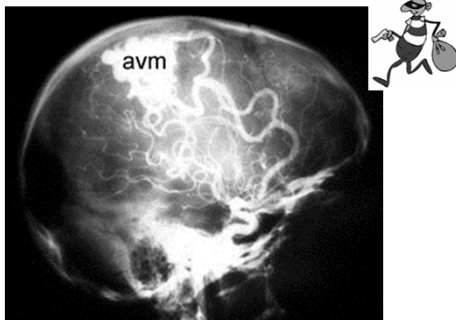
Seizures

...secondary to vascular steal syndrome

...secondary to hemorrhage



## Vascular Steal Syndrome



## AVM Presentation

- Headache
- Pulsatile tinnitus



## Grading of AVM's

### Spetzler-Martin Grading Classification

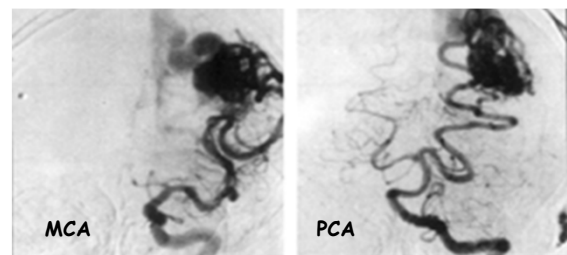
- Grades the AVM on size, venous drainage and proximity to eloquent brain tissue
- The treatment strategy of the AVM is related to the overall grade
- The higher the grade...the more difficult to resect

## Spetzler Martin Grading Classification

Size of AVM	Eloquence of adjacent brain	Pattern of venous drainage
Small (<3cm) 1	Noneloquent 0	Superficial only 0
Medium (3-6cm) 2	Eloquent 1	Deep only 1
Large (>6cm) 3		

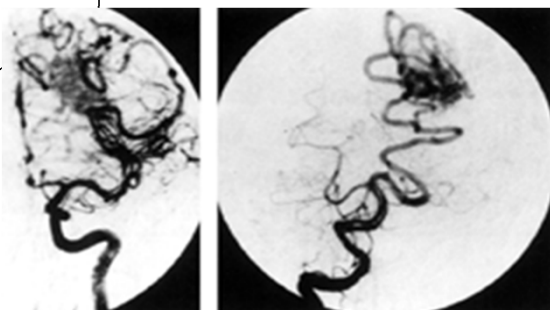
## AVM Management

- Craniotomy-surgical removal
- Endovascular
  - Presurgical embolization of large AVM's to decrease flow
- Stereotactic Radiation
  - Nidus must be <3cm
  - Deep lesions
  - Takes 1-3 years to take effect...so patient is at risk for hemorrhage during this time



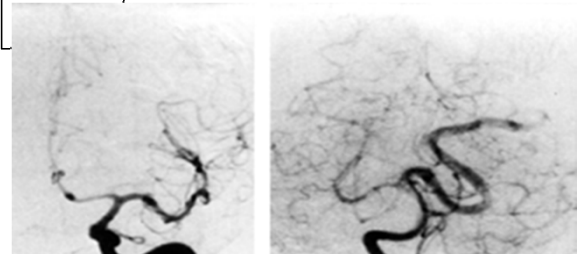
Large AVM of the left parietal region

*J Neurosurg 73:387-391, 1990.*



Same patient post endovascular embolization using N-butyl-cyanacrylate glue

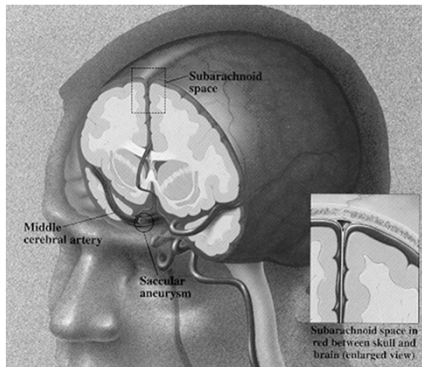
*J Neurosurg 73:387-391, 1990*



Same patient post surgical resection

*J Neurosurg 73:387-391, 1990.*

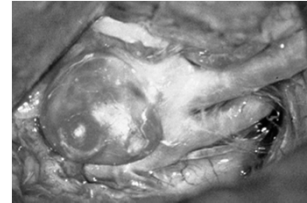
## Subarachnoid Hemorrhage



(6%)

## Aneurysm

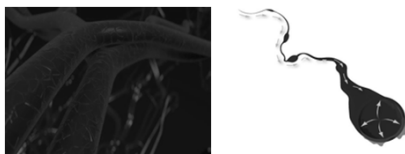
Abnormal, localized dilation of the cerebral arterial wall



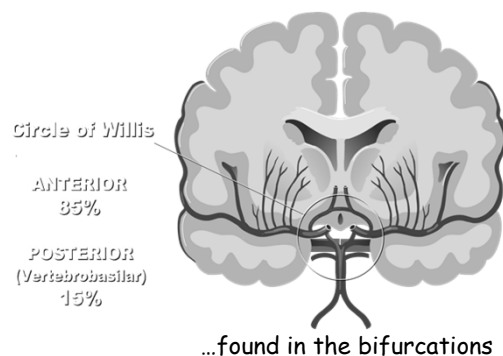
## What causes an aneurysm?

*The exact cause is unclear*

- Two factors:
  - Abnormal degenerative changes in the wall of the artery
  - The effect of pulsations of pressure from the blood being pumped through the artery



## Location



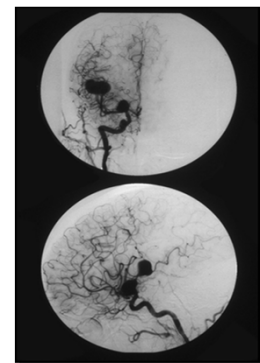
## Natural History

- 12% die before reaching the hospital
- 25% die in the next 3 months
- 40% survive-have neurologic sequelae

Causes of death-  
initial hemorrhage, rebleeding, vasospasm

## Classification

- Berry
- Giant
- Fusiform
- Mycotic
- Traumatic



## Berry

A round  
saccular aneurysm  
that has a  
neck or stem



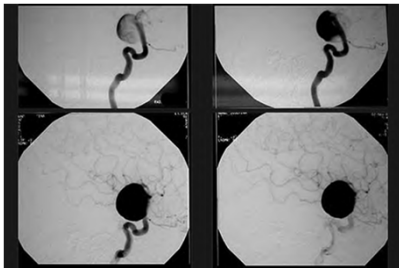
## Berry Aneurysm



Saccular Aneurysm

## Giant Aneurysm

Aneurysms 2.5cm or larger in size and produce  
symptoms of a space-occupying lesion



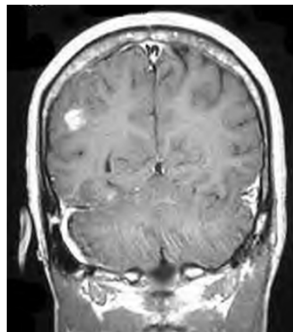
## Fusiform Aneurysm



- No neck or stem
- Bulges out circumferentially

## Mycotic Aneurysm

- Rare
- Caused by septic emboli which separate the endothelial lining forming an aneurysm
- Usually originates due to bacterial endocarditis



## Traumatic Aneurysm



## Traumatic Aneurysm

- Major cause-MVC
- Rare...<1% of aneurysms
- Average length of time from trauma to hemorrhage = 21 days
- Mortality 50%



## Signs and Symptoms



## Aneurysm "Warning Signs"

"Worst headache of my life!"



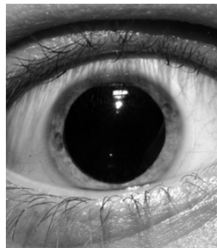
## Other "Warning Signs"

- Cranial nerve deficit (visual difficulties)
- Eye pain
- Dizziness



## Signs of Rupture

- Altered mental status...drowsy/unresponsive
- N&V
- Nuchal rigidity
- Motor deficits
- Pupil dilation
- HTN



## Grading of Aneurysms

Purpose...

Assist the physician to determine timing of surgery and to predict mortality and morbidity

## Hunt and Hess Scale

Grade	Criteria
0	Unruptured
I	Minimal h/a, slight nuchal rigidity, no neurological deficits
II	Moderate to severe h/a, nuchal rigidity, 3 <sup>rd</sup> or 4 <sup>th</sup> cranial nerve palsy
III	Drowsiness, confusion, mild focal deficit
IV	Stupor, moderate-severe hemiparesis, early decerebrate rigidity
V	Deep coma, decerebrate, moribund appearance

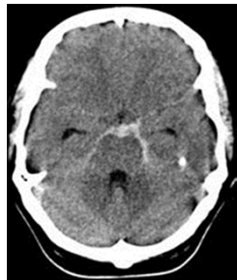
## Diagnosis

- History and Physical
- CT/CTA
- MRI/MRA
- Digital Subtraction Angiography
- LP



## Computerized Tomography (CT)

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



## CT Angiography (CTA)

Combines technology: conventional CT with that of traditional angiography



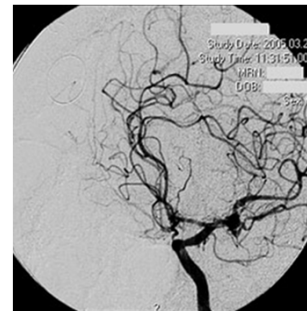
## Magnetic Resonance Imaging (MRI)

- More sensitive for subacute blood or an old SAH
- T2 weighted MRI



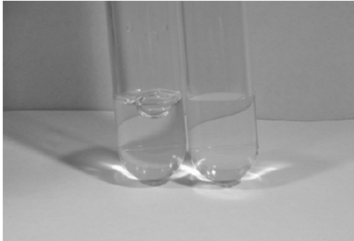
## Digital Subtraction Angiography (DSA)

- "Gold Standard" for diagnosis
- Localizes aneurysms
- Demonstrates vasospasm



## Lumbar Puncture

- Must have CT scan prior to avoid herniation
- CSF analysis-microscopic blood/xanthochromia



## Complications - SAH

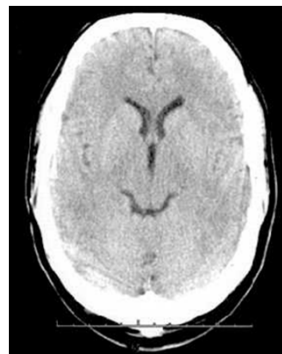
- Vasospasm\*
- Hydrocephalus\*
- Intracranial hypertension ( $\uparrow$  ICP)
- Seizures
- Cardiac complications\*
- Fluid and Electrolyte disorders ( $\downarrow$  Na)\*

## My focus...

Hydrocephalus, hyponatremia, cardiac dysrhythmias and vasospasm

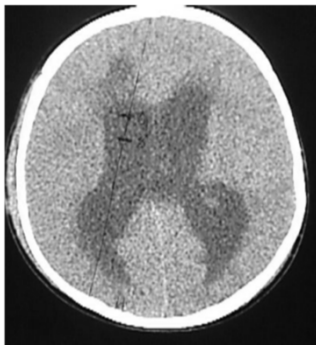


## Hydrocephalus



Normal ventricles

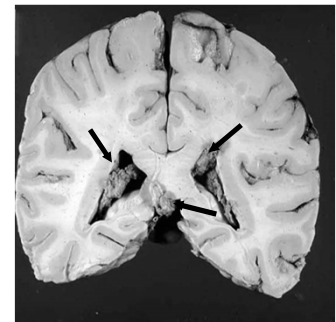
## Hydrocephalus



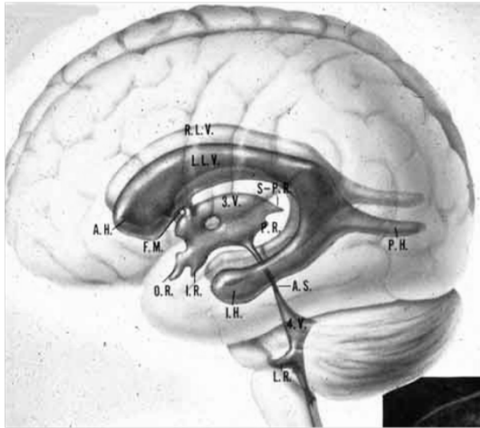
Communicating Hydrocephalus

## CSF Production

Choroid plexus

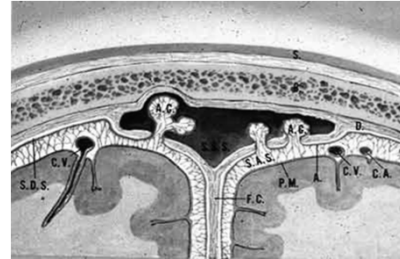




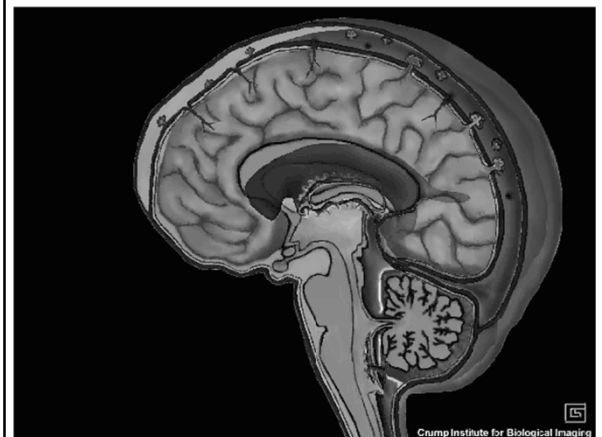
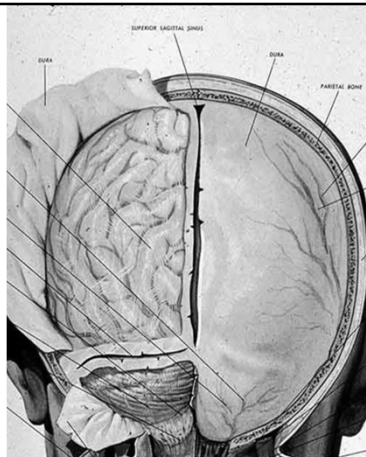


## CSF Absorption

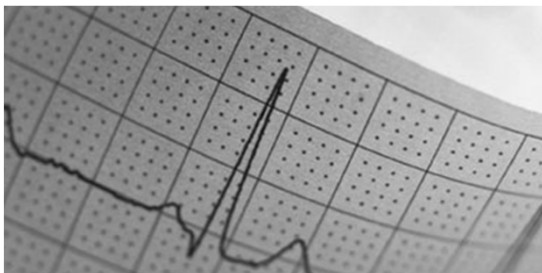
Arachnoid Villi  
(granulations)



Superior  
Sagittal  
Sinus



## Cardiac Disorders



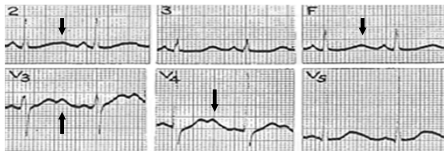
**NEUROGENIC  
STUNNED**



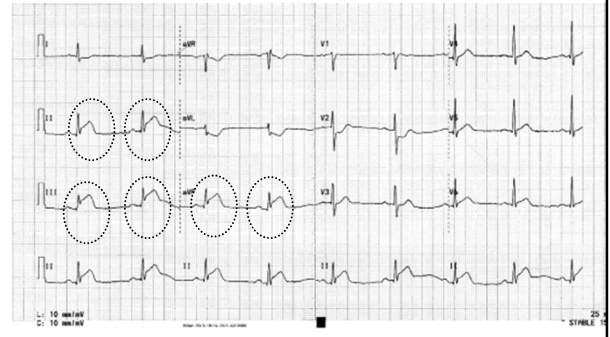
## Cardiac Disorders

### *Neurogenic Induced Myocardial Dysfunction*

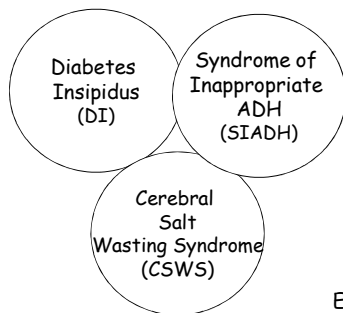
- ST elevation
- T-wave abnormalities
- Prolonged QT
- U waves



## ST Segment Elevation

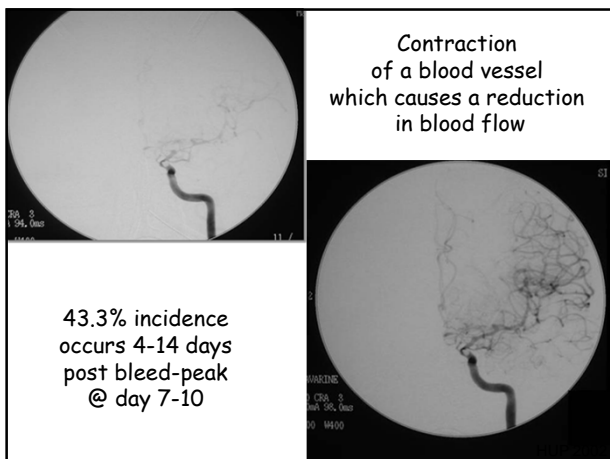
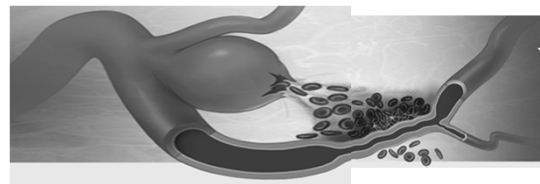


## Fluid and Electrolyte Disorders ...hyponatremia is a problem



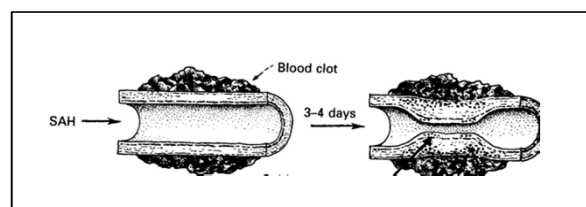
Endocrine abnormalities

## Cerebral Vasospasm



43.3% incidence occurs 4-14 days post bleed-peak @ day 7-10

## Cerebral Vasospasm

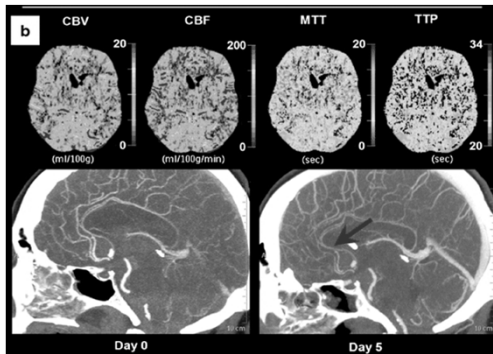


Pathophysiology - remains uncertain  
Thought now...membrane "spreading depolarization"

## Delayed Cerebral Ischemia (DCI)

42 y/o  
male

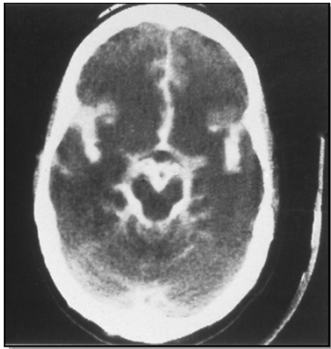
SAH-  
Day 10



## Fisher Grade Scale

Grade	Criteria
0	Unruptured
I	No blood detected
II	Diffuse or vertical layers (<1mm)
III	Clot and/or vertical layers (>1mm)
IV	Intracerebral or intraventricular clot

## Subarachnoid Hemorrhage

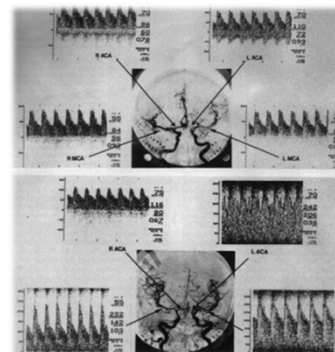


## Transcranial Doppler



Transorbital  
Transtemporal  
Submandibular  
Suboccipital

## Normal Flow Velocities



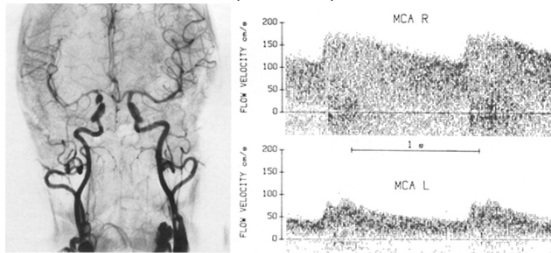
MCA =  $44 \pm 12$

PCA =  $44 \pm 9$

ACA =  $50 \pm 11$

ICA =  $61 \pm 16$

Day 7 - s/p SAH



46 y/o female -aneurysm of right ICA

Transcranial  
Color Doppler  
Imaging  
(TCDI)



What will you see clinically...  
with a patient in vasospasm?

Global



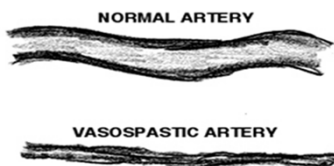
Localizing Signs

- Headache
- Increasing lethargy

- Hemiparesis
- Aphasia
- Loss of spatial awareness

## Treatment of Vasospasm

- HHH therapy (triple H therapy)
- Calcium ( $\text{Ca}^{++}$ ) antagonists (Nimodipine)
- Endovascular therapy



## HHH Therapy

- Hypertension  
Vasopressor, TCD to monitor
- Hypervolemia  
Colloids  $\leq 10\text{mmHg}$ ,  
pcwp  $>18\text{mmHg}$ , urine output  $>0.5\text{mL/kg/h}$
- Hemodilution  
Hct  $30\%$  or lower, viscosity, but may reduce oxygen delivery

## Hypertensive Therapy



## Calcium Channel Blockers



## Calcium Channel Blockers

- Nimodipine-  
60mg po/per NG every 4 hours monitor  
BP-adjust dose if drops
- Administer x 21 days

*Multiple studies demonstrate a modest effect in neurological outcome, but no clear angiographic demonstration of improved spasm was noted*

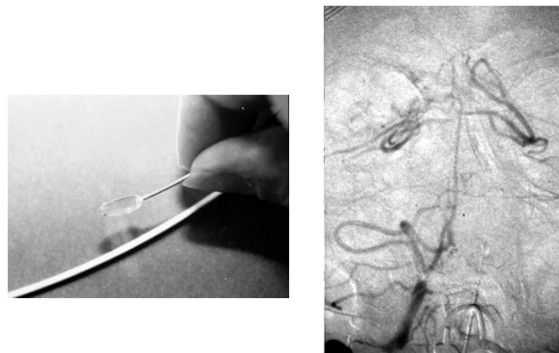
Initial studies were "weight based"



## Endovascular Therapy



## Balloon Angioplasty



## Intraarterial Pharmacologics

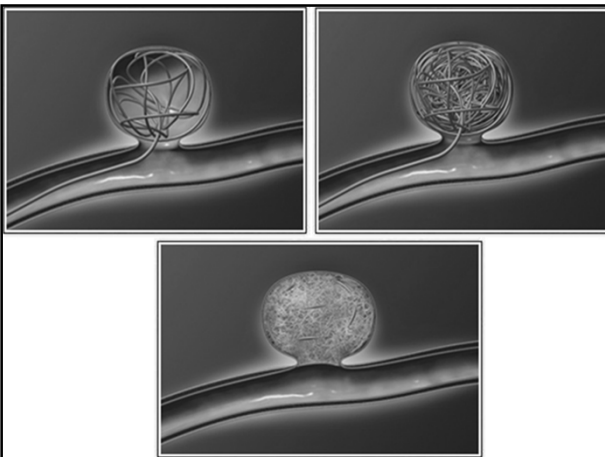
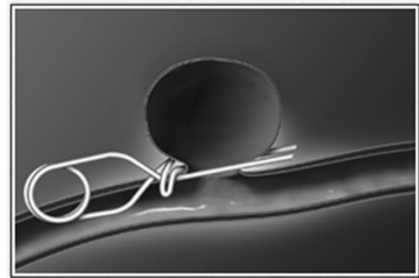


Papaverine  
Verapamil  
Nicardipine

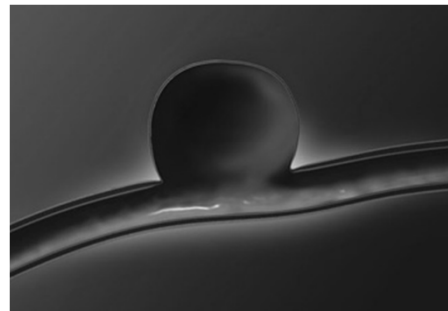


Securing the aneurysm...

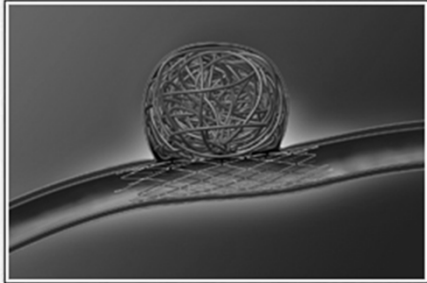
- Surgical
  - surgical clipping
  - prevent rebleeding,
  - allow treatment of vasospasm
- Coiling
  - non surgical
- Palliative
  - ICP management, analgesics, sedatives



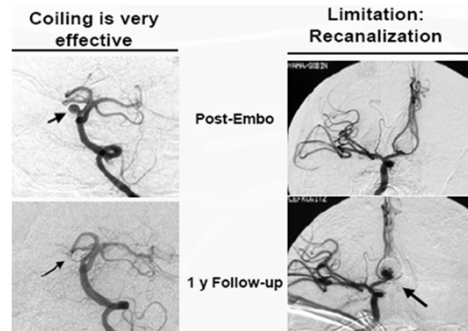
Wide Neck?



## Coil + Stent



## Recanalization Potential



## Clip or Coil?



## Determination of treatment...

Multidisciplinary decision between the cerebrovascular surgeon and the endovascular specialist



Stroke, 2011

## Care of the Patient with Aneurysmal Subarachnoid Hemorrhage

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## Questions?

