Hemorrhagic Stroke
2023 SEQIP Conference

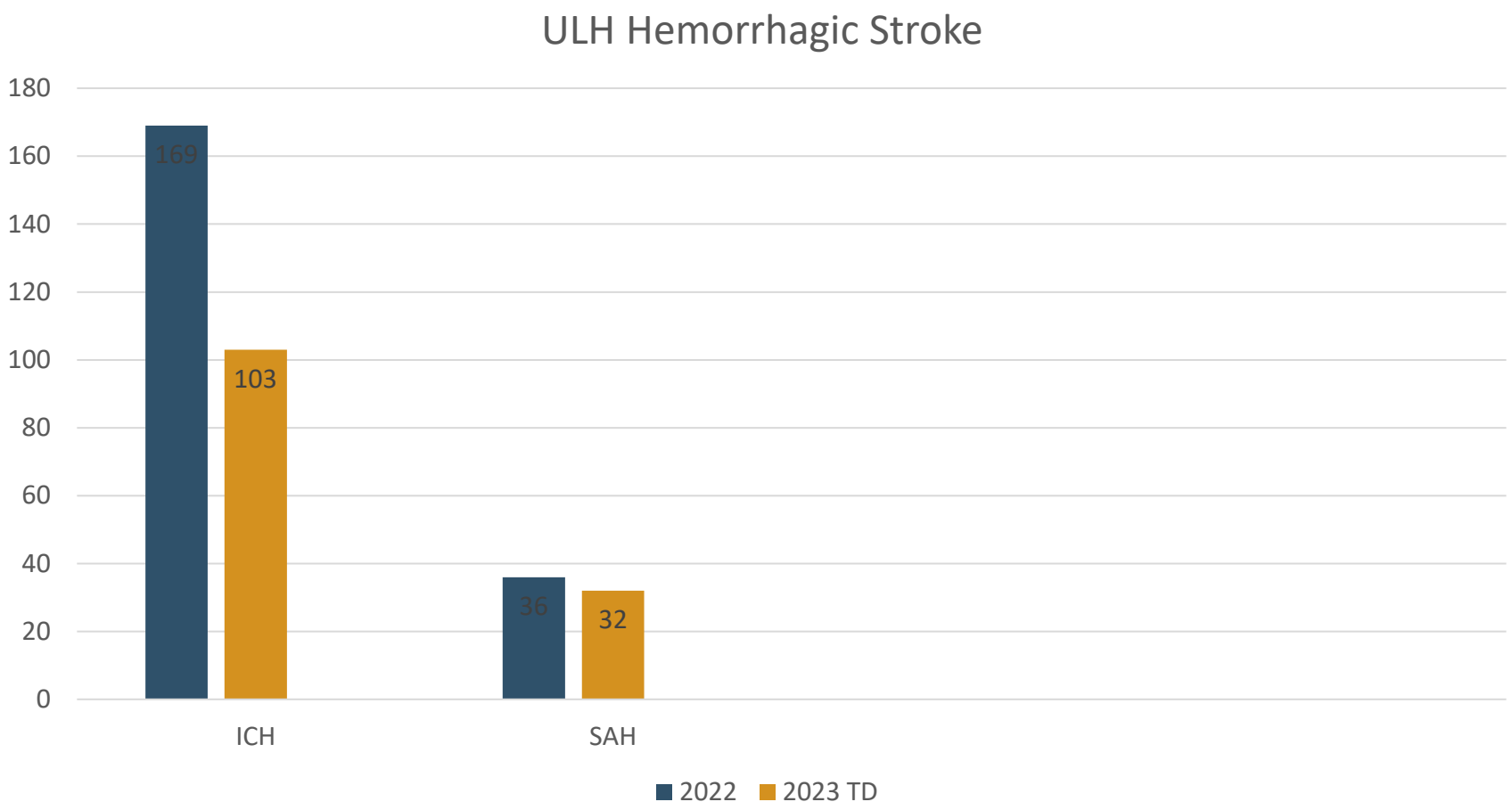
Kimberly Meyer, PhD, APRN, CNRN
Assistant Professor, UofL Neurosurgery

UofL Hospital
UofL Brown Cancer Center

Disclosures

- No financial disclosures
- CPG committee
  - NCS- DVT prophylaxis
  - AANN- Nursing care of patient with SAH
- President-elect AANN

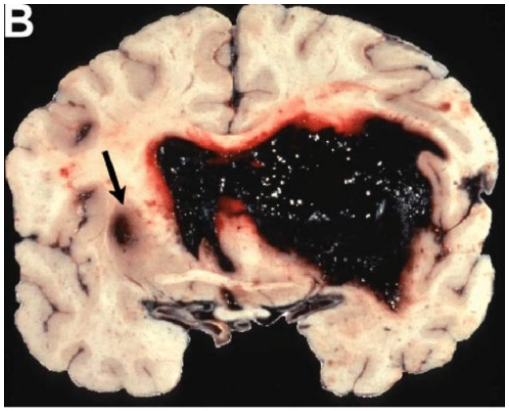
UofL Statistics



Hemorrhagic Stroke

Intracerebral Hemorrhage

Subarachnoid Hemorrhage



Incidence of Intracerebral Hemorrhage

- 10% of all strokes
- Disparity
  - 1.6 fold greater incidence in blacks/Mexican Americans than whites
  - Substantially higher incidence in low to middle incomes
  - Advanced age
- Public health threat
  - High mortality
  - High resource utilization

Intracerebral Hemorrhage (ICH)

- Pathogenesis: Small vessel disease
  - Arteriolosclerosis
    - Deep structures
  - Cerebral amyloid angiopathy
    - Lobar
    - Deposition of B amyloid peptide in the walls of arterioles & capillaries in the leptomeninges, cerebellar hemispheres, and cortex
    - Boston criteria
      - Multiple lobar hemorrhages
      - Subpial siderosis
      - Multiple microbleeds

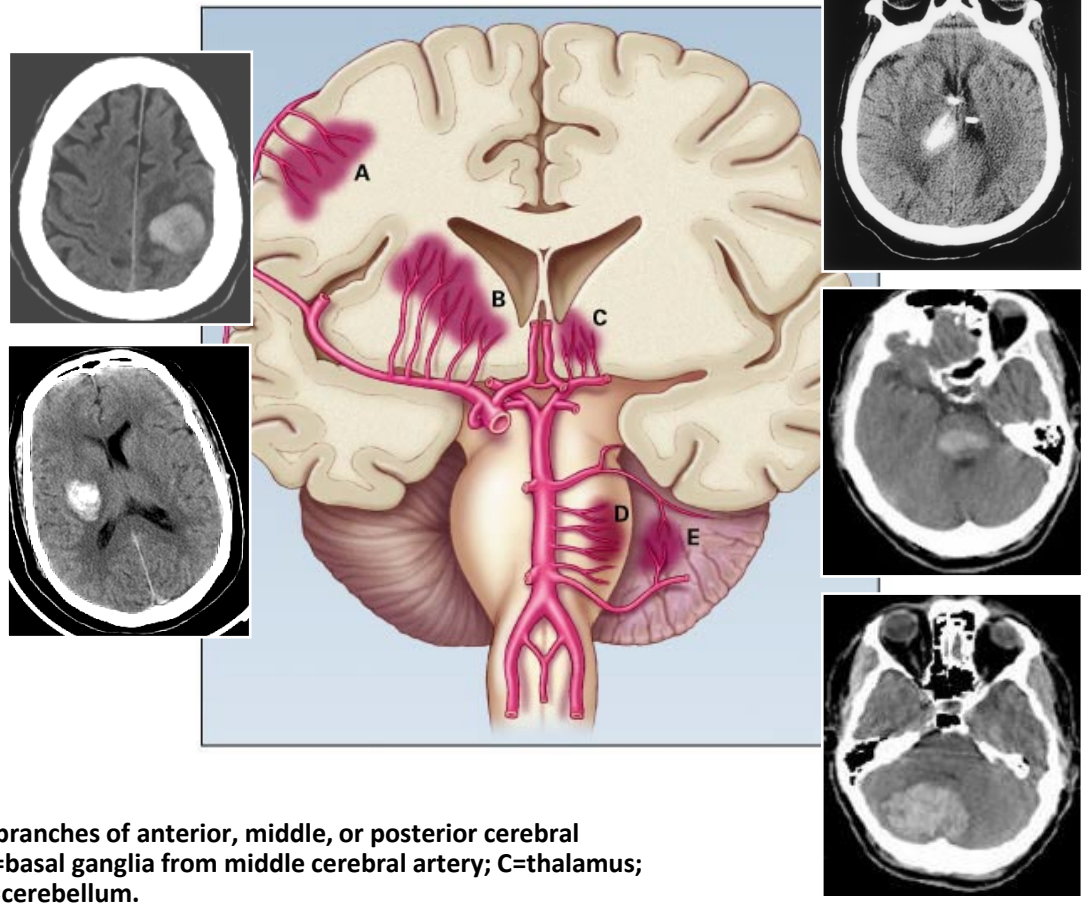
ICH Signs & Symptoms

- Headache
- Loss of consciousness
- Nausea/Vomiting
- Dizziness
- Focal findings depending on location of hemorrhage
  - Speech difficulties
  - Hemiparesis/hemiplegia
- Pupil changes

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=pons; E=cerebellum.

Risk Factors for Hemorrhagic Stroke

- Smoking
- Hypertension
- Illicit drug use
  - Sympathomimetics
  - Injectables

2022 Guideline for the Management of Patients With Spontaneous Intracerebral Hemorrhage: A Guideline From the American Heart Association/American Stroke Association

Steven M. Greenberg, Wendy C. Ziai, Charlotte Cordonnier, Dar Dowlatshahi, Brandon Francis, Joshua N. Goldstein, J. Claude Hemphill III, Ronda Johnson, Kiffon M. Keigher, William J. Mack, J. Mocco, Eileena J. Newton, Ilana M. Ruff, Lauren H. Sansing, Sam Schulman, Magdy H. Selim, Kevin N. Sheth, Nikola Sprigg, Katharina S. Sunnerhagen and ... See all authors

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Other version(s) of this article

ABCDs of Emergency Care

- A Airway
  - Establish airway for GCS < 9
- B Breathing
  - Ensure adequate respiratory rate and tidal volume
  - Monitor ETCO2 (Goal 35-40)
  - Maintain oxygen saturations > 94%
- C Circulation
  - Monitor cardiac function (HR & BP)
  - Maintain SBP 130-150 mm Hg whenever possible
- D Disability
  - Identify neurologic function
  - Specify apparent deficits

ICH Severity Score

- Glasgow Coma Score
  - 3 or 4
  - 5 to 12
  - 13 to 15
- Age
  - >80 yoa
- Location of hemorrhage
- Volume of hemorrhage
- Intraventricular Hemorrhage

ICH Score	Expected Mortality (30 days)
0	0 %
1	13%
2	26%
3	72%
4	97%
5	100%

ICH Guidelines- Takeaway Points

- Organized/specialized system of care
- Minimize hematoma expansion using biomarkers and imaging signs
- Identify markers of macro and microvascular hemorrhage pathogenesis
- Blood pressure regimens that limit variability limit clot expansion & improve outcomes
- Early reversal of anticoagulation using the most effective product is critical
- Many traditional therapies confer no benefit and may produce harm
- Minimally invasive clot evacuation decreases mortality but to date has no impact on functional outcome
- Limitation of life-sustaining measures is complex and should be limited in the first 48 hours

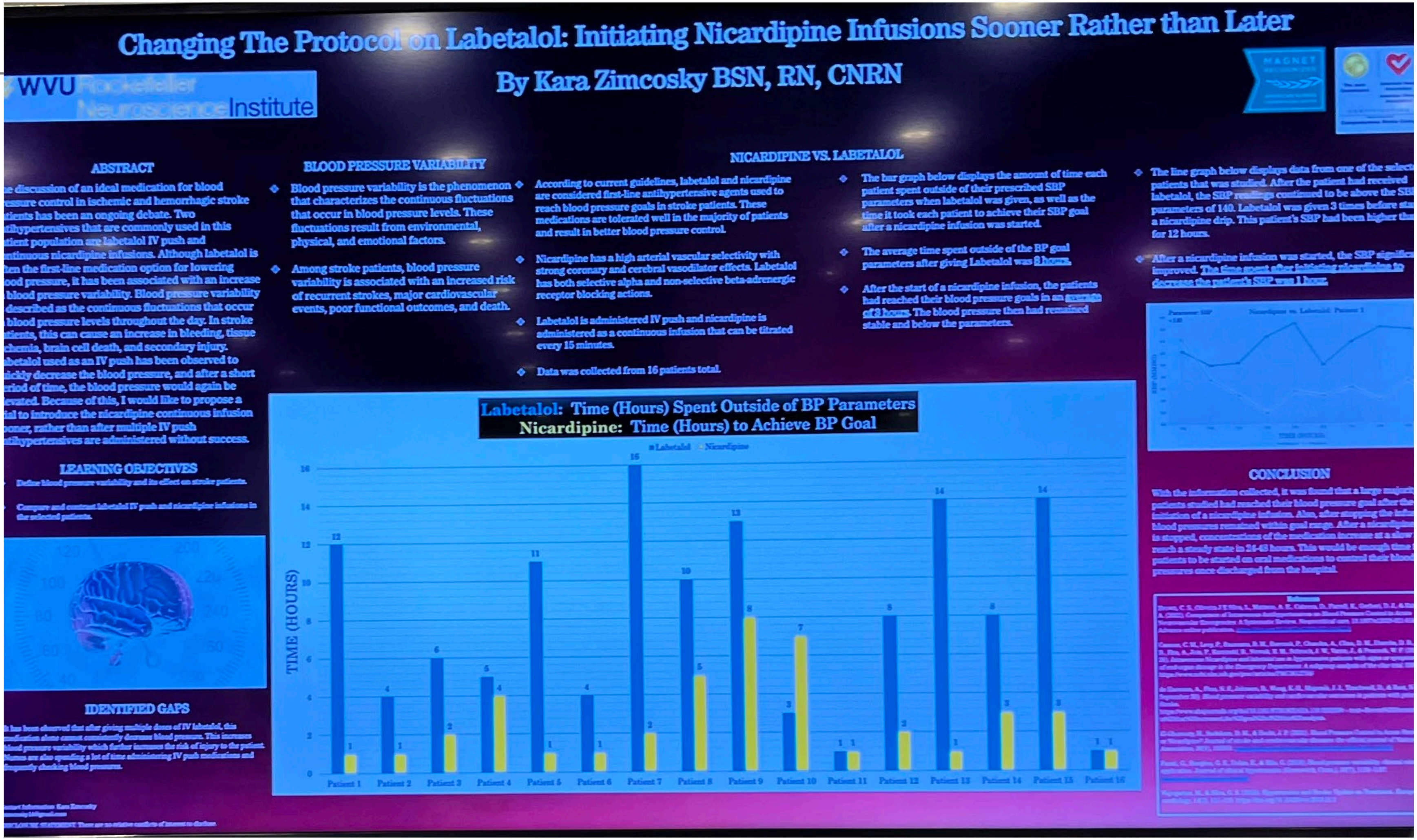
Specific ICH Goals

- Imaging
- Blood pressure management
- Anticoagulation management
- Anti-platelet reversal
- Mechanical ventilation
- General medical management
- Dysphagia care

Blood Pressure

COR	LOE	Recommendation
2a	B-NR	1. In patients with spontaneous ICH requiring acute BP lowering, careful titration to ensure continuous smooth and sustained control of BP, avoiding peaks and large variability in SBP, can be beneficial for improving functional outcomes.[138]
2a	C-LD	2. In patients with spontaneous ICH in whom acute BP lowering is considered, initiating treatment within 2 hours of ICH onset and reaching target within 1 hour can be beneficial to reduce the risk of HE and improve functional outcome.[139,140]
2b	B-R	3. In patients with spontaneous ICH of mild to moderate severity presenting with SBP between 150 and 220 mm Hg, acute lowering of SBP to a target of 140 mm Hg with the goal of maintaining in the range of 130 to 150 mm Hg is safe and may be reasonable for improving functional outcomes.[138,141–147]
2b	C-LD	4. In patients with spontaneous ICH presenting with large or severe ICH or those requiring surgical decompression, the safety and efficacy of intensive BP lowering are not well established.[148]
3: Harm	B-R	5. In patients with spontaneous ICH of mild to moderate severity presenting with SBP >150 mm Hg, acute lowering of SBP to <130 mm Hg is potentially harmful.[146,149,150]

- Avoid fluctuations in blood pressure
- Benefit enhanced when blood pressure controlled EARLY after ICH
- CPP < 60 associated with increased mortality


Changing The Protocol on Labetalol: Initiating Nicardipine Infusions Sooner Rather than Later
By Kara Zimcosky BSN, RN, CNRN
WVU Rockefeller Neuroscience Institute
ABSTRACT
e discussion of an ideal medication for blood
essure control in ischemic and hemorrhagic stroke
tients has been an ongoing debate. Two
tihypertensives that are commonly used in this
tient population are labetalol IV push and
ntinuous nicardipine infusions. Although labetalol is
ten the first-line medication option for lowering
ood pressure, it has been associated with an increase
blood pressure variability. Blood pressure variability
described as the continuous fluctuations that occur
blood pressure levels throughout the day. In stroke
tients, this can cause an increase in bleeding, tissue
chemia, brain cell death, and secondary injury.
betalol used as an IV push has been observed to
ickly decrease the blood pressure, and after a short
riod of time, the blood pressure would again be
evated. Because of this, I would like to propose a
ial to introduce the nicardipine continuous infusion
ooner, rather than after multiple IV push
tihypertensives are administered without success.
LEARNING OBJECTIVES
Define blood pressure variability and its effect on stroke patients.
Compare and contrast labetalol IV push and nicardipine infusions in the selected patients.
IDENTIFIED GAPS
BLOOD PRESSURE VARIABILITY
Blood pressure variability is the phenomenon that characterizes the continuous fluctuations that occur in blood pressure levels. These fluctuations result from environmental, physical, and emotional factors.
Among stroke patients, blood pressure variability is associated with an increased risk of recurrent strokes, major cardiovascular events, poor functional outcomes, and death.
NICARDIPINE VS. LABETALOL
According to current guidelines, labetalol and nicardipine are considered first-line antihypertensive agents used to reach blood pressure goals in stroke patients. These medications are tolerated well in the majority of patients and result in better blood pressure control.
Nicardipine has a high arterial vascular selectivity with strong coronary and cerebral vasodilator effects. Labetalol has both selective alpha and non-selective beta-adrenergic receptor blocking actions.
Labetalol is administered IV push and nicardipine is administered as a continuous infusion that can be titrated every 15 minutes.
Data was collected from 16 patients total.
The bar graph below displays the amount of time each patient spent outside of their prescribed SBP parameters when labetalol was given, as well as the time it took each patient to achieve their SBP goal after a nicardipine infusion was started.
The average time spent outside of the BP goal parameters after giving Labetalol was 8 hours.
After the start of a nicardipine infusion, the patients had reached their blood pressure goals in an average of 3 hours. The blood pressure then had remained stable and below the parameters.
The line graph below displays data from one of the select
patients that was studied. After the patient had received
labetalol, the SBP readings continued to be above the SB
parameters of 140. Labetalol was given 3 times before sta
a nicardipine drip. This patient's SBP had been higher th
for 12 hours.
After a nicardipine infusion was started, the SBP signific
improved. The time spent after initiating nicardipine to
decrease the patient's SBP was 1 hour.
Labetalol: Time (Hours) Spent Outside of BP Parameters
Nicardipine: Time (Hours) to Achieve BP Goal
Labetalol
Nicardipine
TIME (HOURS)
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Patient 7
Patient 8
Patient 9
Patient 10
Patient 11
Patient 12
Patient 13
Patient 14
Patient 15
Patient 16
CONCLUSION
With the information collected, it was found that a large majori
patients studied had reached their blood pressure goal after the
initiation of a nicardipine infusion.
References

Anticoagulation Reversal

COR	LOE	Recommendations
1	C-LD	1. In patients with anticoagulant-associated spontaneous ICH, anticoagulation should be discontinued immediately and rapid reversal of anticoagulation should be performed as soon as possible after diagnosis of spontaneous ICH to improve survival.[162]
VKAs		
1	B-R	2. In patients with VKA-associated spontaneous ICH and INR >2.0, 4-factor (4-F) prothrombin complex concentrate (PCC) is recommended in preference to fresh-frozen plasma (FFP) to achieve rapid correction of INR and limit HE.[163]
1	C-LD	3. In patients with VKA-associated spontaneous ICH, intravenous vitamin K should be administered directly after coagulation factor replacement (PCC or other) to prevent later increase in INR and subsequent HE.[164,165]
2b	C-LD	4. In patients with VKA-associated spontaneous ICH with INR of 1.3 to 1.9, it may be reasonable to use PCC to achieve rapid correction of INR and limit HE.[162,164]

DOACs		
2a	B-NR	5. In patients with direct factor Xa inhibitor–associated spontaneous ICH, andexanet alfa is reasonable to reverse the anticoagulant effect of factor Xa inhibitors.[166,167]
2a	B-NR	6. In patients with dabigatran-associated spontaneous ICH, idarucizumab is reasonable to reverse the anticoagulant effect of dabigatran.[168]
2b	B-NR	7. In patients with direct factor Xa inhibitor–associated spontaneous ICH, a 4-F PCC or activated PCC (aPCC) may be considered to improve hemostasis.[169–171]
2b	C-LD	8. In patients with dabigatran- or factor Xa inhibitor–associated spontaneous ICH, when the DOAC agent was taken within the previous few hours, activated charcoal may be reasonable to prevent absorption of the DOAC.[172–174]
2b	C-LD	9. In patients with dabigatran-associated spontaneous ICH, when idarucizumab is not available, aPCC or PCCs may be considered to improve hemostasis.[175,176]
2b	C-LD	10. In patients with dabigatran-associated spontaneous ICH, when idarucizumab is not available, renal replacement therapy (RRT) may be considered to reduce dabigatran concentration.[177]

Anti-platelet Reversal

- Platelets only for surgery or EVD

COR	LOE	Recommendations
2b	C-LD	1. For patients with spontaneous ICH being treated with aspirin and who require emergency neurosurgery, platelet transfusion might be considered to reduce postoperative bleeding and mortality.[206]
2b	C-LD	2. For patients with spontaneous ICH being treated with antiplatelet agents, the effectiveness of desmopressin with or without platelet transfusions to reduce the expansion of the hematoma is uncertain.[207–209]
3: Harm	B-R	3. For patients with spontaneous ICH being treated with aspirin and not scheduled for emergency surgery, platelet transfusions are potentially harmful and should not be administered.[210]

VTE Prevention & Treatment

COR	LOE	Recommendations
Prophylaxis		
1	B-R	1. In nonambulatory patients with spontaneous ICH, intermittent pneumatic compression (IPC) starting on the day of diagnosis is recommended for VTE (DVT and pulmonary embolism [PE]) prophylaxis.[275,276]
2a	C-LD	2. In nonambulatory patients with spontaneous ICH, low-dose UFH or LMWH can be useful to reduce the risk for PE.[277–280]
2b	C-LD	3. In nonambulatory patients with spontaneous ICH, initiating low-dose UFH or LMWH prophylaxis at 24 to 48 hours from ICH onset may be reasonable to optimize the benefits of preventing thrombosis relative to the risk of HE.[277,281,282]
3: No Benefit	B-R	4. In nonambulatory patients with spontaneous ICH, graduated compression stockings of knee-high or thigh-high length alone are not beneficial for VTE prophylaxis.[276,278,283,284]

Treatment		
2a	C-LD	5. For patients with acute spontaneous ICH and proximal DVT who are not yet candidates for anticoagulation, the temporary use of a retrievable filter is reasonable as a bridge until anticoagulation can be initiated.[285]
2b	C-LD	6. For patients with acute spontaneous ICH and proximal DVT or PE, delaying treatment with UFH or LMWH for 1 to 2 weeks after the onset of ICH might be considered.[286,287]

Risk of DVT is 4X higher in ICH than AIS

Glucose Management

COR	LOE	Recommendations
1	C-LD	1. In patients with spontaneous ICH, monitoring serum glucose is recommended to reduce the risk of hyperglycemia and hypoglycemia.[256,299]
1	C-LD	2. In patients with spontaneous ICH, treating hypoglycemia (<40–60 mg/d, <2.2–3.3 mmol/L) is recommended to reduce mortality.[299–301]
2a	C-LD	3. In patients with spontaneous ICH, treating moderate to severe hyperglycemia (>180–200 mg/dL, >10.0–11.1 mmol/L) is reasonable to improve outcomes.[78,302–307]

Temperature Management

COR	LOE	Recommendations
2b	C-LD	1. In patients with spontaneous ICH, pharmacologically treating an elevated temperature may be reasonable to improve functional outcomes.[311–313]
2b	C-LD	2. In patients with spontaneous ICH, the usefulness of therapeutic hypothermia (<35°C/95°F) to decrease peri-ICH edema is unclear.[314–317]

- Fever associated with worse outcomes
- Normothermia is standard of care
- Therapeutic hypothermia may be helpful in select cases

Anti-epileptic Medications

COR	LOE	Recommendations
1	C-LD	1. In patients with spontaneous ICH, impaired consciousness, and confirmed electrographic seizures, antiseizure drugs should be administered to reduce morbidity.[325,326]
1	C-EO	2. In patients with spontaneous ICH and clinical seizures, antiseizure drugs are recommended to improve functional outcomes and prevent brain injury from prolonged recurrent seizures.
2a	C-LD	3. In patients with spontaneous ICH and unexplained abnormal or fluctuating mental status or suspicion of seizures, continuous electro- (>24 hours) is reasonable to
3: No Benefit	B-NR	4. In patients with spontaneous ICH without evidence of seizures, prophylactic antiseizure medication is not beneficial to improve functional outcomes, long-term seizure control, or mortality.[328–331]

Neuromonitoring and ICP Management

COR	LOE	Recommendations
1	B-NR	1. In patients with spontaneous ICH or IVH and hydrocephalus that is contributing to decreased level of consciousness, ventricular drainage should be performed to reduce mortality.[347–350]
2b	B-NR	2. In patients with moderate to severe spontaneous ICH or IVH with a reduced level of consciousness, ICP monitoring and treatment might be considered to reduce mortality and improve outcomes.[159,351–356]
2b	B-NR	3. In patients with spontaneous ICH, the efficacy of early prophylactic hyperosmolar therapy for improving outcomes is not well established.[357–361]
2b	C-LD	4. In patients with spontaneous ICH, bolus hyperosmolar therapy may be considered for transiently reducing ICP.[362–364]
3: No Benefit	B-R	5. In patients with spontaneous ICH, corticosteroids should not be administered for treatment of elevated ICP.[365–369]

Surgical Intervention for ICH

- Minimally invasive surgery (MIS)
- Clot evacuation
  - Supratentorial
  - Infratentorial
- Craniectomy

Goals of Care

COR	LOE	Recommendations
2a	B-NR	1. In patients with spontaneous ICH who do not have preexisting documented requests for life-sustaining therapy limitations, aggressive care, including postponement of new DNAR orders or withdrawal of medical support until at least the second full day of hospitalization, is reasonable to decrease mortality and improve functional outcome.[479–484]
2a	C-LD	2. In patients with spontaneous ICH who are unable to fully participate in medical decision-making, use of a shared decision-making model between surrogates and physicians is reasonable to optimize the alignment of care with patient wishes and surrogate satisfaction.[485]
3: Harm	B-NR	3. In patients with spontaneous ICH who have DNAR status, limiting other medical and surgical interventions, unless explicitly specified by the patient or surrogate, is associated with increased patient mortality.[180,479,486,487]

Rehabilitation & Recovery

COR	LOE	Recommendations
1	A	1. In patients with spontaneous ICH, multidisciplinary rehabilitation, including regular team meetings and discharge planning, should be performed to improve functional outcome and reduce morbidity and mortality.[231,232]
1	A	2. In patients with spontaneous ICH with mild to moderate severity, early supported discharge is beneficial to increase the likelihood of patients living at home at 3 months.[490]
2b	B-R	3. In patients with spontaneous ICH with moderate severity, early rehabilitation beginning 24 to 48 hours after onset (including ADL training, stretching, functional task training) may be considered to improve functional outcome and reduce mortality.[491,492]
3: No Benefit	A	4. In patients with spontaneous ICH without depression, fluoxetine therapy is not effective to enhance poststroke functional status.[493–497]
3: Harm	B-R	5. In patients with spontaneous ICH, very early and intense mobilization within the first 24 hours is associated with lower likelihood of good recovery.[498,499]

Neurobehavioral Management

COR	LOE	Recommendations
1	B-R	1. In patients with spontaneous ICH and moderate to severe depression, appropriate evidence-based treatments including psychotherapy and pharmacotherapy are useful to reduce symptoms of depression.[507,508]
1	B-NR	2. In patients with spontaneous ICH, administration of depression and anxiety screening tools in the postacute period is recommended to identify patients with poststroke depression and anxiety.[509]
1	B-NR	3. In patients with spontaneous ICH, administration of a cognitive screening tool in the postacute period is useful to identify patients with cognitive impairment and dementia.[510]
2a	B-NR	4. In patients with spontaneous ICH and cognitive impairment, referral for cognitive therapy is reasonable to improve cognitive outcomes.[511–515]
2a	B-NR	5. In patients with spontaneous ICH and preexisting or new mood disorders requiring pharmacotherapy, continuation or initiation of SSRIs after ICH can be beneficial for the treatment of mood disorders.[508,516–518]
2b	C-LD	6. In patients with spontaneous ICH and cognitive impairment, treatment with cholinesterase inhibitors or memantine might be considered to improve cognitive outcomes.[519–521]

- Anti-depressants
- Anti-anxiety treatment
- Neurostimulants
  - Amantadine
  - Methylphenidate
  - Modafinil
- Mood stabilizers
  - Valproic acid
- Treatment of agitation
  - Propranolol
  - Valproic acid

Subarachnoid Hemorrhage

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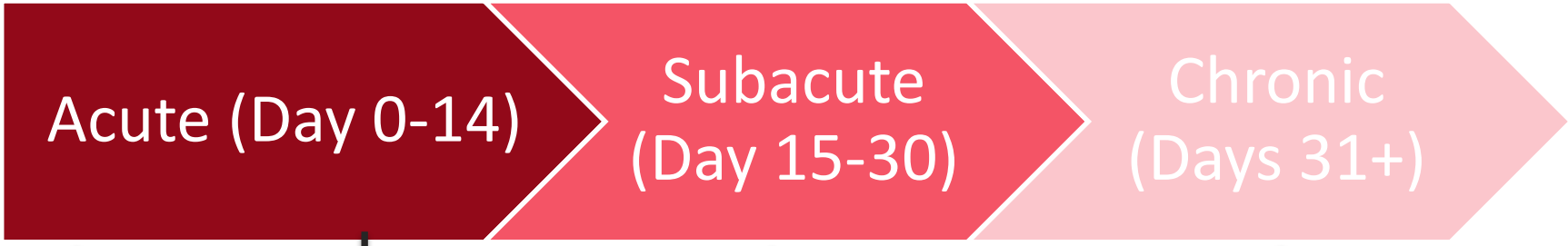
Brain Aneurysm Statistics

- Estimated 6 million people in US have a brain aneurysm
- Annual rupture rate ~ 10 per 100,000
- Most prevalent in ages 35-60
  - Mean age at rupture is 50
- Morbidity and mortality associated with rupture
  - 15-20% die before reaching hospital
  - 500,000 worldwide deaths annually
  - Over 50% of survivors have disability

Recovery from aSAH



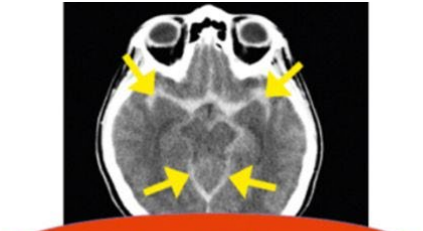
- Acute heart failure
- Neurogenic pulmonary edema
- Rebleeding
- Hydrocephalus
- Death

- Hydrocephalus
- Delayed Cerebral Ischemia
- Hyponatremia
- Dysphagia
- Immobility

- Hydrocephalus
- Headache

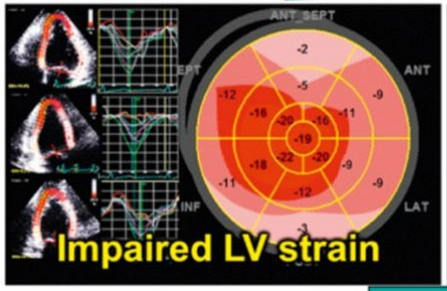
- Rehabilitation
- Headaches
- Fatigue
- Cognitive dysfunction
- Psychological distress

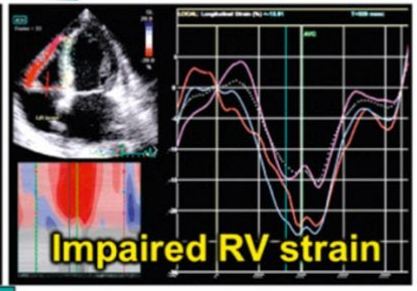
UL Hospital UL Brown Cancer Center



Subarachnoid Hemorrhage

Catecholamine Surge





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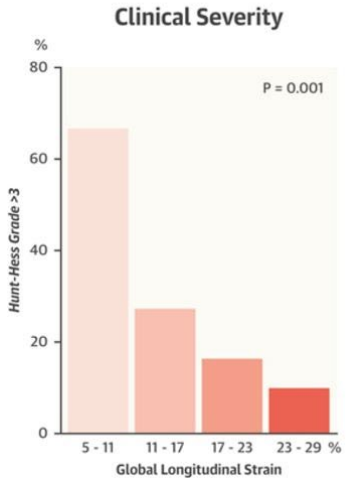

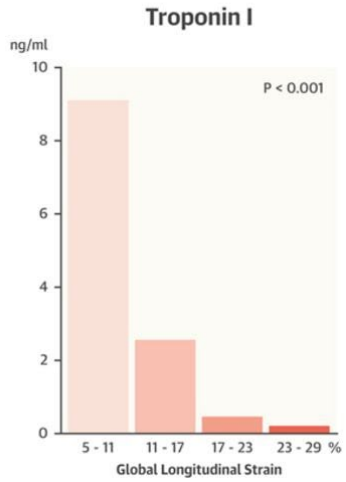

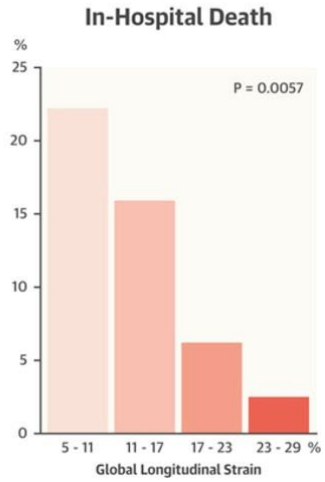

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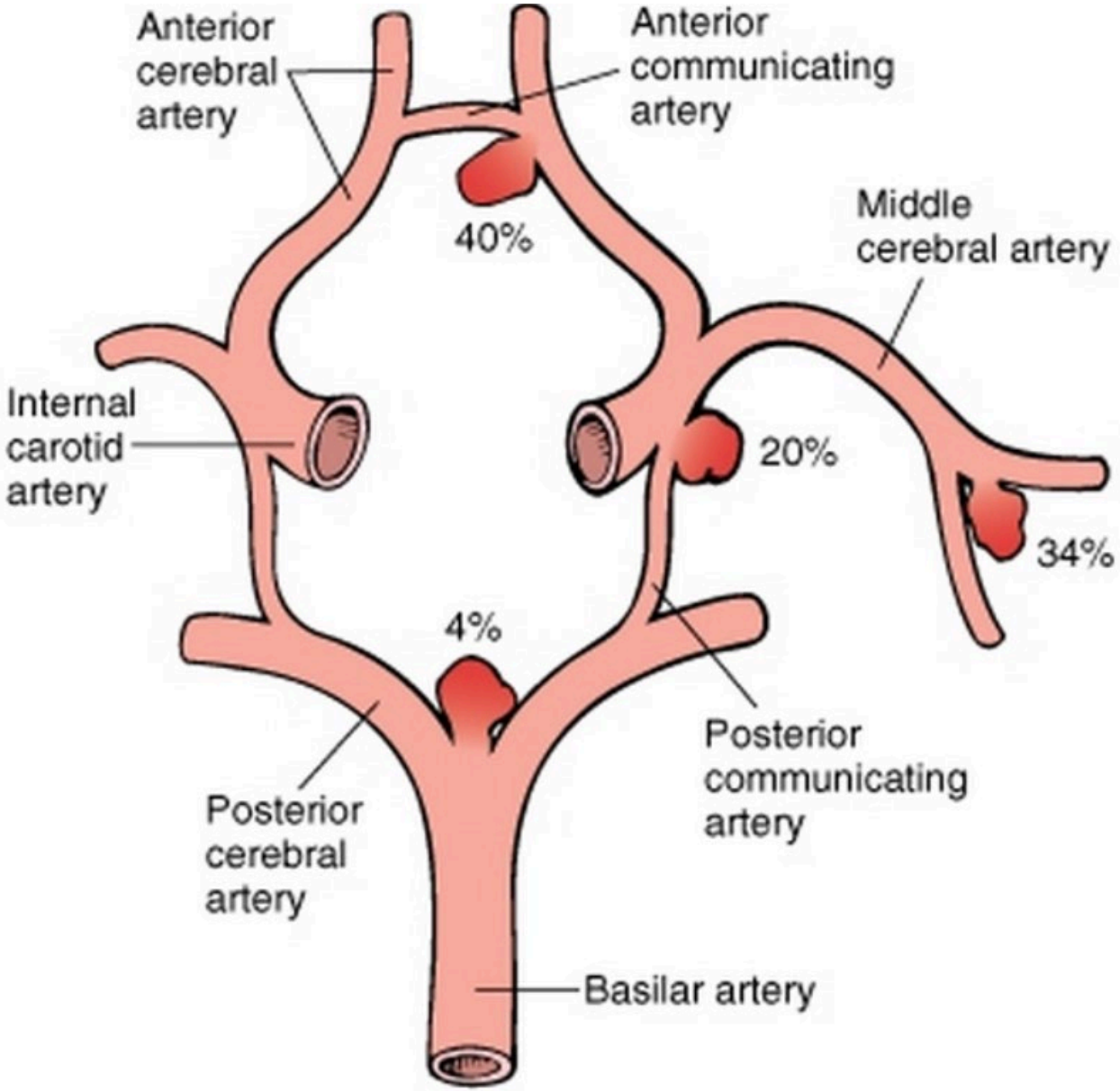
Morbidity and Mortality

- Mortality
  - Prehospital deaths 10-15%
  - Week1 40%
  - 6 month 50%
  - Mortality increases with age and premorbid health conditions
- Morbidity
  - 30-40% survivors have major neurologic deficits

Common Aneurysm Locations



Risk Factors for Aneurysm Development

(Modifiable)

- Smoking
- Hypertension
- Illicit drug use
  - Sympathomimetics
  - Injectables
- Excessive alcohol use
- High dose estrogen oral contraceptives ???
  - Studies show association with SAH
  - Unknown relationship with aneurysm development

Risk Factors for Aneurysm Development (Non-modifiable)

- Age > 40
- Gender
  - Female: Male 3:2
- Congenital abnormality of artery walls
- Trauma/infection
- Other medical conditions
  - Polycystic kidney disease
  - Ehler's-Danlos Syndrome (Type IV)
  - Fibromuscular dysplasia
  - Marfan's Syndrome
- Family history

Typical Presentation

- Headache
  - Sudden onset of severe headache
  - “Worst headache of my life”
  - Sentinel headache(30-50%)
    - Few hours to months prior
    - ? Minor blood leakage
    - Inflammatory response or change in vessel wall
- Seizures
- Nausea & vomiting
- Coma

2023 Guideline for the Management of Patients With Aneurysmal Subarachnoid Hemorrhage: A Guideline From the American Heart Association/American Stroke Association

Brian L. Hoh, Nerissa U. Ko, Sepideh Amin-Hanjani, Sherry Hsiang-Yi Chou, Salvador Cruz-Flores, Neha S. Dangayach, Colin P. Derdeyn, Rose Du, Daniel Hänggi, Steven W. Hetts, Nneka L. Ifejika, Regina Johnson, Kiffon M. Keigher, Thabele M. Leslie-Mazwi, Brandon Lucke-Wold, Alejandro A. Rabinstein, Steven A. Robicsek, Christopher J. Stapleton, Jose I. Suarez, … See all authors

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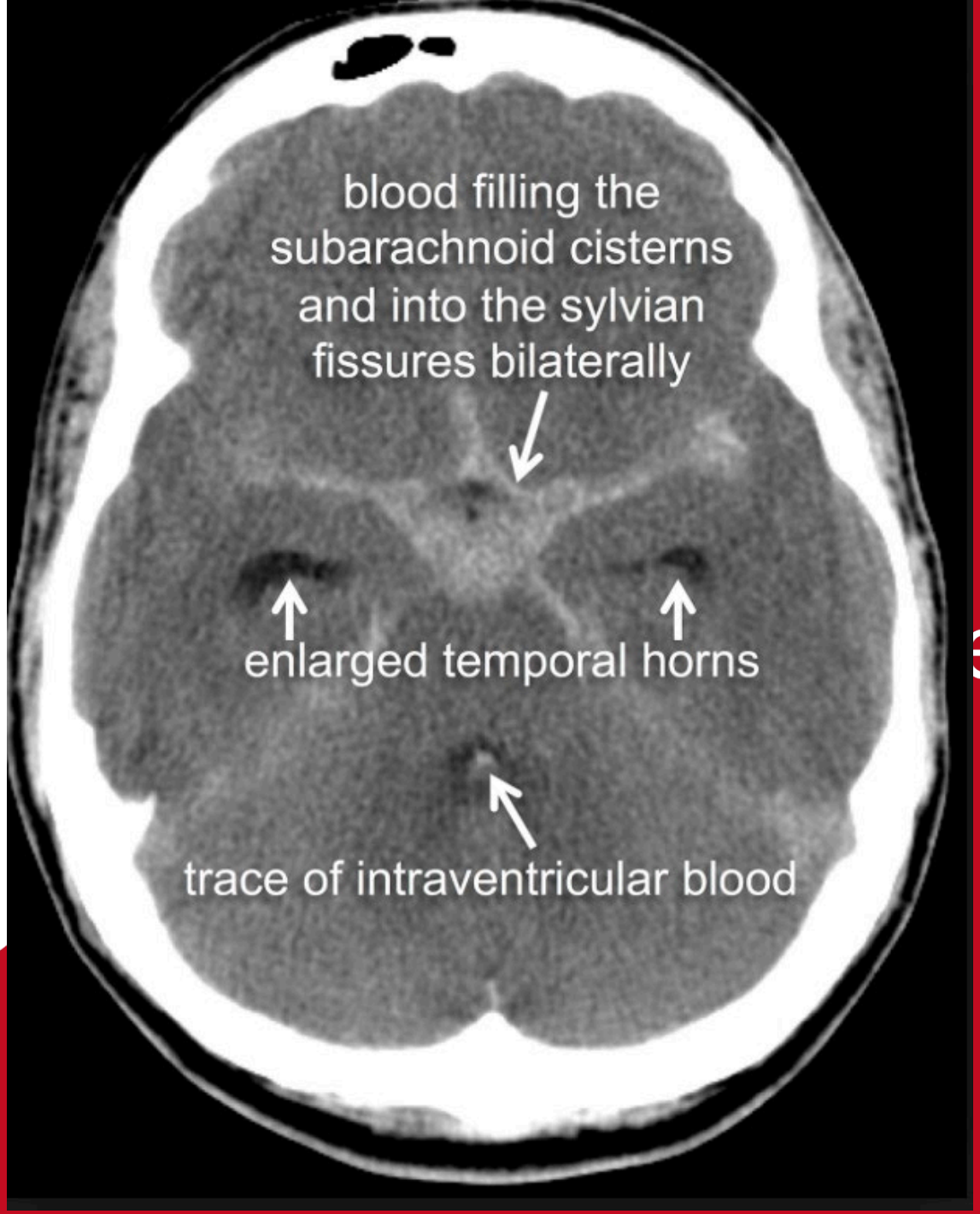
Diagnostics

- CT angiography
  - Sensitivity and specificity approaching that of conventional angiography
- Angiography
  - Invasive testing to evaluate vascular anatomy
  - Negative in 10-20% of SAH cases
- Electrocardiogram
  - Increased catecholamine release lead to myocardial ischemia
    - Increased QT intervals, non-specific ST changes, U waves
- Echocardiogram
  - High risk for acute heart failure


blood filling the
subarachnoid cisterns
and into the sylvian
fissures bilaterally
enlarged temporal horns
trace of intraventricular blood

enter

Presentation

- Meningeal signs
  - Neck stiffness
  - Photophobia
- Loss of consciousness
- Cranial nerve deficits
  - Oculomotor nerve palsy
    - Dilated pupil
  - Optic nerve palsy
    - Monocular vision loss from opthalmic artery aneurysm

Presentation

- Motor deficits
  - MCA aneurysms
- Opthalmologic signs
  - Papilledema
  - Retinal hemorrhage
- Vital signs
  - Labile BP
  - Fever
  - Tachycardia
- No localizing signs

Hunt/Hess Grading System

- Grade I Asymptomatic or minimal H/A with slight nuchal rigidity
- Grade II Mod to severe H/A, CN III palsy but no other neuro deficits
- Grade III Drowsiness, confusion or mild focal deficits
- Grade IV Stupor, mod to severe hemiparesis
- Grade V Deep coma, moribund appearance

World Federation Neurosurgeons Scale (WFNS)

WFNS Grade	Glasgow Coma Score
1	15, No focal deficit
2	13-14, no focal deficit
3	13-14 with focal deficit
4	7-12 +/- focal deficit
5	< 7 +/- focal deficit

Fischer Grade

- Based on CT scan findings
  - Grade 1 – no hemorrhage
  - Grade 2- SAH less than 1 mm thick
  - Grade 3- SAH greater than 1 mm thick
  - Grade 4- SAH with IVH or parenchymal hemorrhage
- Predicts vasospasm

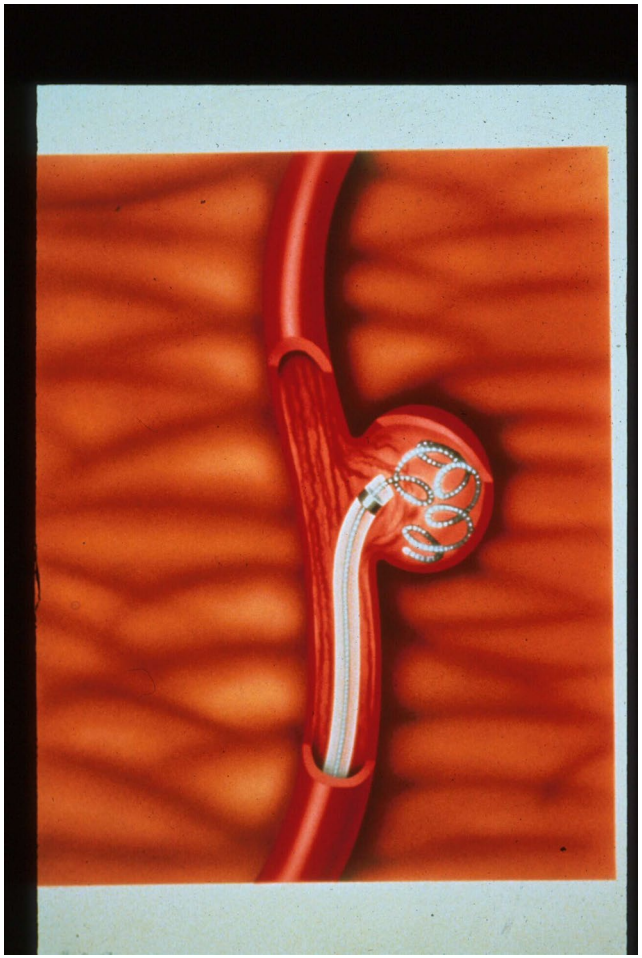
Initial Management

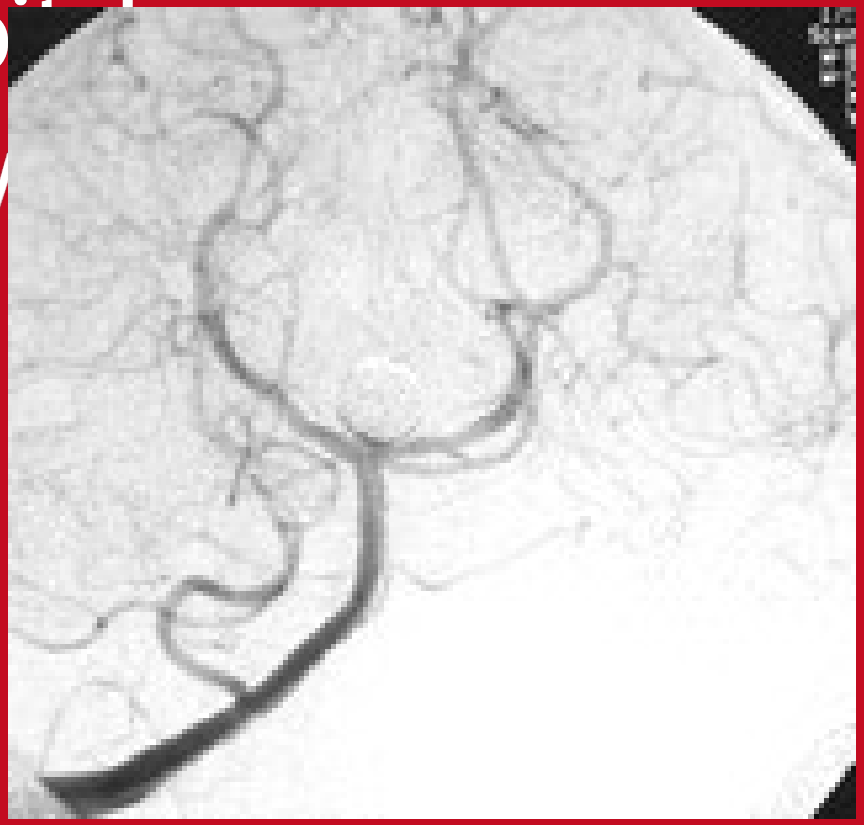
- Evaluate for hydrocephalus
  - Ventriculostomy
- Establish method for securing aneurysm
  - Surgical
  - Endovascular
  - No treatment
- Goal is to secure aneurysm within 24-48 hours
  - Prevents rebleeding

Endovascular Treatment

Endovascular Treatment
Coiling

- Platinum coils packed into aneurysm
- Technical factors
  - Location of aneurysm
  - Size of neck
  - Surrounding anatomy
- Requires periodic follow-up angiography
- Coils MRI compatible

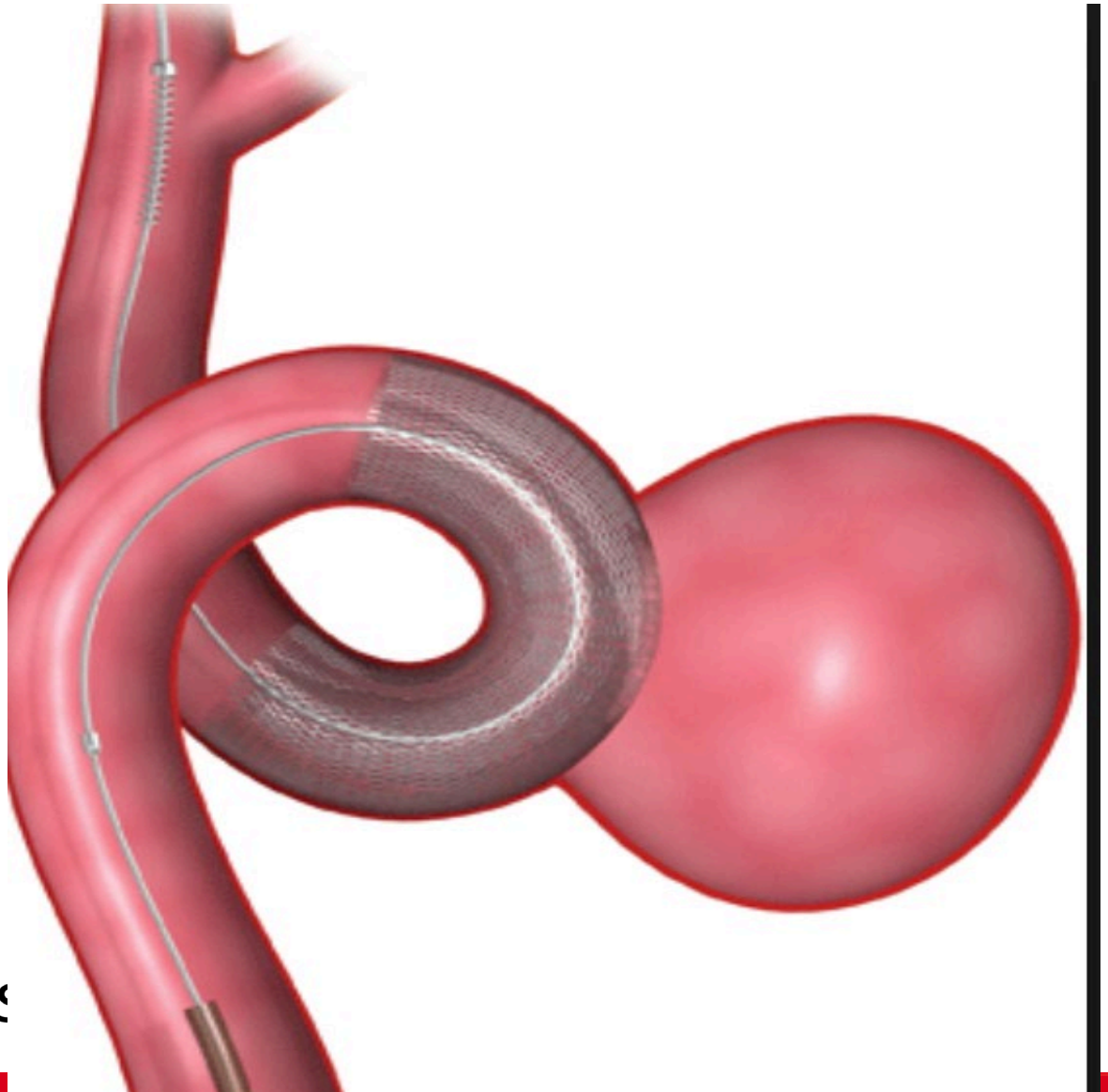




Endovascular Treatment
Stent/Flow Diversion

- Diverts blood flow down vessel and away from aneurysm
- Requires dual antiplatelet therapy
  - Needs to be loaded prior to procedure
  - Increased bleeding risk with ruptured aneurysms
- Full “cure” of aneurysm may take 6-12 months

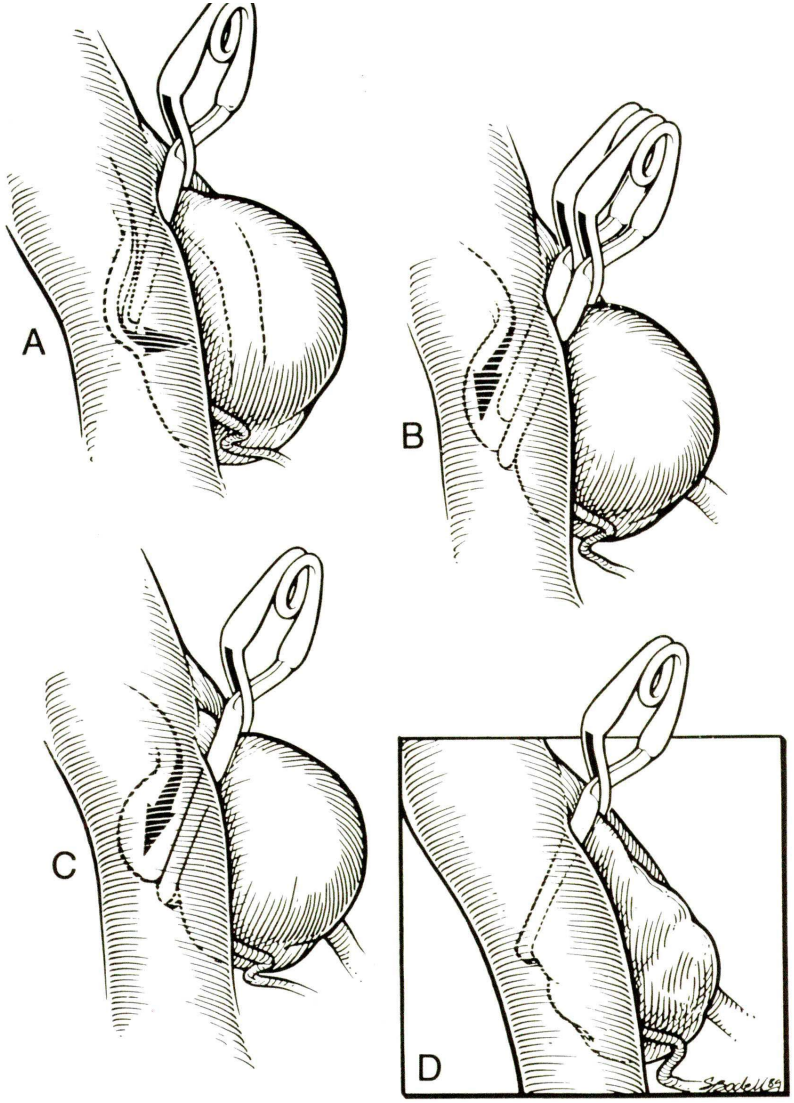
Endovascular Flow Diversion

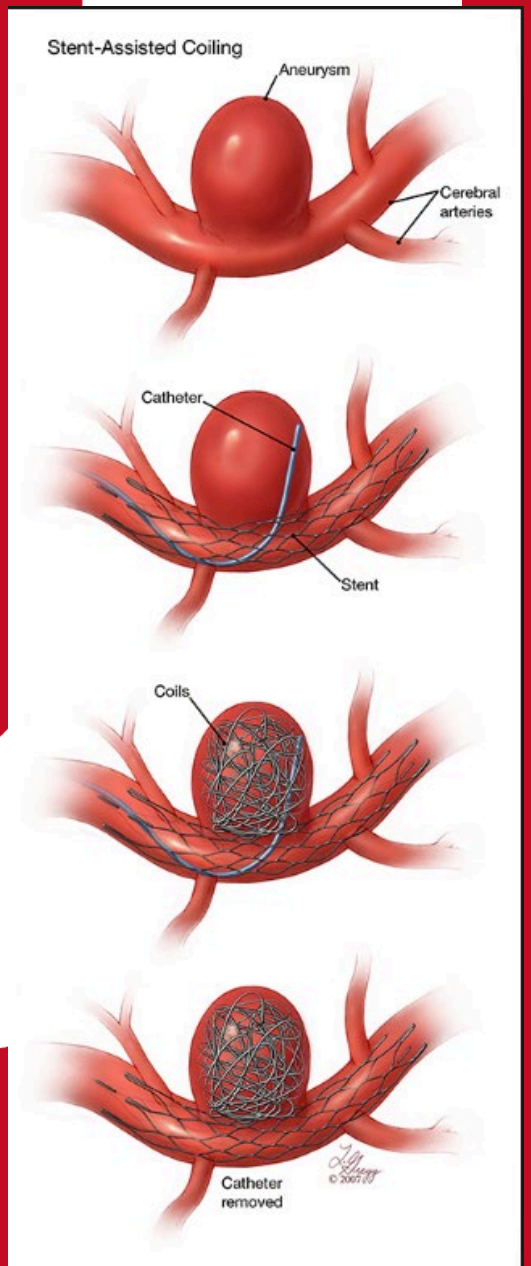


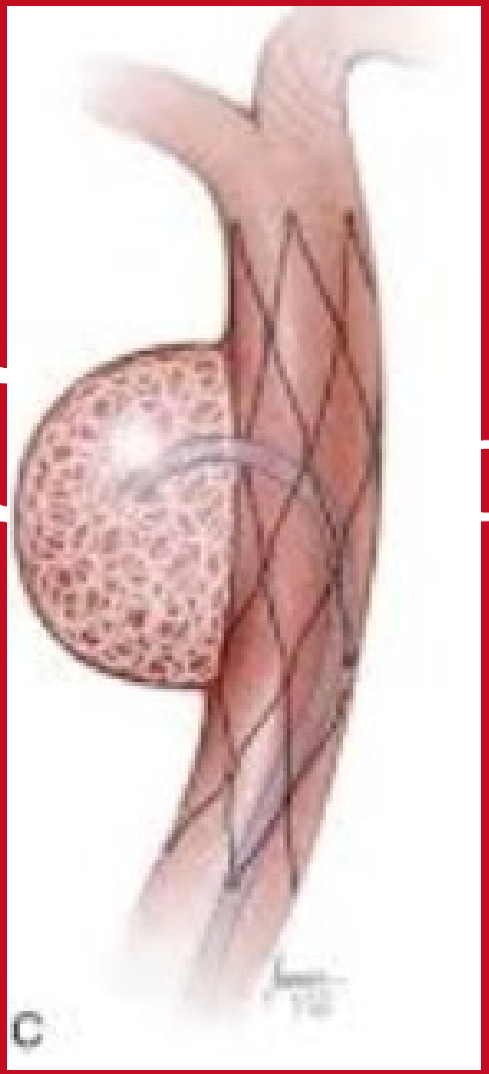
Endovascular Nursing Care

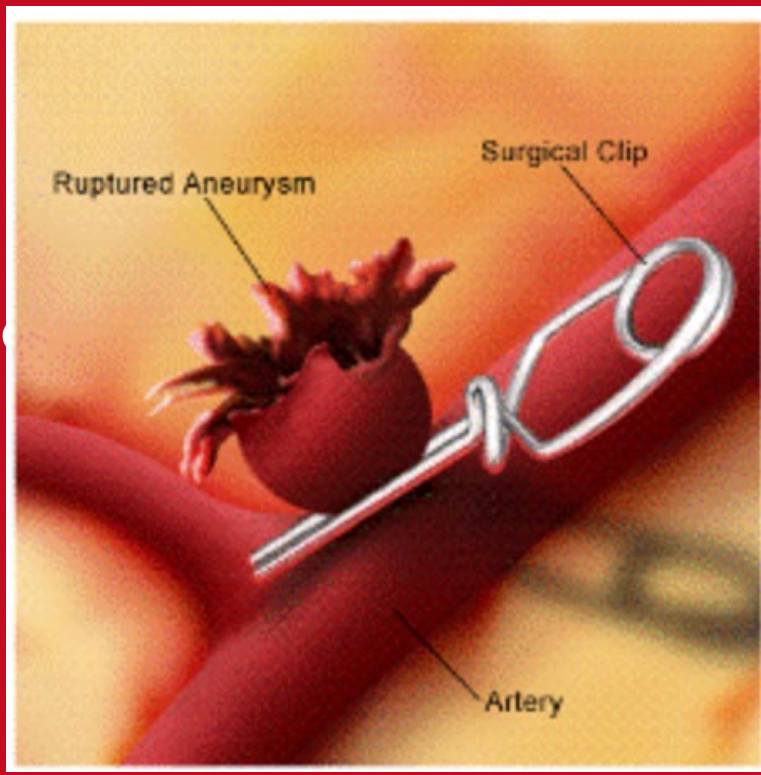
- Groin checks
  - Bleeding or hematoma
    - Hold pressure and have someone else call provider
- Vital signs
- Pedal pulses/cap refill
- Bedrest 2-6 hours depending on success of closure device

Surgical Intervention




Stent-Assisted Coiling
Aneurysm
Cerebral arteries
Catheter
Stent
Coils
Catheter removed


C


Ruptured Aneurysm
Surgical Clip
Artery

Crani Nursing Care

- Elevate HOB
- Ice to eye prn for swelling
- Empty & record drain outputs
- Frequent neuro checks

ICU Management

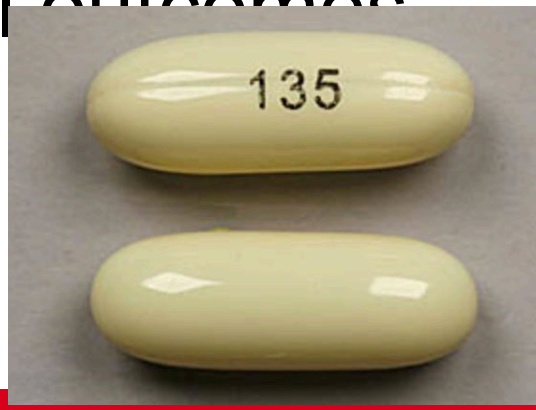
- Meticulous neuro exams
  - Subtle changes indicative of vasospasm
- Control of vital signs
  - Allow mild permissive hypertension once secure
- Strict I/Os – maintain euvolemia
- Serum glucose monitoring
  - Keep 80-180mg/dl
- Temperature control
- ICP control if needed

ICU Management

- Seizure prevention
  - Prophylaxis is controversial
  - 7 day prophylactic course, esp if crani done
  - Ongoing treatment of known seizures
- Venous thromboembolism prophylaxis
  - Mechanical device on admission
  - Chemoprophylaxis asap
- GI Prophylaxis

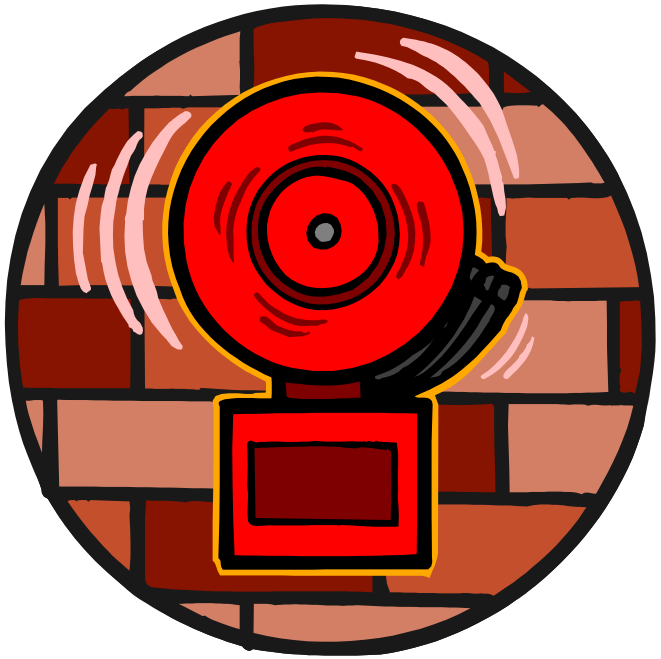
Prevention- Nimodipine

- Cerebral specific calcium channel blocker
  - Can lower blood pressure in sensitive people
- Only indication is aSAH
  - Neuroprotective effects
  - Direct smooth muscle relaxer
- Shown to improve radiologic appearance of vasospasm & improve clinical outcomes



SAH Complications

- Rebleeding
- Vasospasm
- Hydrocephalus
- Hyponatremia



REBLEED

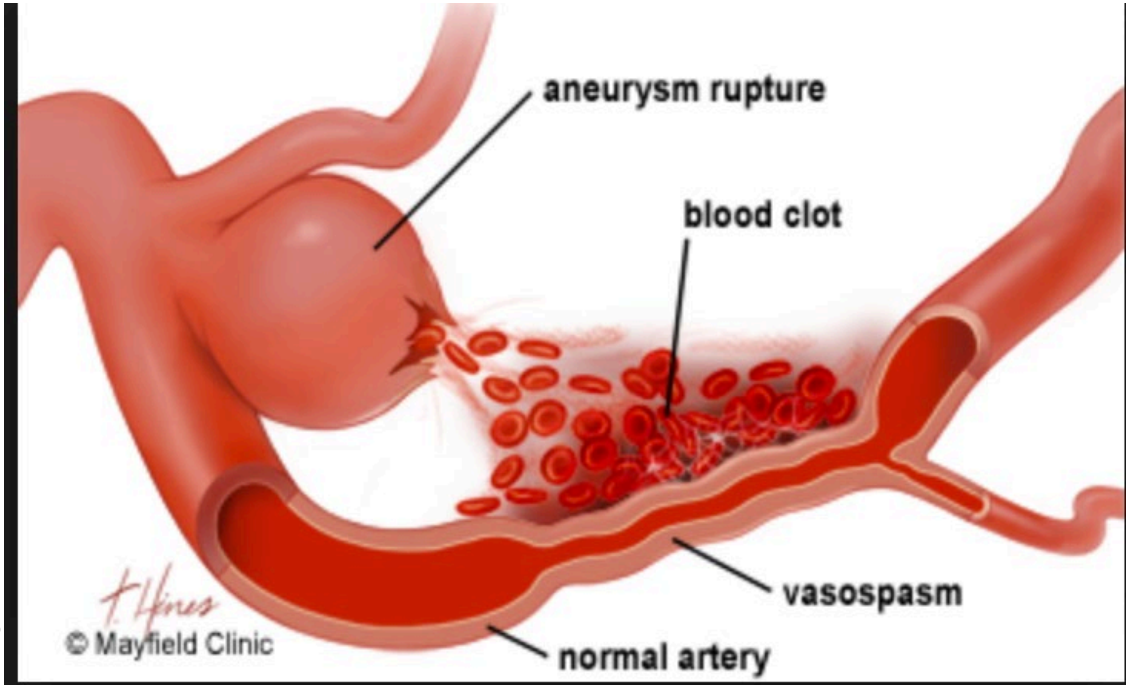
- Of 18,000 who survive initial rupture; 3000 will either die or be disabled from rebleeding
- Incidence as high as 30%;
  - Peaks the day after SAH
  - Highest in 1st 2 weeks
- Approximately 70% of those who rebleed will die
- Signs/Symptoms
  - Sudden severe headache, severe nausea & vomiting, decrease in LOC, new neuro deficits
  - Confirmed by CT, sudden spike in ICP, new blood in EVD

VASOSPASM

- Definition: abnormal narrowing of the cerebral arteries near or distant to SAH
- Causes delayed ischemic neuro deficit
- Stats:
  - 10% who survive initial bleed will die from vasospasm
  - 30% of patients develop vasospasm”

Vasospasm

- Vasoconstriction or narrowing of the cerebral vessels
  - Typically related to aSAH



Complications of Vasospasm

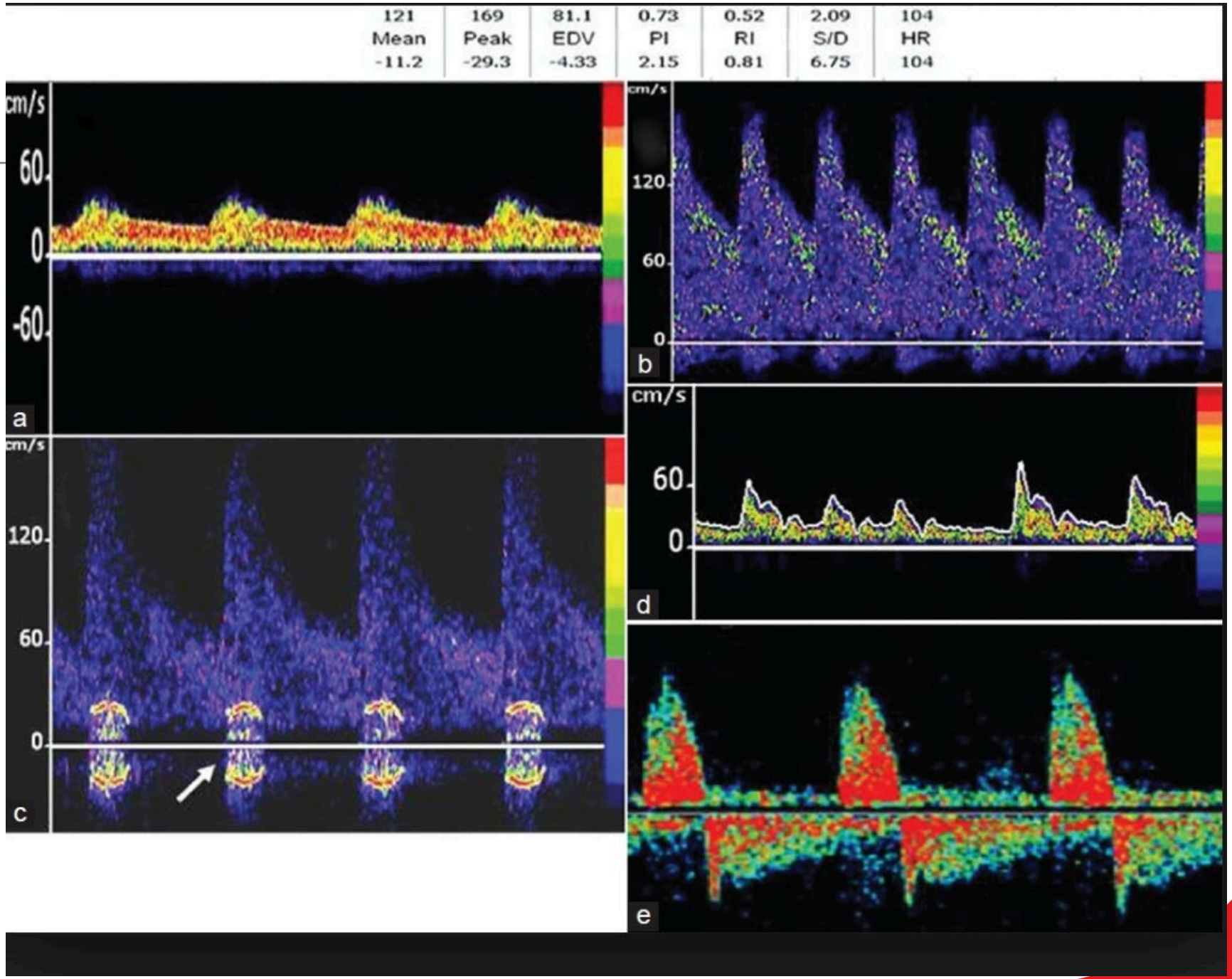
- Delayed cerebral ischemia (DCI)
  - Reversible
  - Stroke
- Increased morbidity
- Increased mortality

Timing of Vasospasm

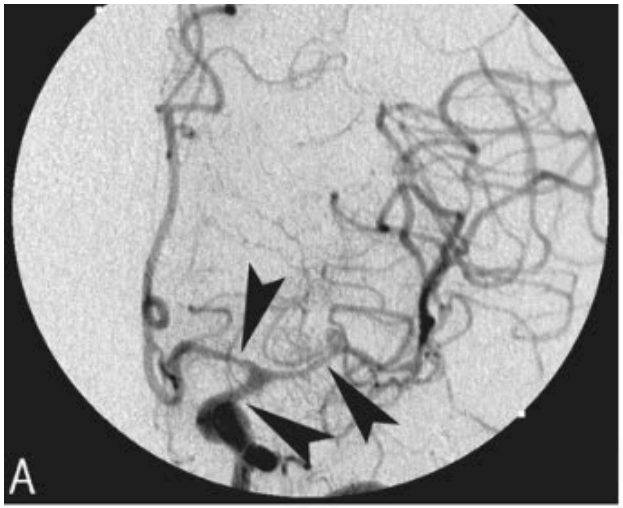
- Risk peaks days 3-7
- Plateaus until day 14
- Remains at risk for 21 days following aSAH
- Higher risk in illicit drug users
  - Methamphetamine
  - Cocaine

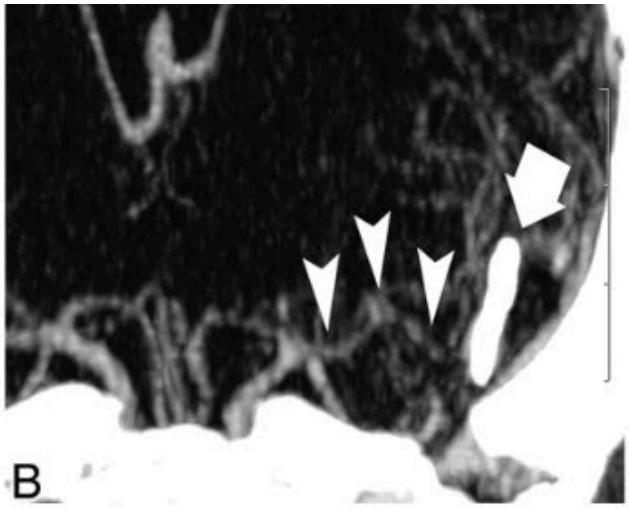
Monitoring for Vasospasm

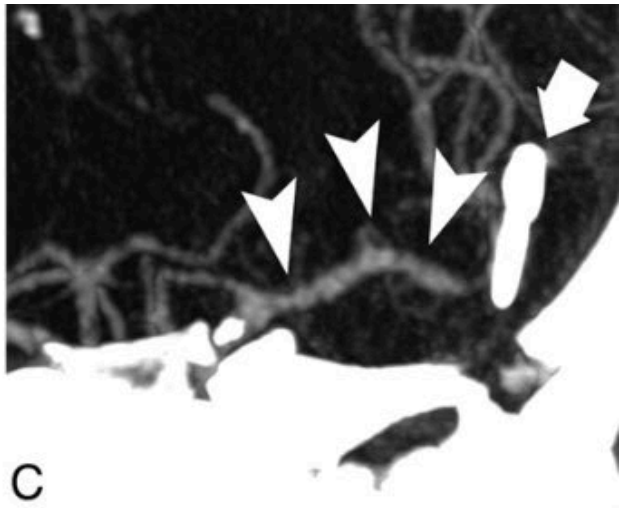
- Transcranial Doppler
  - Noninvasive
  - Uses ultrasound to monitor blood flow velocities through the circle of willis
  - Not all patients have “windows”
  - Performed daily
- CT Angiography
  - Requires dye load
    - Limits utility
  - Useful if unable to get TCD windows

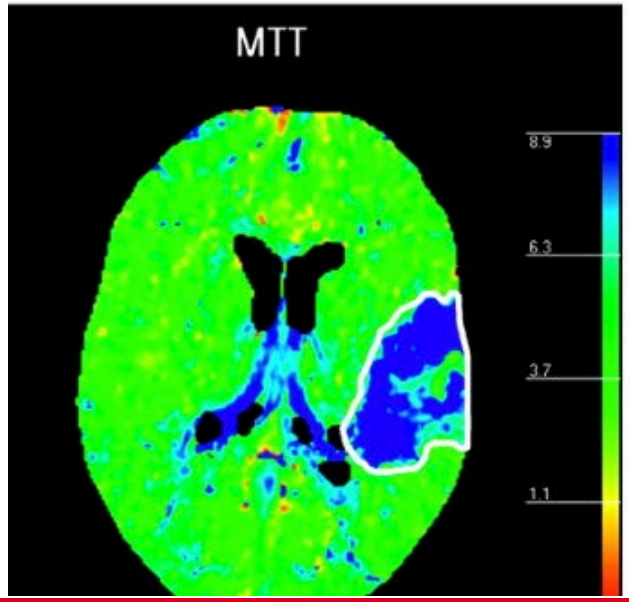

121 Mean -11.2
169 Peak -29.3
81.1 EDV -4.33
0.73 PI 2.15
0.52 RI 0.81
2.09 S/D 6.75
104 HR 104
cm/s
60
0
-60
a
cm/s
120
60
0
b
cm/s
120
60
0
c
cm/s
60
0
d
e

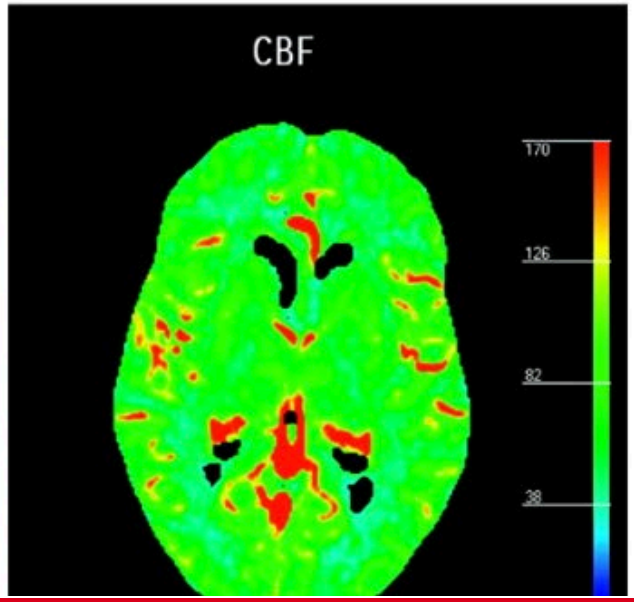
CT Perfusion

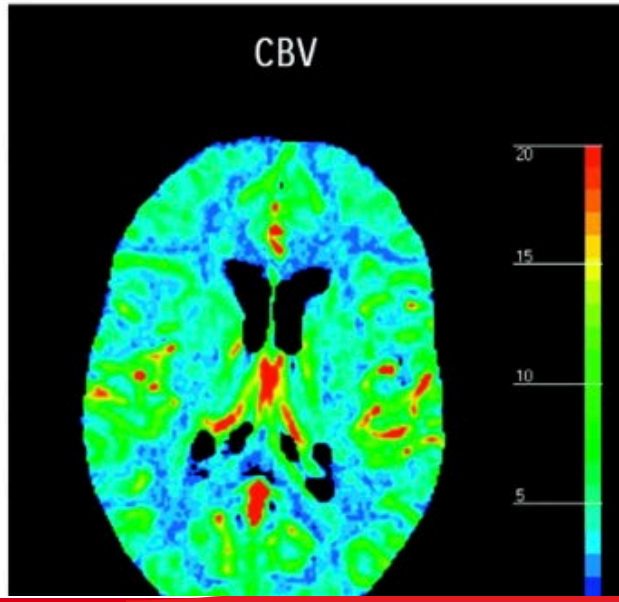








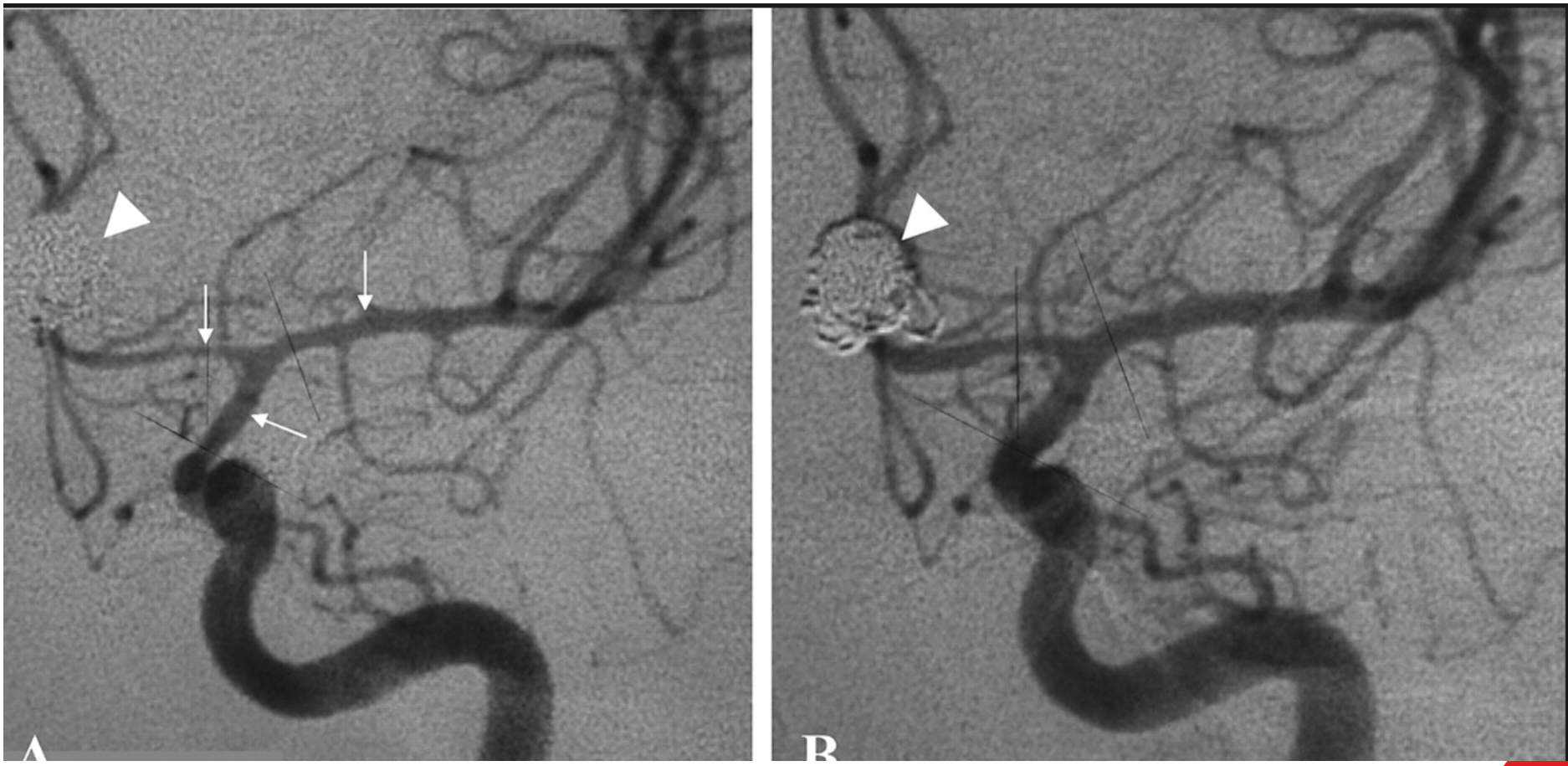




Triple H Therapy

- Not used prophylactically
- Treatment of symptomatic vasospasm
- Triple H therapy
  - Hypertension
  - Hypervolemia
  - Hemodilution

Intra-arterial Vasodilators



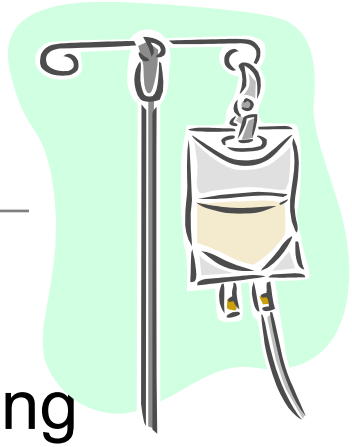
Hydrocephalus

- Communicating
  - Problem with absorption of CSF; blood in CSF plugs the arachnoid villi
- Diagnosed by CT – dilated ventricles
- Severity related to size of bleed
- Three types:
  - Acute
  - Subacute
  - Delayed

Hyponatremia

- SIADH vs. Cerebral Salt Wasting (CSW)
  - SIADH
    - Plasma volume is increased
    - Serum osmo is decreased
  - CSW
    - Plasma volume decreased
    - Serum osmolality increased or normal
    - Dehydration is present

Different Treatments



- SIADH
  - Restricting free water and slowly replacing sodium with saline or hypertonic saline
  - Allow high Na beverages (soda, gatorade)
  - Fludricortisone
- CSW
  - Fluid replacement
  - Sodium repletion
    - **Hypertonic saline**
    - **Sodium chloride tabs**

QUALITY METRICS

- Dysphagia screening
  - Did patient get food or meds prior to screening
- Severity scales within 6 hours
- Nursing endovascular care documentation
  - Groin checks, vitals, pulses
- Nimodipine within 24 hours of admission

Summary

- High morbidity
- High resource utilization
- Outcomes best when care is provided at high volume center
- Interdisciplinary care is critical

Kim.meyer@uoflhealth.org

502-727-3896 (cell)

UofL Hospital

UofL Brown Cancer Center