



# Hemorrhagic Stroke

## Objectives:

- Introduction
- Etiology
- Pathophysiology
- Clinical presentation
- Diagnosis and Imaging
- Treatment

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**Resources:** 435 team + Davidson + kumar + Recall questions step up to medicine.

- [Editing file](#)
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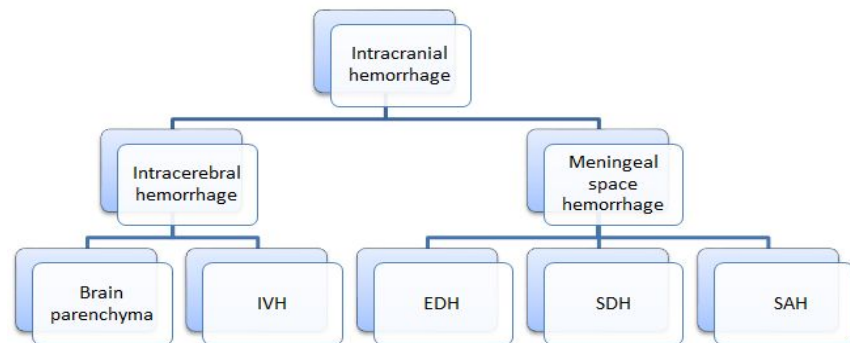
# Introduction

IVH: IntraVentricular Hemorrhage

EDH: Epidural Hemorrhage

SDH: Subdural Hemorrhage

SAH: SubArachnoid Hemorrhage



## ★ Epidemiology

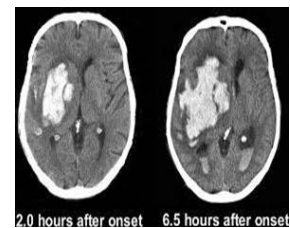
- Asian countries have a higher incidence of intracerebral hemorrhage than other regions of the world.
- A higher incidence of intracerebral hemorrhage has been noted in Chinese, Japanese, and other Asian populations, possibly due to environmental factors (eg, a diet rich in fish oils) and/or genetic factors.
- Annually, more than 20,000 individuals in the United States die of intracerebral hemorrhage.
- Intracerebral hemorrhage has a 30-day mortality rate of 44%.
- Pontine or other brainstem intracerebral hemorrhage has a mortality rate of 75% at 24 hours. **in general, If you have a hemorrhage in the brain stem it's too bad with a high mortality rate.**
- US strokes, approximately 87% are ischemic. and 13% are hemorrhagic.
  - Of those 87% that are ischemic, about 80% of them are non-cardioembolic.
- Incidence of intracerebral hemorrhage increases in individuals older than 55 years and doubles with each decade until age 80. **As long as they have many risk factors. Especially with uncontrolled or chronic HTN.**
- **Ischemic has better prognosis in comparing to Hemorrhagic .**

## Mortality and Disability:

Overall, 40% mortality at 1 month and 54% at one year.

Only 12-40% are functionally independent long term.

In 2010, 62.8 million lost daily with ICH<sup>1</sup> compared to 39.4 million in ischemic stroke.



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<sup>1</sup> Intracerebral hemorrhage

# Intracerebral ICH

**Risk Factors:** The best method is prevention rather than treatment.

1. **HTN.** The most most most important risk factor.
  2. Excessive ETOH<sup>2</sup> use.
  3. **Smoking.**
  4. **Obesity and physical inactivity.**
  5. **Age.**
  6. Ethnicity/Race.
  7. Medications. Such as warfarin, anticoagulation drugs, and **Aspirin.**
  8. Sympathomimetics. Like amphetamine and cocaine.
  9. **Fen-phen**, was an anti-obesity treatment in the past which was pulled out from the market.
- A study was done here in KSA found that around 43%-45% of HTN cases are undiagnosed which is similar to other populations, and even those who are diagnosed around half of them are uncontrolled.
  - 3 months ago, 3 international studies, found out that the use of aspirin as a primary prevention in people above 50 years of age with no cardiac diseases has no efficacy, rather it increases risks of hemorrhage.

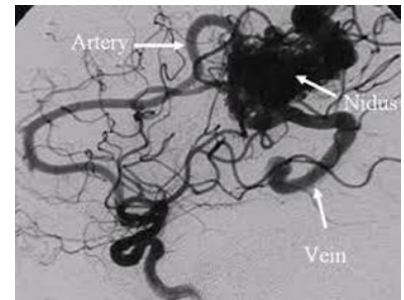
**Etiology:** Important

**Hypertensive ICH:** The most most most important cause.

- Essential.
- Eclampsia.

Non-hypertensive ICH:

- Vascular malformation: AVM<sup>3</sup>, Aneurysm, Cavernous hemangioma.
- Bleeding disorders/anticoagulant.
- Amyloid angiopathy.
- Trauma.
- Tumor.
- Drug abuse: amphetamine, cocaine, PPA.



**Other Causes:**

1. **CVT<sup>4</sup>.**
2. Intracranial neoplasm.
3. Moyamoya.

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<sup>2</sup> Ethyl alcohol (Ethanol)

<sup>3</sup> Arteriovenous Malformation

<sup>4</sup> Cerebral venous thrombosis

## ★ Pathophysiology:

- **Primary immediate effect:**
  - Hemorrhage growth.
  - Increase ICP.
- **Secondary effect:**
  - Downstream effect.
  - Edema.
  - Ischemia

The brain is contained within the skull with a constant intracranial pressure. An increase in the pressure will cause hydrocephalus, herniation, edema or even compressing other vessels leading to stroke.

patients don't die from direct effect of hemorrhage alone, complications of hemorrhage can also be fatal. Just by making the patient bedridden it can increase the risk of DVT then PE or pneumonia.

### Site:

1. basal ganglia (40-50%).
2. lobar regions (20-50%).
3. thalamus (10-15%).
4. pons (5-12%).
5. cerebellum (5-10%).
6. other brainstem sites (1-5%).

## ★ Clinical presentation:

- Alteration in level of consciousness (approximately 50%)<sup>5</sup>.
- Nausea and vomiting (approximately 40-50%).
- Headache (approximately 40%)<sup>6</sup>.
- Seizures (approximately 6-7%).
- Focal neurological deficits:
  - **Putamen** - Contralateral hemiparesis (**Mainly**), contralateral sensory loss, contralateral conjugate gaze paresis, homonymous hemianopia, aphasia, neglect, or apraxia.
  - **Thalamus** - Contralateral sensory loss (**Mainly**), contralateral hemiparesis, gaze paresis, homonymous hemianopia, miosis, aphasia, or confusion.
  - **Lobar** - Contralateral hemiparesis or sensory loss, contralateral conjugate gaze paresis, homonymous hemianopia, abulia, aphasia, neglect, or apraxia.
  - **Caudate nucleus** - Contralateral hemiparesis, contralateral conjugate gaze paresis, or confusion.
  - **Brainstem** - crossed signs facial weakness in one side and sensory loss on the other side, eye movement problems, vertigo and coma.

we can't know from the clinical presentation whether the stroke is hemorrhagic or ischemic.

الأعراض قد تشترك فيما بينهم، we must do CT with all patients who are suspected to have a stroke,

So we can not distinguish between them with certainty without doing further investigation to confirm.

\*Intracerebral hemorrhage: 1- Hypertensive hemorrhage, 2- Intravenous hemorrhage.

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<sup>5</sup> With large hemorrhage such as in putamen hemorrhage.

<sup>6</sup> Not all of them will have headache and it is not sensitive or enough to rule out hemorrhage, but when we have headache and altered mental status we think more of hemorrhagic stroke.

## ★ Hypertensive hemorrhage: The most important cause (from 1 most common to 5, in order)

- **Putamen.** The most common location for hemorrhage is Putamen, for example if an elderly patient known to have HTN came with acute weakness, and CT scan show putamen hemorrhage, for sure it is hypertensive hemorrhage. only 10% will survive.
- **Thalami.**
- **Pontine.** quadriplegia, motor function is affected in both sides, patient would be locked inside his body, oriented with normal cognitive functions and he can only blink.
- Cerebellum.
- Lobar.

**IMPORTANT:- CVT or VST** (from Harrison's Neurology in clinical medicine)

## ★ Venous Sinus thrombosis of the lateral or sagittal sinus or of small cortical veins.

- **Occurs** mainly as a complication of **Oral contraceptives use**, and other causes like pregnancy, postpartum, IBD, meningitis, and dehydration. also seen in patients with blood disorders.
- **Patient present** with **headache** and may have a focal neurological signs like paraparesis and seizures. the patient may develop signs of Increased intracranial pressure (**like papilledema**) and coma.
- **CT is normal.** Venous sinus occlusion is readily **visualized by MRI or CT venography.**
- **Treat by:** Intravenous **heparin** regardless of the presence of intracranial hemorrhage.

Patient with large ischemic stroke, 3 days later came without any additional symptoms if you repeat the CT scan you will find hemorrhage. **So also ischemic stroke can lead to hemorrhagic stroke, it is called ischemic stroke with hemorrhagic transformation.** We see them everyday, it's very common.

## Hemorrhagic Transformation (HI 1/2 – PH 1/2)<sup>7</sup>:

> 50% have some hemorrhage

- 0.6%-3% >> untreated patients.
- 6% in treated patients.

### Risk Factors:

- Older age.
- larger stroke size. **The most important factor.**
- cardioembolic stroke etiology.
- anticoagulant use.
- fever.
- hyperglycemia.
- low serum cholesterol.
- Acutely elevated systolic blood pressure.
- **thrombolytic therapy/recanalization.**



<sup>7</sup> After the ischemic stroke, some will have hemorrhagic transformation. some pts with hemorrhagic transformation will have (HI) Hemorrhagic Infarction type 1 or 2, and some will have (PH) Parenchymal hemorrhage type 1 or 2. ([extra](#))

## Meningeal space hemorrhage

\*MSH: 1- SAH, 2- SDH, 3- EDH.

### ★ Subarachnoid Hemorrhage:

- Usually due to aneurysm rupture.
- Can be perimesencephalic SAH.
- Treat by: Surgery: Coil/Clip, Medication: NIMOTOP/NIMODIPINE, Strict BP control.
- Need to check Sodium Levels, Treat the Hyponatremia.
- Need to check Urine output.
- Treat the Hydrocephalus.
- treat the Vasospasm. with a vasodilator (Nimodipine).

## Investigations

### ★ Laboratory studies:

- CBC. we look for platelets
- Coagulogram. we check the INR to look for blood disorders
- Electrolyte.
- others.

### ★ Imaging: The most important to us (initially)

- CT brain w/o contrast. No need for contrast we are looking for hemorrhage with hyperdensity.

**CT-brain:** (CT will show you the blood if there's a hemorrhagic stroke<sup>8</sup> while in ischemic stroke CT would be normal in the first 12-24 hours of ischemia). In MRI it'll take 30 min only.

- Demonstrates acute hemorrhage as hyper dense signal intensity.
- Multifocal hemorrhages at the frontal, temporal, or occipital poles suggest a traumatic etiology.
- Hematoma volume can be approximated by (AxBxC)/2.
- Iodinated contrast may be injected to increase screening yield for underlying tumor or vascular malformation.

### Vessel imaging:

CT angiography permits screening of large and medium-sized vessels for AVMs, vasculitis, and other arteriopathies.

### The Workup:

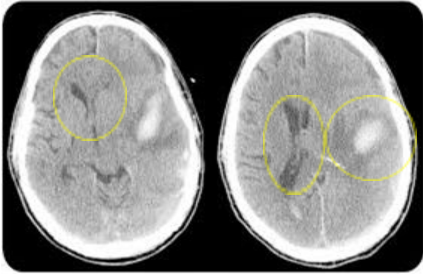
1. CT head - no contrast.
2. CTA head/neck - suspect vascular etiology.
  - Careful interpreting noncon CT head after CTA or other dye study.
3. MRI brain - with gado if looking for neoplasm.
4. MRA/MRV - if allergic to CT dye or if you're looking at venous outflow.
5. Cerebral angiography.

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<sup>8</sup> CT→ 100 SR → 3 min→ give me 100% sensitivity for hemorrhage. So it is enough to show hemorrhage, while MRI ~2000 SR → takes about 45 min.

## ★ Cerebral Edema: (management) Sodium and CO<sub>2</sub>.

- Use the ventilator to manage CO<sub>2</sub>. By hyperventilation; decrease CO<sub>2</sub> to decrease blood flow<sup>9</sup>.
- Get the Sodium levels up. By hypertonic saline to shift fluid out from the cells in the brain.
- Mannitol 3% or even 23.4% (requires central line). Given for brain herniation that's caused by the cerebral edema.



## Treatment

Start with ABC and admit them to ICU because the hemorrhage may expand and we'll have to watch them very closely.

Control BP!!!!

an opinion: if there's a hemorrhage compressing small blood vessels, a great reduction in Bp will decrease the hemorrhage, but at the same time it will decrease perfusion at capillary levels causing ischemia. but will it??

a study, divided people with hemorrhage, to three groups, one group they lowered their blood pressure to between 180-160, second group between 160-140 and third group from 140-120. All of them have the same result at the end. So low BP does not cause ischemia.

Guidelines – reduction of SBP to 140 is safe

- Anderson/Qureshi studies – Interact 2 and ATACH 2.
  - Not clear if SBP > 220.
- Use labetalol and/or nicardipine drip to titrate blood pressure.

Between 15-23% of patients > hematoma expansion in first few hours.

(A word about penumbra)<sup>10</sup>.

**EBP nursing care** (evidence based practice):

- Watch for neuro decline.
- Type and cross with your labs!
- HOB > 30. Head of bed should be elevated in contrast to ischemic stroke were it should be lowered.
- Head midline.
- Prevent vagal maneuvers. you want the patient to be relaxed to decrease the BP.
- Control SBP.
- Treat hyperglycemia. We have evidence that hyperglycemic & hyperthermic patients have worse prognosis.

<sup>9</sup> Because if we have high CO<sub>2</sub> we will have high perfusion and more bleeding.

<sup>10</sup>In pathology and anatomy the **penumbra** is the area surrounding an ischemic event such as thrombotic or embolic **stroke**. Immediately following the event, blood flow and therefore oxygen transport is reduced locally, leading to hypoxia of the cells near the location of the original insult.

- Treat hyperthermia.
- Seizure prophylaxis. controversial..
- DVT prophylaxis.< very important. After 48h we do CT. if there's no hemorrhage, we start anticoagulants (heparin), and many patients die from complications such as PE not from stroke itself.
- Surgery only for superficial lobar or cerebellar hemorrhage.
- Aspiration precautions.
- Treat Infections.

Typically, do not make patients DNR within the first 48 hours.

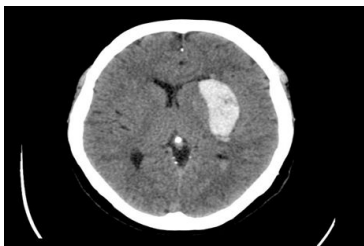
The best treatment is always prevention.

## Surgery:

- EVD (external ventricular drains)
  - CLEAR III trial – no outcome benefit with vent use of tPA.
- Craniotomy
  - Depends on etiology.
  - Depends on (AC/APT status)<sup>11</sup>.
  - Depends on timing.
  - Depends on location
    - STICH II – no overall favorable outcome.
    - MISTIE II – MIS techniques.
    - MISTIE III – underway.
  - Cerebellar ICH.
  - Surgery does not work for deep hemorrhage,
  - Drainage doesn't work because the tissue is deep, the only two indications to drain or evacuate is when it is **1- superficial lobar. or 2- in the cerebellum** (very accessible) (very serious may compress the brainstem).
  - The only treatment available is admission to the neuro ICU to prevent complication.
  - The best way to manage is to prevent and treat HTN

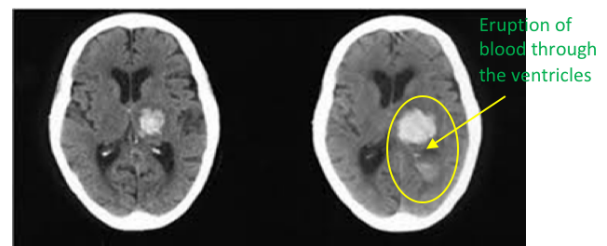
## Imaging interpretation:

### Putamen Hemorrhage



If young patient 25 y/o come with Putamen hemorrhage, think about other causes such as (AVM, cavernous angioma or drugs like amphetamine)

### Thalamic hemorrhage

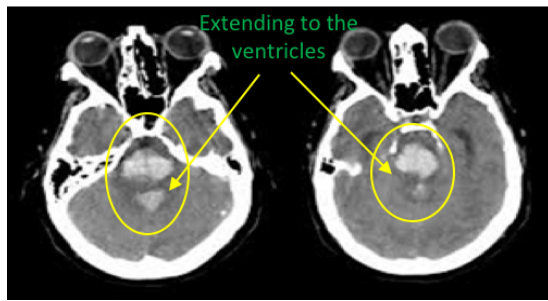


The patient present with right sided loss of sensation, in general any lesion (hemorrhagic or ischemic) in thalamic will affect the sensation on the contralateral side.

<sup>11</sup> AC: Alternating current, APT: Anti-Platelet Therapy

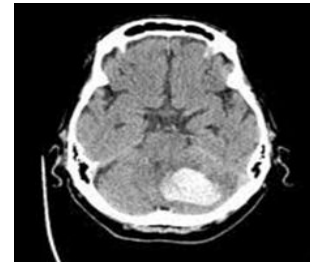


### Pontine hemorrhage



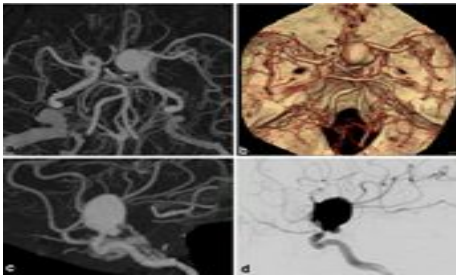
The worst prognosis --> to the grave (really really bad). Both side are affected, the patient is comatose.

### Cerebellar hemorrhage



The surgery is easy with excellent prognosis. You can also remove one hemisphere of cerebella. You have to monitor the patient in ICU, it may compress the brainstem.

### Aneurysm



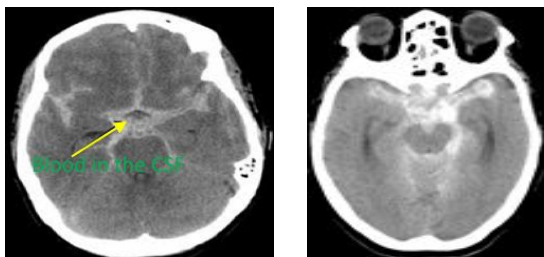
It is going to rupture and patient is going to die, when patient comes with SAH it is only leaking. how do we treat it? they should undergo CT angiogram of the brain to coil it. it is done through a catheter through the groin and then they inject coil to close the aneurysm. Coiling is now the first line treatment.

### AVM "Arteriovenous Malformation"



Any young patient with this typical MRI with worms like appearance. Any young patient comes with hemorrhage you have to rule out AVM. How to treat it? First endovascular embolization to clot the vessels to prevent or reduce bleeding during surgery.

### SAH



severe headache but the **most important is the acuity** of the pain. You should ask the patient how it occurred and what he/she was doing. Consider anything **SUDDEN** as SAH until proven otherwise. If you miss it, it will rupture and it has a high mortality and morbidity. How to rule it out? First do CT scan for blood, but 10% is normal in CT. with this history you have to do spinal tap looking for blood in CSF, if Lumbar puncture also is negative we can rule it out. If it is positive you have to do CT angio to demonstrate an aneurysm which is a major cause of SAH

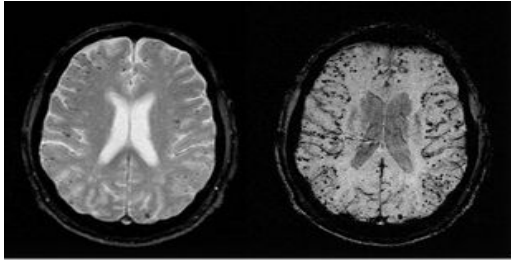
### SDH Subdural hemorrhage.



It is bleeding in meningeal veins or bridging veins, and the patient may have this without any trauma or minor trauma which may the patient forget about it. So we need a neurosurgeon to evacuate. it crosses suture lines.

### Amyloid Angiopathy

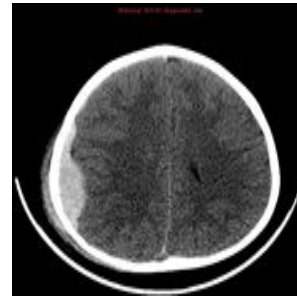
Any elderly patient you have to rule it out



Hypertensive hemorrhage and Amyloid Angiopathy. Which is Deposition of amyloid protein on the vessel wall making it very fragile.

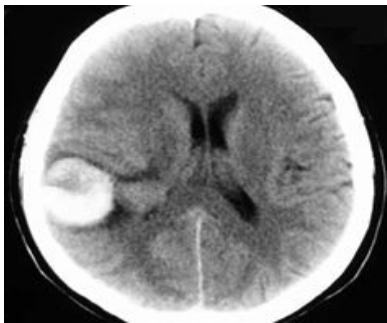
- All these small dots are hemorrhage.
  - To differentiate between hypertensive and amyloid, we Do a sequence MRI in amyloid you will see multiple old and new hemorrhages this is indicative of amyloid. It means that the patient has been bleeding every now and then.
  - high recurrence rate. no definitive treatment, it may be associated with Alzheimer.
  - can't undergo surgery if you touch the vessel it will bleed.
- There's nothing you can do. :(

### EDH



It is usually associated with trauma or fracture of the skull. It is very serious you need to watch the patient very closely, surgeons have to interfere very quickly because it's an arterial hemorrhage and they can compress and expand very quickly. It does not cross the suture line.

### Tumor with ICH



We have to do an MRI to pick up tumors and know which type it is, whether a metastasis or primary.  
Very hyperdense then it's a hemorrhage, but if Hypodense it is a tumor.

### Lobar hemorrhage



It is hemorrhage from warfarin with high INR in this case, it could be due to HTN also.  
It has a very bad prognosis, we can do a surgery if it is superficial.

# Summary

- It is best to **prevent** HS by preventing and treating HTN.
- Risk factors:
  - HTN ; Most important risk factor
  - Medications ; eg. Aspirin
- Causes (Etiology) :
  - Hypertensive Intracranial hemorrhage : Essential - Eclampsia
  - Non-Hypertensive ICH:
    - Vascular malformation: AVM, Aneurysm, Cavernous hemangioma
    - Bleeding disorders, amyloid angiopathy, trauma, tumor, drug abuse.
- Clinical presentation
  - Altered level consciousness 50%
  - Nausea and vomiting ( 40-50%).
  - SUDDEN Severe Headache (40%).
  - Seizures (6-7%).
  - Focal neurological deficits:
    - Putamen - Contralateral hemiparesis (Mainly)
    - Thalamus - Contralateral sensory loss (Mainly)
    - Lobar - Contralateral hemiparesis or sensory loss, contralateral conjugate gaze paresis, homonymous hemianopia, abulia, aphasia, neglect, or apraxia.
    - Caudate nucleus - Contralateral hemiparesis, contralateral conjugate gaze paresis, or confusion.
    - Brainstem - crossed signs, facial weakness on one side and sensory loss on the other side, eye movement problems, vertigo and coma.
- Can we tell if the stroke is hemorrhagic or ischemic clinically? No, we must do CT with all patients who are suspected to have a stroke.

## Investigations :

- Imaging :
  - CT- no contrast: shows hemorrhagic stroke by hyperdensity  
In ischemic stroke CT would be **normal** in the first 12-24 hours of ischemia)
  - CTA: do it if you suspect vasculopathies like AVM, Vasculitis. (young patient who is not hypertensive)
  - MRI shows immediate changes in both ischemic & hemorrhagic stroke, but it will take you 30-45 min to do it, MRA/MRV.
- Laboratory studies:
  - CBC, Coagulogram, INR, Electrolyte.
- Subarachnoid Hemorrhage
  - Usually due to aneurysm rupture. Treat by: coil/clip, NIMOTOP/NIMODIPINE, Strict BP control.

## Management of HS : The best way to manage is to prevent and treat HTN

1. Admit to ICU, Control BP, Watch for neuro decline, DVT prophylaxis. for **Cerebral Edema:**
  - a. Put on ventilator to decrease CO2 to decrease blood flow
  - b. Hypertonic saline to shift the fluid out from cells in the brain
  - c. Mannitol
2. Surgery : only for two (**superficial lobar** or **cerebellar hemorrhage**)

# Questions

**1. 74 year old hypertensive male presented with sudden onset unilateral arm weakness and altered level of consciousness, you suspected hypertensive hemorrhage CT Head was performed, where do you expect to find the hemorrhage ?**

- A. Putamen
- B. Thalamus
- C. Cerebellum
- D. Pontine

**2. 25 year old male brought to the ER with sudden onset unilateral arm weakness and slurred speech, CT Head was performed and showed a putamen damage due to ICH which of the following would be the most likely cause?**

- A. Hypertensive hemorrhage
- B. Amyloid angiopathy
- C. Ischemic stroke
- D. Cavernous angioma

**3. 84 year old diabetic male presented with decreased sensation on right arm and leg, confusion, slurred speech and blurry vision, what is the most likely cause of his presentation?**

- A. Hyperglycemia
- B. Pontine hemorrhage
- C. Cerebellar hemorrhage
- D. Thalamic hemorrhage

**4. A patient presented with hemorrhagic stroke was stabilized and admitted to the ICU, his situation deteriorated in the past few days. A neurosurgeon was contacted to discuss the possibility of surgical intervention. which of the following hemorrhages have the best prognosis if managed surgically?**

- A. Amyloid angiopathy
- B. Thalamic hemorrhage
- C. Cerebellar hemorrhage
- D. Lobar hemorrhage

**Answers:**

1. A /2. D /3. D /4. C