

# Neurocritical Care – Management of Elevated Intracranial Pressure

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**UC Irvine Health**

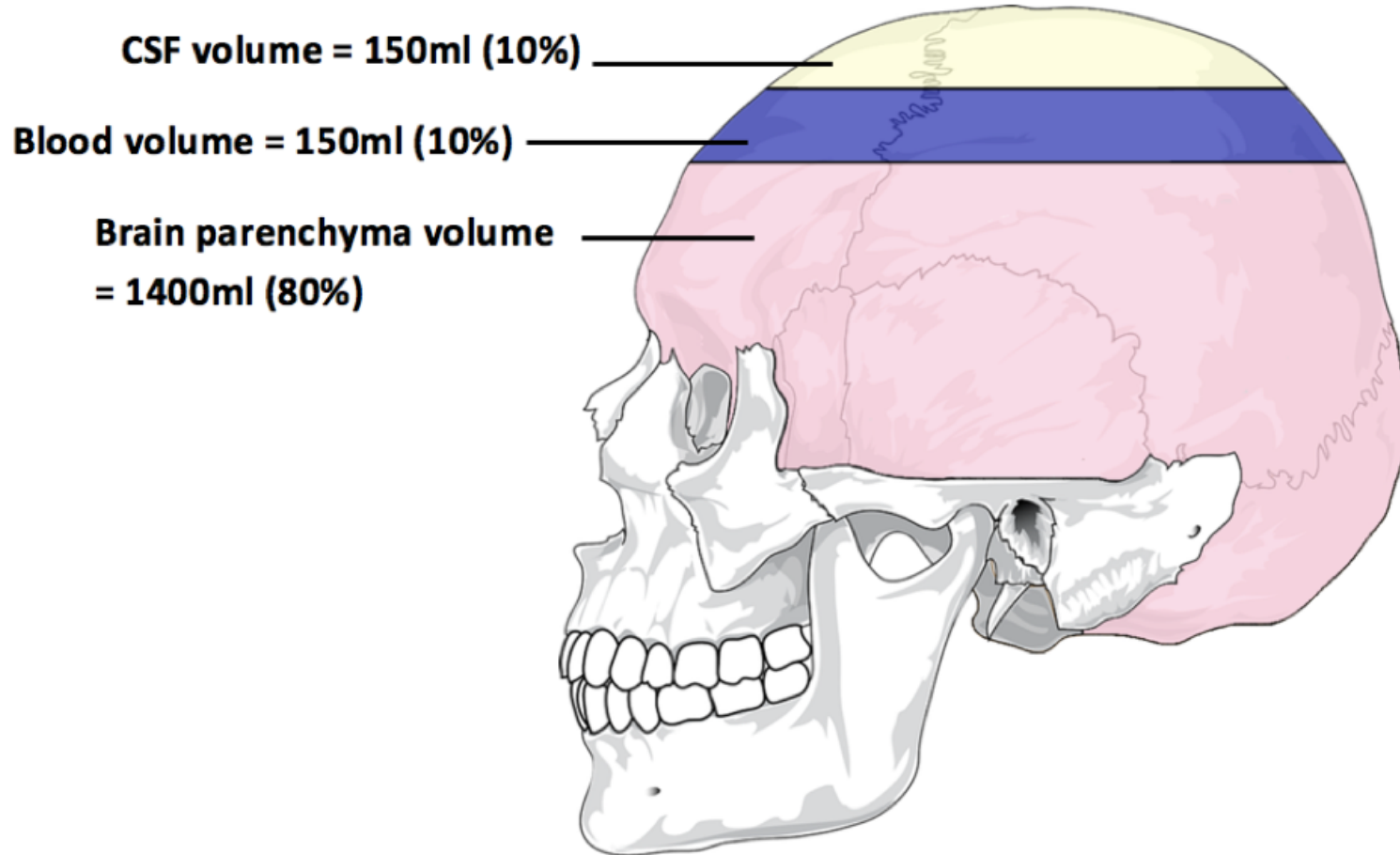
# Disclosures

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None

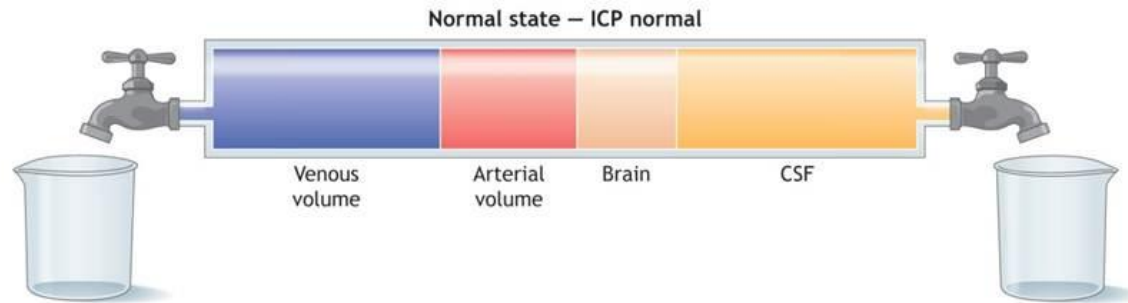
# What is ICP?

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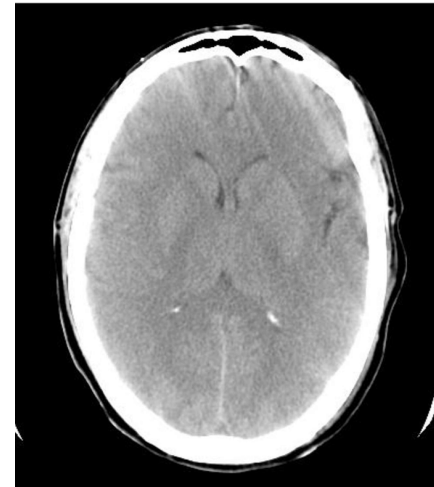
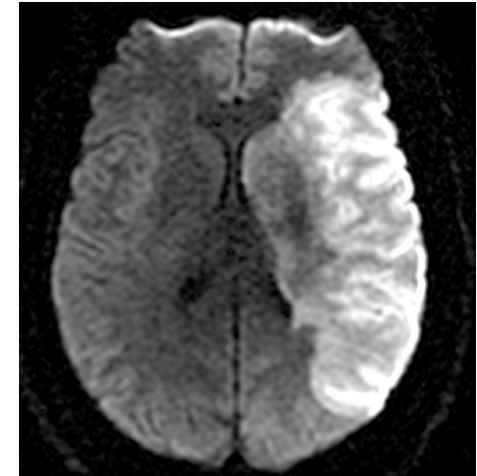
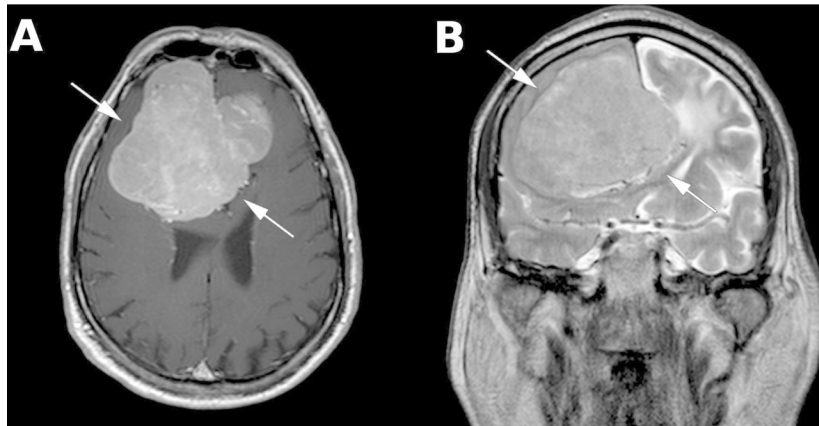
# Monroe-Kellie Hypothesis

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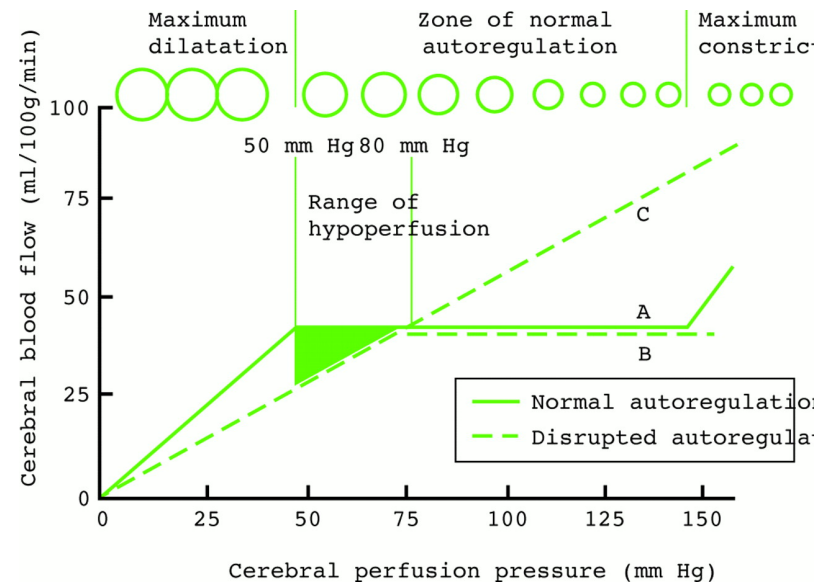
# Causes of Elevated ICP



# Why Care?

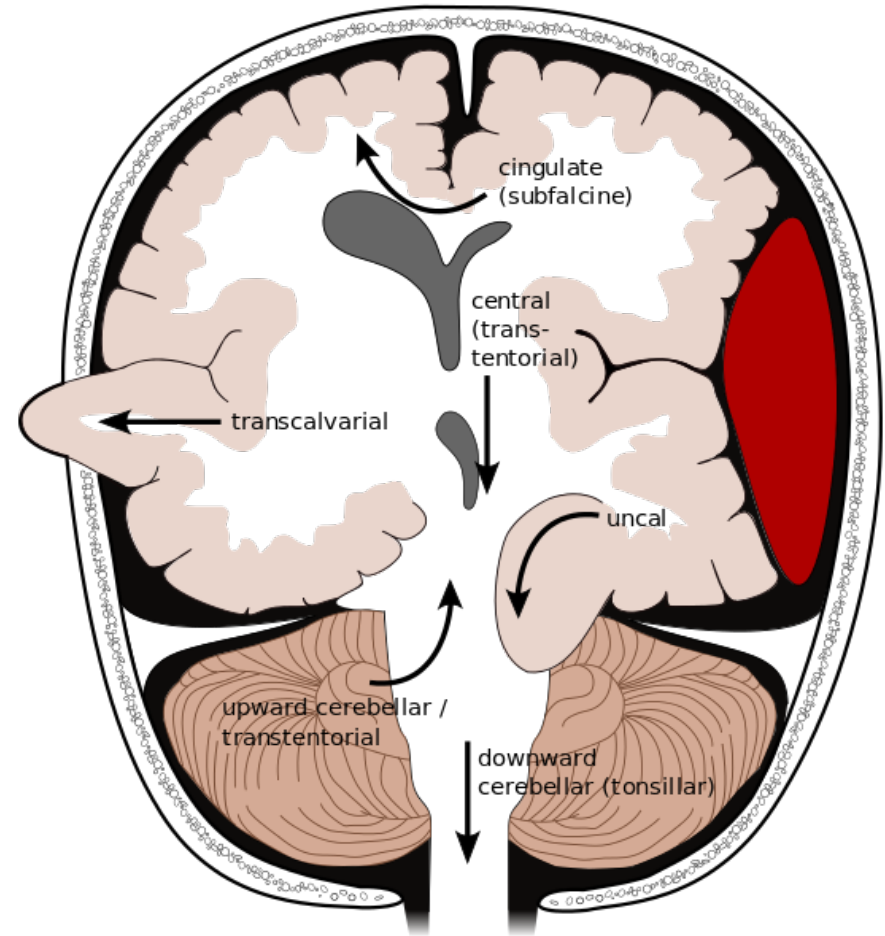


$$CPP = MAP - ICP$$

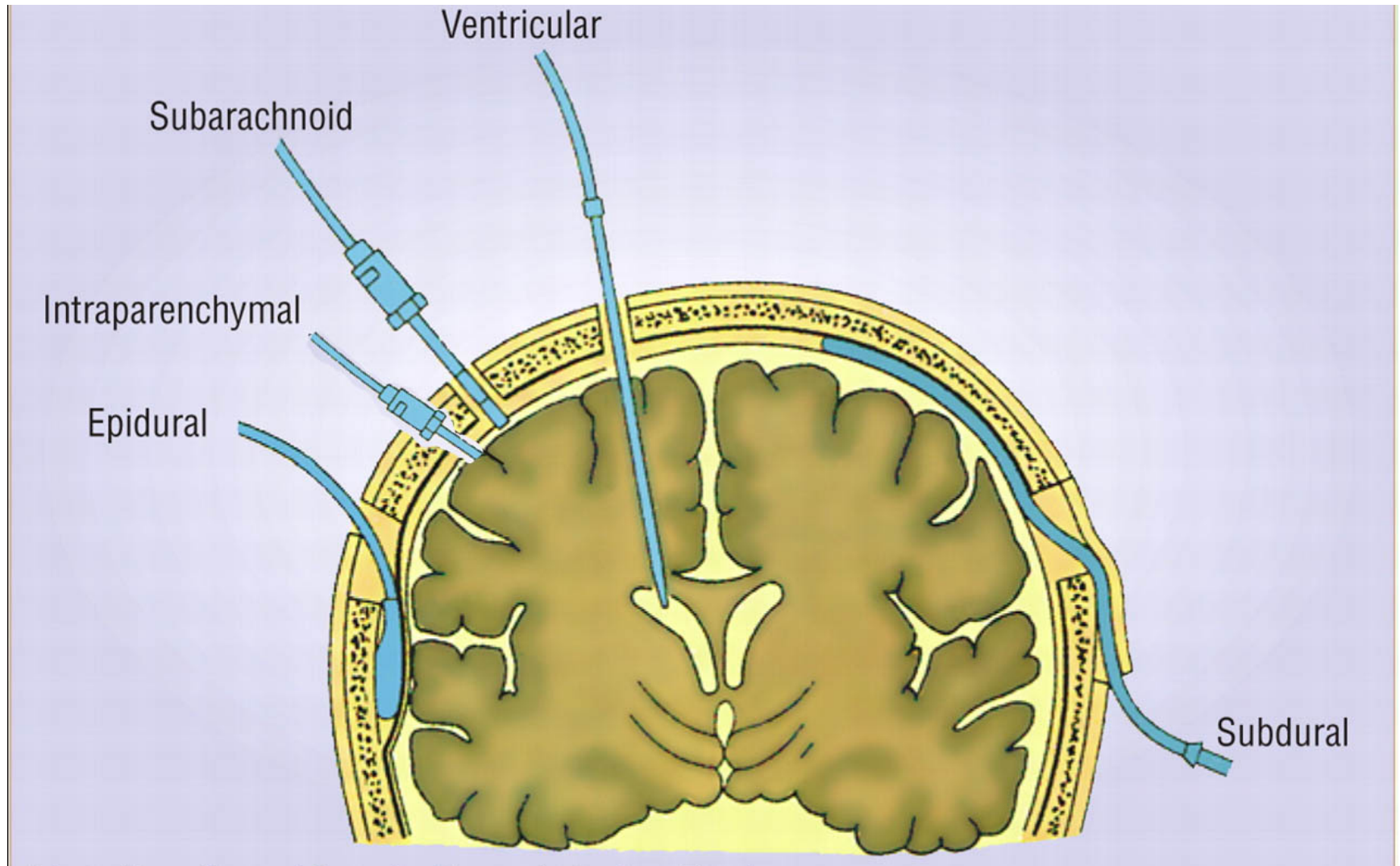


# When to consider ICP monitor

- GCS <8
- Significant IVH or hydrocephalus
- Clinical evidence of herniation



# ICP Monitors





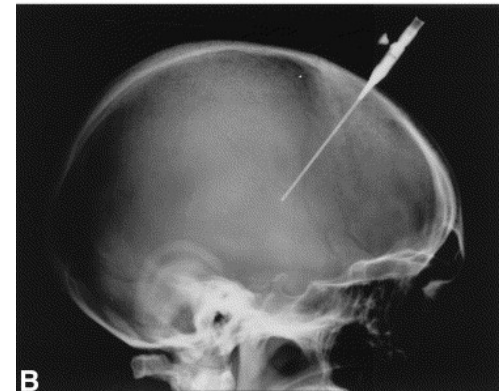
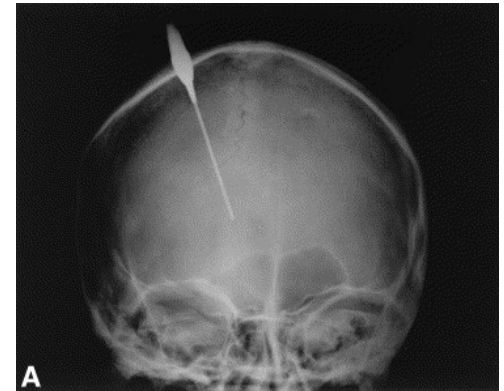
# ICP Monitors: Extraventricular Drain

## Advantages:

- Accuracy
- Therapeutic and diagnostic
- Can calibrate in-situ

## Disadvantage

- Most invasive
- Difficult to place in collapsed ventricles
- Skilled nursing required
- Obstruction of fluid column by clot can make pressure measurements inaccurate
- Transducer must be maintained at fixed reference point to patient's head



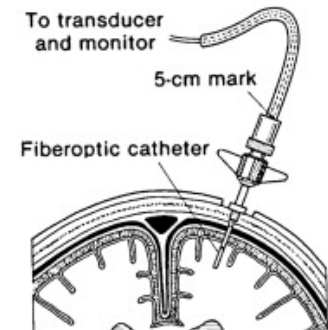
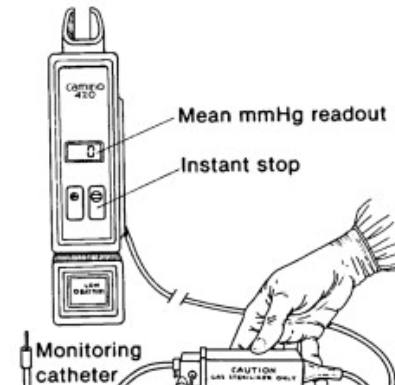
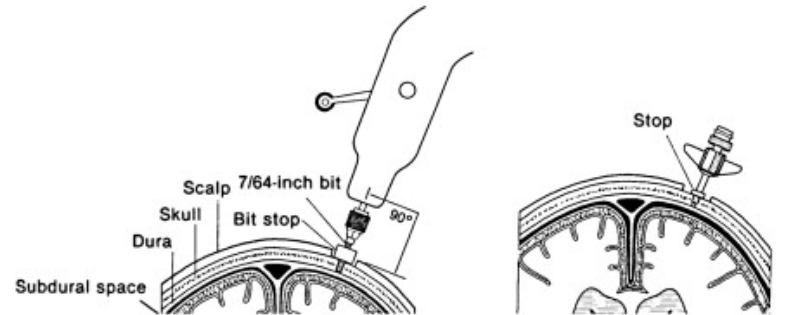
# ICP Monitors: Intraparenchymal devices

## Advantages

- Less invasive
- Can be used with collapsed ventricles
- Not dependent on fluid coupling
- Low infection rate

## Disadvantages

- Diagnostic only
- Looses accuracy – “Zero Drift”
- Local measurement of pressure

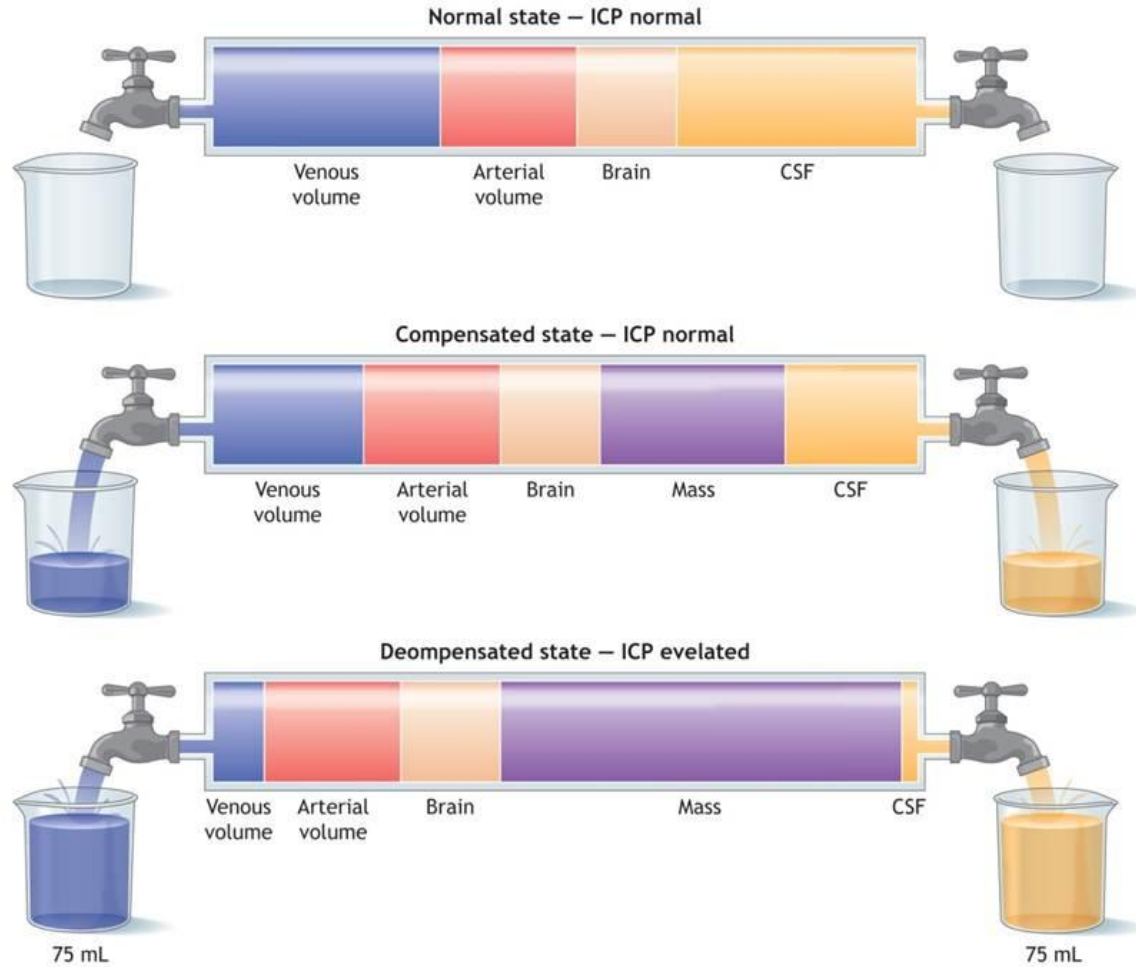


# Management of Elevated ICP



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# Monroe-Kellie Hypothesis





# General Care

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- Optimize cerebral venous outflow
  - HOB 30°
  - Keep head straight
  - Avoid tight head/neck ties for endotracheal/tracheostomy tubes
  - Treat elevated intra-thoracic or intra-abdominal pressures
- Respiratory Failure
  - Maintain eucapnea to very mild hypocapnea
- Sedation and Analgesia
  - Agitation and pain may worsen ICP
  - Shorter duration agents preferred
- Seizures
  - Prophylaxis for TBI patients vs. other etiologies
- Anemia
  - Goal H/H closer to 10/30?
- Fever Management

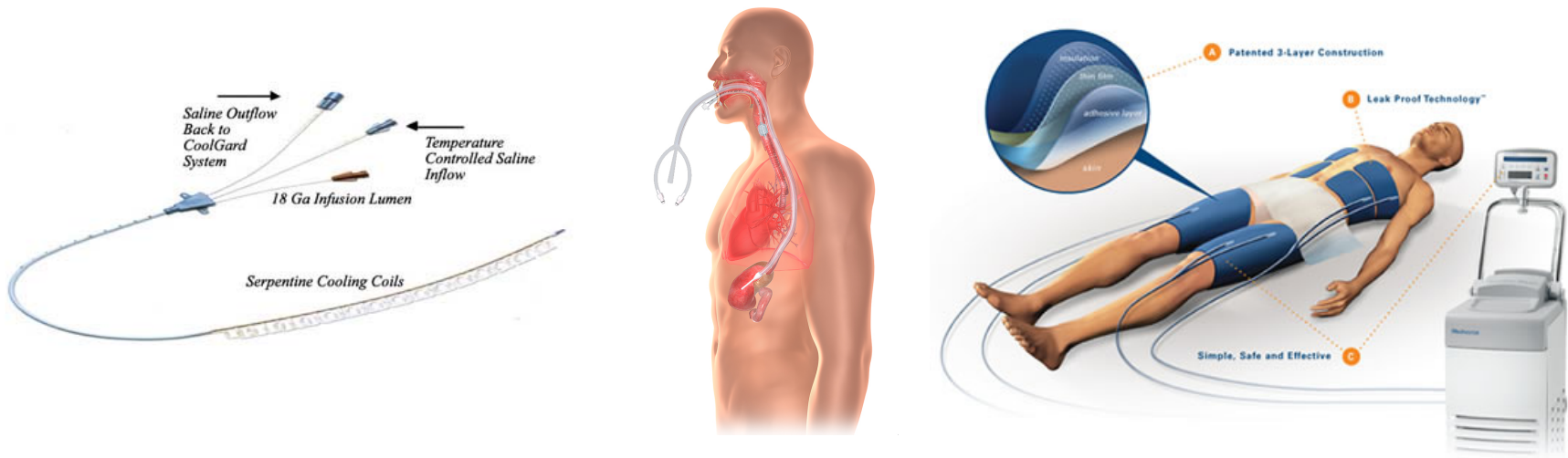
# Fever Management

Fever is not uncommon

Clear association with worse outcome

Aggressive treatment

- antipyretics, surface cooling, cold saline, intravascular cooling catheter



# BP and Volume Management

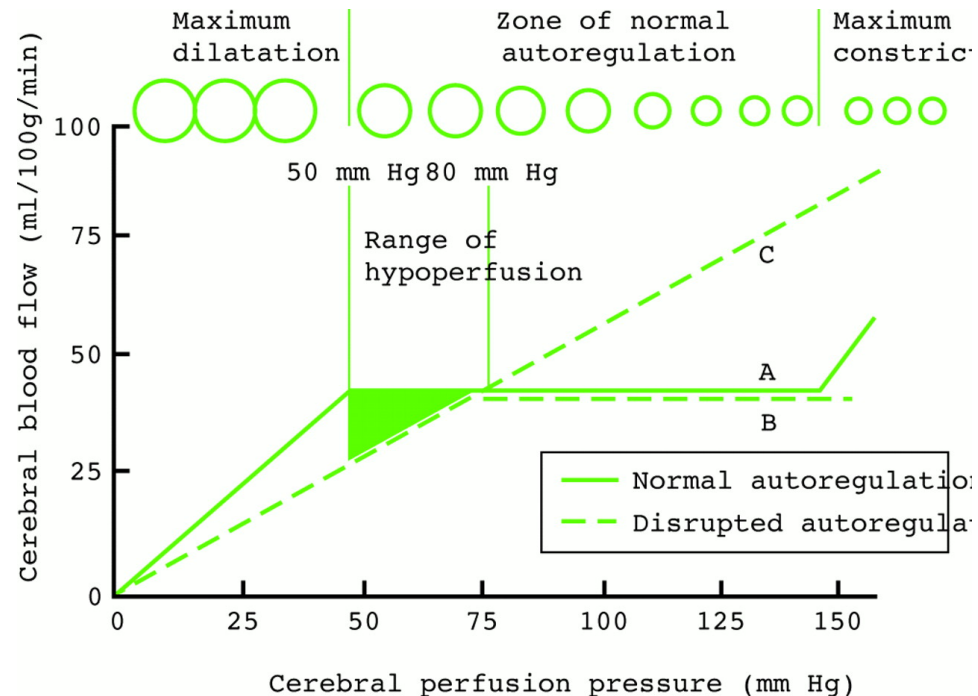
## Optimize intravascular volume status

- Isotonic crystalloid solution (0.9% saline)
- Target euolemia to mild hypervolemia
  - May require use of hemodynamic monitoring

$$CPP = MAP - ICP$$

## Optimize blood pressure

- Permissive HTN where applicable
- Avoidance of hypotension



# Medical ICP management

- Decrease metabolic demand
  - Sedation/Paralysis
  - Fever Management
- Hyperosmolar Therapy
  - Mannitol
  - Hypertonic Saline
    - 3% NaCl
    - Goal Na 140-150 – titrate to individual patients
    - Strict avoidance of rapid declines in Na levels



# Malignant MCA Stroke with D5W

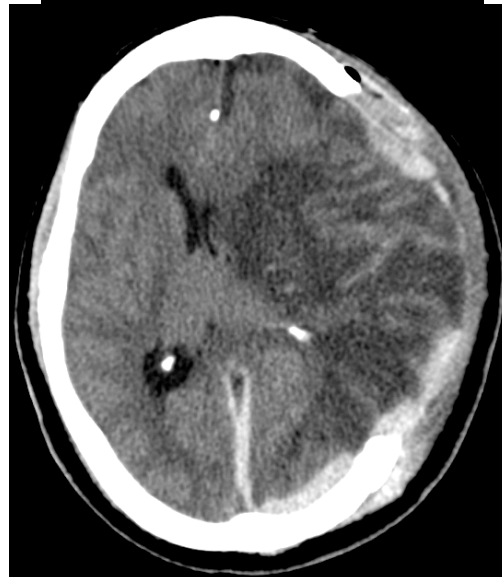
April 9



April 10



April 17



April 18



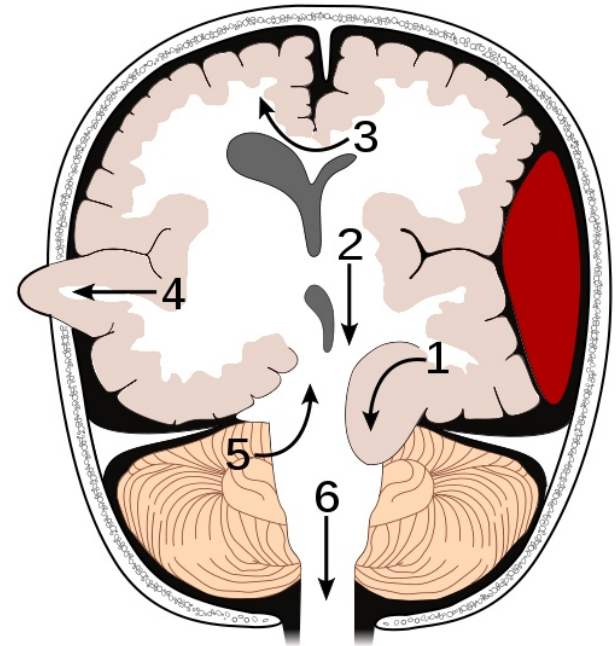
# Herniation

## Clinical Manifestations

- Decreased mental status, change in respiration patterns, unilateral dilated and non-reactive pupil, hemiparesis, posturing of limbs
- Failure to recognize and respond likely fatal

## Management

- Hypertonic Saline
  - 23.4% 30ml push over 3-5 minutes
  - BP Monitoring q2 min x 10 min
  - Serial Na levels
- Mannitol 1-2 gm/kg
- Hyperventilation
  - Goal pCO<sub>2</sub> 25-30
- STAT surgical decompression



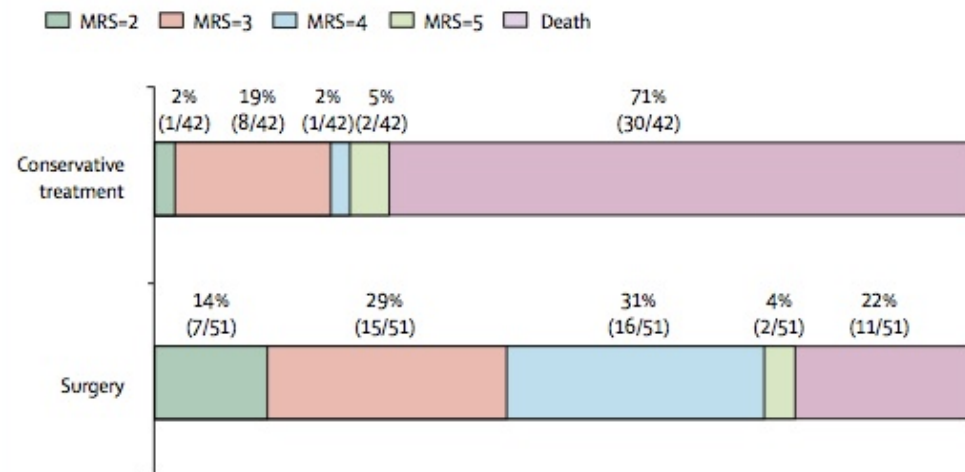


# Decompressive Hemicraniectomy

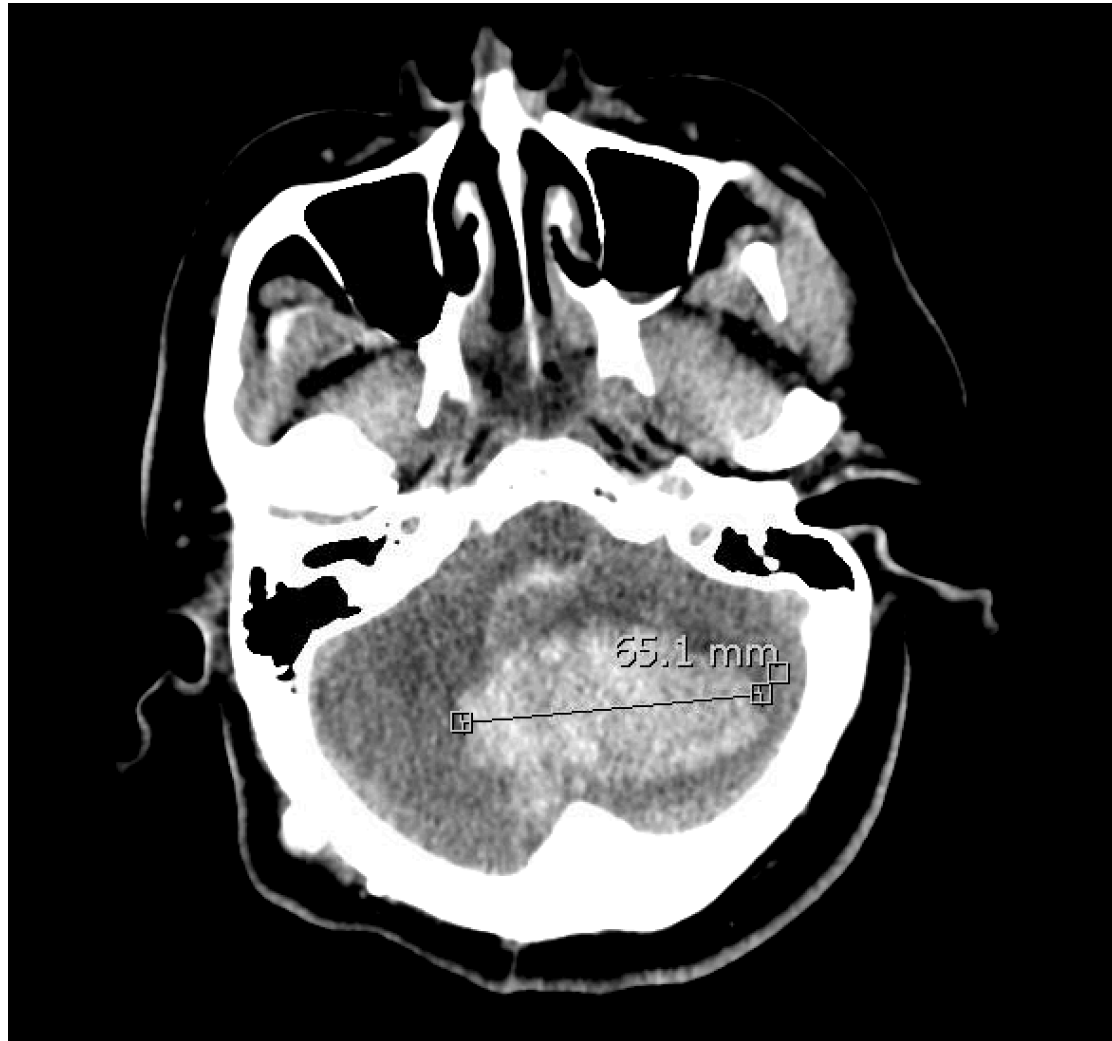
## Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials

Katayoun Vahedi, Jeannette Hofmeijer, Eric Juettler, Eric Vicaut, Bernard George, Ale Algra, G Johan Amelink, Peter Schmiedeck, Stefan Schwab, Peter M Rothwell, Marie-Germaine Boussier, H Bart van der Worp, Werner Hacke, for the DECIMAL, DESTINY, and HAMLET investigators  
*Lancet Neurol* 2007; 6: 215-22

- Early decompression (<48 hrs)
  - Decreased mortality by 30%
  - Number needed to treat = 2
  - Increases number of patients with favorable functional outcome
- No specific guidelines
  - Age <60
  - <48 hours from stroke onset
  - Non-dominant hemisphere

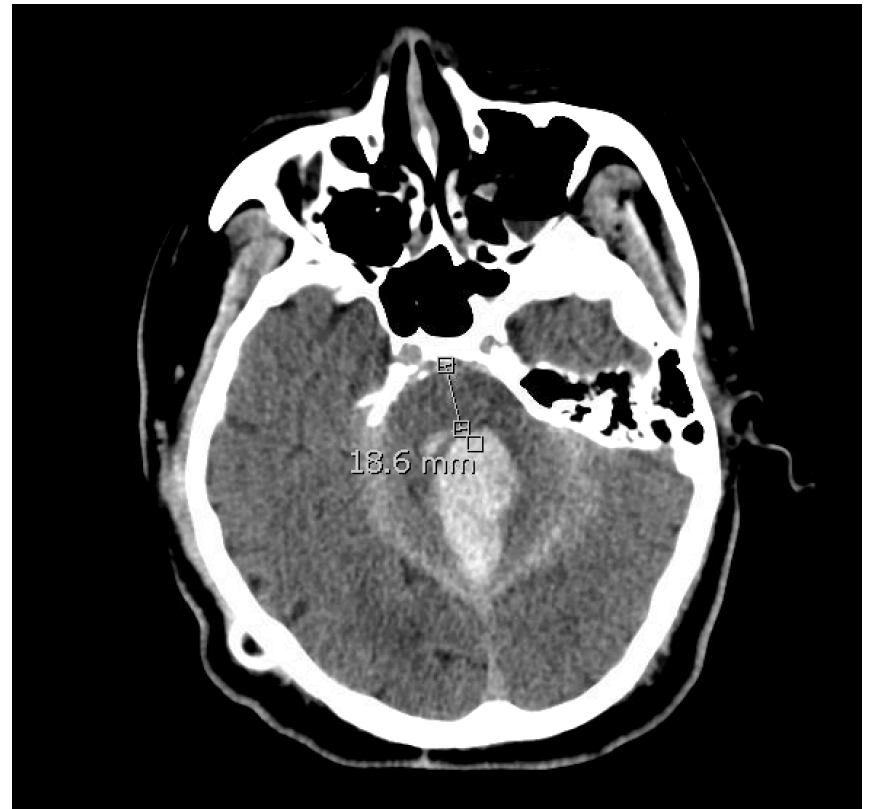


# ICH?

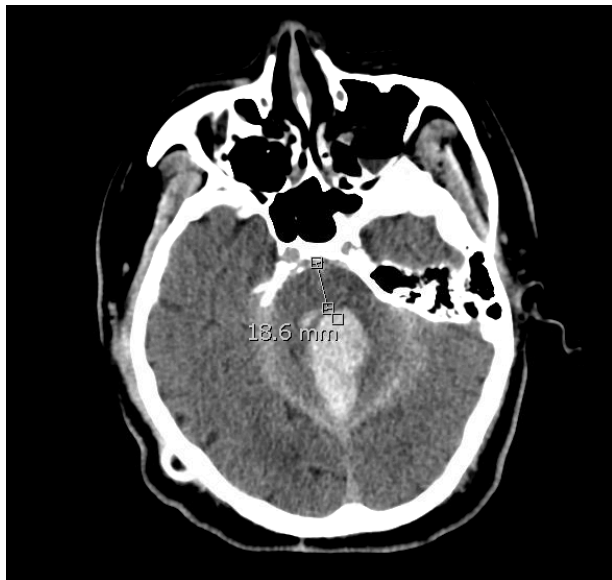




## 67 yo male

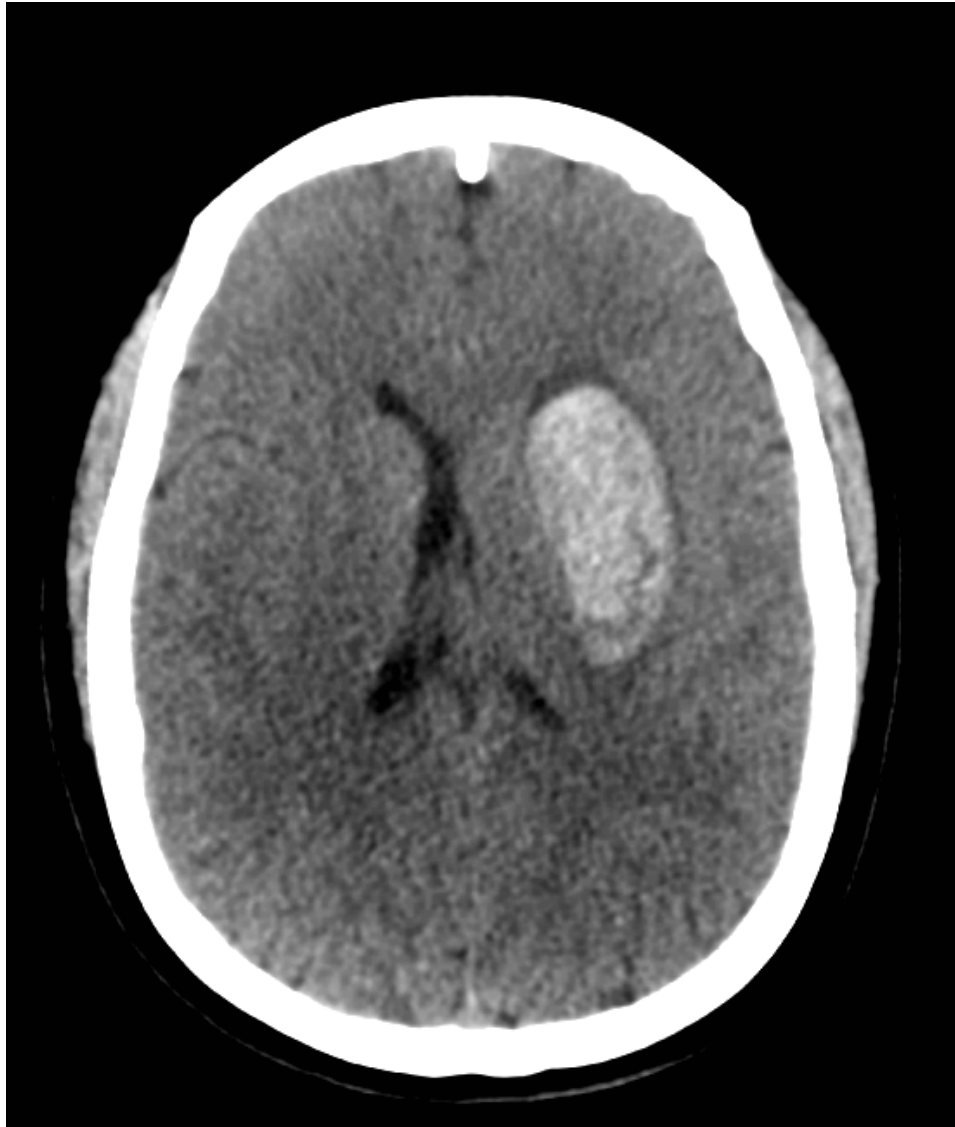


## 67 yo male



## 36 yo female with Basal Ganglia Hemorrhage

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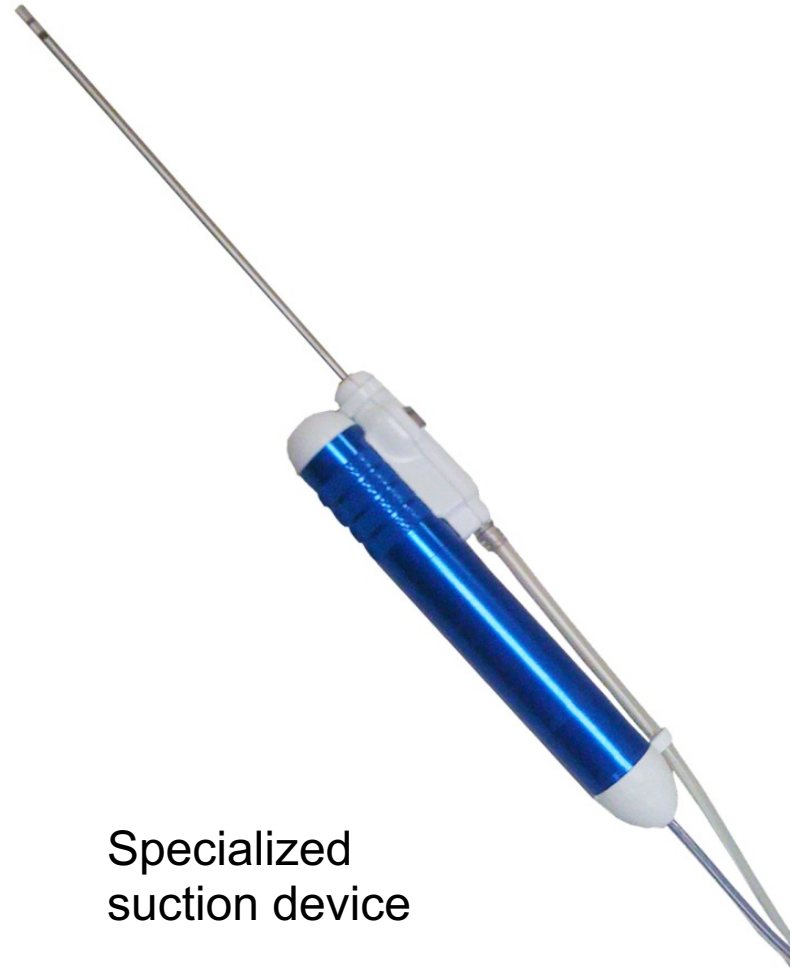


# Brainpath and Myriad

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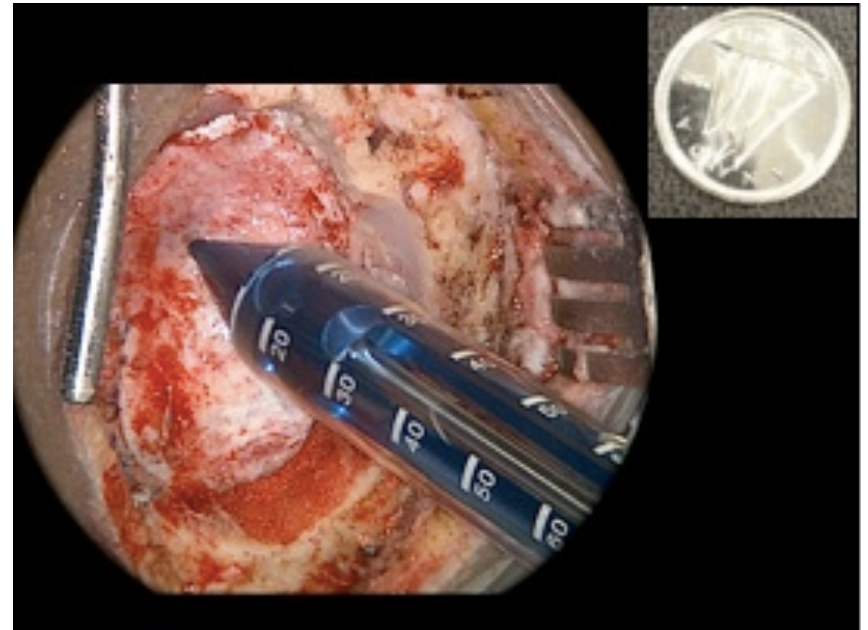
Specialized cannulas that  
part the white matter



Specialized  
suction device

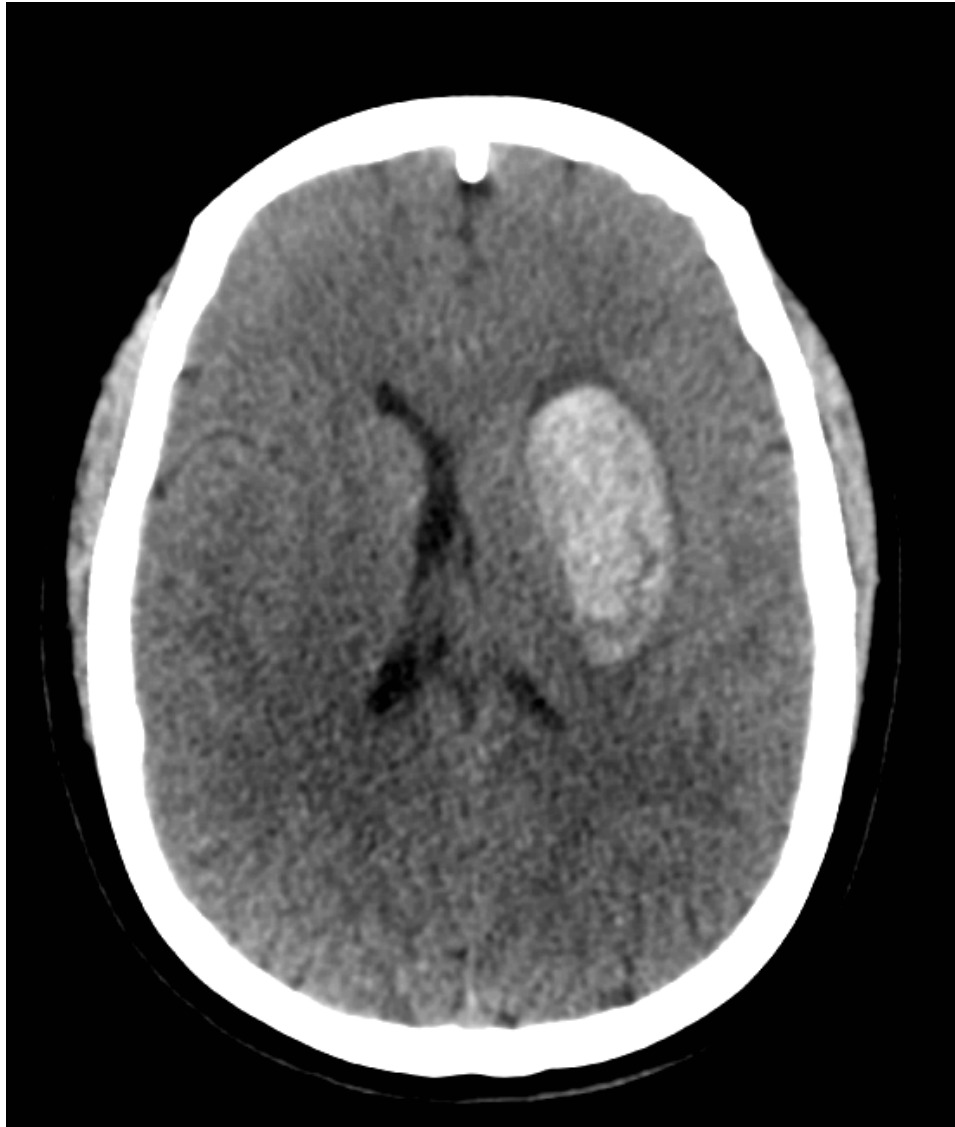
# Respect the Fiber Tracts

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## 36 yo female with Basal Ganglia Hemorrhage

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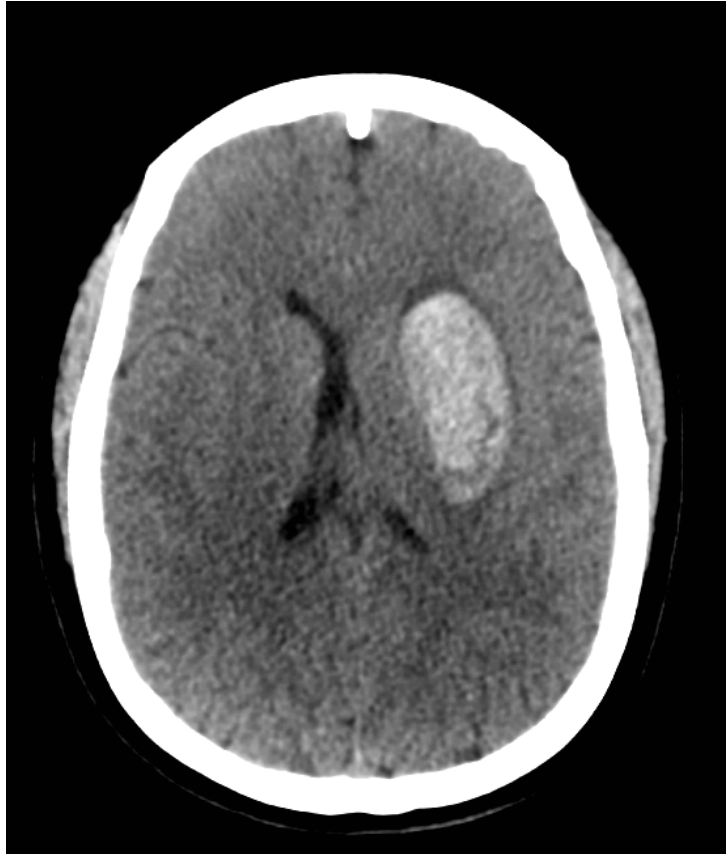




## 36 yo female with Basal Ganglia Hemorrhage

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Pre-op

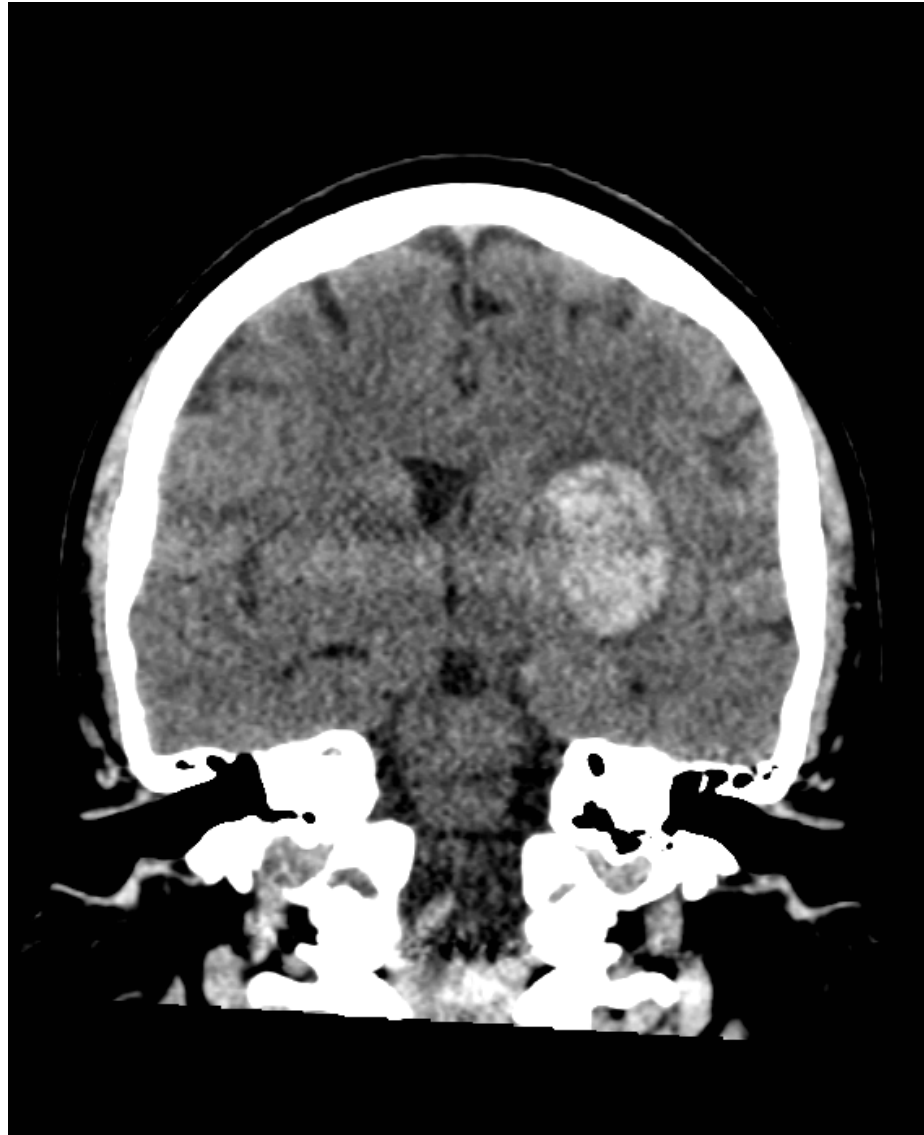


Post-op



## 36 yo female with Basal Ganglia Hemorrhage

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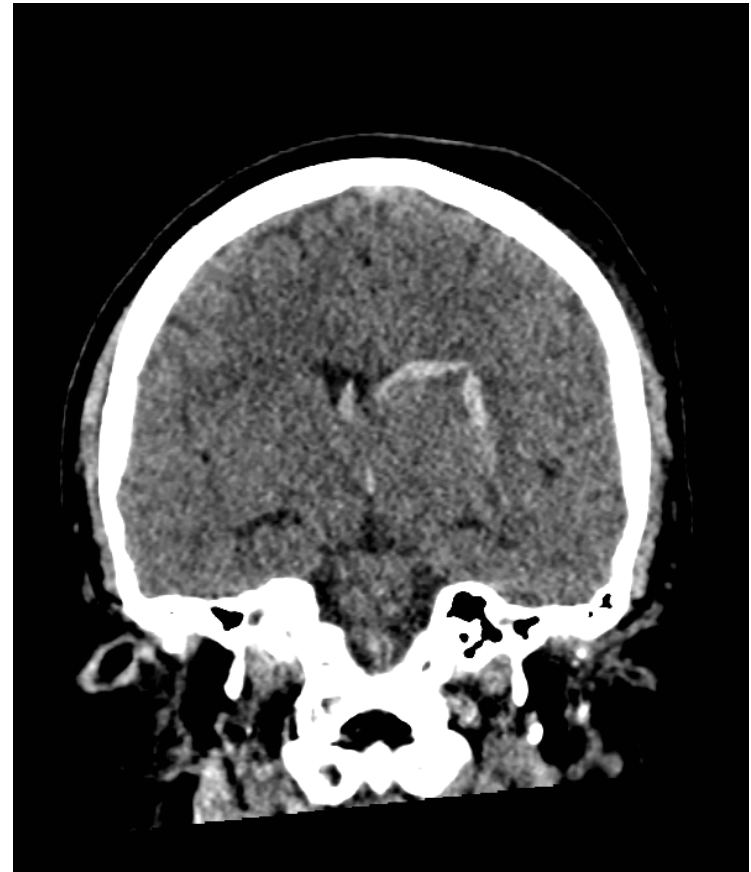
## 36 yo female with Basal Ganglia Hemorrhage

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Pre-op



Post-op



# 54 yo Male with Basal Ganglia Hemorrhage

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10/9/14



## 54 yo Male with Basal Ganglia Hemorrhage

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10/9/14



10/25/14



# Summary

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- When to consider monitoring ICP?
  - GCS < 8
  - Significant IVH or Hydrocephalus
  - Clinical evidence of herniation
  - EVD vs Intraparenchymal
- Medical Treatment
  - Optimize venous outflow
  - Ensure adequate ventilation (Hyperventilate temporarily only)
  - Sedation and analgesia
  - Fever Management
  - Optimize intravascular volume and blood pressure
    - $CPP = MAP - ICP$
  - Hyperosmolar Therapy
    - Mannitol
    - Hypertonic Saline
- Surgical Treatment