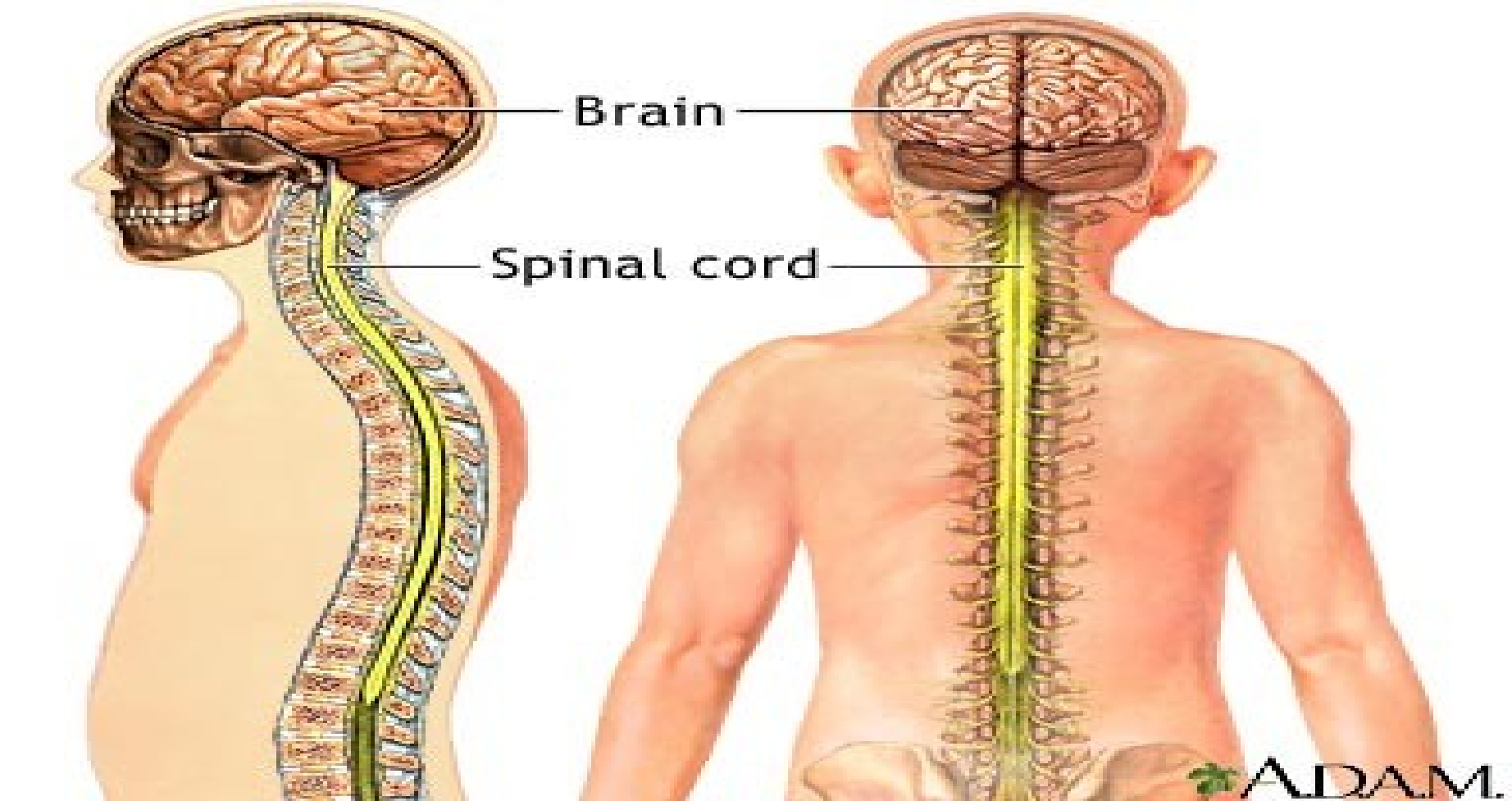
# Head Injury



# Case Scenario

- **58-year-old male fell from a roof in a small rural town**
- **Initial GCS score = 12**
- **On admission after 2-hour transfer, GCS score is 6**

*What injuries would you suspect?*

*What are your priorities in managing this patient?*

# Epidemiology

- Injuries are the leading cause of death in persons < age 45.
- Traumatic brain injuries account for 50% of these deaths.
- In the United States, non-fatal TBI occurs in 1.5 million persons yearly.
- Resulting in 370,000 hospitalizations, and 80,000 cases of residual neurological disability.
- In the same country about 52,000 persons die yearly due to TBI.
- In sever TBI mortality approaches 40%, most deaths occur within the first 48 hours.

# Review of anatomy

- Skull
  - Protects the brain
  - Made up of several bones with seam like sutures
  - Regions of the scalp- frontal, occipital, parietal, temporal regions
  - Bones of the face
    - Orbits
    - Mandible
    - Maxillae
    - Nasal bones
    - Zygomatic bones

- CNS
  - Controls all basic bodily functions and responds to external stimuli
  - Composed of: brain, spinal cord, and major nerve
- PNS
  - Complete network of motor and sensory nerve fibers connecting the CNS to the rest of the body.

# Mechanisms of Head Injury

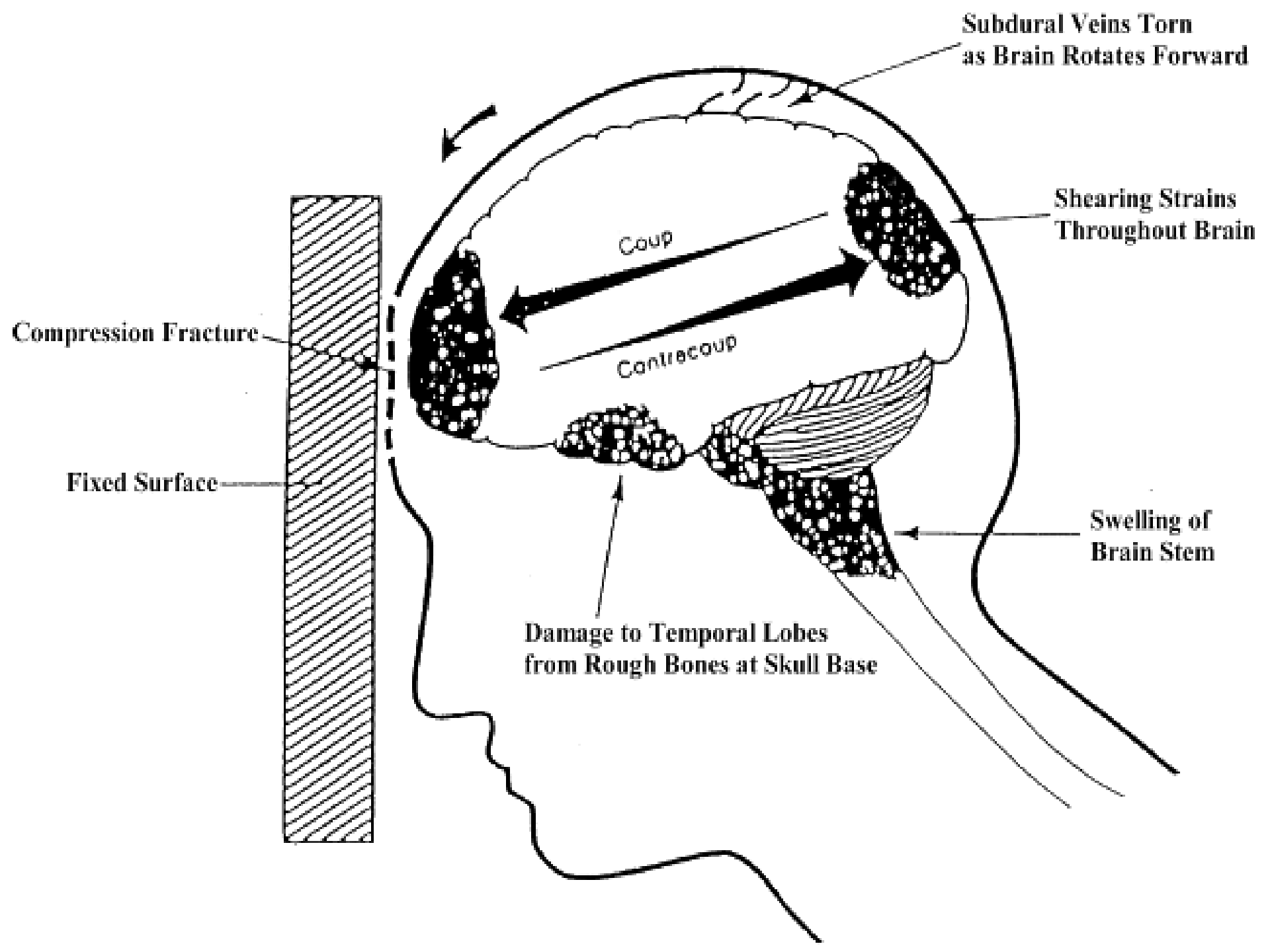
- Motor vehicle crashes/road traffic accidents
- pedestrian-vehicle collisions
- Falls from heights
- Interpersonal violence
- Sports injuries
- Forceful blunt/penetrating trauma to head

# Suspect a Head Injury

- With any unresponsive trauma patient
- Significant mechanism of injury
- When wounds or other injuries suggest large forces involved
- Observe patient carefully during the initial assessment

# Pathopysiology

- TBI results from direct or indirect forces to the brain matter.
- **Direct injury** is sustained by the force of an object striking the head.
- **Indirect injury** is caused by acceleration or deceleration forces that result in the movement of the brain inside the skull.
- When contusion occur at **the site** of the blunt force it is known as **coup injury.**
- When contusion occur at **opposite side** of the brain, it is known as **contrecoup injury.**


Subdural Veins Torn
as Brain Rotates Forward
Shearing Strains
Throughout Brain
Coup
Contrecoup
Compression Fracture
Fixed Surface
Swelling of
Brain Stem
Damage to Temporal Lobes
from Rough Bones at Skull Base

- Regardless of mechanism, the brain sustains an immediate **irreversible** insult, termed the **“primary injury,”** which is dependent on the cause and **severity** of the inciting event.

- A **“secondary injury”** occurs **minutes to days later** and is the result of **neurophysiologic** and **anatomic** changes at the cellular level.

- Primary and secondary injuries directly damage brain cells and cause cerebral edema, which increases **ICP**.
- The caranium is a closed space with **3** components: blood, CSF, and brain.

- Increases in the size of any of the **3** components without a corresponding decrease in one of the others result in **increased ICP**.

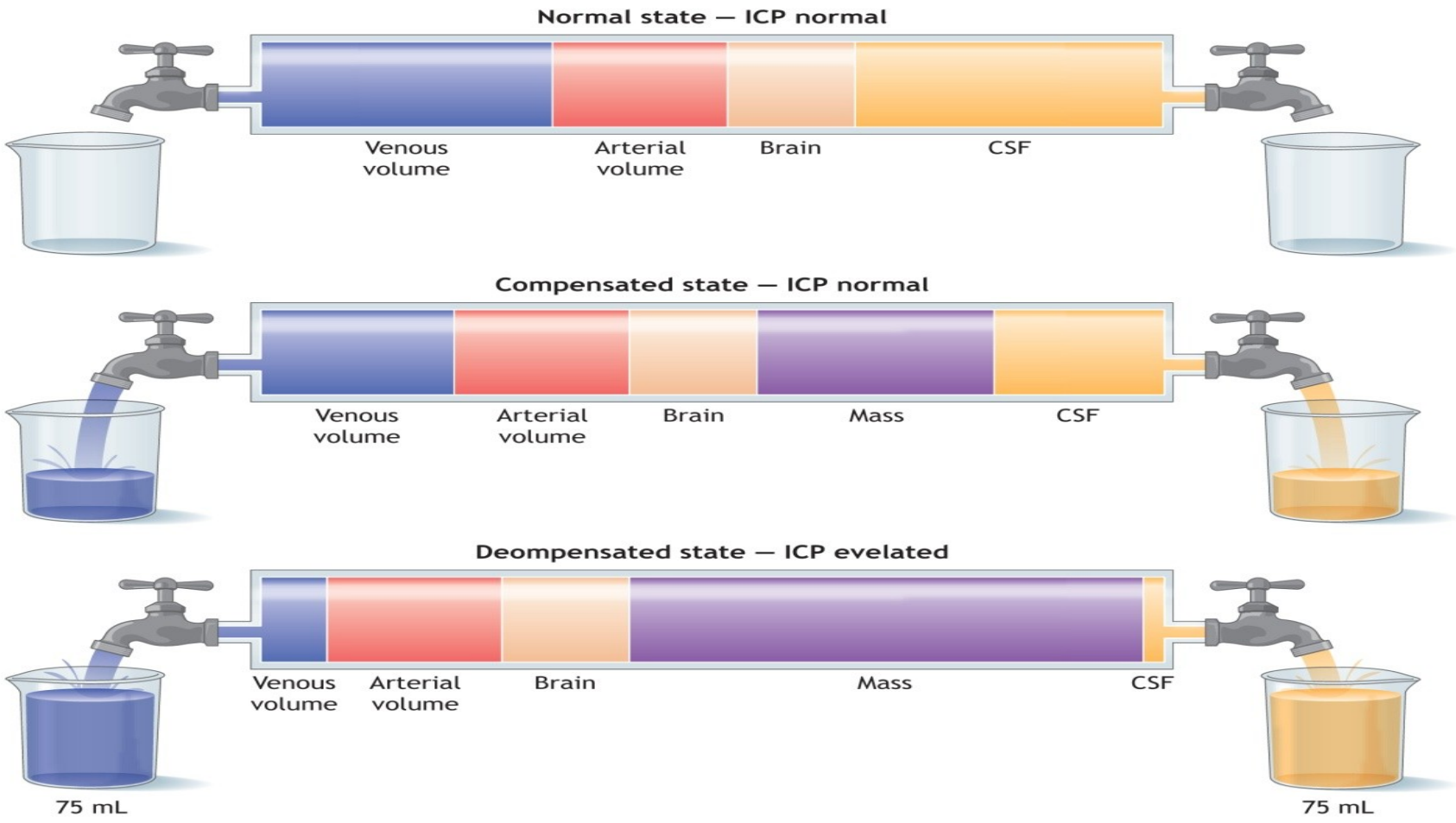
# Cerebral perfusion pressure

- CPP is the pressure gradient required to perfuse the cerebral tissue

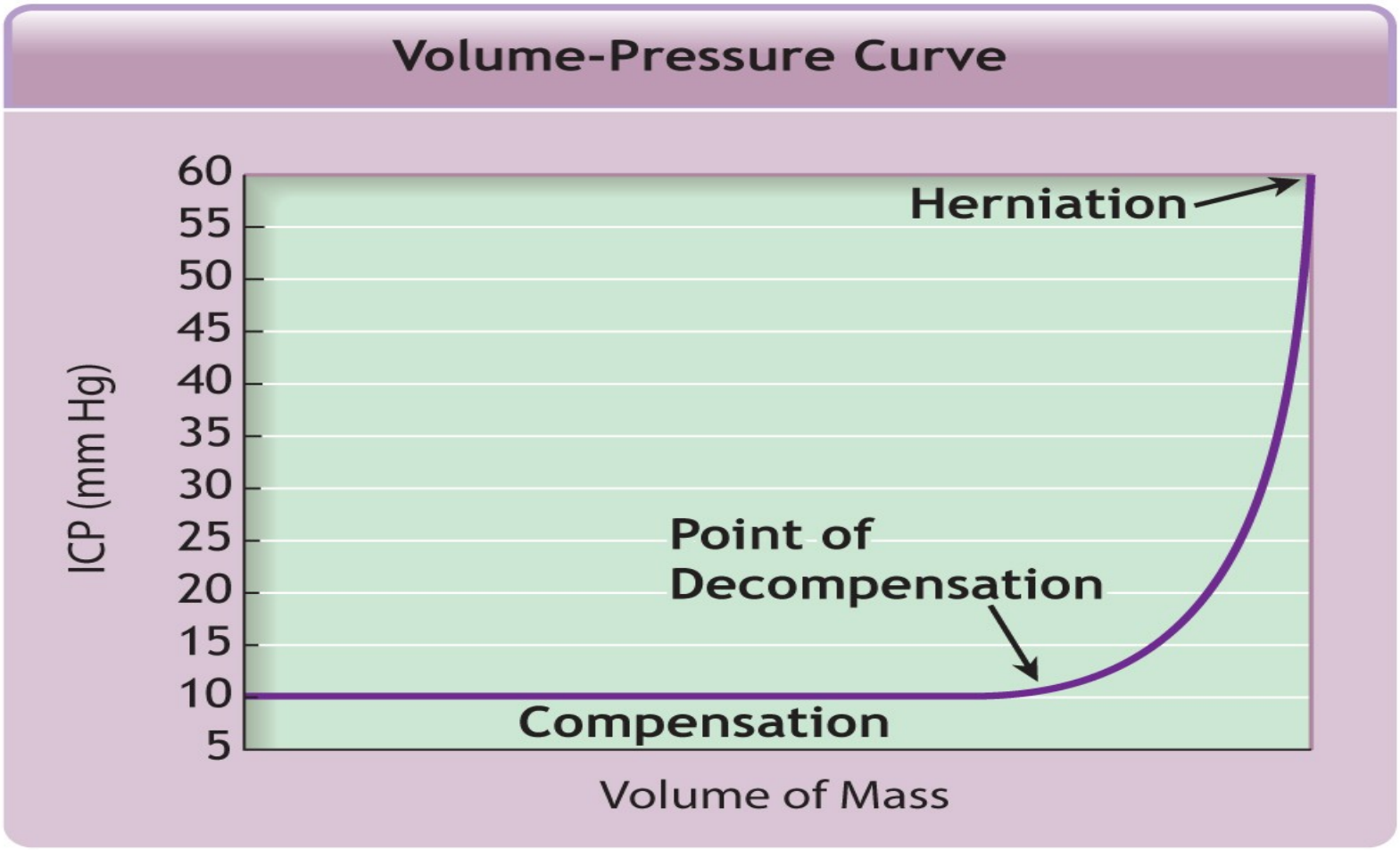
  **CPP= MAP-ICP**

- MAP= diastolic+(pulse pressure/3)
- Cerebral blood flow is generally maintained when CPP is **>60** mmHg
- CPP is so one indicator to monitor cerebral blood flow
- Local adjustment of cerebral blood flow is termed as **autoregulation**.

# Monro-Kellie Doctrine



# Volume-Pressure Curve



# Intracranial Pressure (ICP)

| | | |
|---|---|---|
| **10 mm Hg** | **=** | **Normal** |
| **>20 mm Hg** | **=** | **Abnormal** |
| **>40 mm Hg** | **=** | **Severe ICP** |

- *Sustained increased ICP leads to decreased brain function and poor outcome*

# Cerebral Perfusion Pressure

| | MAP | – ICP | = CPP |
|---|---|---|---|
| Normal | 90 | 10 | 80 |
| Cushing's Response | 100 | 20 | 80 |
| Hypotension | 50 | 20 | 30 |




**CPP ≠ Cerebral Blood Flow**

# General Signs and Symptoms

- Weakness, numbness, loss of sensation, paralysis
- Nausea and vomiting
- Headache
- Clear fluid from nose or ears
- Seizures
- Unequal pupils
- Problems with vision or speech
- Breathing problems or irregularities
- Changing levels of responsiveness
- Drowsiness
- Confusion

# Classifications of Head Injury

## By Mechanism of Injury

- **Blunt**

  **High and low velocity**

- Penetrating
  GSW and other





# Classifications of Head Injury

## By Morphology – Skull Fractures

### Vault

- **Depressed/ non depressed**
- **Open/ closed**

### Basilar

- With / without CSF leak
- With / without cranial nerve palsy

# Classifications of Head Injury

## By Morphology – Brain Injuries

### Focal

- **Epidural(extradural) hematoma**
- **Subdural hematoma**
- **Subarachnoid hematoma**
- **Intracerebral hematoma**

### Diffuse

- Concussion= is a traumatic alteration of neurological function in the absence of findings on CT scan.
- Multiple contusions= Localized deformation of skull most commonly seen in the frontal, temporal, or occipital regions.
- Hypoxic / ischemic injury

# Epidural Hematoma

- Often occurs as a result of bleeding from the middle meningeal artery.
- **Associated with skull fracture**
- **Classic: middle meningeal artery tear**
- IpsiLateral Dilation of Pupil, not reacting to light
- Contra Lateral Hemiparesis
- **Lenticular/ biconvex on CT scan**
  - Followed by **Lucid interval/ talk and die** of few hrs to a week
- **Can be rapidly fatal and Early evacuation is essential**

# Epidural Hematoma

**Temporal Epidural Hematoma**



**Uncal herniation**

# Subdural Hematoma

- Is caused by bleeding from bridging veins in the

subdural space.

- **Venous tear/ brain laceration**
- **Covers cerebral surface**
- **Morbidity/ mortality due to underlying brain injury**
- **Rapid surgical evacuation recommended, especially if >5 mm shift of midline.**

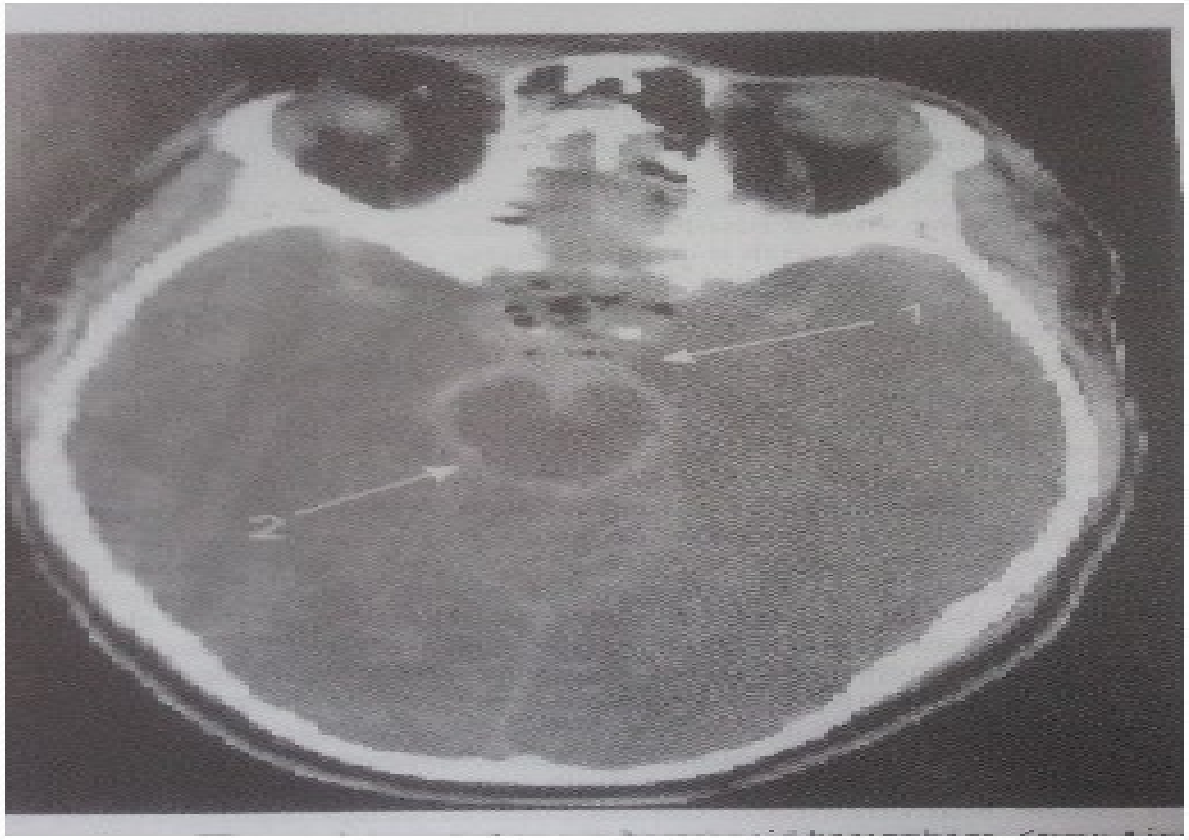
# Subdural Hematoma



# Subarachnoid hemorrhage

- Is caused by lacerations of the superficial vessels in the subarachnoid space.
- Due to Acceleration- deceleration force with tearing of the subarachnoid vessels
- Traumatic subarachnoid hemorrhage is probably the most common CT abnormality in patients with moderate to severe TBI.
- May present with headache, photophobia, and meningeal signs

# Subarachnoid hemorrhage

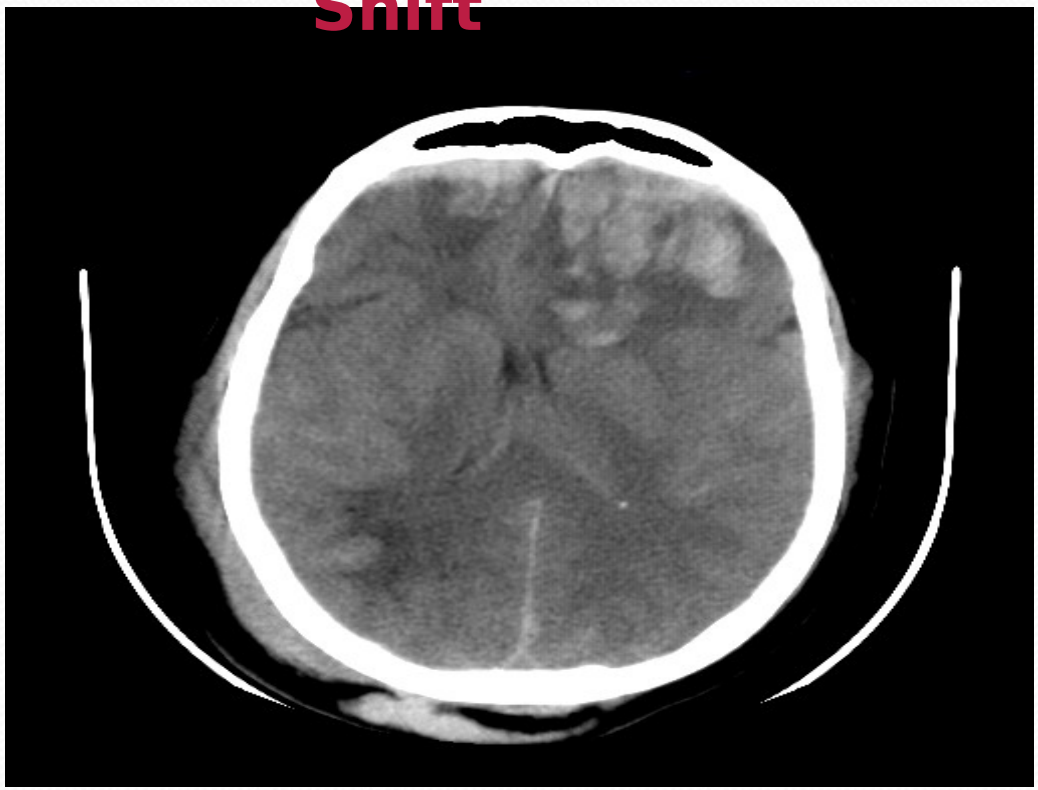


# Intracerebral Hematoma / Contusion

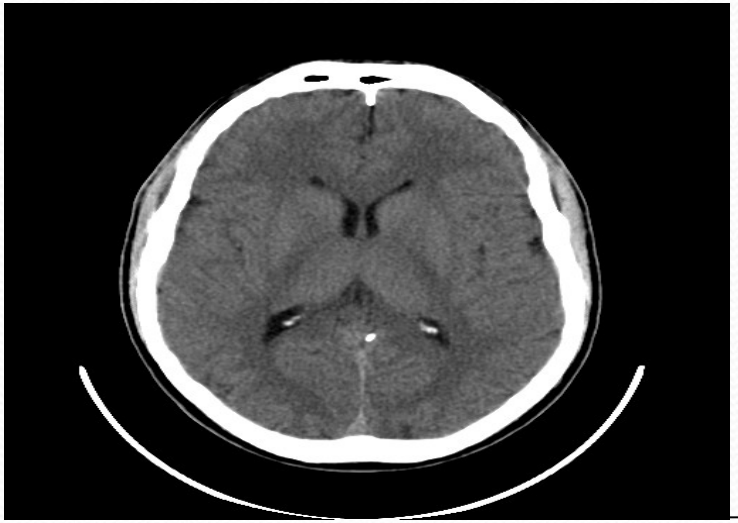
- Hemorrhage into brain tissue due to trauma usually occurs near the surface.
- **Coup/ contracoup injuries**
- **Most common: frontal /temporal lobes**
- **CT changes usually progressive**
- **Most conscious patients: no operation**

# Intracerebral Hematoma/ Contusion

## Large Frontal Contusion with Shift



# Diffuse Brain Injury



Normal CT




Diffuse Injury

- is seen when there is a disruption of axonal fibers in the brain due to shearing forces.
- Range from mild concussion to severe ischemic insult

# Classifications of Head Injury

## By Severity of Injury Based on GCS Score

- Mild GCS 14-15
- Moderate GCS 9-13
- Severe GCS <9



# Mild Brain Injury

## Initial evaluation

- GCS score =14 – 15
- History
- Exclude systemic injuries
- Neurologic exam
- X-rays as indicated
- Alcohol/ drug screens as indicated
- Liberal use of head CT scan

**Observe or discharge based on findings**

# Moderate Brain Injury

- GCS score = 9–13
- Initial evaluation same as for mild injury
- CT scan for all
- Admit and observe
  - Frequent neurologic exams
  - Repeat CT scan
- Deterioration: Manage as severe head injury

# Severe Brain Injury

- GCS score= 3– 8
- Evaluate and resuscitate
- Intubate for airway protection
- Focused neurologic exam
- Frequent reevaluation
- Identify associated injuries

# Diagnostic modalities

- Head CT scan
- MRI of the brain
- blood studies

# Management of head injury

- Three primary goal of the management of sever or moderate TBI.

- ✓ Prevent secondary brain injury
- ✓ Identify treatable mass lesions
- ✓ Identify other life-threatening injuries

# Emergency assessment and management

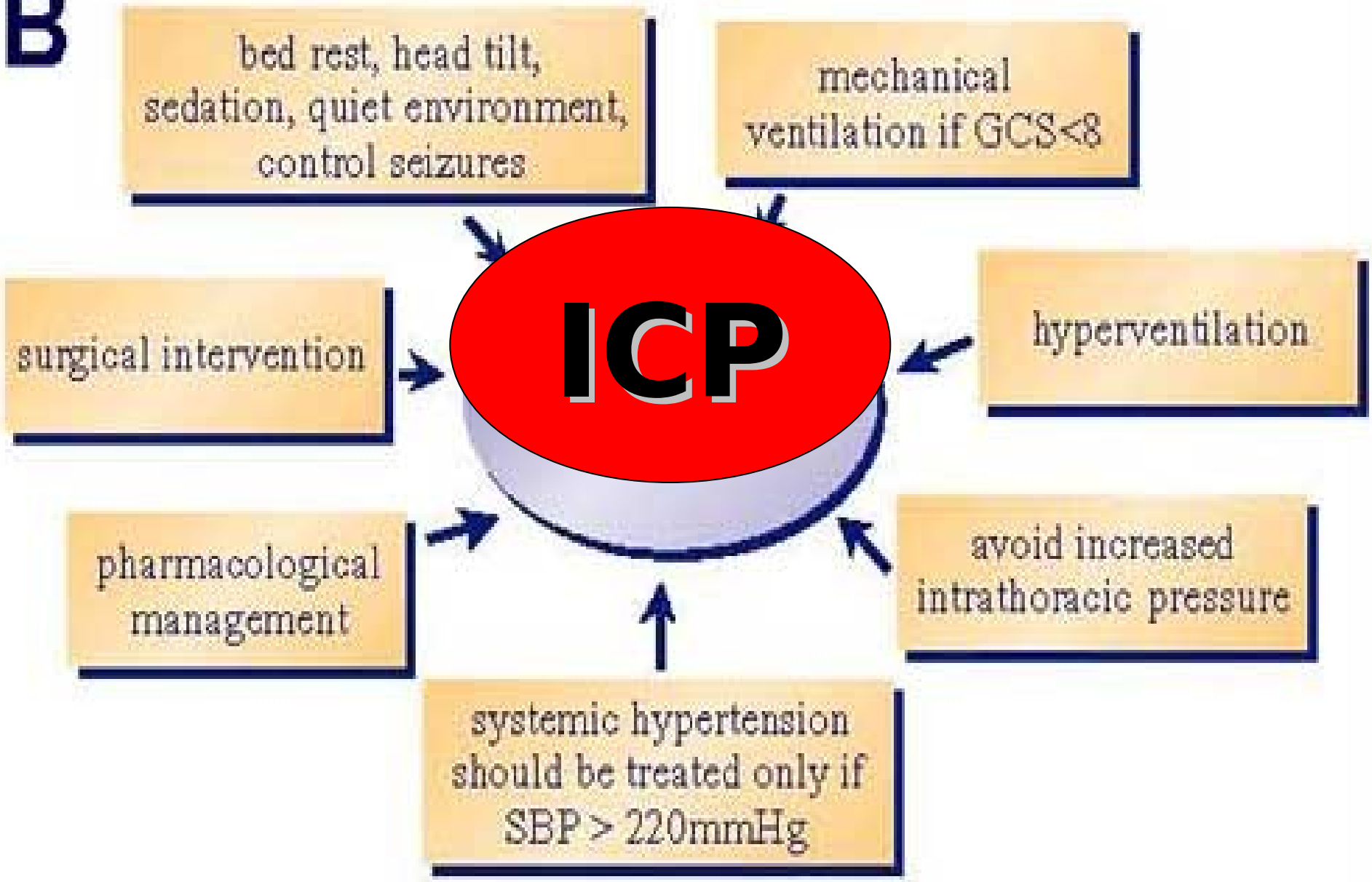
- Ensure scene safety and personal safety
- Assume spinal injury and complete spinal immobilization
- Primary survey- maintain ABCDE
- ✓ Open airway and ensure adequate oxygenation
- ✓ Severe TBI require prompt airway control- intubation
- ✓ Control bleeding and treat hemorrhagic shock
- ✓ Aggressive fluid resuscitation– isotonic crystalloids
- Maintain systolic blood pressure >90mmHg and MAP >80mmHg to preserve CPP. Also maintain Hct >30%
- If fluid resuscitation is not effective, vasopressors be used
- ✓ Calculate GCS score and Treat hypo/hyperglycemia
- ✓ Closely monitor patient status and V/S

# So treat secondary insult

- Hypoxia
- Hypotension
- Hypoglycemia
- Infections
- Increased intracranial pressure



B


bed rest, head tilt, sedation, quiet environment, control seizures
mechanical ventilation if GCS<8
surgical intervention
ICP
hyperventilation
pharmacological management
avoid increased intrathoracic pressure
systemic hypertension should be treated only if SBP > 220mmHg

# ICP control..

- Hyperventilate to maintain **Paco2** level at **35** mmHg to **40** mmHg and oxygen saturation at **>95%.**
- Brief course of hyperventilation is recommended b/s of cerebral vasoconstriction and cerebral ischemia.

- **Mannitol 0.5-1** gram/kg can reduces ICP within **30** min
- Prophylactic anticonvulsants like **phenytoin** can reduce post-traumatic seizures.

- Pain management- avoid use of NSAID like diclofenac

# Secondary survey
## V/S + History- SAMPLE FORMAT

**Important historical information to obtain include**

- Patient's baseline mental status.
- mechanism of injury.
- condition before and after injury.
- recent use of intoxicants.
- presence and length of LOC.
- vomiting, seizure activity.
- anticoagulant use.

- Vital signs and pulse oximetry should be assessed.
- Both hypotension (systolic BP < 90 mm Hg) and hypoxia (pulse oximeter < 90%) are associated with worse outcome
- Complete neurologic assessment
- Complete spinal immobilization
- Transport to closest appropriate facility

# Indications for CT Scan

## High Risk

- GCS score still < 15 two hours after injury
- Neurologic deficit
- Open skull fracture
- Sign of basal skull fracture
- Extremes of age

# Indications of CT scan for mild TBI

Even if no loss of consciousness if one or more present:

- GCS <15
- Focal neurologic findings
- Vomiting more than two times
- Moderate to sever headache
- Age >65 yrs
- Physical signs of basilar skull fracture
- Coagulopathy
- Dangerous mechanism of injury (e.g. fall>4 ft)

# Indication cont’d

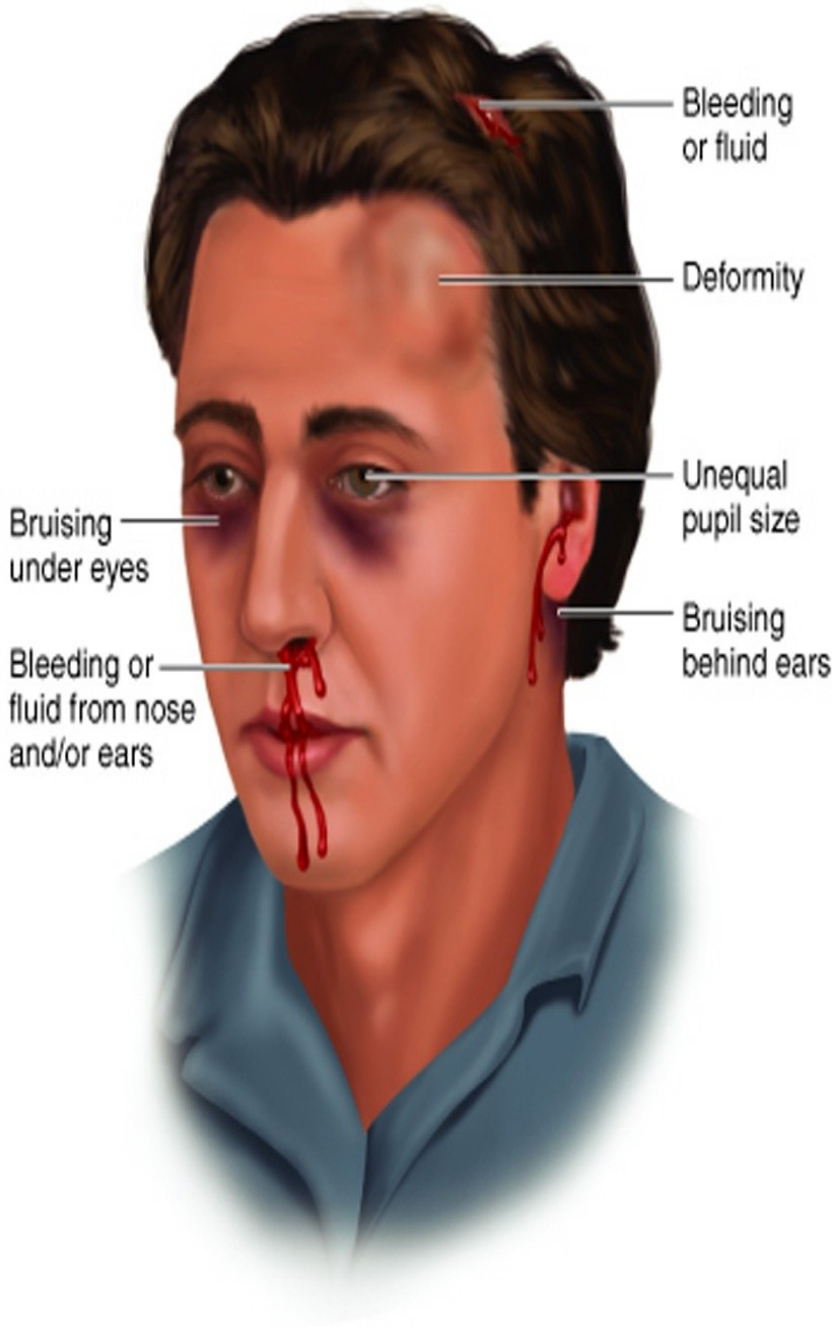
Mild TBI with loss of consciousness if one or more present :

- Drug or alcohol intoxication
- Physical evidence above the clavicles
- Persistent amnesia
- Post-traumatic seizures

# Skull Fracture

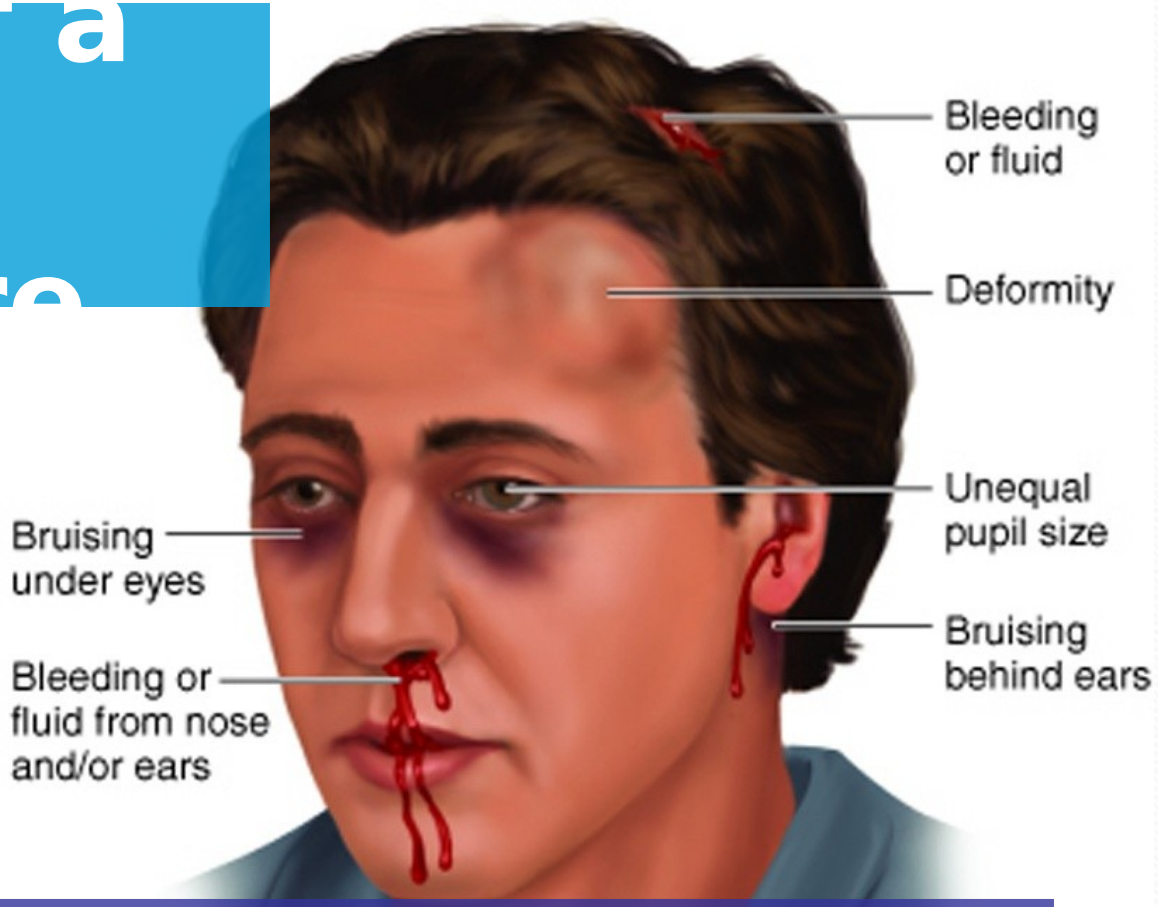
- Check for possible skull fracture before applying direct pressure to scalp bleeding
  - Direct pressure could push bone fragments into brain
- Skull fracture is life threatening

# Signs of a Skull Fracture




- Deformed area
- Depressed or  spongy area
- Blood or fluid from ears or no
- Eyelids swollen or becoming

# Signs of a Skull Fracture




- Bruising under eyes (raccoon eyes)
- Bruising behind ears (Battle's sign)
- Unequal pupils
- An object impaled in skull

# Emergency Care for Skull Fractures

- Care as for any head/spinal injury
- Don’t clean wound, press on it, or remove impaled object
- Cover  wound with **sterile dressing.**
- **Antibiotics** for open skull fractures

# Emergency Care for Skull Fractures



- If bleeding, apply pressure only around edges of wound. Use a ring dressing
- Do not move victim unnecessarily

Further reading

- Tintinalli’s emergency medicine 7th ed from page 1692-1709

- 28 years old female patient brought to ED after head trauma with RTA. Initially she is conscious and complain head ache and nausea. V/s: HR 120, BP 150/90, RR 28, Sao2 90% with atmospheric air.
- What is our priority of assessment
- List clinical clues and DDX
- How do we manage this patient

# THANK YOU