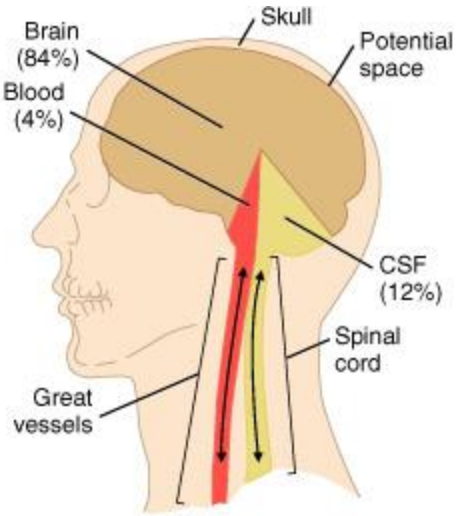
Increased ICP – Lesson Description by Mitch Taylor

- Identify basic anatomy and physiology of the brain.
- Assess neurologic dysfunction clinically and by Glasgow Coma Scale.
- Recognize steps needed to prevent further injury.
- Identify the need for quick assessment and diagnostic testing (CT scan).
- Discuss physiologic changes and the nursing implications resulting from the diagnostic tests.
- Discuss pharmacological interventions for clients with altered level of consciousness, increased intracranial pressure, craniocerebral trauma and tumors.
- Evaluate effectiveness of nursing interventions for clients with altered level of consciousness, increased intracranial pressure, craniocerebral trauma and tumors.

Anatomy and Physiology



- Four components to the brain
  - Skull – cannot expand
  - Brain
  - Blood
  - CSF (Cerebral Spinal Fluid)
- Munro-Kellie Hypothesis states
  - Skull – cannot expand/contract
  - Other 3 components – if one changes, the other 2 compensate by decreasing in volume

Anatomy and Physiology

- Brain – As a vital organ, it needs blood flow or perfusion to keep it alive.
  - CPP – Cerebral Perfusion Pressure is how we measure that flow to the brain
  - CPP = MAP – ICP MAP = (SBP + 2XDBP)/3 it will be the number in parenthesis on the monitor next to the BP.
  - ICP = Intracranial Pressure is the force exerted in the cranial vault by its contents. We are concerned with that pressure on the brain. < 20 is normal.

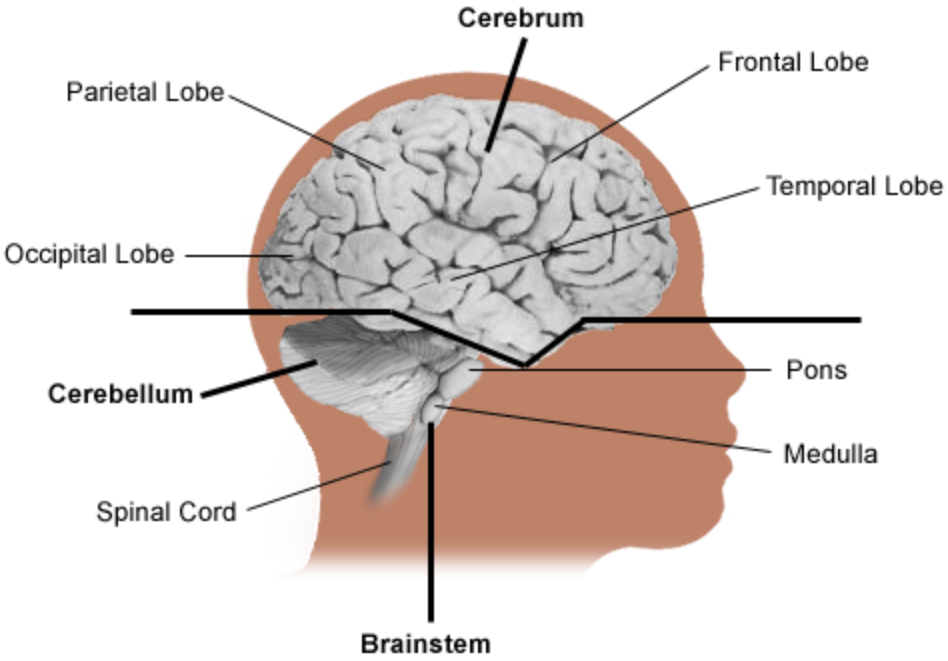
Anatomy and Physiology

- ICP is the pressure on the brain: keep < 20mmHg.
- CPP is the blood flow to the brain: keep the brain perfused > 70mmHg.
- Munro-Kellie hypothesis-If one changes, the other 2 compensate by decreasing in volume.
  - First compensation due to swelling from injury or bleeding is displacement of CSF out of the brain and into the spinal canal – only can compensate to a point then ICP will increase.
  - Second compensation is reducing blood volume to the brain, perfusion to the brain is altered.
  - Third compensation is no where else to go the brain is forced in to the only opening down into the spinal cord. This is called herniation and produces death.

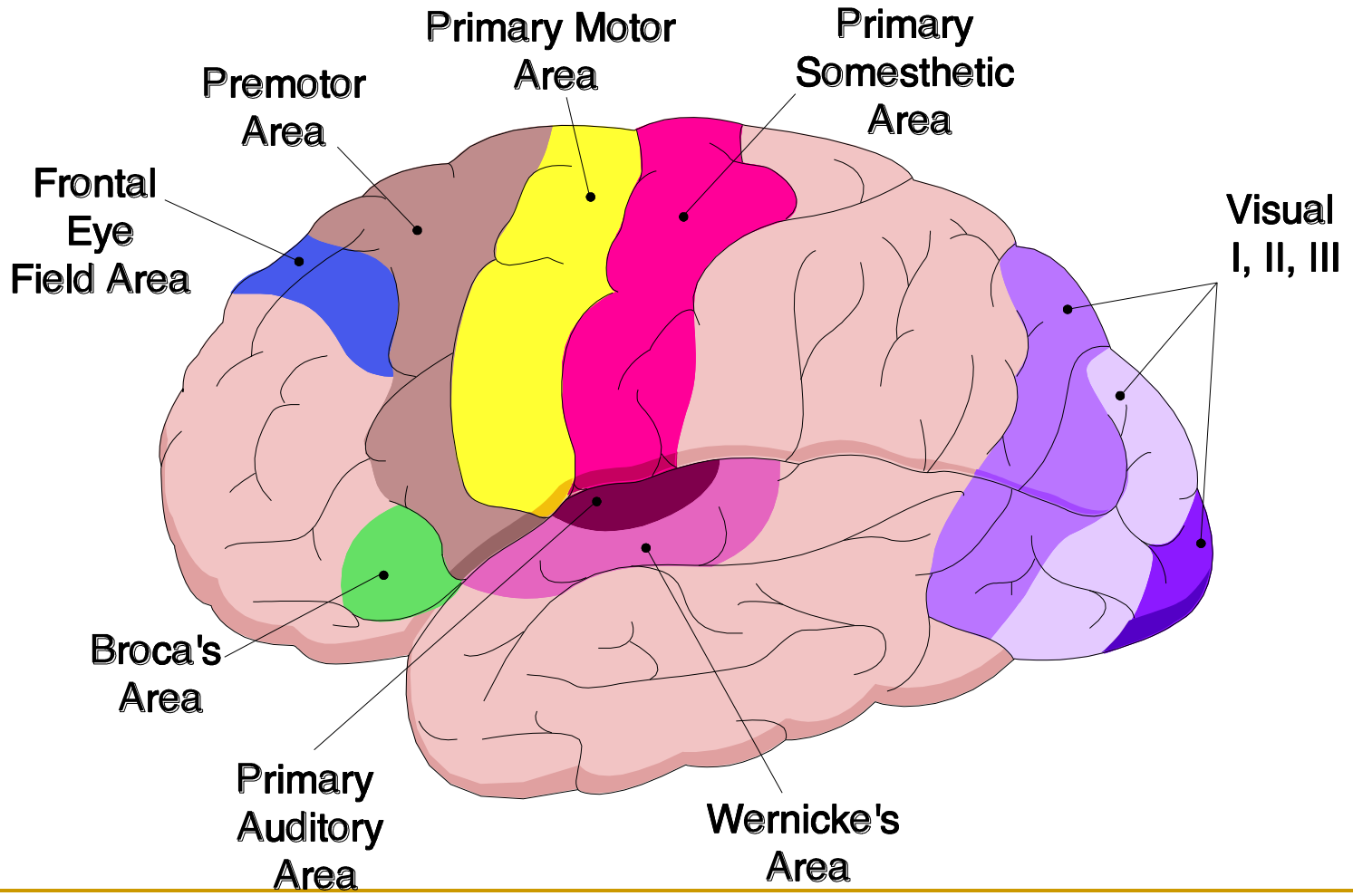
Above is the Cerebrum
Below is the Cerebellum and Brainstem

- This line represents the Tentorial Membrane. Only 2 cranial nerves operate above this level (Supratentorial). CN I – smell and CN 2 – sight.
- CN III-XII operate in the Brainstem.

This is good to know when evaluating for the source of the lesion.



Areas of Function in the Brain



Glasgow Coma Scale (15 points)

Eye-opening	Verbal Response	Motor Response
4 Spontaneous	5 Oriented	6 Obeys command
3 To loud voice	4 Confused	5 Localizes pain
2 To pain	3 Inappropriate words	4 Withdraws from pain
1 None	2 Incomprehensible words/sounds	3 Flexion from pain
	1 None	2 Extension from pain
		1 None

This assessment scale helps to quantify changes and identify worsening symptoms for treatment. Decorticate posturing is considered flexion on the scale. Decerebrate is considered extension. I always remembered decerebrate as celebrate (extend arms to celebrate) to remember which is which.

Other changes seen can be in one sided weakness, facial drooping, nausea, vomiting, hyperthermia, headaches, hypoxia, Cheyne-Stokes Respirations, Cushing's Triad (late sign of high ICP) – of increased SBP, widening pulse pressure, and bradycardia.

Neuro. Changes

- Glasgow Coma Scale – p. 1930 (assessment)
  - Point of maximum stimulation, so sleeping is not a neuro. deficit. If they are awakened, the patient should be able to respond appropriately. Pinching around axilla, sternal rub, pinching nail bed with Kelly clamp, ice water to ear canal are all ways to stimulate a comatose patient.
  - Clamping you fingers may be reflexive but releasing would not be.
  - Have the patient give a thumbs up to follow directions.
  - Always perform as a baseline before procedures or movement.
- Symmetry of movement and strength checked
- Pupil size and response checked
- Babinski sign – stimulation to the bottom of the foot should be negative in adults, toes do down – positive, toes go up and fan out, indicating altered perfusion to cerebral cortex.

Classic signs - expanded

- Headache – usually severe
- Early changes in mental state include lethargy, irritability, slow decision making and abnormal social behavior. Untreated, can deteriorate to stupor, coma and death.
- Vomiting (in early stages without nausea) and can progress to projectile with rising ICP.
- Pupil changes including irregularity or dilatation in one eye.
- Fundoscopy shows blurring of the disc margins, loss of venous pulsations, flame-shaped hemorrhages. In later stages, may see obscured disc margins and retinal hemorrhages.
- Late signs include motor changes (hemiparesis) raised arterial pressure, widened pulse pressure and slow irregular pulse.
- ‘Talk and deteriorate’ patients typically talk recognizably following head injury then go into coma in the first two days. Usual cause is an intracranial hematoma.

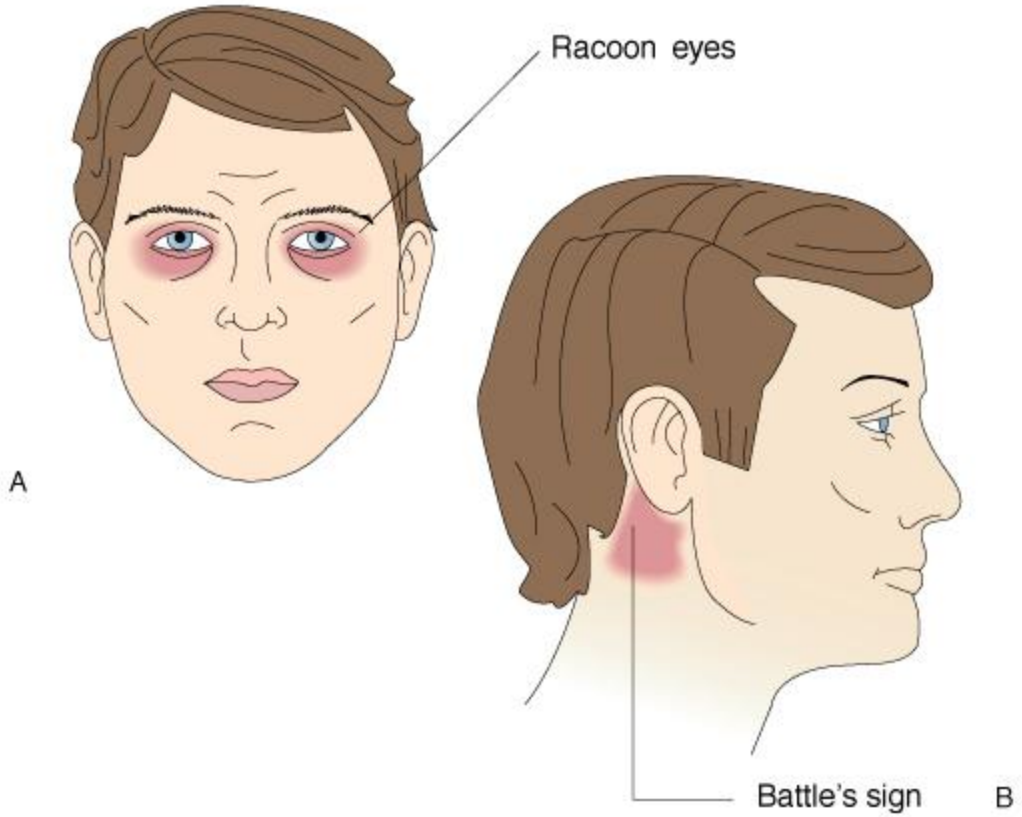


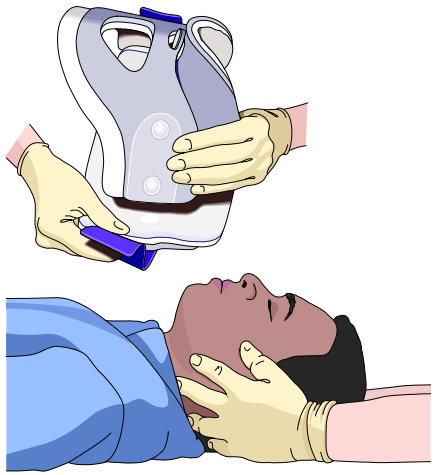
Figure 41-4 (**A**) Periorbital ecchymosis, called racoon eyes, and (**B**) periauricular ecchymosis, called Battle's sign.

Case Study

- A 22 year old comes into the ER with MVC (motor vehicle crash) at 6:30am. Patient was not wearing a seat belt. Patient lost control and hit a tree going about 30mph.
- Initially patient lost consciousness at the scene and was given a Glasgow Coma Score of 3 and then 14 as patient began to wake.
- Patient is transported to the ER with a Glasgow Coma Score is given of 15.

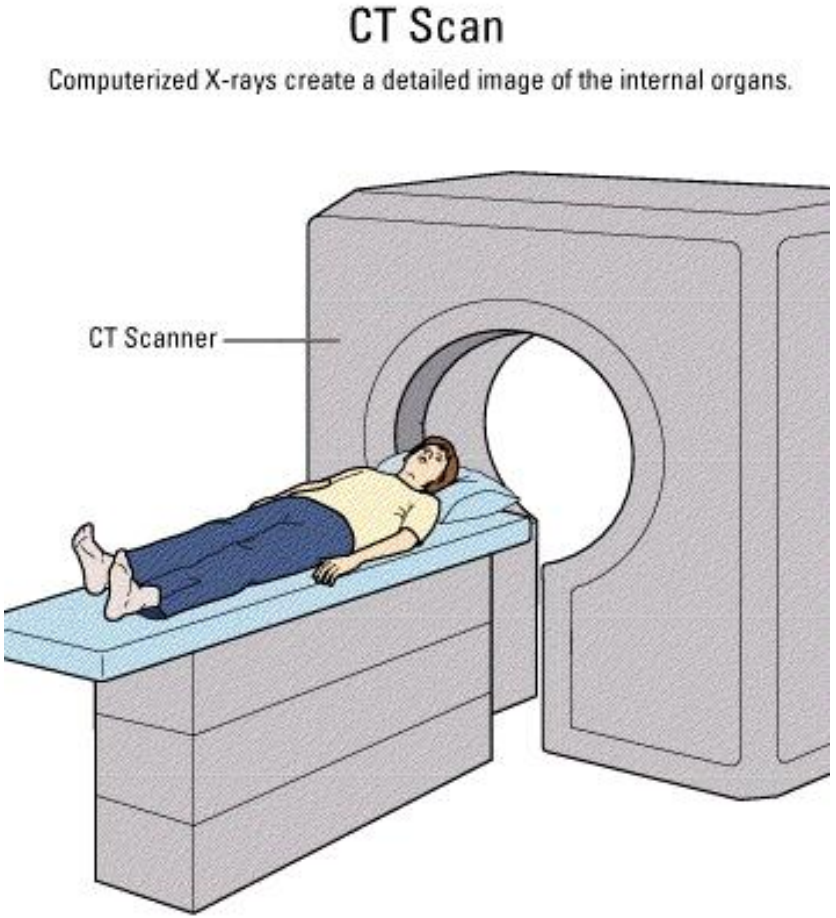
Case Study

- Patient is placed on a nasal cannula to maintain oxygenation at 4L.
- A rigid C-collar is placed on the patient's neck and spinal precautions are maintained.



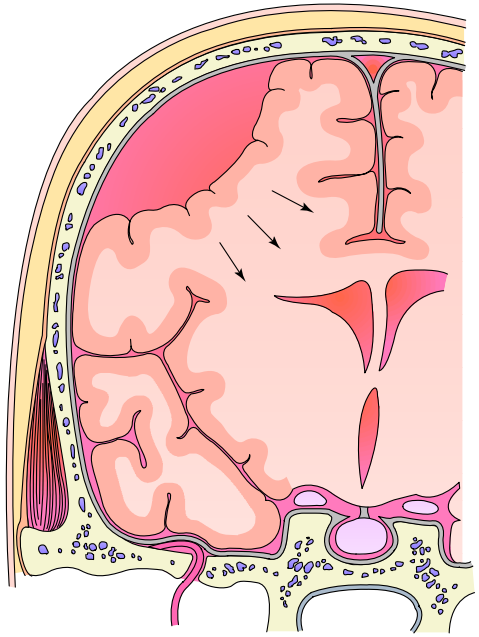
Case Study

- A CT scan is done without contrast to the head to look for any gross bleeding or abnormalities. Important to rapidly get the patient to a noncontrast CT.



Case Study

- A small subdural hematoma is reportedly found on the CT scan in the right temporal area.

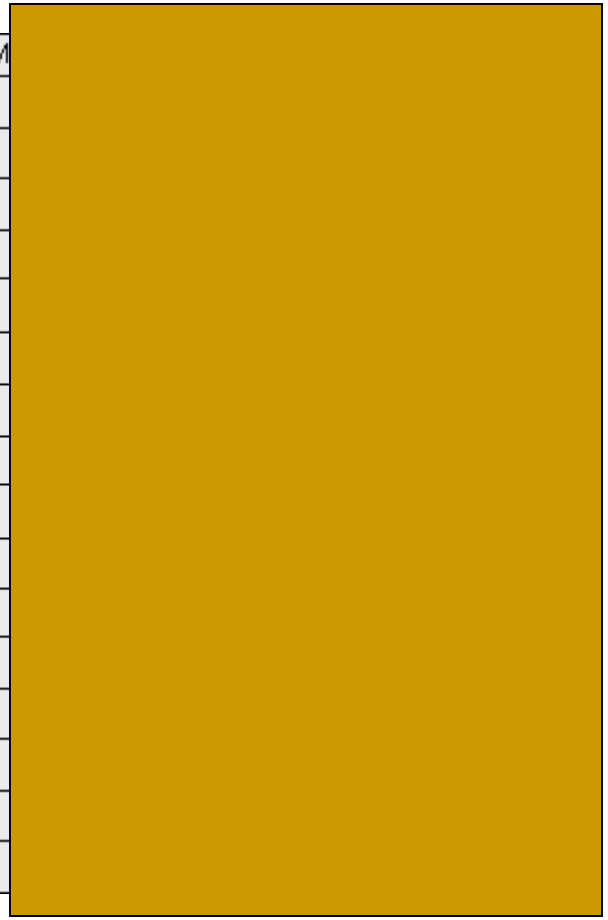


Case Study

- Patient is to be transported to your unit in SICU at change of shift 7:30am.
- Report is called to you.
- A neurosurgeon has been consulted to see if surgery is an option to remove the blood by craniotomy.
- The neurosurgeon is on the way and will evaluate the patient in SICU.
- Your first assessment at 8am, shows a 15 on the Glasgow Coma Scale. Symmetry of movement and strength bilaterally, and PERRLA +3/Brisk +3/Brisk reaction to the pupils.

Glasgow Coma Scale 8 am

Glasgow Coma Scale			A.M
Assessment	Reaction	Score	8
Eye Opening	Spontaneously	4	X
Response	To speech	3	
	To pain	2	
	No response	1	
Verbal Response	Oriented x3	5	X
	Conversation confused	4	
	Inappropriate speech	3	
	Incomprehensible sounds	2	
	No response	1	
Motor Response	Obeys verbal command	6	X
	Localizes pain	5	
	Flexion withdrawal	4	
	Flexion	3	
	Extension	2	
	No response	1	



Case Study

- Patient is wanting to get up and drink some water.
- Patient education: Reverse Trendelenburg position is provided and explained to the patient that until the neck can be cleared, the same trauma that caused the bleed could have caused a small fracture to the neck. It is important to stay in alignment until that is checked or the patient can cause spinal chord injury and possibly paralysis.
- Also maintaining the patient NPO until Neurosurgeon decides if will go to surgery or not is important to not risk the chances of aspiration.
- Patient and family verbalize understanding.

Case Study

- At 9am, no change on the Glasgow Coma Scale, still a 15.
- The Neurosurgeon is evaluating the patient for surgery and talking to patient and family.
- Cervical, Thoracic, and Lumbar spinal films are done and awaiting to be evaluated by the Trauma physicians.
- The patient is becoming more agitated with the C-collar and wants to get up.

Case Study

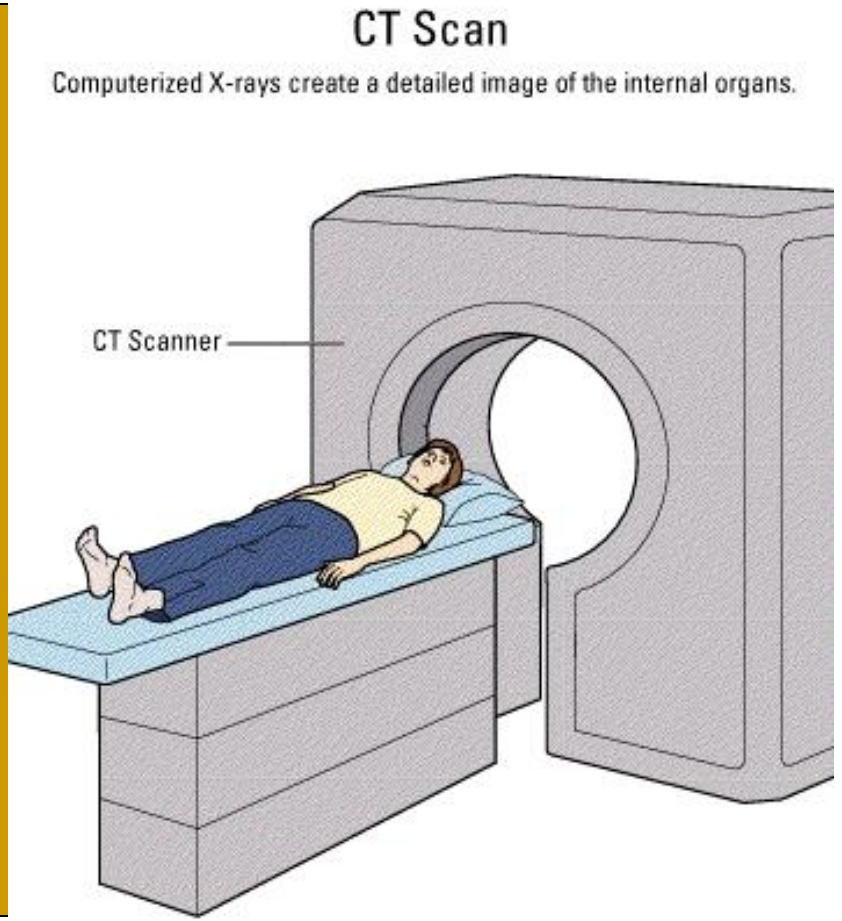
- The neurosurgeon tries to explain the importance of maintaining spinal alignment.
- The nurse called the Trauma doctor and they report that it is ok to let the patient sit up, but still want the patient to be NPO and keep the C-Collar on. This is told to the patient which is ok and sits up with C-Collar on.
- The neurosurgeon asks to monitor the patient hourly for neuro checks and to call with changes.

Case Study

- At 10am, the Glasgow Coma Scale is 12. Patient only opens eyes to speech, localizes to pain, and is confused with speech. The RN notifies the Neurosurgeon of the changes, a stat CT scan is ordered without contrast. Left pupil is larger than Right pupil, (CN-III).
- RN notifies the Trauma doctor as well of the changes. Order for intubation. Anesthesia on call is called for stat intubation and Respiratory Therapy is called for a ventilator.

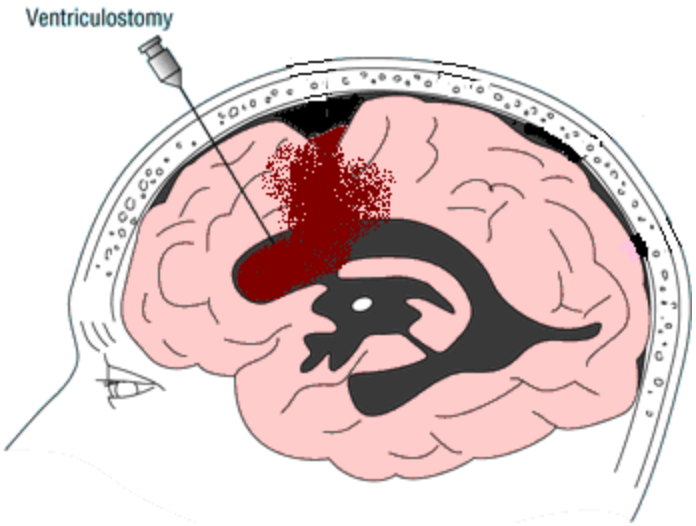
Glasgow Coma Scale 10 am

Glasgow Coma Scale			A.M.	
Assessment	Reaction	Score	8	10
Eye Opening	Spontaneously	4	X	
Response	To speech	3		X
	To pain	2		
	No response	1		
Verbal Response	Oriented x3	5	X	
	Conversation confused	4		X
	Inappropriate speech	3		
	Incomprehensible sounds	2		
	No response	1		
Motor Response	Obeys verbal command	6	X	
	Localizes pain	5		X
	Flexion withdrawal	4		
	Flexion	3		
	Extension	2		
	No response	1		



Case Study

- The CT scan is done and report from radiology called to the Neurosurgeon.
- The Neurosurgeon calls the RN and states the bleed is worse and to set up for a Ventriculostomy and ICP monitor (p. 2197). The physician hopes to be able to place a catheter into the ventricles of the brain to drain off CSF and monitor ICP.



Ventriculostomy Drainage System

Zeroed at the tragus.

After drain is placed by the physician, attach the drainage system and level at ordered measurement.

Case Study

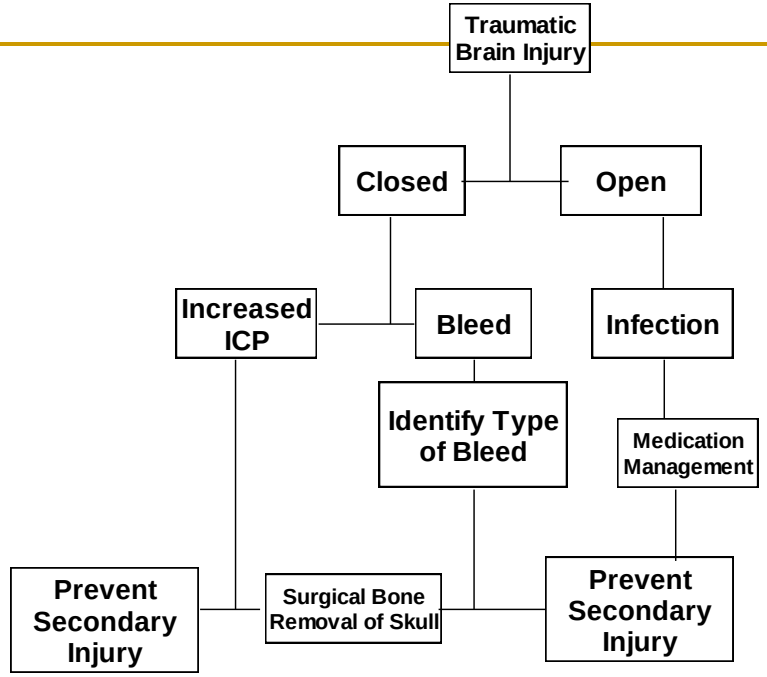
- Consent from family is obtained and the Ventriculostomy is placed (initially 150 mL of blood tinged fluid comes out). ICP is 45, initially with a MAP of 85. The CPP is MAP-ICP = 40.
- Neuro protocols ordered by the Trauma physician.
  - Patient started on Fluid boluses of NS, then Dopamine, then Norepinephrine, then Phenylephrine (Neo-synephrine) to get CPP > 70. Mannitol is given to reduce ICP, Foley is placed to monitor urine output.
- After 1 hour another 80 mL comes out. ICP is down to 22. CPP is up to 72.

Nursing Diagnosis and Management

- Ineffective Tissue Perfusion: Cerebral
  - Would like to have CPP > 70mmHg
  - Would like to have ICP < 20mmHg.
  - BP will be maintained or supported to keep CPP > 70mmHg
  - Temperature will be maintained at less than 38.5 Celsius (101.3F).
  - Maintain urine output > 30mL/hr and not >200mL/hr (may indicate diabetes insipidus)
  - Keep HOB up 30-45 degrees if not contraindicated
  - Monitor for changes in Neuro status

Case Study

- At this point we need to maintain some things. Realistically, we need help from the charge nurse to take or have someone else monitor our other patient.
- Delegate responsibilities of recording vital signs, placing SCDs on patient, dumping and recording urine hourly, hourly accu-checks to monitor Blood Sugars. Many of these patients will be on insulin drips that you regulate, but the monitoring of BSs can be delegated.
- Communicate well with patient, family, respiratory therapy (they will be managing your ventilator), physicians, lab, and diagnostic procedures.
- Goal is to prevent any other injuries like pneumothorax from intubation, infections and blood clots from immobility and being on a ventilator, pressure sores, malnutrition or decreased perfusion to the GI tract, hypoxia, hypovolemia from using Mannitol as a hyperosmotic diuretic to pull off fluid.



Prevent Secondary Brain Injury by:

- Keep paO2 > 60 - oxygenate patient and check ABGs
- Keep SBP > 100 and Keep CPP >70 - use pressors like dopamine, norepinephrine, phenylephrine, vasopressin
- Keep ICP < 20 -Keep HOB elevated 30-45 degrees, chemically sedate patient, treat pain with opiods, avoid meperidine, treat with osmotic diuretics like Mannitol or with hypertonic solutions such as 3%NaCl, chemically paralyze if ICP still high.
- Prevent vasospasms with calcium channel blockers: nimodipine
- Prevent seizures with antiseizure medications such as phenyltoin
- Prevent infection by antibiotics, frequent turning, oral care, up HOB
- Prevent blood clots by TED hose, SCDs/foot pumps, anticoagulants if not contraindicated
- Prevent gastric irritability with proton pump inhibitors if not contraindicated
- Support digestive system and nutrition by early use of enteral feeding
- Prevent hyperthermia
- Monitor End Tidal CO2

Nursing Diagnosis and Management

- Ineffective Airway Clearance
  - This is always the first concern of anyone with a head injury.
- In our case study, the patient was initially unconscious and then came around quickly or he would have been intubated at the scene.
- The patient then was alert and appeared to be able to control his airway.
- Then after a couple hours, that changed and then the airway needed to be secured and protected.
- Ineffective Cranial Tissue Perfusion.
  - This will affect every other system.

Pharmacology

- Mannitol – hyperosmotic diuretic, pulls fluid out of the cells into the vascular space and patients urinate out the extra fluid. Make sure you don't dehydrate these patients. Check serum/urine osmolarity.
- Sedation/Pain meds may be given (after patient unresponsive – if high ICP) initially it might not be given if patient is awake as to not interfere with evaluation of LOC.
- Pain – Opiates like Morphine or Hydromorphone (Dilaudid) about 4 times as potent as Morphine, Demerol is relative contraindication in head injury patients. Watch resp. depression and low BP. Antidote - Naloxone is a drug used to counter the effects of opioid overdose
- Sedation – Versed or Ativan benzodiazepines are a class of drugs with sedative, hypnotic, anxiolytic, anticonvulsant, amnestic and muscle relaxant properties. Watch resp. depression and low BP. Antidote -Flumazenil (Romazicon) is a benzodiazepine antagonist.

Must be mechanically ventilated.

- Propofol is a short-acting intravenous anesthetic agent used for the induction of general anesthesia in adult patients and pediatric patients older than 3 years of age; maintenance of general anesthesia in adult patients and pediatric patients older than 2 months of age; and sedation in medical contexts, such as intensive care unit (ICU) sedation for intubated, mechanically ventilated adults, and in certain procedures. Watch for low BP.
- May use BIS monitoring to watch for sedative effects.
- Patient may need sedation holiday, daily.

Paralytic

- A paralytic may be required to prevent any movement.
- Must be mechanically ventilated.
- They can still feel everything, so sedation/pain medication needs to be given prior to and concurrent with administration.
- Nondepolarizing blockers
  - Atracurium (Tracrium)
  - Vecuronium (Norcuron)
  - Rocuronium (Zemuron)
  - Cisatracurium (Nimbex) – eliminated through resp. system – favored because not eliminated through the kidneys or liver.
- Depolarizing blocker
  - suxamethonium (succinylcholine) – very short duration – 5 minutes. Favored by some for short duration for procedures such as intubation.

Train of Four

- Train of Four is used to determine twitches on the ulnar nerve or at near the eyebrow for patients on a paralytic.
  - 4 light shocks are given causing the unparalyzed person to twitch 3-4 times. Paralytic would need to be increased.
  - 2 twitches out of 4 would be no change in paralytic.
  - 1 twitch out of 4 would be a need to decrease paralytic according to protocol orders.

Seizures - prevent

- Benzodiazepines – common Valium
- Phenytoin - like:
  - Phenytoin (Dilantin) – very caustic to vessels, can cause tissue destruction, make sure you get a good blood return if giving in a peripheral site.
  - Carbamazepine (Tegretol)
  - Valproic Acid (Depakene)

Vasospasms

- Nimodipine - Nimotop is a calcium channel blocker originally developed for the treatment of high blood pressure. It is not frequently used for this indication, but has shown good results in preventing a major complication of subarachnoid hemorrhage, vasospasm
- This is now the main use of nimodipine.
- Also seen given after a craniotomy, cerebral arteriogram or aneurysm clipping or repair.

Surgery

- A craniotomy is the surgical removal of a section of bone (bone flap) from the skull for the purpose of operating on the underlying tissues, usually the brain. The bone flap is replaced at the end of the procedure. If the bone flap is not replaced, the procedure is called a craniectomy. A craniotomy is used for many different procedures within the head, for trauma, tumor, infection, aneurysm, etc.

Craniotomy

- As with any post-op surgery, closely monitoring vital signs is important.
- Patient will come back, generally with a head wrap dressing, face very swollen (this will go down in 2-3 days), and may be very lethargic if they are responsive at all.
- Good neurological checks, a baseline neuro-exam before any procedure will help identify changes afterwards. These patients need to be stimulated to be awakened every hour to check neurological status.
- Let the surgeon know of any deteriorating changes in neurological status, even if slight.

Phenobarbital – given as a last chance to reduce ICP.

- Phenobarbital causes a "depression" of the body's systems, mainly the central and peripheral nervous systems; thus, the main characteristic of phenobarbital overdose is a "slowing" of bodily functions, including decreased consciousness (even coma), bradycardia, bradypnea, hypothermia, and hypotension (in massive overdoses). Overdose may also lead to pulmonary edema and acute renal failure as a result of shock.
- The electroencephalogram of a person with phenobarbital overdose may show a marked decrease in electrical activity, to the point of mimicking brain death. This is due to profound depression of the central nervous system, and is usually reversible.
- If brain death is suspected, then this drug has to be stopped and let out of the system before a patient can be pronounced dead.

Tests to determine brain death.

- Apnea testing. When taken off the vent and CO2 builds up a person will breath if they have basic brain activity. It is not a conscious effort. If a patient fails to breath with an elevated CO2 and low O2, then brain death can be pronounced.
- Blood flow to the brain has to be completely absent to pronounce brain death.
- Keep the rest of organs perfused and may be a good donor for organ retrieval.