TBI: Missed cause of Dementia

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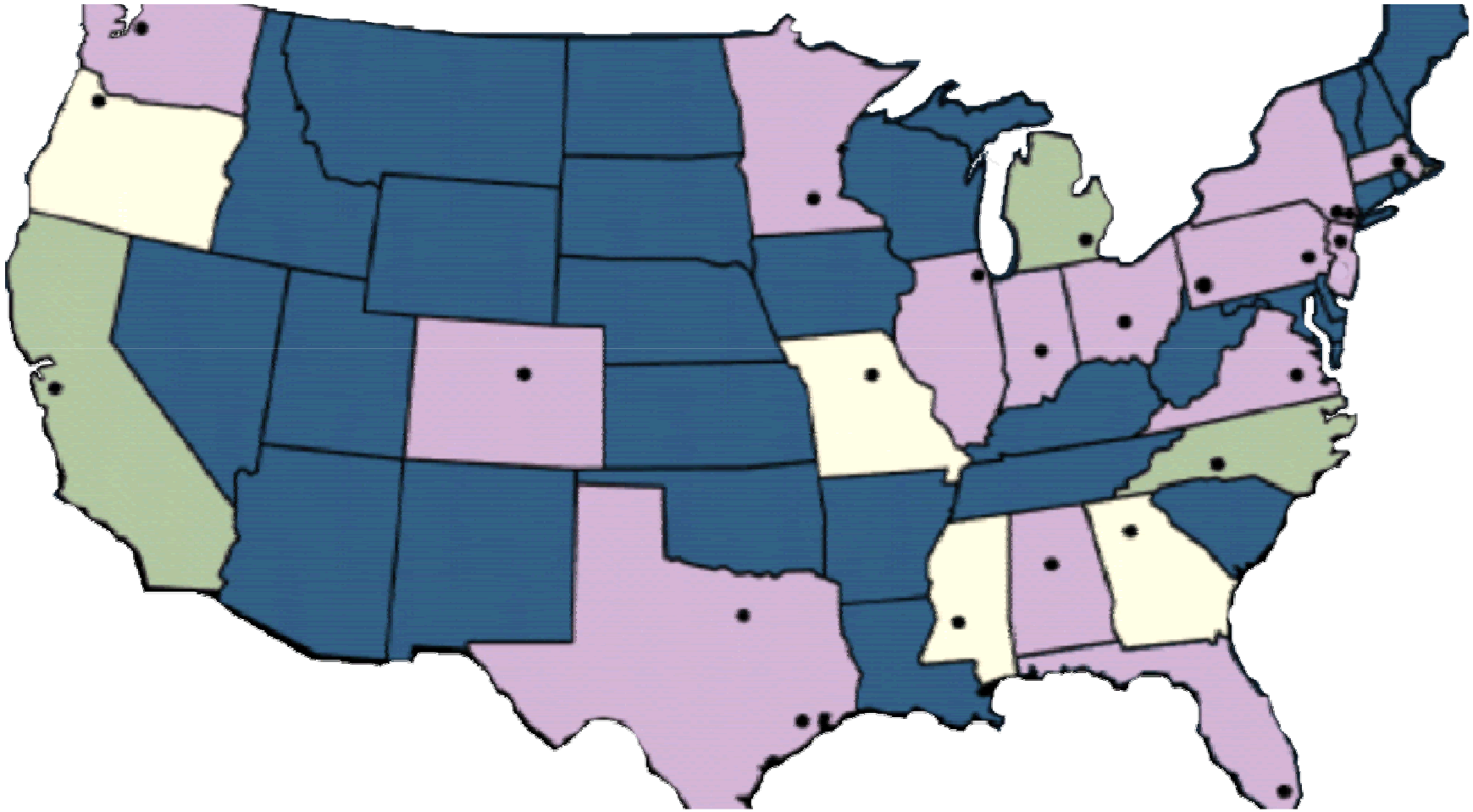
Mount Sinai

NY-TBI Model Systems



Case

- 63 year old man
- Accountant
- Mild cognitive impairments 3 years ago following a cardiac stent
- Recently rapid deterioration in cognition, behavior and mood

DEFINITION

TRAUMATIC BRAIN INJURY

Definition

1. Traumatically induced physiologic disruption of brain function

2. One or more of the following

   a. Any period of loss of consciousness

   b. Any loss of memory of the event immediately before or after the accident, with posttraumatic amnesia

   c. Any alteration in mental state at the time of the accident (eg, feeling dazed, disoriented, or confused).

   d. Focal neurological symptoms

ACRM, 2003

Definition-Mild TBI

1. Traumatically induced physiologic disruption of brain function

2. One or more of the following

   a. Any period of loss of consciousness (<5minutes)

   b. Any loss of memory of the event immediately before or after the accident, with posttraumatic amnesia (<24hrs)

   c. Any alteration in mental state at the time of the accident (eg, feeling dazed, disoriented, or confused).(<24hrs)

   d. Focal neurological symptoms(<24hrs)

3. GCS 13-15

ACRM, 2003

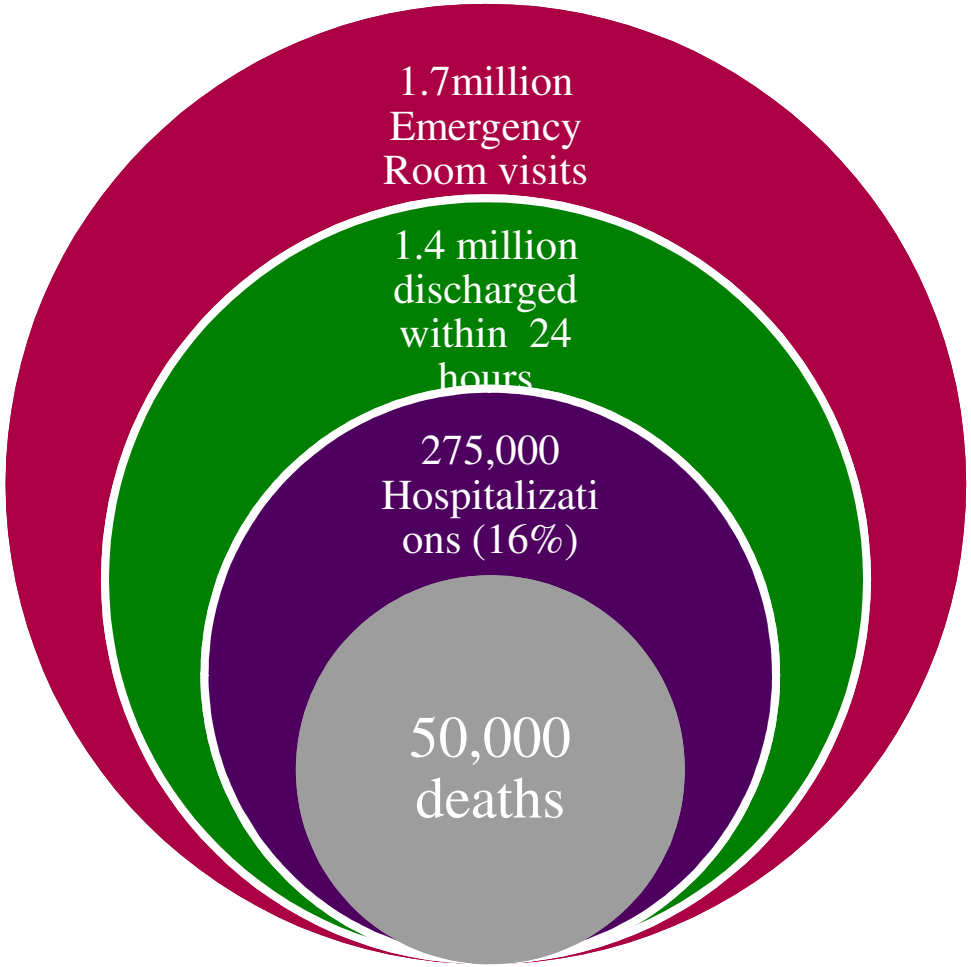
Post concussive Symptoms

- Physical symptoms of brain injury
  - eg nausea, vomiting, dizziness, headache, blurred vision ,sleep disturbance, quickness to fatigue, lethargy, or other sensory loss
- Cognitive Symptoms
  - concentration, perception, memory, speech/language, or executive functions
- Behavioral changes and/or alterations in degree of emotional responsivity
  - eg, irritability, quickness to anger, disinhibition, or emotional lability

Global Estimates

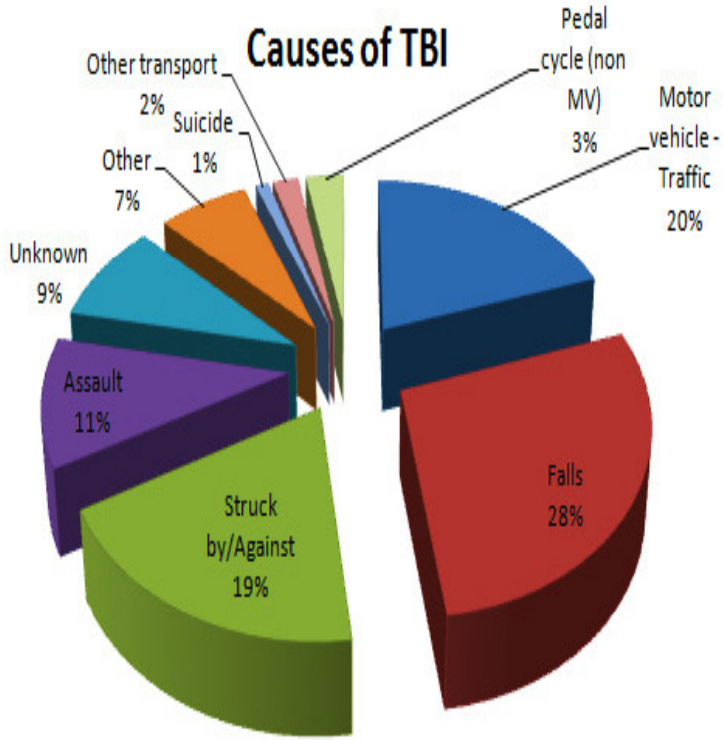
- WHO (2011) -Global incidence rate of TBI
  - Estimated at 200 per 100 000 population/ year
  - Estimated deaths – 1.2 million/Year
  - 70 percent fatalities (850,000) < 45 years of age
- Global Burden of Health (2010)
  - Disabilty adjusted life years (DALY) from road traffic accidents increased by 33% from 1990 to 2010,

Annual Incidence: TBI in the General Population (1.7-3.8 M)

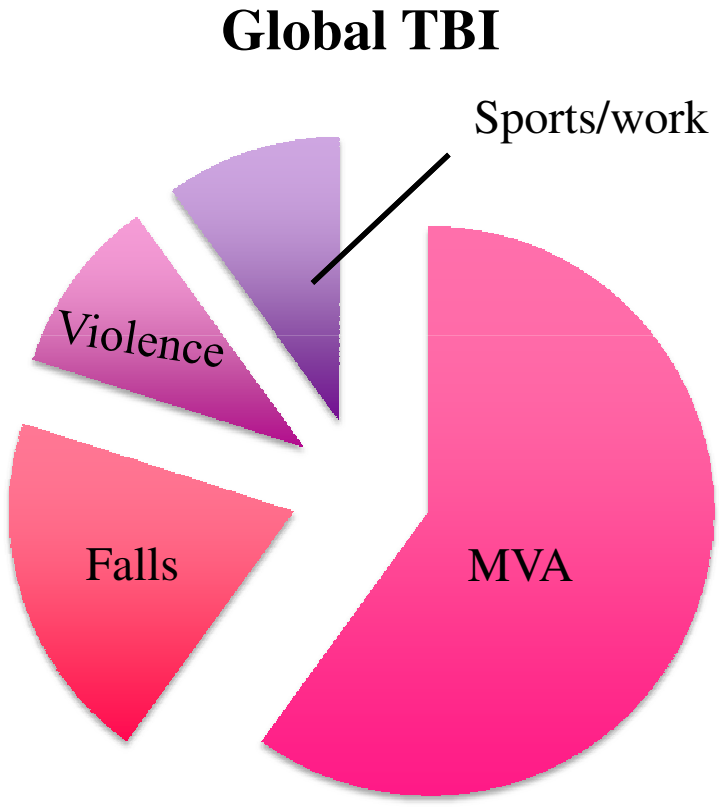


CDC 2006

Epidemiology-Causes

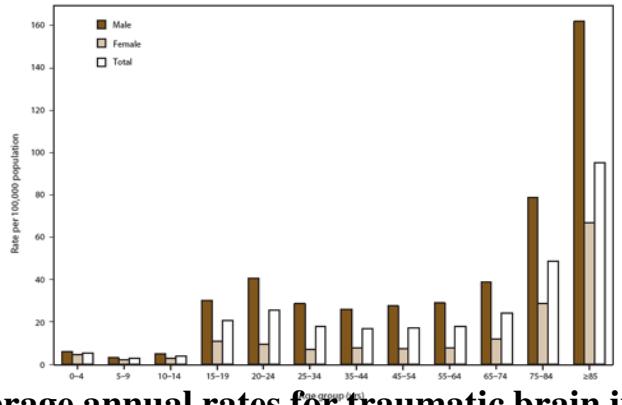


CDC 2006



WHO 2009

Mortality



Average annual rates for traumatic brain injury deaths, by age group and external mechanism of injury --- United States, 1997--2007

Figure 10. Traumatic brain injury rates by age group and cause of injury - Arizona, Colorado, Minnesota, Missouri, New York, Oklahoma, and South Carolina, 1994

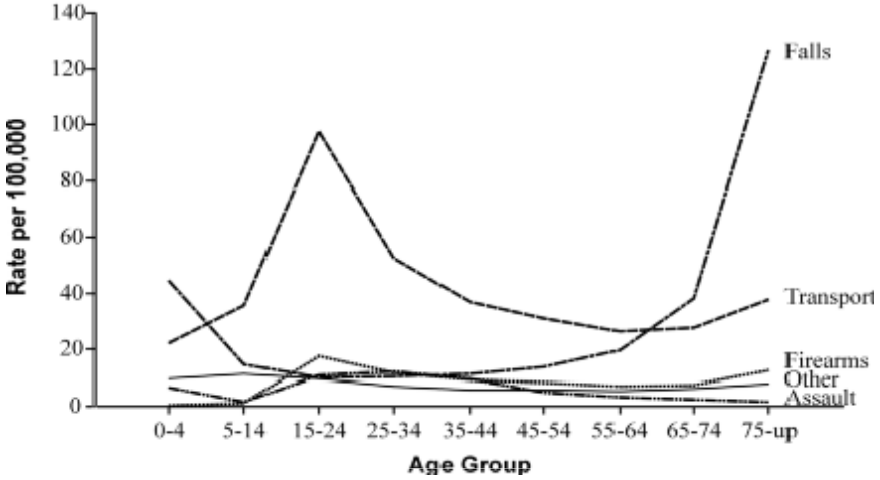
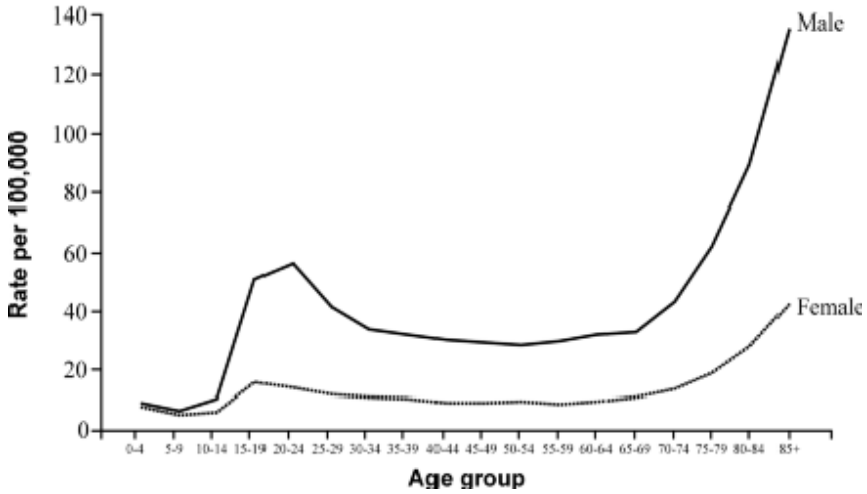
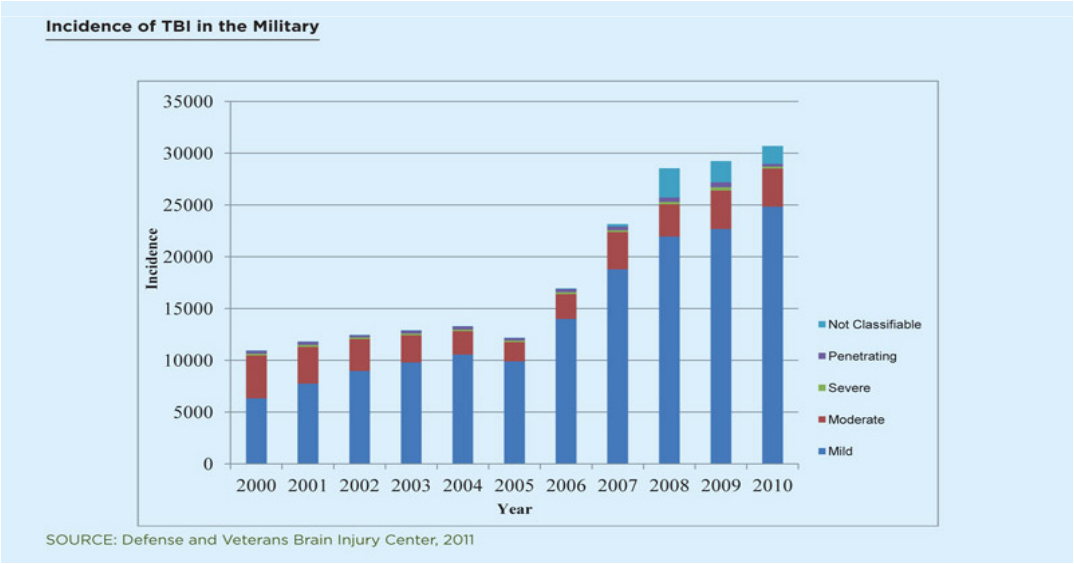


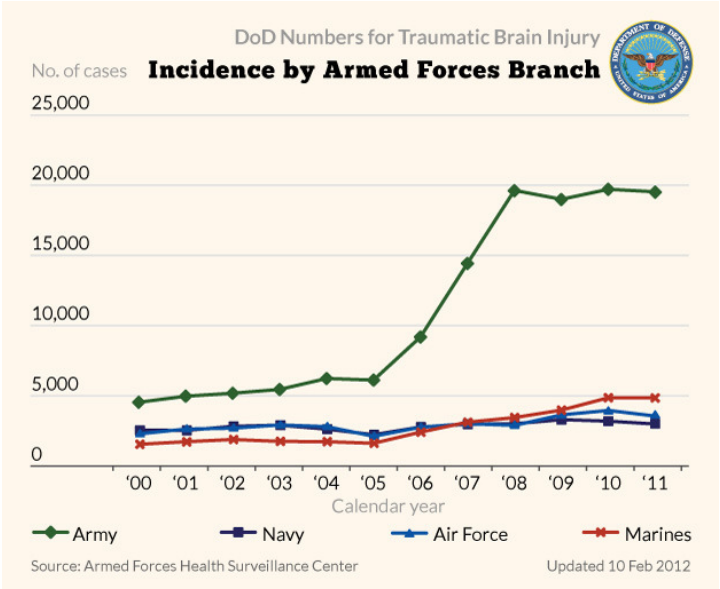
Figure 2. Traumatic brain injury-related death rates by age and gender, United States, 1994



Military

More than 2.5 million Americans have been deployed to OEF/OIF,

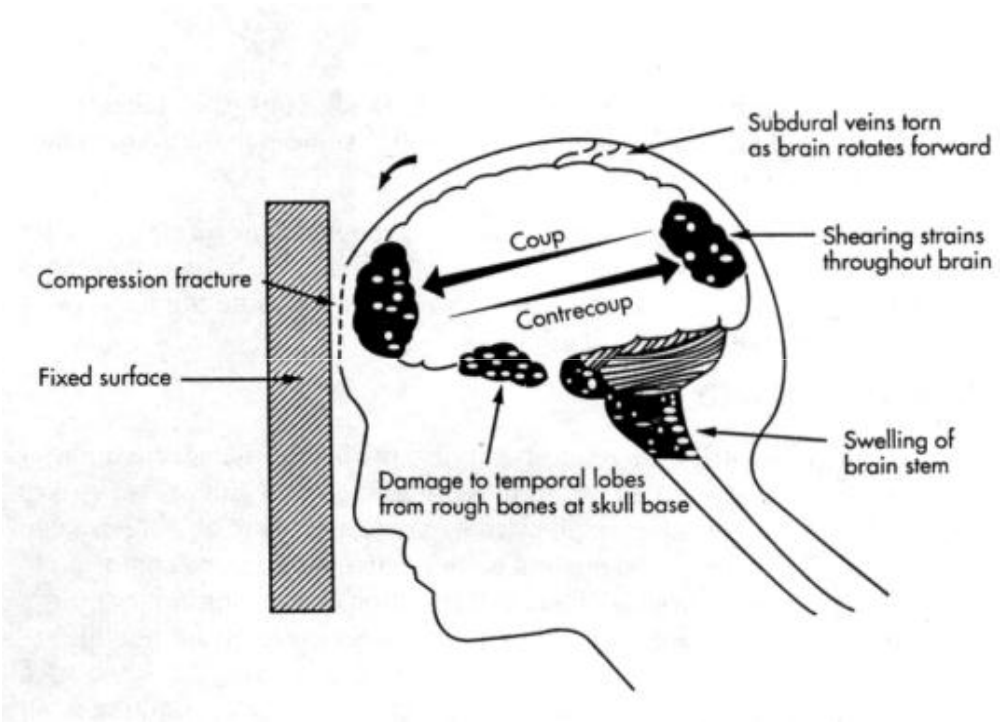




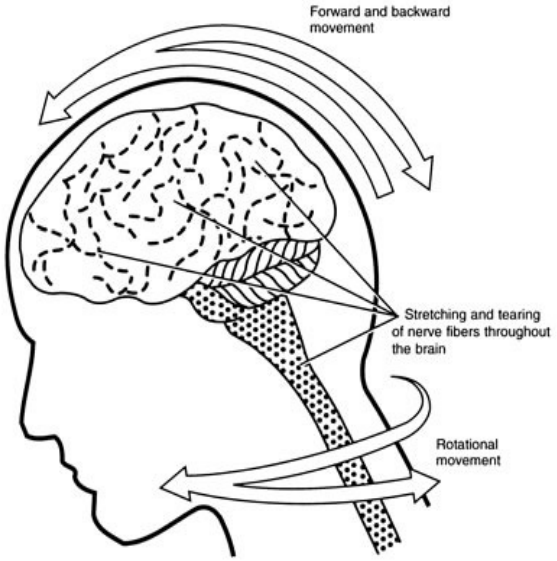
PATHOPHYSIOLOGY

TRAUMATIC BRAIN INJURY

Mechanisms of Injury



Acceleration–decleration



Rotational

Intracranial hematoma (TARN study)

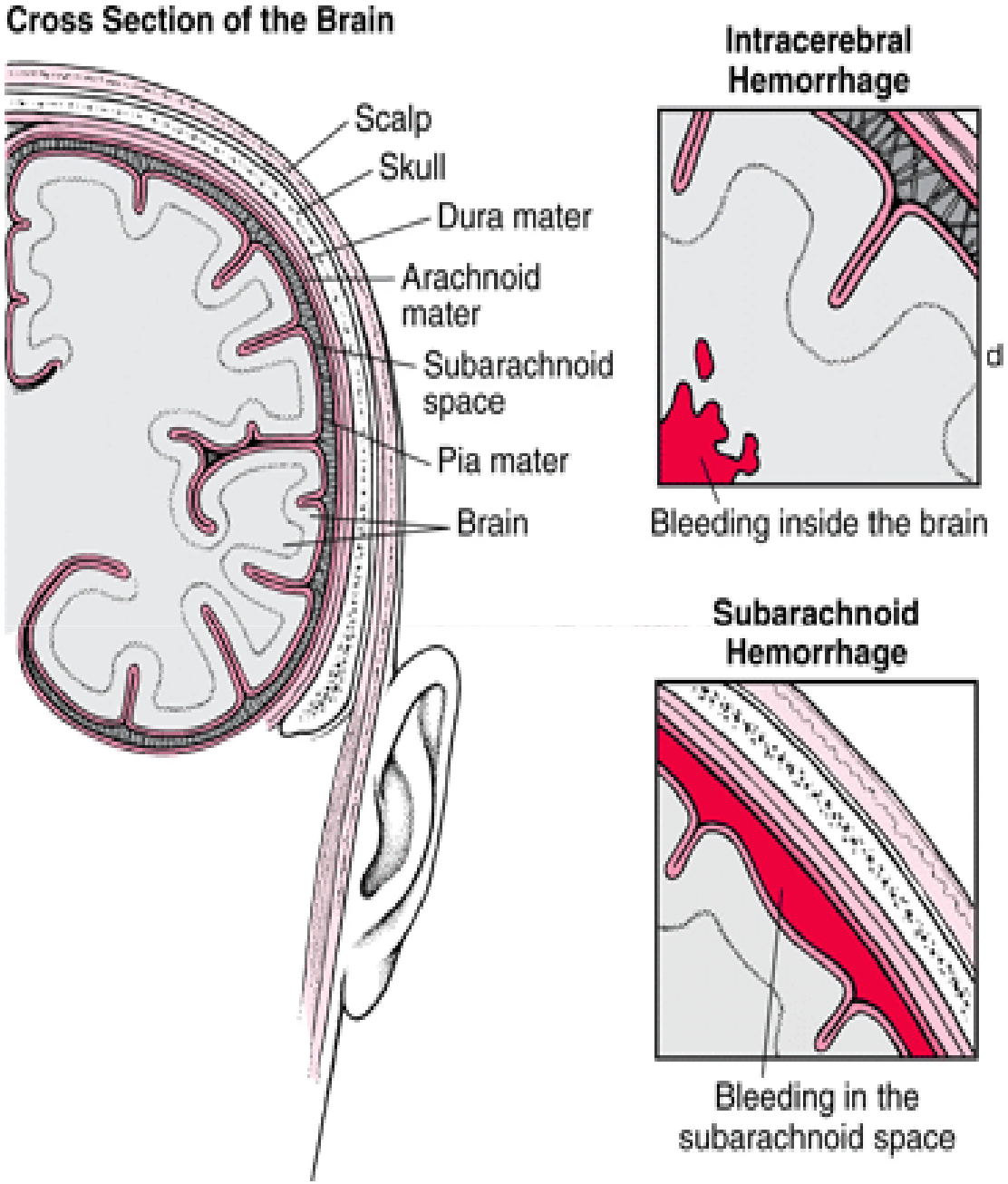
13,962 patients between 2001 and 2008 with a Glasgow Coma Score (GCS) less than 15 at presentation or any head injury with Abbreviated Injury Scale (AIS) severity code 3 and above.

Intracranial hematoma-46%

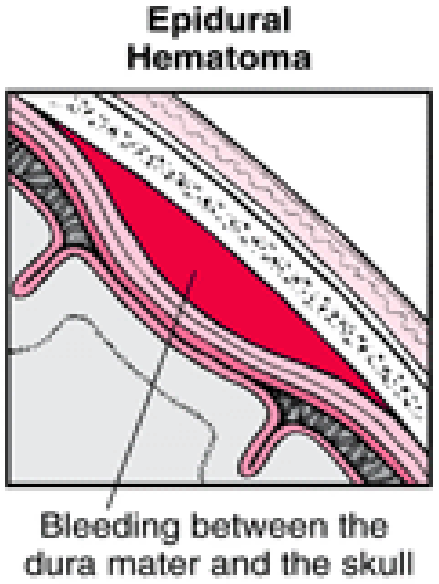
- Epidural hematoma-22%
- Subarachnoid hemorrhage_22%
- Subdural hematomas-30%
- Intracerebral and

Intracerebellar hematomas

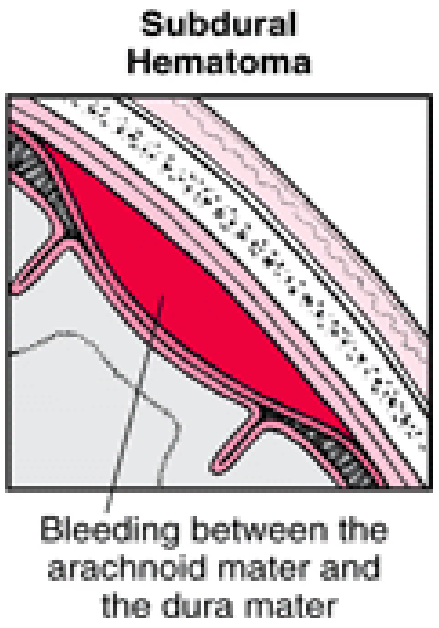
Emergency Medicine 2009,


Cross Section of the Brain
Scalp
Skull
Dura mater
Arachnoid mater
Subarachnoid space
Pia mater
Brain

Intracerebral Hemorrhage
Bleeding inside the brain

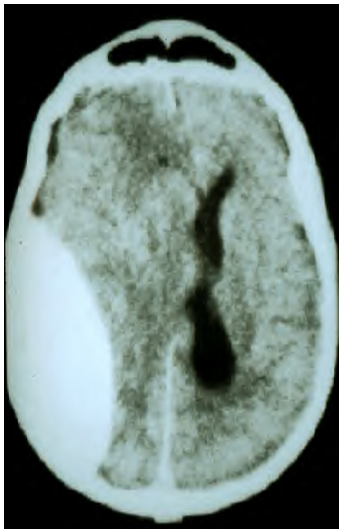

Epidural Hematoma
Bleeding between the dura mater and the skull

Subarachnoid Hemorrhage
Bleeding in the subarachnoid space


Subdural Hematoma
Bleeding between the arachnoid mater and the dura mater

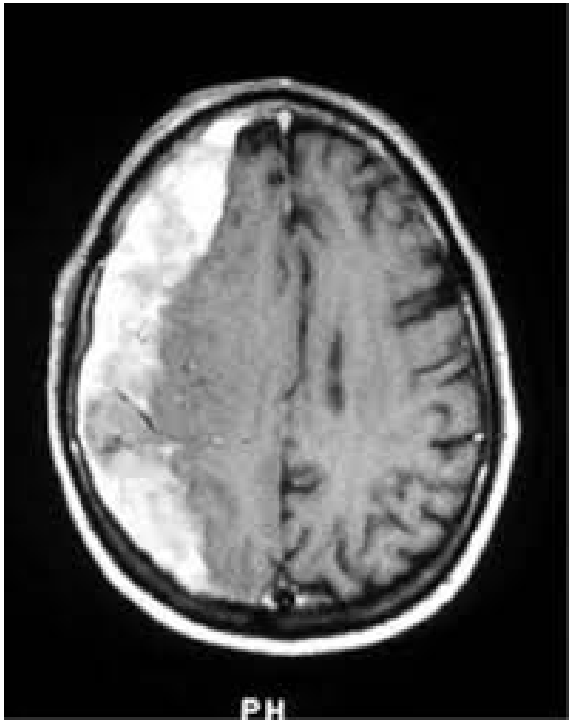
Epidural hematoma (EDH)

Natasha Williams

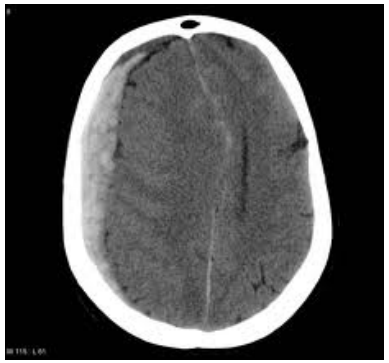


- Lucid interval
- Associated skull fracture (squamous part of temporal bone)
- Most commonly arterial (middle meningeal artery)
- Enlarges fairly rapidly ,causing mass effect
- Appears biconvex on CT scan
- Even with appropriate care, 15 – 20% will die.

Subdural Hematomaral

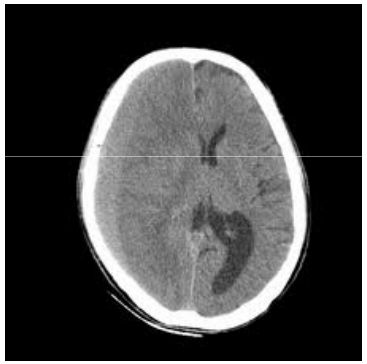


- Crescent-shaped, hyperdense, extra-axial collection spreading diffusely over one hemisphere and can extend along the falx and tentorium-rupture of veins that bridge the subdural space due to sudden change in velocity of the head
- Can be seen in elderly with “minor” trauma
  - Brain atrophy; tension on bridging veins
  - Anticoagulants More common in alcoholics, fallers



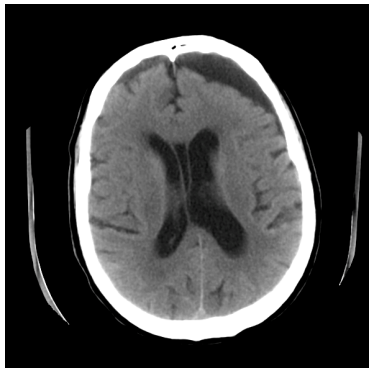
Acute SDH

- 6 hours to 3 days.
- 50% – 80% mortality rate



Subacute SDH

- 2-10 days.
- 25% mortality rate



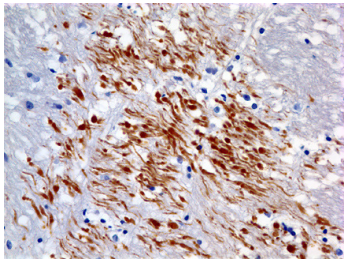
Chronic SDH

- after 2 weeks.
- 20% mortality rate.

Subarachnoid Hemorrhage

- Seen to a degree in most serious TBI brain injuries
- Increased risk of NPH
- Prognosis is grim, with mortality and permanent disability a common result of subarachnoid hemorrhage.
- Mortality-35%

Diffuse Axonal Injury

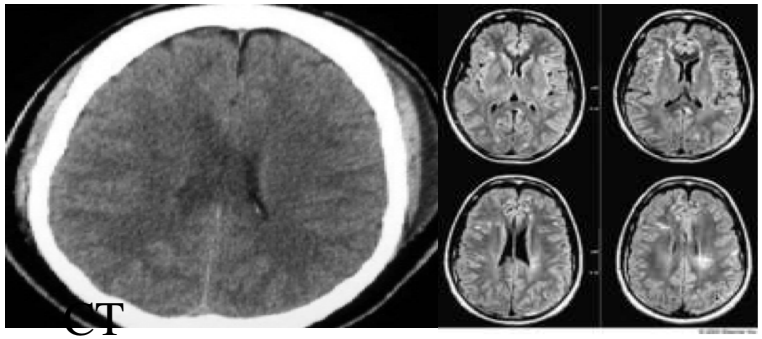


H &E stain

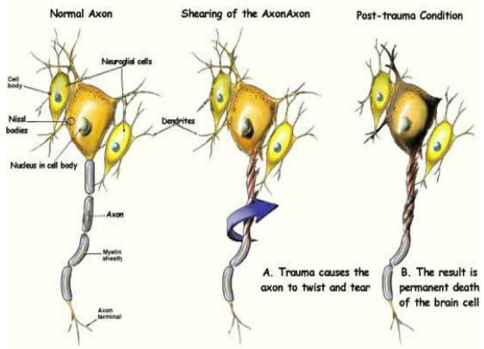
- Axonal Shearing
- Cerebral hemispheric gray-white matter

  interface and subcortical white matter, body

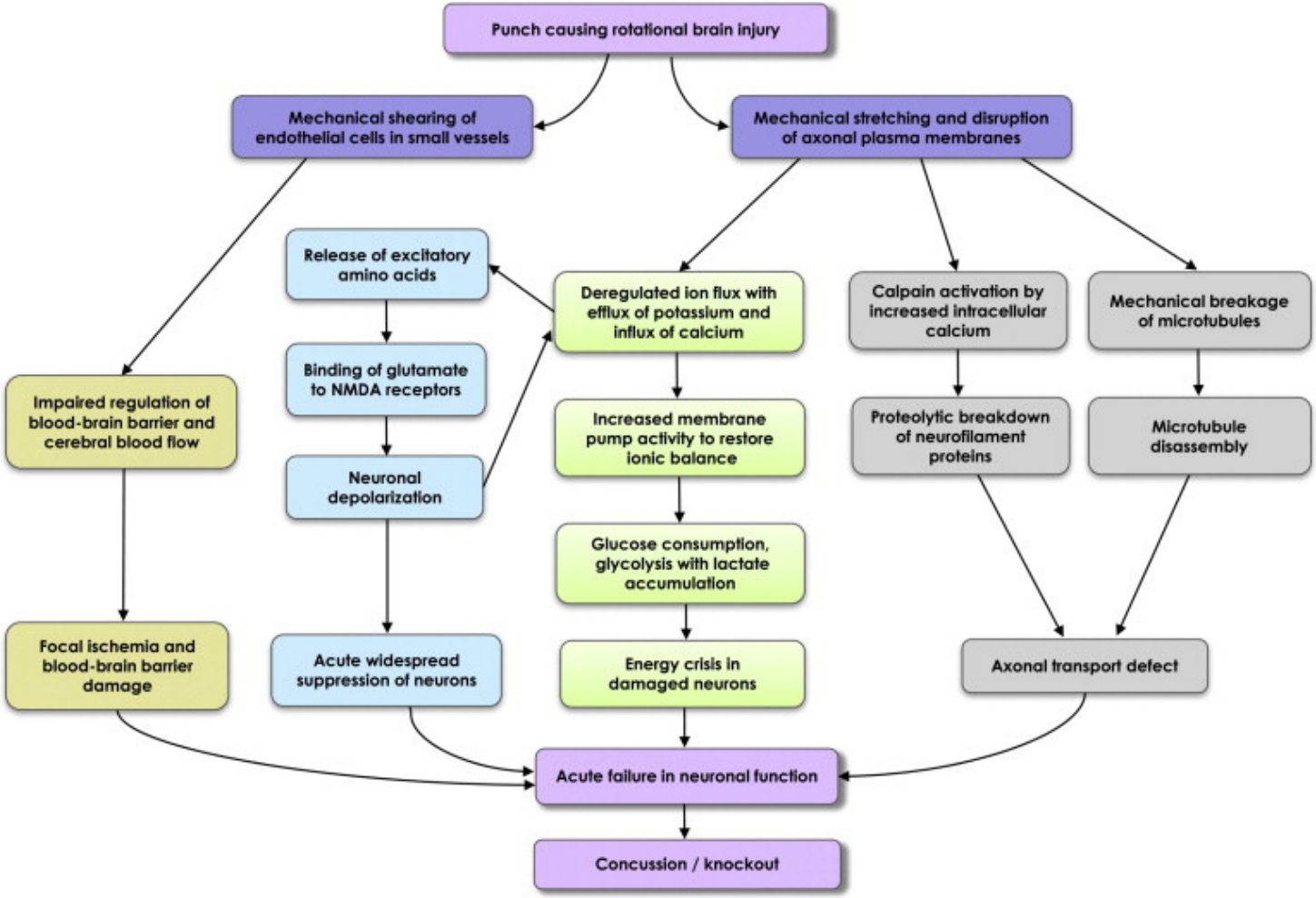
  and splenium of corpus callosum, basal ganglia, dorsolateral aspect of brainstem, and cerebellum.
- Serum marker-S-100B, Neuron specific enolase (NSE)



CT



Secondary Pathology



Complications

- **Cerebral edema**
  - Disruption of the blood-brain barrier, with impairment of vasomotor autoregulation leading to dilatation of cerebral blood vessels,

- **Hydrocephalus**
  - Communicating type-More common. Results from the presence of blood products that cause obstruction of the flow of the cerebral spinal fluid (CSF) in the subarachnoid space and the absorption of CSF through the arachnoid villi.
  - The non-communicating type of hydrocephalus is often caused by blood clot obstruction of blood flow at the interventricular foramen, third ventricle, cerebral aqueduct, or fourth ventricle.

- **Brain herniation**
  - **3 major types-**Subfalcine herniation. Uncal herniation Cerebellar herniation -

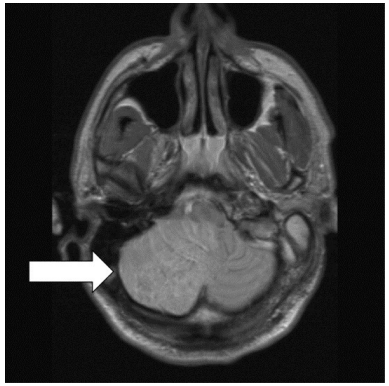
Herniations

Sub-falcine

Cingulate gyrus of the frontal lobe is pushed beneath
the falx cerebri . Most common type of herniation. Often clinically silent.

Uncal herniation

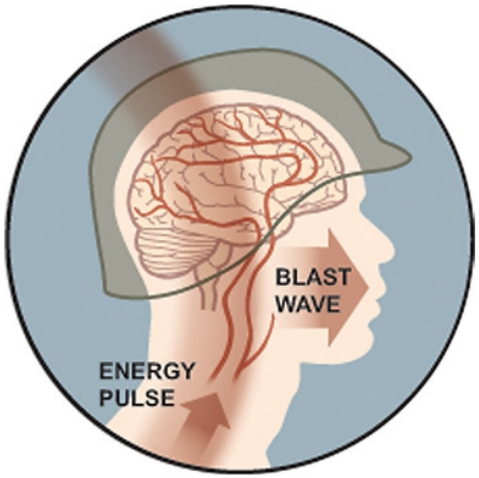
Displacement of the medial edge of the uncus and the hippocampal gyrus medially and over the ipsilateral edge of the tentorium cerebelli foramen,
Causing compression of the midbrain; the ipsilateral or contralateral third nerve may be stretched or compressed



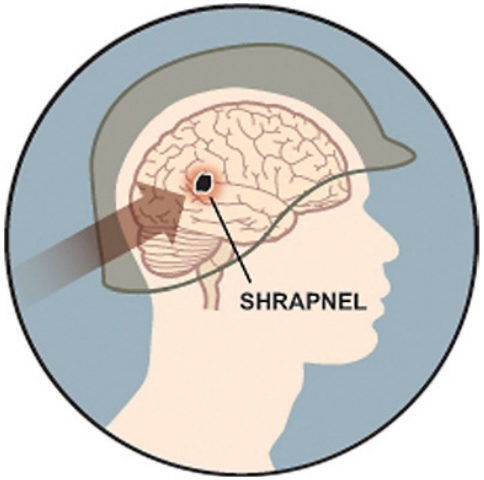
Cerebellar

This injury is marked by an infratentorial herniation in which the tonsil of the cerebellum is pushed through the foramen magnum and compresses the medulla, leading to bradycardia and respiratory arrest.

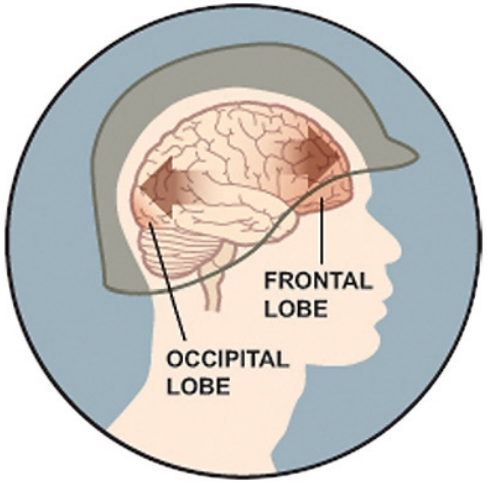
Blast Injuries



Primary Blast Injury



Secondary Blast Injury



Tertiary Blast Injury

Quaternary Blast injury

Degloving, TM haemorhages, perforation, choleastoma, ossibular bone disruption vestibular damage

EYES

corneal abrasions, Open globe injuries, Eyelid laceration, traumatic cataract, vitreous hemorrhage, retinal detatchment, choroidal rupture, optic nerve injuries

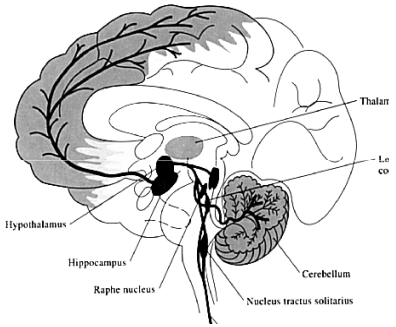
Third spacing,
compartment syndrome,
Renal Failure ,
Rhabdomyolysis ,
Metabolic abnormalities
Hypocalcemia ,
hyperkalemia
Lactic acidosis ,
life-threatening cardiac arrhythmias

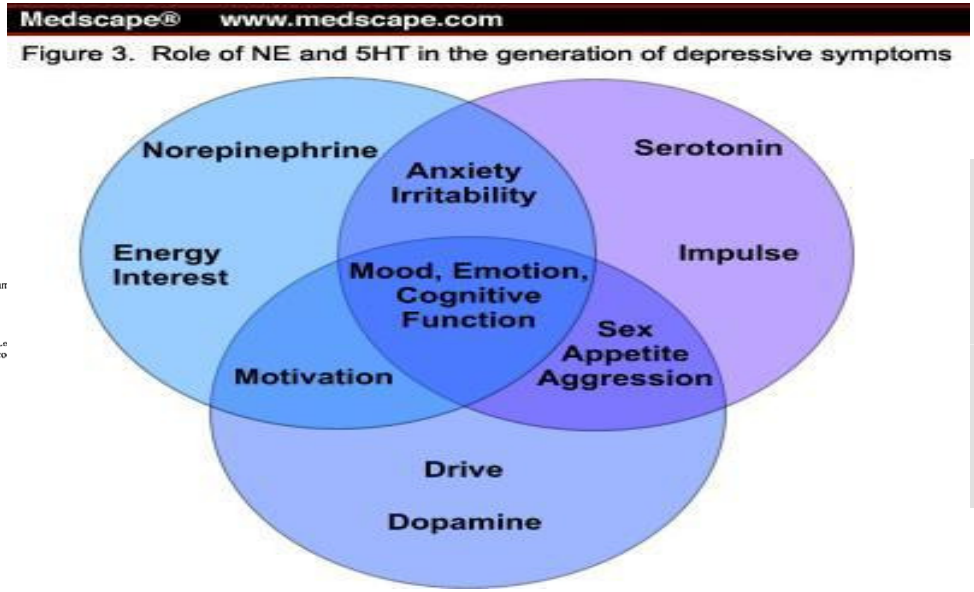
hemorrhage, contusion, edema, bronchopleural fistula, air emboli,

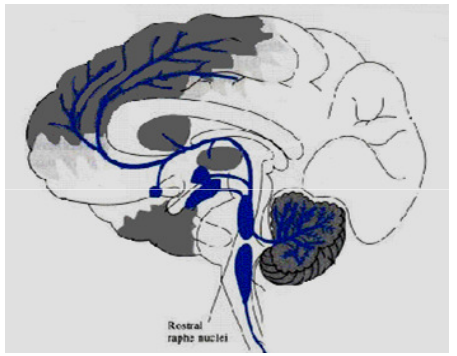
hemorrhage, perforation Trauma to liver, spleen, aortic, illiac vessels

Role of Neuro-transmiters

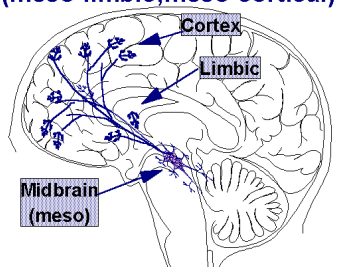
Norepinephrine Pathways







Dopamine Pathways
(meso-limbic;meso-cortical)



Post Concussive Symptoms

Physical

- Headache
- Dizziness
- Balance problems
- Nausea/Vomiting
- Fatigue
- Visual disturbances
- Sensitivity to light/noise
- Ringing in the ears

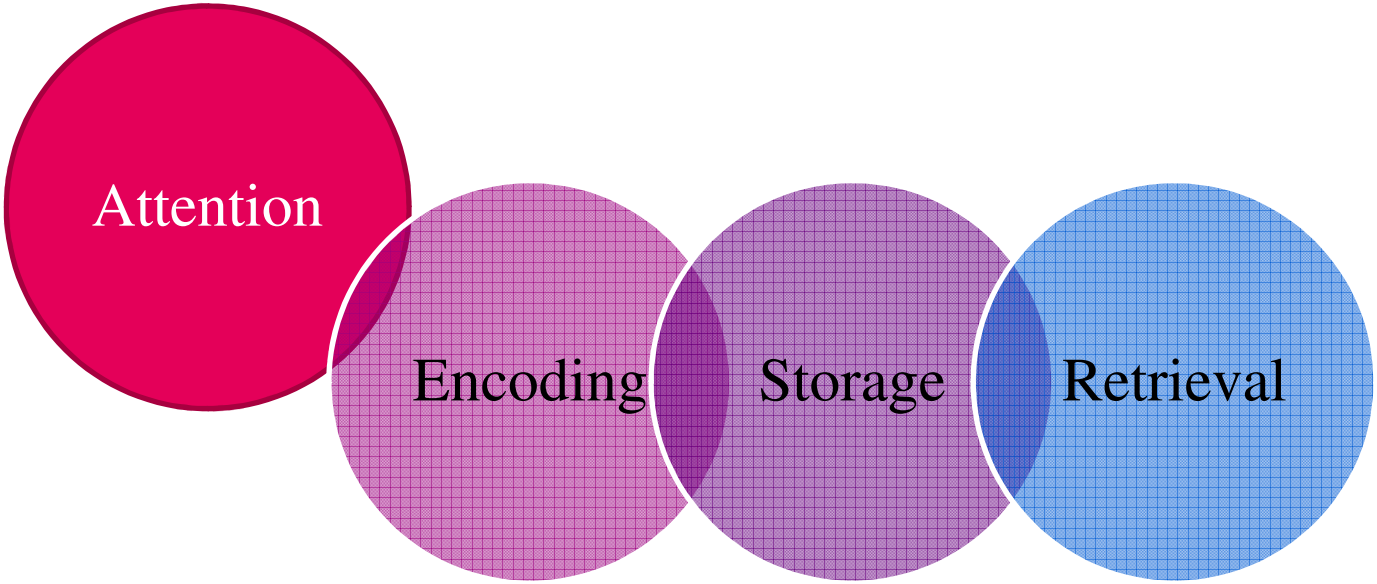
Emotional

- Anxiety
- Depression
- Irritability
- Mood lability

Cognitive

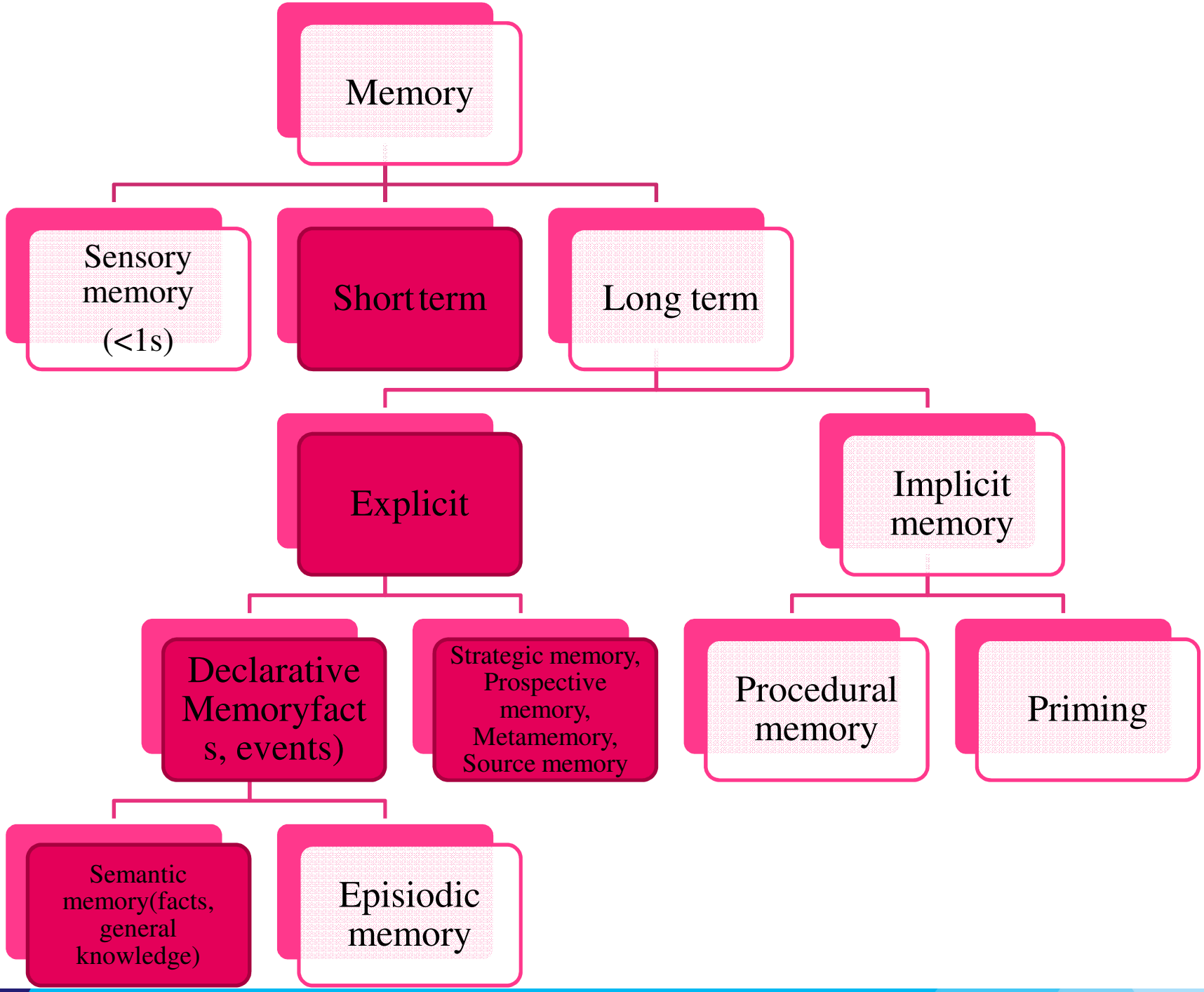
- Slowed processing
- Decreased attention
- Poor Concentration
- Memory Problems
- Verbal dysfluency
- Word-finding
- Abstract reasoning

Process of Memory



Attention

- Simple attention
- **Selective attention**
- **Sustained attention**
- **Divided attention**
- **Supervisory control**


Memory
Sensory memory (<1s)
Short term
Long term
Explicit
Implicit memory
Declarative Memoryfacts, events)
Strategic memory, Prospective memory, Metamemory, Source memory
Procedural memory
Priming
Semantic memory(facts, general knowledge)
Episiodic memory

TBI Executive Dysfunctions

Difficulty problem solving

Difficulty planning/ setting goals

Difficulty organizing

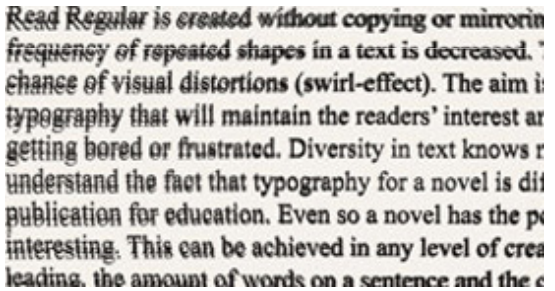
Difficulty prioritizing

Difficulty being flexible

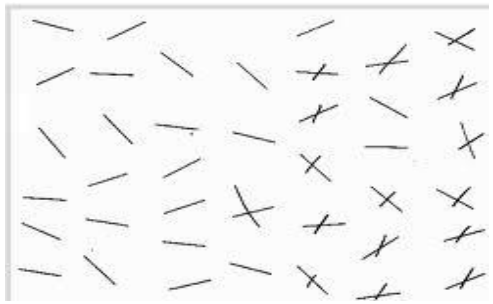
Decreased self awareness and self monitoring

Post-trauma vision syndrome

- Injury to Cranial Nerves II,III, IV,V,VI and VII (7%)
- Accommodation (41 %)
- Tear film integrity (70%)
- Ocular motility-vergence(56.3%) and version(51%-deficit in saccades)
- Visual-vestibular interaction
- Light-dark adaptation
- Visual fields integrity
- Speed and nature of visual processing


Read Regular is created without copying or mirrorin
frequency of repeated shapes in a text is decreased.
chance of visual distortions (swirl-effect). The aim i
typography that will maintain the readers' interest ar
getting bored or frustrated. Diversity in text knows r
understand the fact that typography for a novel is dif
publication for education. Even so a novel has the po
interesting. This can be achieved in any level of crea
leading, the amount of words on a sentence and the

- Ciuffeda et al, Optometry 2007



EVALUATIONS

TRAUMATIC BRAIN INJURY

HISTORY

- History of event-date, time, circumstances
  - MVA-driver vs passenger, front vs back seat, seat belt, helmet
  - Fall-previous falls, syncope, trip, orthostatic, vertigo/ medication(type and number)
  - Sports injury-describe play, other concussions
- Memory of events preceding or following injury
- Anoxic events (CPR, pneumothorax,hypotension)
- PMH- other TBI

HISTORY-ROS

- Persistent headache,
- Confusion,
- Pain,
- Cognitive and/or memory problems,
- Fatigue,
- Changes in sleep patterns,
- Mood changes, and/or
- Sensory problems such as changes in vision or hearing (post-concussion syndrome).

Cognitive Screening

- GCS
- MMSE
- ACE
- SCAT
- Impact
- ANAM

Definitions-GCS

	Motor response	Eye opening	Verbal response
1	No response	No response	No response
2	Extensor (decerebrate) posturing	To painful stimulation	Says incomprehensible sounds
3	Flexor (decorticate) posturing to pain	To speech	Says inappropriate words
4	Makes withdrawal movements to pain	Spontaneous	Converses but is disoriented
5	Makes localizing movements to pain		Oriented to person, place, and date
6	Follows commands		

MINI MENTAL STATE EXAMINATION

- Orientation to time (5)
- Orientation to place (5)
- Registration of 3 words:(3)
- Attention And Calculation (5)
- Recall of 3 words (3)
- Language (2)
- Repetition (1)
- 3 Stage Command.(1)
- Write A Sentence ()
- Copy The Design.(1)

Total Score (30)

-Folstein MF. et al

MMSE	Alzeihmer’	Vascular	Lewy Body	mTBI
1-5 Orientation to time	X			
6-10 Orientation to place	X			
11 Repeat three objects				
12 Spelling WORLD backward			X	X
13 Recall three objects	X	X	X	
14,15 Recognize objects		X		
16 Recognize idiom eyes		X		
17 Close your eyes				
18 Copy a design		X	X	
19 Write a sentence		X		
20 Three-step command		X		

Acute concussion evaluation (ACE)

- Injury Characteristics
  - Date/Time of Injury /Injury Description and Cause
  - Amnesia-before and after/ Early signs/Seizures/LOC
  - Symptom checklist
- Risk Factors for Protracted Recovery
- RED FLAGS
- Diagnosis
- Follow up plan

SCAT 2

- Symptom Score (22-symptom)
- Physical Signs Score
- Glasgow Coma scale
- Sideline Assessment-Maddocks Score
- Cognitive assessment (SAC)-orientation, immediate memory, concentration, delayed memory
- Balance assessment-Double leg/single leg and tandem stance
- Coordination assessment-finger to nose
- Overall score(out of 100)

Impact

- Most widely used by sporting bodies
  - NFL, NHL, FIFA 10,000 high schools and1,000 colleges.
- There are two parts to the test,
  - the Symptom Score component
  - six part neurocognitive test component.
- Both component scores should return to baseline or normal before an athlete is allowed to resume playing a contact sport.
- Generally, the symptoms of a concussion disappear before the neurocognitive findings return to normal, although occasionally, this can be reversed.
- Migraine symptoms following concussion are associated with a longer recovery time.

Automated Neuropsychological Assessment (ANAM)

- Computer-based tool designed to detect speed and accuracy of attention, memory, and thinking ability.

- It is being conducted prior to deployment and can be used to identify and monitor changes in function. It takes about 20 minutes to complete. It does not diagnose any medical condition.

Post Traumatic Amnesia

GALVESTON ORIENTATION AMNESTIC TEST

- Total 100 points
- >76 on 2 consecuitive days, 24 hours apart
- Requires trainning for administration

ORIENTATION LOG

- Total 30 points
- >25 on 2 consecutive days, 24 hours apart

- More robust tool
- No special training required
- Can be used for non-TBI

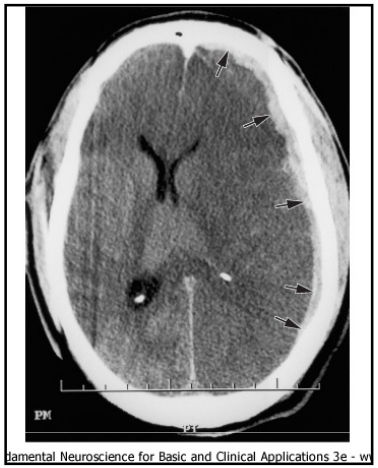
IMAGING

CT SCAN

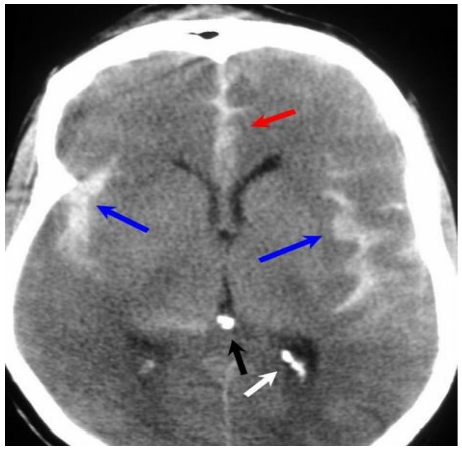
- Most common test, >550,000 in ED
- Most important first-line tool to detect lesions that require emergent neurosurgical intervention, such as depressed skull fractures, large hematomas, or massive brain edema.
- Useful in monitoring size of bleeds, midline shifts, herniation, hydrocephalus

Hematomas

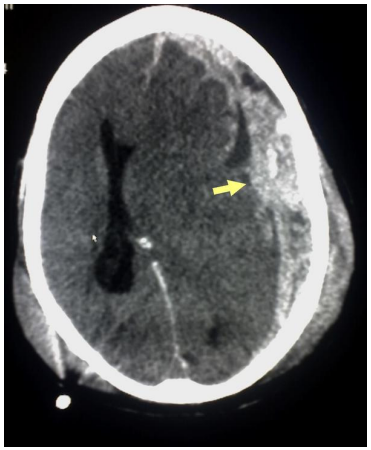
EDH

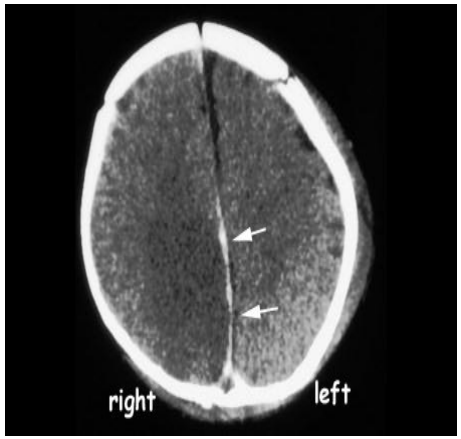


SAH



SDH

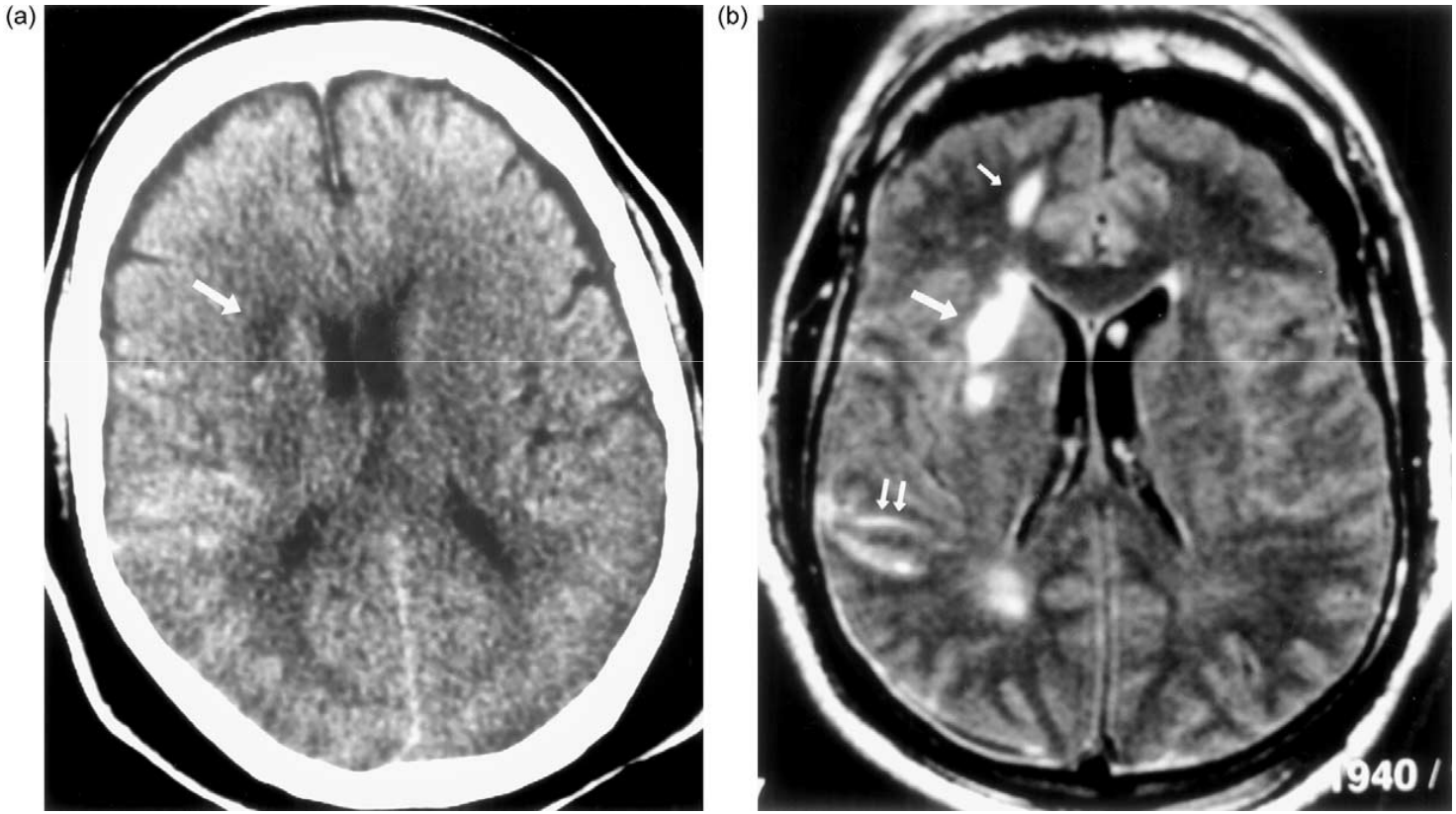




MRI

- Detecting diffuse axonal injury (DAI) and infarction, often invisible on conventional CT or MRI
- Subtle micro hemorrhages , 1-2mm in size, hemosederin
  - Susceptibility-weighted imaging (SWI).
  - Gradient Echo(GRE)
- Chemical markers of injury
  - MR spectroscopy
- Non hemorrhagic shearing injuries
  - Flair, DTI
- Embolic infarcts
  - MR diffusion-weighted imaging (DWI).
- Measuring disturbances in blood flow
  - PET, CT perfusion, or MR perfusion.
- Metabolic and cognitive dysfunction
  - PET and functional MRI,

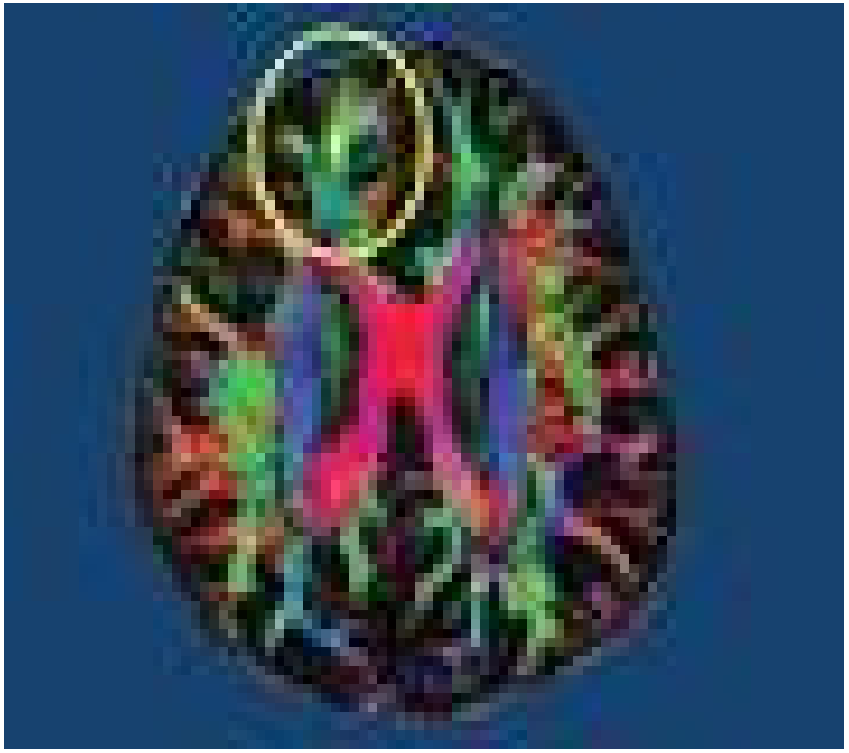
Fluid-Attenuated Inversion Recovery MRI



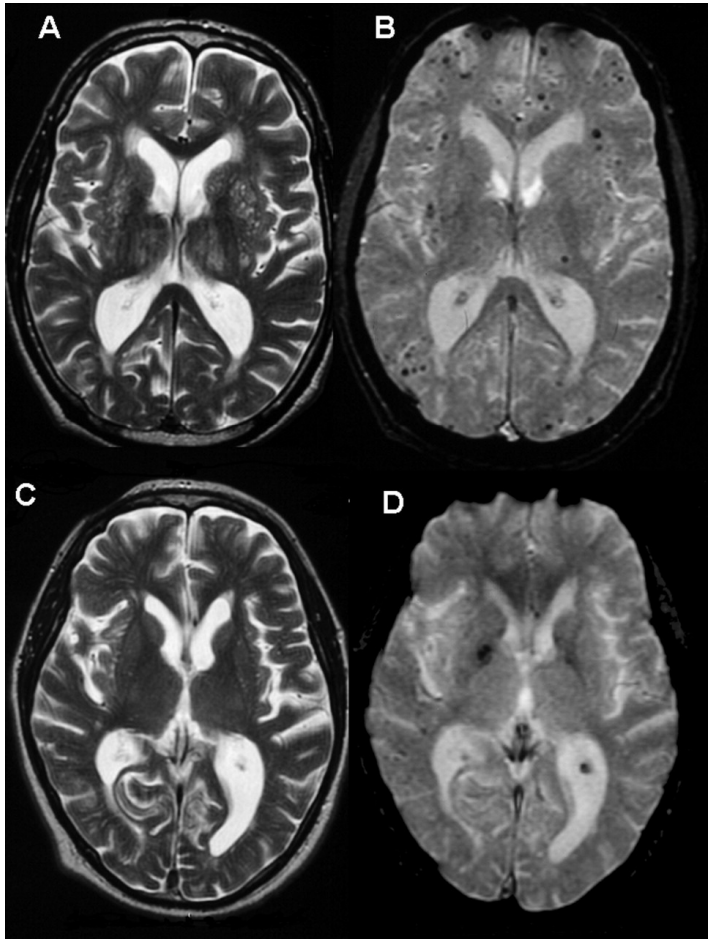
- Fluid-Attenuated Inversion Recovery (FLAIR) MRI is also sensitive to water content in brain tissue.

Diffusion Tensor Imaging (DTI)

- Torn or missing white matter fiber will allow perpendicular movement of the water molecules.



Gradient Echo MRI (GRE)



- Shows micro-bleeds that can be missed by CT scans

A and B-

63 yr old with TBI

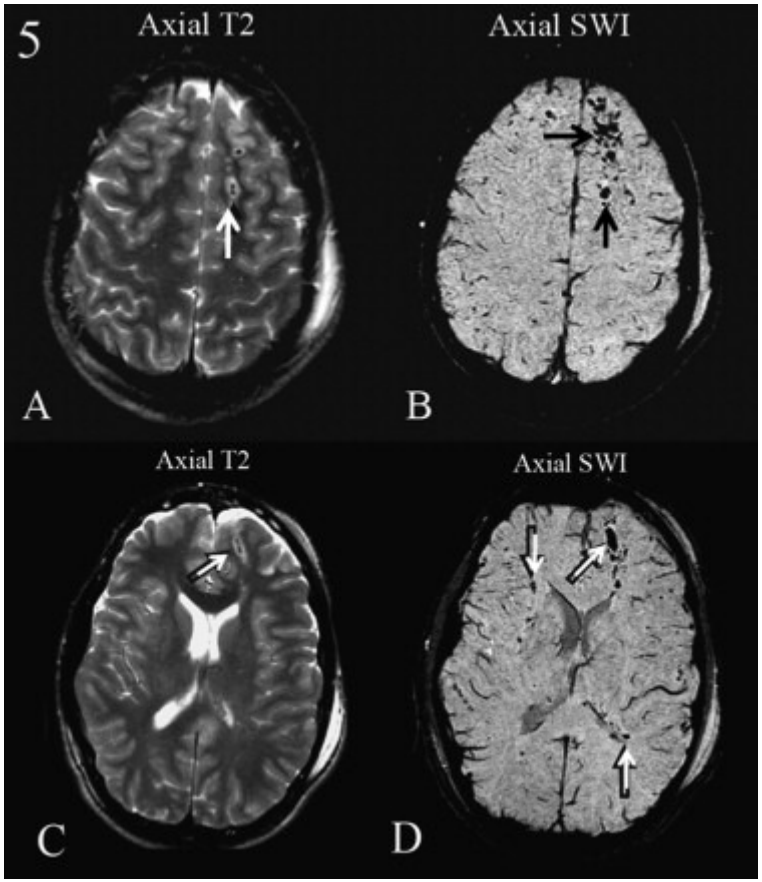
C and D

81 year old with TBI

Susceptibility Imaging

High-spatial-resolution susceptibility MR

- Images more lesions and details greater volume of lesions than GRE
- Greater sensitivity to small hemorrhages (<10mm^2) than GRE in a study of acute TBI patients.
- Longer acquisition time increases potential for motion artifact
  - Tong KA, et al.: Radiology 2003;227:332-9



MANAGEMENT

Management

- Rest /Symptomatic treatment
- Improve Sleep Quality
- PT/OT/Vestibular/Vision rehabilitation
- Assessment of cognitive and Behavioral Impairments
- Cognitive remediations
- Medications
- Return to School/Work/play

Cognitively impairing Medication

- Antibiotics-Keflex, Flagyl, Anti-Tb
- Anticholinergics-Atropine, TCA,
- Anticonvulsants-Phenytoin, Phenobarital
- Antiemetics-Promethazine
- Antihistamines-Cimetidine, Promethazine
- Anti-inflamatory- Corticosteroids, NSAIDs
- Analgesics- Opiates, Salicylates, Narcotics
- Cardiac-β-blockers- Clonidine, Digitalis, Lidocaine, Quinidine, Procainamide
- Drug withdrawls-Alcohol, Barbituarates, Benzodiazepine
- Sympathomimetics-Amphetamines, Theophylline
- Over the counter-Excedrin PM, Sleep-Eze, Compoz

Sleep

- Comprehensive medical evaluation, Sleep logs,
- Sleep hygiene, Environmental alterations
- Pharmacology
  - Benadryl-confusion
  - Zolpidem (ambien)-confusion, impaired balance;
  - flurazepam- confusion, addiction, withdrawl
  - Trazodone (Deyrel), nightmares
  - Notriptyline (Pamelor),
  - Anticonvulsants-Neurontin
  - Antipsychotics

Treatment of impaired arousal

- Optimize cardiopulmonary status
- Minimize sedating medications
- Improve sleep
- Cognitive exercises
- Medications
  - Neurostimulants-Methylphenidate(√),Amphetamines(x)
  - Dopaminergic agents-Amantadine(√), Bromocriptine (√)
  - Antidepressant-Sertaline (√), Amitriptline (√)
  - Modafanil (√)
  - Zolpidem (+/-)

Treatment of Impairment in Attention

- Environmental control
- Medications
    - Psycho stimulants
        - -methylphenidate, (√)
        - dextroamphetamine(√)
    - Dopminergic
        - Amantadine(√)
        - Provigil, (√)
        - Bromocriptine(√)
    - Cholinesterase inhibitor -donepezil

Treatment of Behavioral Instability

- Avoid Haldol, Benzodiazepam
- Depakote (valproic acid)
- Carbamezine
- Tegretol
- Seroquel
- Propranolol

KEY POINTS

- Establishing diagnosis
  - History
  - Neuropsychological Assessment
  - Imaging
- Management
  - Stimuli management
  - Sleep and pain
  - Cognitive remediation
  - Behavioral interventions
  - Medications