Dr. Nora Cullen

West Park Healthcare Centre

Dr. Nora Cullen graduated from medical school at the University of Toronto in 1994 and completed a residency program in Physical Medicine and Rehabilitation in 1998. She did subspecialty training in Traumatic Brain Injury Rehabilitation in Detroit at the Rehabilitation Institute of Michigan, in 1998-99 where she developed a passion for improving the quality of life of adults with brain injury. Subsequently, she joined the staff at Toronto Rehab where she has worked clinically and in research. The focus of her research and clinical care is on long term recovery of patients with brain injury and the treatments that might improve their recovery. She is an Associate Professor at the University of Toronto, teaching medical students, residents and fellows the rehabilitation management of brain injured adults. She is also the Chief of Staff at West Park Healthcare Centre.

Brain Injury in the Adult Brain
September 28, 2017

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Specialist in Physical Medicine and Rehab
Scientist, Toronto Rehab
Chief of Staff West Park Healthcare Centre
Associate Professor, University of Toronto

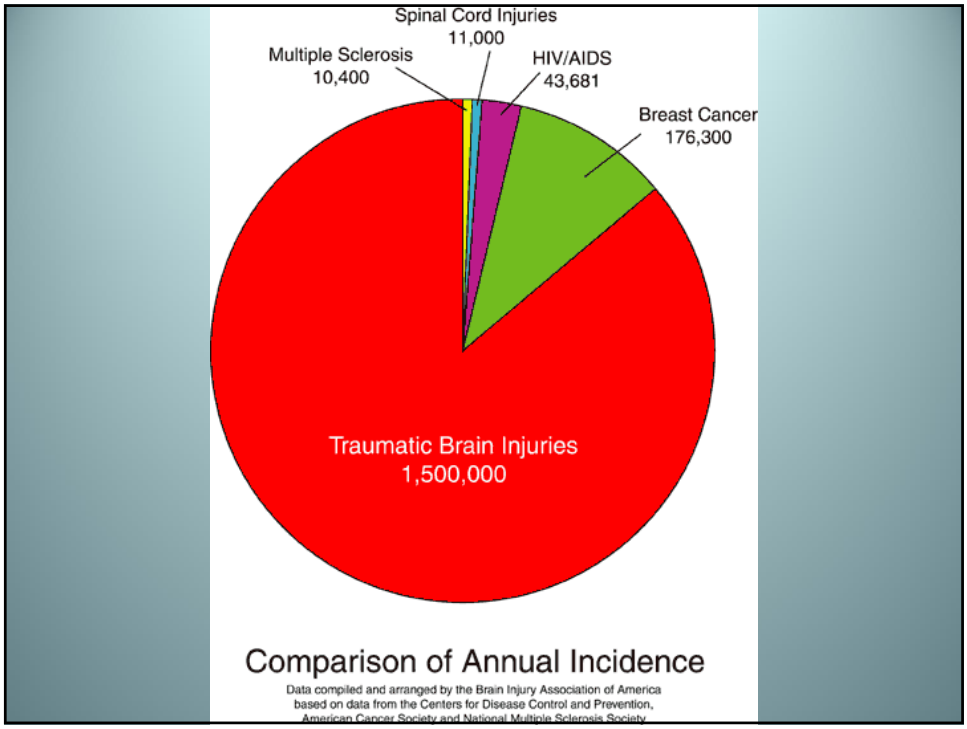
Objectives

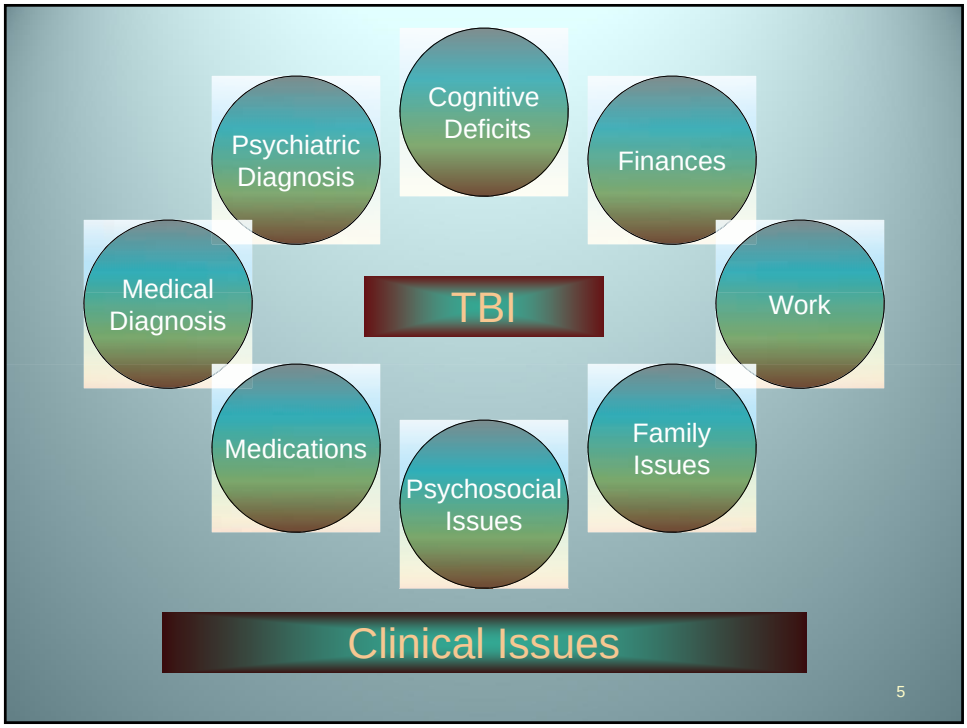
- Physiological and/or structural changes
- Clinical presentation
- Measuring severity and outcome
- Diagnostic tools
- Rehabilitation

Where is the lesion?

- Each function that the body performs can be traced back to a specific area of the brain
  - Physical
    - Motor
    - Sensory
    - Autonomic
  - Cognitive
  - Behavioural

Brain Map


Spinal Cord Injuries
11,000
Multiple Sclerosis
10,400
HIV/AIDS
43,681
Breast Cancer
176,300
Traumatic Brain Injuries
1,500,000
Comparison of Annual Incidence
Data compiled and arranged by the Brain Injury Association of America
based on data from the Centers for Disease Control and Prevention,
American Cancer Society and National Multiple Sclerosis Society


Cognitive Deficits
Psychiatric Diagnosis
Finances
Medical Diagnosis
TBI
Work
Medications
Family Issues
Psychosocial Issues
Clinical Issues
5

Question 1

Patients with TBI tend to be:

A) Women
B) Unemployed
C) Middle Age
D) Married
E) None of the above

Epidemiology of TBI

- Annual incidence of TBI is 250/100,000
- Males 15 – 24 years old, also peaks in >75 yrs
- male: female ratio 3:1 ratio
- 80% mild, 20% moderate to severe
- leading cause of death and disability in children and young adults

Epidemiology of TBI

- 53 % single, 13 % divorced, 5% separated, 3% widowed = 74% are not married
- 53% employed, student 10%, 9% homemaker/retired = mostly employed
- tend to be injured on Saturday or Sunday between 8 pm and 4 am
- 73% have associated fractures which may obscure or delay detection of TBI

Question 1

Patients with TBI tend to be:

A) Women
B) Unemployed
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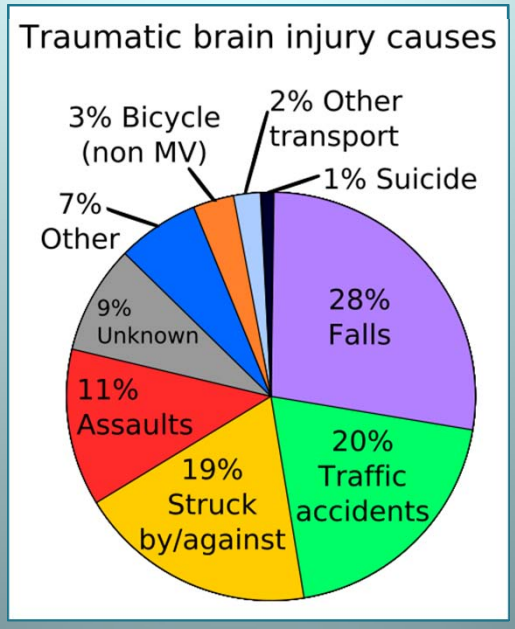
E) None of the above



Traumatic Brain Injury Epidemiology

TBI is often the result of substance abuse, crime, environmental hazards, driving safety and supervision of elderly

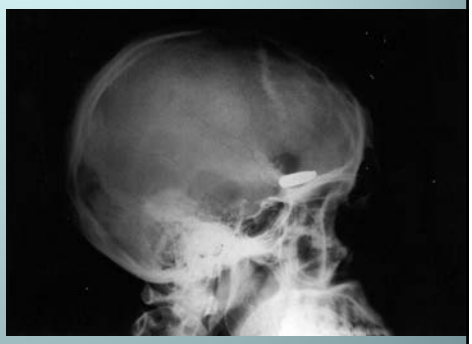
Acquired Brain Injury - Traumatic

Traumatic Brain Injury

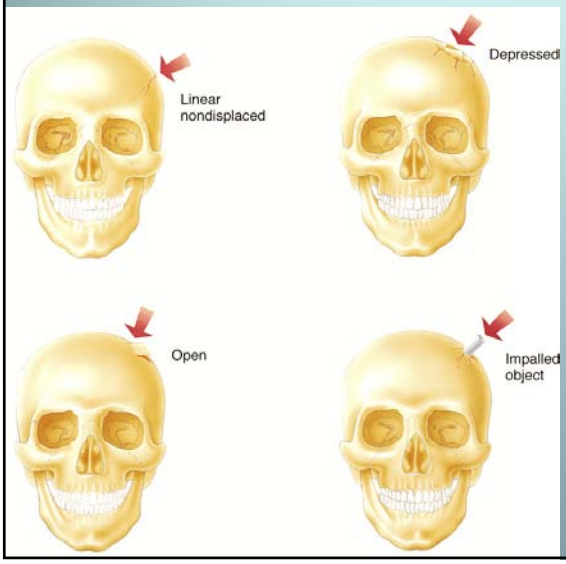
- non-degenerative, non-congenital
- mechanical force
- permanent or temporary impairments of cognitive, physical, and psychosocial functions

Open Brain Injuries

- Missiles e.g. Gun shot wounds
- High velocity missiles inflict the most damage
- Bullets often fragment, causing damage in multiple directions



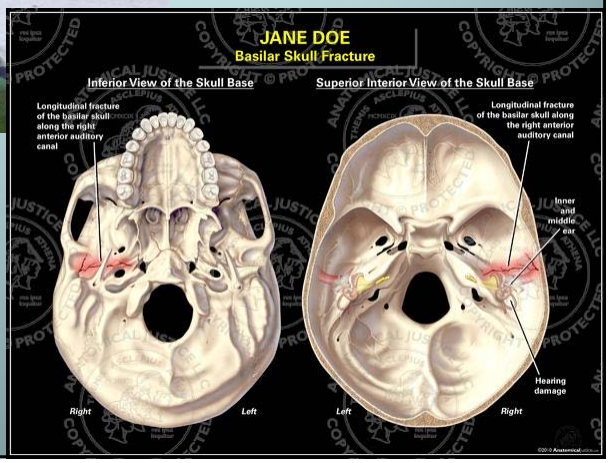
Skull Fractures



- Vault fractures
  - Closed or open, simple or compound, linear or stellate, non-depressed or depressed

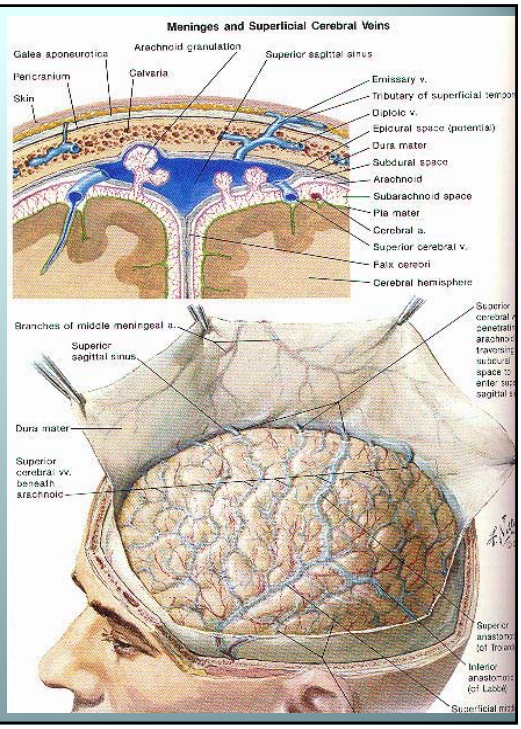
Basal Skull Fractures

Associated with increased risk of brain injury, hematoma, CN damage

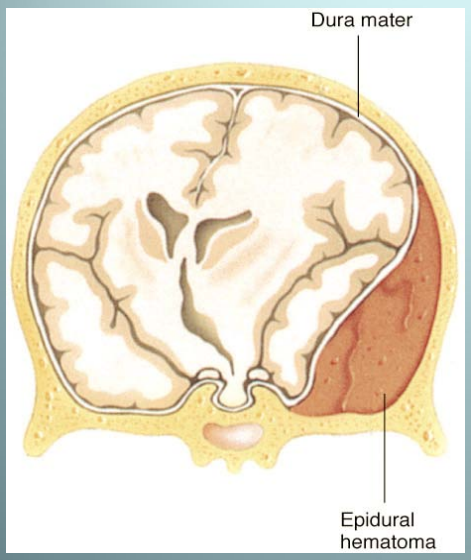


Intracranial Hemorrhages

- Epidural
- Subdural
- Subarachnoid
- Intracerebral
- Intraventricular
- Diffuse Axonal Injuries

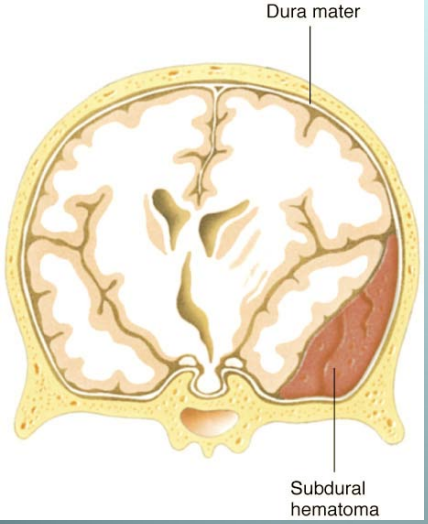


Epidural Hematomas



- Relatively uncommon (<1% of head-injured pts, <10% of comatose pts)
- Located between skull and dura mater
- Commonly associated with tear in middle meningeal artery (often in presence of skull #)

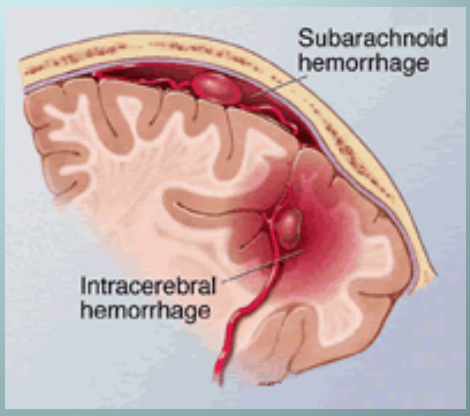
Subdural Hematomas



- More common than epidurals (30% of severe head injuries)
- Located between the dura mater and arachnoid layer of meninges
- Poor prognosis, high mortality (60-80%) due to underlying parenchymal injury

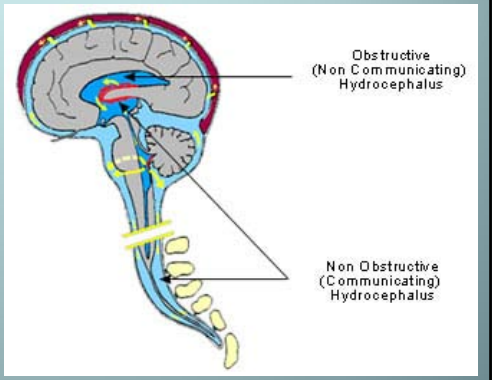
Subarachnoid Hemorrhages

- Occur frequently in TBI
- result of shearing of microvessels in subarachnoid space
- May lead to a communicating hydrocephalus



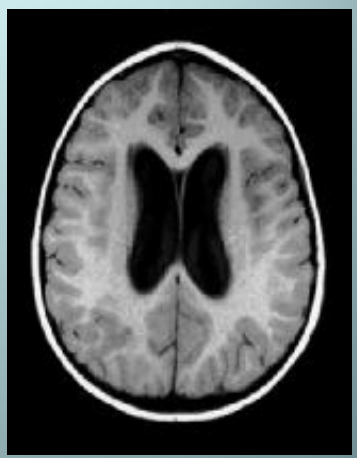
Hydocephalus

- The dilation of the cerebral ventricular system
- Occurs when normal CSF flow is impaired, leading to fluid accumulation
- Limits blood flow to the brain.



Hydrocephalus

- communicating - h/a, n&v, lethargy, decreased mental status,
- non-communicating - obstructed, CSF backs up
- normal pressure - weird, wet ,wobbly = gait ataxia, dementia, incontinence



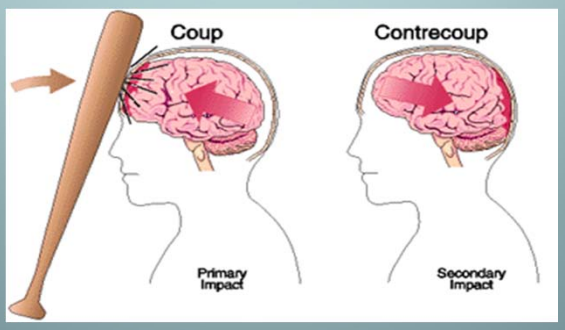
Intraventricular Hemorrhages

- Tend to occur in the presence of very severe TBI
- Associated with an unfavourable prognosis

Cortical Contusions

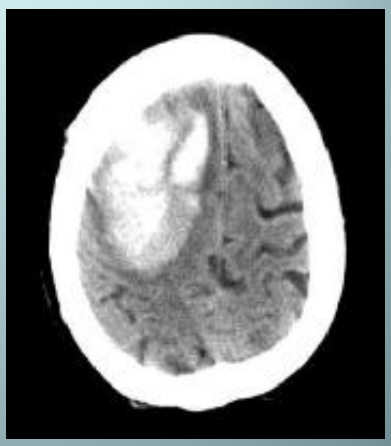
Cortical Contusions

- Vascular and tissue damage (bruising)
- Coup contusions occur at area of direct impact
- Contrecoup contusions occur as brain rebounds in a contralateral direction

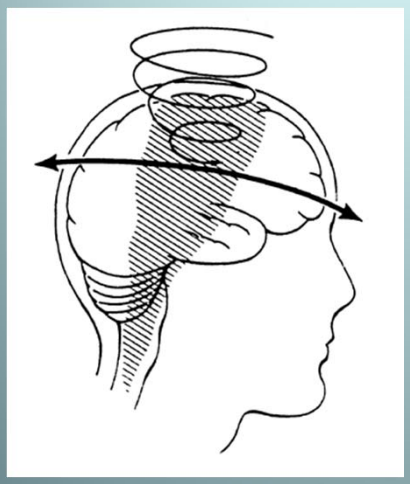


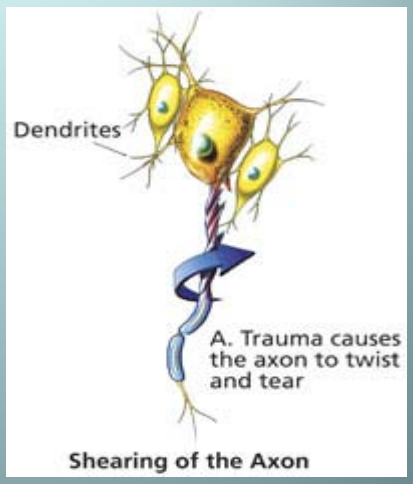
Intracerebral Hemorrhages

- Commonly associated with moderate/severe head injuries
- Majority occur in frontal and temporal lobes
- Arise from lacerations of brain or contusional hemorrhages

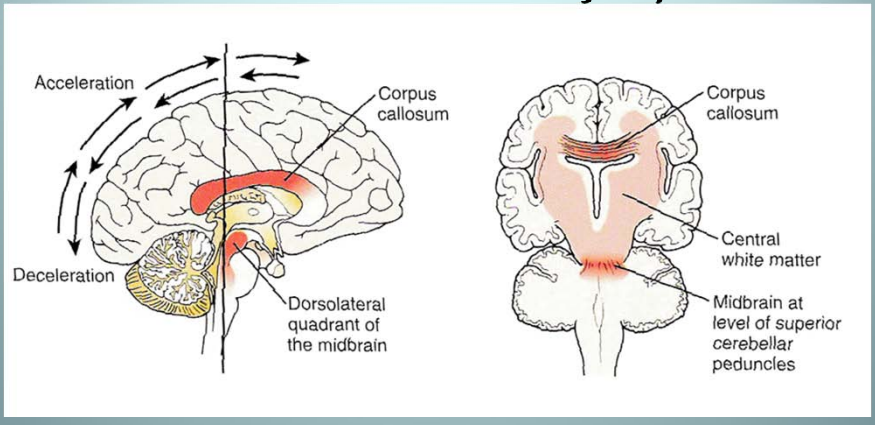


Diffuse Axonal Injury





Diffuse Axonal Injury



Most significant cause of morbidity in patients with TBI (frequent cause of persistent vegetative state)

Primary vs. Secondary Brain Injury

Primary injury occurs at the time of impact

Secondary injury evolves over hours or days following traumatic insult

- Causes cerebral ischemia and tissue hypoxia leading to further neuron loss
- Mechanisms:
  - Neurochemical and Cellular Events
  - Cerebral Edema
  - Hydrocephalus

Severity Measurement and Predictors of Outcome

- Glasgow Coma Scale
  - best motor and speech response and the weakest stimulus needed to elicit eye opening
  - severe 3 to 8, moderate 9 to 12, mild 13 to 15 (the lowest score in the 1st 24 hours)
- Duration of Coma
  - does not open the eyes, no evidence of cognition, such as following commands or communicating
  - Severe > 6 hours
- Length of Post Traumatic Amnesia (PTA)
  - time elapsed from injury until return of ongoing memory
  - Measured by the Galveston Orientation and Amnesia Test
  - >11 weeks is inconsistent with independent living

Glasgow Coma Scale

Glasgow coma scale

		Score
Eye opening	spontaneously	4
	to speech	3
	to pain	2
	none	1
Verbal response	orientated	5
	confused	4
	inappropriate	3
	incomprehensible	2
	none	1
Motor response	obeys commands	6
	localises to pain	5
	withdraws from pain	4
	flexion to pain	3
	extension to pain	2
	none	1
Maximum score		15

Injury Severity

- GCS
  - Mild TBI = GCS 13-15
  - Moderate TBI = GCS 9-12, > 30 min duration
  - Severe TBI = GCS 3-8, >6 hours duration
    - Severe = GCS 6-8,
    - Very Severe = GCS 3-5

Injury Severity using Post Traumatic Amnesia

Severity	PTA
Very mild	< 5 minutes
Mild	5–60 minutes
Moderate	1–24 hours
Severe	1–7 days
Very severe	1–4 weeks
Extremely severe	> 4

Hannay HJ, Howieson DB, Loring DW, Fischer JS, Lezak MD (2004). "Neuropathology for neuropsychologists". In Lezak MD, Howieson DB, Loring DW. Neuropsychological Assessment. Oxford [Oxfordshire]: Oxford University Press. pp. 160.

GOS and GOS-E

Patient's abilities	Definition	Score
Death	-	1
Persistent vegetative state	No cerebral cortical function as judged behaviorally; unable to interact with environment; unresponsive	2
Severe disability	Conscious and able to follow commands but dependent on 24-h care and unable to live independently	3
Moderate disability	Disabled but capable of independent care; unable to return to work or school	4
Good recovery	Mild impairment with persistent sequelae but able to participate in a normal social life, including able to return to work or school	5

Patient's abilities	Score
Death	1
Persistent vegetative state	2
Lower severe disability	3
Upper severe disability	4
Lower moderate disability	5
Upper moderate disability	6
Lower good recovery	7
Upper good recovery	8

Disability Rating Scale

- Outcome that is used from "Coma to community"
- Reliable and Valid
- Not useful for milder brain injuries

Patient Name_____
Rater_____
Date Completed_____

Disability Rating Scale (DRS)

Arousability, Awareness, & Responsivity

Eye Opening
❑ 0 Spontaneous
❑ 1 To Speech
❑ 2 To Pain
❑ 3 None

Communication Ability
❑ 0 Oriented
❑ 1 Confused
❑ 2 Inappropriate
❑ 3 Incomprehensible
❑ 4 None

Motor Response
❑ 0 Obeying
❑ 1 Localizing
❑ 2 Withdrawing
❑ 3 Flexing
❑ 4 Extending
❑ 5 None

Cognitive Ability for Self Care Activities
Knows how and when to feed, toilet or groom self

Feeding
❑ 0.0 Complete
❑ 0.5
❑ 1.0 Partial
❑ 1.5
❑ 2.0 Minimal
❑ 2.5
❑ 3.0 None

Toileting
❑ 0.0 Complete
❑ 0.5
❑ 1.0 Partial
❑ 1.5
❑ 2.0 Minimal
❑ 2.5
❑ 3.0 None

Grooming
❑ 0.0 Complete
❑ 0.5
❑ 1.0 Partial
❑ 1.5
❑ 2.0 Minimal
❑ 2.5
❑ 3.0 None

Dependence on Others

Level of Functioning
Physical & cognitive disability
❑ 0.0 Completely Independent
❑ 0.5
❑ 1.0 Independent in special environment
❑ 1.5
❑ 2.0 Mildly Dependent-Limited assistance
Non-resident helper
❑ 2.5
❑ 3.0 Moderately Dependent-moderate assist
Person in home
❑ 3.5
❑ 4.0 Markedly Dependent
Assistance with all major activities, all times
❑ 4.5
❑ 5.0 Totally Dependent
24 hour nursing care

Psychosocial Adaptability

Employability
As full time worker, homemaker, student
❑ 0.0 Not Restricted
❑ 0.5
❑ 1.0 Selected jobs, competitive
❑ 1.5
❑ 2.0 Sheltered workshop, Noncompet.
❑ 2.5
❑ 3.0 Not Employable

Total Score (sum all scores) _____

Cognitive

While in Posttraumatic Amnesia (PTA) – patient has inappropriate responses to environment, poor memory, inattention

Treatment focus

- Discipline-specific goals
- Re-orient to the environment using calendars, schedules etc.
- Compensatory strategies
- Focus on specific areas of deficits
- Carry-over learning

Maximizing Cognition

- Rule out correctable biological etiologies
- Cognitive Rehabilitation - OT, SLP, Psychology
- Cognitive Enhancing Medications

Cognitive Rehabilitation

Rehabilitation

- Structured settings - Challenged in novel environments
- Adaptive strategies and cognitive techniques
- Community Integration
- Address adjustment issues
- Speech issues (e.g. aphasia)

Emotional & Behavioural Changes

- Reduced Insight
- Lack of control
- Social Behaviour
  - *Loss of social skills, withdrawal from social interactions*
- Apathy
  - *Lack of initiative, poor motivation*
- Depressed & Anxious Mood
  - *60% of all TBI survivors*
  - *1/5 contemplate suicide during first 5 years*

Agitation post TBI

Ranchos Los Amigos Scale

I No Response
II Generalized response
III Localized response
IV *Confused and agitated*
V Confused and non-agitated
VI Confused and appropriate
VII Appropriate and automatic
VIII Appropriate

Physical Impairments

Motor

Weakness, spasticity, incoordination, imbalance, dysarthria, expressive aphasia, pain, headaches

Sensory

Hyper/hypo, visual disturbance, hearing loss, receptive speech, proprioception

Autonomic

Temperature, hormonal, blood pressure and pulse, sleep dysregulation

Reintegrate to Community

Focus on Function

Basic activities of Daily living

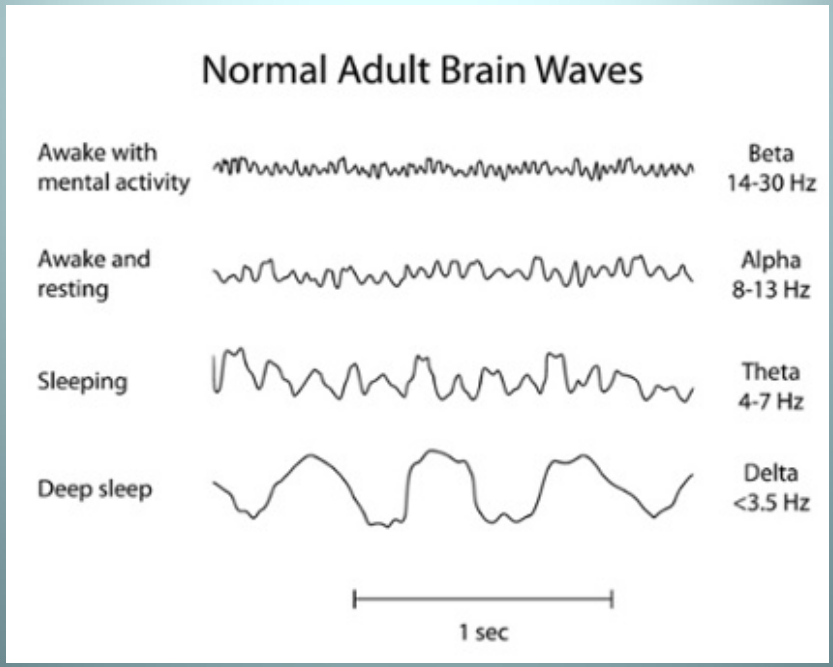
E.g. Self care, Accessible Environment (home & work), Attendant Care, mobility Transportation

Instrumental Activities of Daily Living

e.g. Vocational/avocational Goals, banking, Sexuality, parenting etc

Sleep

- Revitalizing
- Restoring
- Rejuvenating



Traumatic Brain Injury

- Sleep too much
- Sleep too little
  - As high as 70% in first 3 months after injury
  - Continues to be as high as 30% long after injury
- Lack of restful sleep

Sleep and TBI

- Abnormal sleep patterns can exacerbate behavioral disturbances and increase difficulty with new learning. Early identification and evaluation of sleep disorders with appropriate environmental and pharmacological intervention can limit cognitive and behavioral sequelae following TBI.

Zafonte RD. Neurorehabilitation 1996.

Fatigue post TBI

- 21% at one year post injury
- decreased amount of sleep
- increased sleep interruptions
- reduction or absence of deep sleep
- sleep wake reversal
- Decreased growth hormone, testosterone

Treatment

- **Education** - prioritizing, pacing, delegating, scheduling, structured routines, one activity at a time, scheduled rest times
- **Exercise** - regular, graded physical activity, adaptive devices, social activities, biofeedback, relaxation techniques, meditation, music, pet/ horticulture therapy
- **Medications** - consider stimulant

Post Traumatic Headache

Headache develops within 7 days after head trauma

Headache persists for > 3 months after head trauma

Post Traumatic Headache approach

Determine the primary headache disorder that most closely resembles the patient's symptoms and then implement treatment strategies aimed at treating that headache subtype (Baandrup & Jensen,2005).

Basic lifestyle strategies to try to mitigate headache

Summary

- TBI in adults is common and can be life altering
- Location of damage results in a pattern of impairment
- Severity can be classified by outcome measures
- Team approach to treatment is essential

Resources

- Mild TBI guidelines - Ontario Neurotrauma Foundation: http://onf.org/documents/guidelines-for-concussion-mtbi-persistent-symptoms-second-edition
- Evidence Based Review of Moderate to Severe ABI: www.abiebr.com
- Centre for Outcome Measurement in Brain Injury- outcome measures www.tbims.org/combi
- Emedicine- good medical explanations www.emedicine.com/pmr/contents.htm
- Center for Disease Control (US) www.cdc.gov
- Peer support: Ontario Brain Injury Association www.obia.on.ca or Brain Injury Society of Toronto www.bist.ca